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Impact of Cluster Farming On Farmers Productivity and Commercialization: The Case of Dera Woreda, South Gondar Zone

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THESIS ON

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BY

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IMPACT OF CLUSTER FARMING ON FARMERS PRODUCTIVITY AND COMMERCIALIZATION: THE CASE OF DERA WOREDA, SOUTH GONDAR ZONE

By

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This Thesis Entitled ‘’**Impact Of Cluster Farming On Farmers Productivity And Commercialization: The Case Of Dera Woreda**’’, Is Approved For The Degree Of Master Of Science In Development Economics.

By
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DECLARATION

I, the undersigned, declare that this thesis entitled ‘’ Impact of cluster farming on farmers Productivity and Commercialization: The case of Dera Woreda, South Gonder Zone, Amhara Regional State’’ is my original work and has not been presented for a degree or any other purpose in any institution and all the sources for the thesis used have been dully acknowledged.

Solomon Abate

February, 2021

BHIR DAR, ETHIOPIA

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LETTER OF CERTIFICATION

This is to certify that Solomon Abate has carried out his thesis on the topic entitled ‘’**Impact of cluster farming on farmers Productivity and Commercialization: The case of Dera Woreda, South Gonder Zone, Amhara Regional State**’’. This work is original in nature and suitable for the award of Master of Science (MSC) in Development Economics.

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Belayneh Kassa (Phd)

February, 2021

ABSTRACT

Smallholder farmers who accounts for 96 percentage of total area cultivated land and generated 95 percent of total production dominate the agriculture farming in Ethiopia. However, the agriculture has not been used to its full potential for development in Ethiopia due to low productivity and low-level commercialization of smallholder. Enhancing productivity and commercialization among smallholder farmers is widely perceived as a key strategy which is achieved through promoting agricultural cluster farming approach. The objective of this study is to analyze the impact of cluster farming on farmer's productivity and commercialization and to explain factors that affect cluster farming participation in Dera woreda of South Gondar Zone of Amhara National Regional state. Cross-sectional primary data is collected from a sample of 203 household's selected using multistage sampling techniques from a cross-sectional data. The data is analyzed using descriptive statistics and econometric models. The logit model, PSM and IPWRA estimation methods are used to analyze impact of cluster on maize productivity and commercialization. The results indicated that education level, farming experience, training access, cooperative membership and off-farm engagement are the variables that influenced farmers decision to join agricultural cluster farming positively and significantly whereas age of the household head and distance of extension office from household home negatively affected the participation decision. Impact assessment result showed that CLFP increased yield up to 8.46 qt/ha (21.34% change) using PSM and 6.59qt/ha (15.83%) using IPWRA. Commercialization level is 11.92% (40.31% change) higher compared to NCFP using PSM and 14.18% (50.84% change) using IPWRA. The commercialization level of maize in the study area is categorized in semi-commercialized level. In both estimation methods, cluster farming positively affects maize productivity and commercialization at 1% level of significant. Based on the findings, the study recommends that strengthening and scaling-up the cluster farming will have significant role towards improving maize yield and commercialization. Therefore, to enhance the benefit of cluster farming in improving productivity and commercialization, the government and other stakeholders should give a priority in strengthening education, extension, cooperatives, experience sharing, training, and supporting off-farm activities.

Keywords: Cluster farming, Commercialization, Dera, Maize, IPWRA, PSM, and Productivity.

ACRONYMS AND ABBREVIATIONS

ACCs	Agricultural Commercialization Clusters
ACSI	Amhara Credit and Saving Institution
ADLI	Agricultural Development Leads Industrialization
AFDB	African Development Bank Group
ATA	Agricultural Transformation Agency
CSA	Central Statistics Agency
CLF P	Cluster farming participant
CRS	Catholic Relief Services
DWAO	DeraWoreda Agriculture Office
GTP	Growth and Transformation Plan
IFPRI	International Food Policy Research Institute
ILO	International labour organization
IPWRA	Inverse probability weighted regression adjustment
MoFED	Ministry of Finance and Economic Development
M.A.S.L	Mean above sea level
NCFP	Non-cluster farm participants
NPC	National Plan Commission
OECD	Organization for Economic Co-operation and Development
PADETES	Participatory Demonstration and Training Extension Systems
PASDEP	Plan for Accelerated Sustained Development to End Poverty
SDPRP	Sustainable Development and Poverty Reduction Program
SSA	Sub Saharan Africa
X^2	Chi-square

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CHAPTER 1. INTRODUCTION

1.1. Back ground of the study

Agriculture is the main means of livelihood in Africa. Agriculture currently employs 65–70 percent of the African workforce, supports the livelihoods of 90 percent of Africa's population, and accounts for about a quarter of the continent's GDP (OECD and FAO, 2016 and World Bank, 2016). The importance of the agricultural sector is such that agricultural growth in sub-Saharan Africa is more effective in reducing poverty than growth in non-agricultural sectors. However, Africa's agricultural sector performs poorly and its enormous potential remains untapped. Over the past four decades, the average agricultural productivity growth in sub-Saharan Africa is only 2.4%, while the productivity of the rest of the developing world improved by 4% (Dzanku *et al*., 2015). Agricultural sector growth in Africa has been lagging (Diao *et al*., 2012), particularly the agricultural productivity in Sub Saharan Africa (SSA) remains stagnant (Tittonell and Giller, 2013). The continent still lags behind other regions of the world in terms of productivity, agricultural mechanization, advisory and extension services, and access to credit and financial markets. For instance, cereal yield has only slightly improved in Sub-Saharan Africa since 2000 and in 2014 it was estimated at around 14.3qt/ha of cultivated land, compared to 40qt/ha in Latin America and the Caribbean, or 52qt/ha in East Asia and the Pacific (Mukasa *et al*., 2017).

Ethiopia is among the countries in this region where agriculture plays a vital role in the economy. Agriculture continues to play a vital role in Ethiopian economy, which accounts for 38.8% for real GDP contributes 73% of employment, major source of food for domestic consumption, supplies 70% of the raw-material requirements of local industries primary commodities for export. Moreover, the sector, and livestock products, as well as food crops, were the leading contributors to agriculture-sector growth in 2014/15 (Wondifraw, Wakiaga and Haile, 2016).

Agriculture will remain a key driver of poverty reduction, improved nutritional outcomes, and will help meet rising food demand in growing urban centres. However, agriculture has not been used to its full potential for development in Ethiopia due to low productivity caused by lack of modern inputs, lack of market access for commercialization including credit markets and ineffective extension system. Climate change is also increasing vulnerabilities in the sector (World Bank, 2017; Derese and Zerihun , 2018).

The majority of smallholder farmers found in developing countries produce their most of food consumed but their productivity growth has slowed down. In sub Saharan Africa, productivity is characterized by declining soil fertility, low cereal yield, low input purchase ability, insufficient adoption of productive technologies, lack off financial services and market access 2015 and FAO, 2015). Ethiopian agriculture is dominated by smallholder farmers who accounts for 96 percent of total area cultivated land and generated 95 percent of total production for the main crops; cereals, pulses, oilseeds, vegetables, root crops, fruits, and cash crops (Alemayehu *et al*., 2012). Enhancing productivity and commercialization among smallholder farmers is widely perceived as a key strategy for rural development, poverty reduction, and food security in Sub-Saharan Africa (World Bank, 2008).

Ethiopian smallholder farmers are constrained by low yields, low productivity and lack of access to markets. For productivity gains to be achieved and to transform subsistence farming to commercialized, smallholder farmers need to have better access to technology, market and improve their technical efficiency. The transition from subsistence (or semi-subsistence) to commercial agriculture represents a key ingredient for the economic development of low-income countries (Carletto *et al*., 2016).

The aim of ADLI is improving agricultural extension services, promoting better use of land and water resources, enhancing access to financial services, improving access to domestic and export market and providing rural infrastructure (Demese *et al*., 2010). To improve agriculture production and productivity, the government of Ethiopia has adopted and started implementing a strategy of Agricultural Development Leads Industrialization (ADLI) since 1991 (Demese *et al*., 2010) and to alleviate low productivity and commercialization level of small- scale farmers, agricultural growth and transformation plans (GTPI and GTPII) has been adopted recently. In these transformation plans, agricultural cluster farming approach is practiced more recently as an effort to change and improve subsistence farming productivity and income by transforming subsistence farming to market oriented farming through Agricultural Commercialization Clusters (ACCs). In cluster farming, farmers are organized according to their proximity to their adjacent farms. Under agricultural commercialization cluster, cluster farming (CF) approach currently implemented in four regions including

Amhara Regional State. Agricultural Cluster farming focused on geographical area, which is undertaking by the collaboration of agricultural Transformation Agency (ATA) and the Ministry of Agriculture (MoA). This current agricultural cluster program focused on increasing agricultural productivity and income through market-oriented approach. In line with this, the research paper focused on assessing the impact of cluster farming service on farmer's maize productivity and commercialization factors determining cluster farming participation in Dera District of Amhara regional state.

1.2. Statement of problem

Agriculture continues to play a vital role in Ethiopian economy, which accounts for 38.8% for real GDP, and dominated by smallholder's farmer who produce majority of total production of main crops. Major crops produced by these smallholder farmers are cereals, pulses, oilseeds, vegetables, root crops, fruits, and cash crops (Alemayehu *et al.*, 2012). Enhancing productivity and commercialization among smallholder farmers is widely perceived as a key strategy for rural development, poverty reduction, and food security in Sub-Saharan Africa (World Bank, 2008). Studying productivity, in particular, is very crucial as it fundamentally affects the income of households (Fulginiti & Perrin, 1998).

The government of Ethiopia gave considerable attention to agriculture to improve productivity and to meet the growing demand of food, industrial raw material and foreign currency. Agricultural extension as a key policy instrument has been given a priority to achieve agricultural development, poverty reduction and food security. Regardless of the major investment and considerable effort made to improve the extension system of the country in the past, the system is not bringing the desired results (ATA, 2017). In Ethiopia official numbers indicate there is improvement of agricultural production in Ethiopia since 2000 (FAO, 2018) however, use of modern inputs (including knowledge input) and productivity levels remain low, low adoption rates of fertilizer and improved seed (Dercon and Gollin, 2019 as cited Louhichi *et al.*, 2019) implying that there is potential for further productivity growth. . Cognition to this, the government has made a great effort to transform the agricultural sector mainly through straightening by adopting various policies and strategies.

The development of the Ethiopian economy heavily depends upon the speed with which agricultural growth is achieved which in turn depends on how fast the current subsistence oriented production system is transformed into a market orientated production system (Berhanu *et al.*, 2006). The agricultural productivity growth policy particularly extension services in Ethiopia until about 2002 focused on increasing production and targeting achieving food security (Mathewos and Chandargi, 2005). However, the government acknowledged sustained growth in the agriculture sector would not be realized without enhancing market linkage for farmers. Therefore, as a basis for long-term development of the agricultural sector, the government policy on agricultural development started emphasizing the transformation of subsistence agriculture into market orientation.

Though Ethiopia shows economic growth, growth in and of it-self is insufficient; it must be accompanied by economic transformations that equip smallholder farmers with the ability to grow and diversify their livelihoods that is; the agriculture sector itself must transform (Getachew & Man, 2019). For this reason, Ethiopia established Growth and Transformation Plan (GTPI) in 2010 to sustain accelerated and broad-based growth path.

Ethiopia introduced several development policies and strategies; allocated huge investment to develop its agricultural sector. According to Berhanu and Poulton (2014) in period between 2002/3-2011/12 agriculture allocated with an average of 15% of the government development budget. Ethiopia implemented a series of medium term plans and policies such as Agricultural Development Led Industrialization (ADLI) strategy, Sustainable Development and Poverty Reduction Program (SDPRP), Plan for Accelerated and Sustained Development to End Poverty (PASDEP), more recently, Growth and Transformation (GTP-I and GTP-II) and Agricultural Commercialization Cluster programs.

The Agricultural Commercialization cluster initiative (ACCs) program is one of the institutional support services that has a central role to play in the transformation process. Agricultural Commercialization clusters (ACC), which is organized by Agricultural Transformation Agency (ATA) uses a cluster farming approach mainly supporting smallholder farmers in increasing crop productivity and to transform from subsistence to commercial oriented farming(ATA, 2017). The ACC aims to provide a strong platform to deliver on Ethiopia’s agricultural development strategy through prioritization of high potential geographies and commodity value chains. It focuses on 10 priority commodities in a geographically clustered and integrated approach currently implemented in four regions in Amhara, Oromia, SNNP and Tigray. The ACC initiative prioritized 10 commodities are

Wheat, Maize, Sesame, Malt Barley, Teff, Tomato, Onion, Mango, Avocado, and Banana. The program includes 252 woredas from Amhara, Oromia, SNNP and Tigray (Louhichi, *et al.*, 2019). Among the cereal crops maize is the second most widely cultivated crop in Ethiopia and is grown under diverse agro-ecologies and socio economic conditions typically under rain-fed production. The major areas currently growing the crop are situated in the moist and semi-moist mid-altitude zones comprise the bulk of the national maize area in Ethiopia (MOA, 2005). Maize is an important crop both in its potential agro-ecological suitability, area coverage and increasing consumption in Amhara region and Dera woreda.

The agricultural commercialization intervention program follows an agro-based cluster farming approach. Cluster policies are argued to be crucial for small-scale farmers and agribusiness, as they enable them to engage in higher productivity, and more market-oriented and higher value-added production. Farmers can benefit from participating in farmers cluster as it allows them to achieve scale economies and share costs related to training, information sharing, and certification and technology application. A cluster allows stakeholders to discuss key strategic barriers and facilitators of an industry's competitiveness and strategize effective solutions cohesively. In the process, trust is built along the value chain together with the ability to coordinate and cooperate (Felzensztein, 2009).

In Ethiopia and Amhara region cluster farming is organized and facilitated by cooperation mainly by ministry of agriculture and agricultural transformation agency (ATA). Cluster farming approach, being an agenda in the growth and transformation plan, follows an approach focuses on scaling up productivity of labor and land, focus on specialization, diversification, and strengthening agricultural marketing system. The Agricultural Commercialization Cluster (ACCs) is of the institutional support services that have a central role to play in the transformation process (ATA, 2018). The essence of increasing productivity is through scaling up of best practices drawn from the achievements of Plan for Accelerated and Sustained Development to End Poverty (PASDEP).

The main objective of cluster farming in Ethiopia is improving small holders' productivity and transforming the subsistence agriculture to market oriented (commercialized) agriculture. However, there is very limited evaluation impact study of this cluster approach on farmers' productivity and commercialization in Ethiopia, particularly in the study area. In Ethiopia a study assessed on scaling up in Ethiopia using the farm household model FSSIM-Dev (Farm

System Simulator for Developing Countries using) by Louhichi *et al*.(2019) showed the relatively positive effects of the agricultural commercialization clusters (ACC) initiative in increasing staple crop productivity and production, marketing decision, enhancing income, consumption and reducing poverty. However this study considers productivity performance achieved by the model farmers in the areas (clusters). It also assumes all farms in the four regions (Amhara, Oromia, SNNP and Tigray) studied are assumed to adopt the ACC package and to perform like the model farmers. Besides it is a generalized study at regional level focused on up-scaling of ACC successes and not a study on a specific crop maize commercialization level.

Cluster approach is a sub-system farming aiming at improving productivity of smallholder farmers, creating surplus and transforming to commercialization. Commercialization can transform agriculture by altering the current production practices from highly subsistence level towards highly market-oriented level (Bank, 2007; Barrett et al., 2012 and ATA, 2017). The performance of this new and up to date program service is not studied rigorously in Ethiopia in general and in the study area in Amhara region and Dera Woreda in particular. In the study area what is the impact of clustering farming on farmers' productivity and commercialization is not yet evaluated. In this study investigation is done on the performance of the cluster farming approach intervention contribution for transforming subsistence production to market oriented farming. Policy recommendations on the current cluster farming approach effectiveness, impact on agricultural productivity and commercial oriented agriculture requires reliable assessment of impact of current level of farmers' productivity and commercialization as well as what factors determine farmers participation in cluster farming.

In general a prioritizing agriculture, transforming from subsistence to market oriented farming is allocated with considerable amount of budget at country, regional and district level. This huge money allocation to transform the agriculture through new approach (cluster farming) needs to be evaluated for its effectiveness. Besides focused at a country level, agricultural productivity varies across regions and agro-ecological locations, which needs for area-specific studies. Most studies so far focused on determinants of commercialization and productivity and up to the knowledge of the researcher, no research works were done focusing on analyzing the impact of the cluster farming approach introduced to the farmers on maize productivity and commercialization in Ethiopia, Amhara Region particularly Dera Woreda where cluster farming has been implemented. Thus, this paper also intended to fill the existing gaps on policy impact evaluation, supporting policy makers working in agriculture and development matters, and enriching the existing literature.

1.3. Objective of the study

The overall objective of the study is to assess the impact of cluster farming approach on maize productivity and commercialization on cluster farm participants and cluster non-participant farmers in Dera woreda.

The specific objectives are:

1. To assess the factors affecting decision participation in cluster farming
2. To evaluate the impact of cluster farming on maize productivity
3. To investigate the impact of agricultural cluster farming on farmers commercialization

1.4. Research questions

Having the above specific objectives, the study tried to address the following questions:

1. What are the main factors affecting CLFP and how these factors affect CLFP?
2. What is the impact of cluster farming on productivity?
3. What is the impact of cluster farming on maize commercialization in the study area?

1.5. Significant of the study

The study focused on micro-evidence based study on four kebeles in Dera Woreda in Amhara regional state. The study can provide a useful information and evidence to government, policy makers, researchers and public community to assess the cluster farming approach impact effectiveness, possible future improvement for better benefit. The result of the study will be used to enhance the previous studies related to agricultural development studies in line with impact on productivity and commercialization.

1.6. Scope and limitation of the study

The study carried out in Dera Woreda focusing on evaluating the impact of cluster farming on maize productivity, commercialization and identifying factors affecting cluster farming participation using surveying of households from selected kebeles. The data used for this study is limited to cross-sectional and one Woreda and four kebeles due to limited availability of finance, time and resource. In addition to this the study focussed on maize crop due to its importance for food consumption, increasing market demand and agro-ecological suitability to grow this crop in the study area.

The remainder of the paper organized as follows. Section 2 is the review the relevant literature, with special reference. Section 3 is research methodology. Section 4 focused on descriptive and econometric result and discussion. Section 5 is concerned with conclusion and recommendation.

CHAPTER 2. LITERATURE REVIEW

2.1. The potential and importance of maize in Ethiopia and Amhara Region

Ethiopia has a diverse agro-ecology potential to grow various crops. Maize, wheat, teff, sorghum, barely, millet and sesame are the most common cereal crops grown in Ethiopia. The maize agro-ecologies in Ethiopia broadly divided into six major categories (MOA, 2005). These agro - ecologies distributed in Ethiopian regional states, as the moist and semi-moist mid-altitude zones comprise the bulk of the national maize area in Ethiopia. These are mostly located in the southwest and west Oromia, west and North West Amhara, parts of the Southern Nations Nationalities and Peoples Region (SNNPR), and Ben Shangul-Gumuz (BSG). Semi-moist and Moist ecologies cover about 75 % of the national maize production area whereas the dry ecologies cover the remaining 25 %.

Maize became increasingly important in the food security of Ethiopia following the major drought and famine that occurred in 1984. More than 9 million smallholder households, more than for any other crop in the country, grow maize in Ethiopia at present. National maize yields have doubled from about 1.50 MT/ha during the early 1990s to 3.23 MT/ha in 2013. The increases in maize production in Ethiopia resulted more from increases in productivity rather than area expansion indicating the yield grew faster than the area (Tsedeke *et al*., 2015).

In Ethiopia, smallholder farmers almost in all regions of the country dominantly produce maize (USAID, 2017). In terms of regional distribution, 41.9% of the producers are found in Oromia, 28.6% in Amhara, 18.7% in SNNP, 6.9% in Tigray, and 2.4% in Benishangul Gumuz regional states (CSA, 2013). The key maize producing zones include East Wollega, West and East Gojjam, south Gondar and South Eastern Shoa. Together, they produce over half of the total maize production in Ethiopia.

The major portion of the maize produced is consumed at the household level by the small-scale producers themselves (CSA, 2017). Its use in various forms makes maize one of strategic commodity crops selected to ensure food security, increasingly used both separately and in mixed flour with other more expensive cereals in traditional Ethiopian diets. Maize is the most important staple in terms of calorie intake in rural Ethiopia. The 2004/5 national survey of consumption expenditure indicated that maize accounted for 16.7 % of the national calorie intake followed by sorghum (14.1 %) and wheat (12.6 %) among the major cereals (Guush *et al*., 2011). As the result, maize considered as one of the prioritized commodity crop in Ethiopia and in Amhara region as the region amongst potential agro-cluster geographical location (Louhichi *et al*., 2019).

In Ethiopia maize gives the highest yield per unit area (3.7 t/ha), followed by rice (2.8 t/ha), wheat (2.6 t/ha), sorghum (2.5 t/ha), barley (2.1 t/ha), and tef (1.7 t/ha), respectively (CSA, 2017). In Ethiopia, maize is one of the principal cereal crops ranking first in total production and productivity, and second to teff in area coverage (FAO, 2017), which makes the highest proportion of annual grain production of the country accounting up to 27.02 % followed by teff (17.29 %) of the total produce. Despite the importance of maize as a principal food crop, its average yield in Ethiopia is 3.7 tons/ha (CSA, 2017) and 3.6 tons ha-1(FAO, 2017), is still lower than that of the world's average (5.6 t/ha in 2016).

2.2. Agricultural Policies and Strategies in Ethiopia

Ethiopia introduced several development policies and strategies; allocated huge investment to develop its agricultural sector. Most noticeable medium term plans and policies implemented in Ethiopia are Agricultural Development Led Industrialization (ADLI) strategy, Sustainable Development and Poverty Reduction Program (SDPRP), Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and Growth and Transformation Plan (GTP).

Agricultural Development Led Industrialization (ADLI)

Recognizing these facts the government of Ethiopia has tried to improve the performance of agriculture by planning and implementing different policies and strategies, notably Agricultural Development Led Industrialization (ADLI). Agricultural Development Led Industrialization (ADLI) is the central pillar of the economic policy of the country that sets out agriculture as a primary stimulus to generate increased output, employment and income for the people, and as the spring board for the development of the other sectors of the economy (Belay & Abebaw, 2004). A major intervention under ADLI includes provision of fertilizers, improved seeds and extension services to smallholder farmers. Indicated ADLI success is its role in improving agricultural productivity and poverty reduction in rural areas, however, it did not lead to agricultural based industrialization as initially expected.

Sustainable Development and Poverty Reduction Program (SDPRP)

Sustainable Development and Poverty Reduction SDPRP) Program was launched and implemented in 2002-2005 as a continuation of PADETES with objectives achieve sustainable development in rural areas through increasing farm productivity (yield), reducing poverty, increasing the level of food security, increasing the volume and variety of industrial raw materials (primary products), and producing for the export market (Belay K., 2003). SDPRP focused on strengthening agricultural extension services; training extension agents in technical and vocational education and training (TVET) and training farmers in Farmers Training Centers (FTC). SDPRP helped farmers enhance their production capacity by providing agricultural extension services and assigning three DAs to each kebele level (MoFED, 2002). However, heavy dependency of agricultural sector on the amount and timing of rainfall makes the output continuously fluctuate. In addition, agricultural sector's productivity did not show significant improvement (Diao, 2010).

Plan for Accelerated and Sustained Development to End Poverty (PASDEP) 2005/06–2009/10

The previous agricultural development strategy including SDPRP exclusively targeted the smallholder agriculture in the rural areas. Due to their failure to improve agricultural productivity, the Ethiopian government framed another five year plan (2005/06-2009/10) called Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (MoFED, 2005; MoFED, 2006) which focused more on commercialization and intensification of and developments of large-scale commercial agriculture (MoFED, 2005). The key objective of PASDEP was to accelerate the transformation of smallholder agriculture from subsistence to commercial purposes by strengthening extension services through increasing such as technical and vocational trainings (MoFED, 2006).

Growth and Transformation Program GTP I (2010/11 – 2014/15)

At the end of Plan for Accelerated and Sustained Development to End Poverty (PASDEP), Growth and Transformation Plan (GTP I) which will be in action between 2010/11 and 2014/15 was implemented in order to realize wider scale development in a sustainable manner. The Growth and Transformation Plan is an Ethiopian based development strategy, which in its second phase of implementation period is between 2016 and 2020 G.C. Significantly increasing the share of industry in the economy along with the rise in agricultural production, strengthen the agricultural extension system, use of improved agricultural technologies , scaling up best results of smallholder farmers, high attention to research-extension linkage and transforming the agricultural sector was the aim of the GTP (MoFED, 2010 and NPC, 2015). In addition to a continual focus to smallholder agriculture as a pillar for growth, the government designed plan to private sector involvement in large-scale commercial farms which is expected to result in boost in the size of investment.

Growth and Transformation Plan, (GTP II), 2015/16-2019/20

The second growth and transformation plan (GTP II) was built on the success of GTP Iwhich continued to 2020. In this plan, emphasis is given to a high-value crops and livestock, Increased crop production and productivity focusing on strategic crops; identified as key food crops, export/high value commodities (coffee, spices, horticulture); and, industrial inputs. and market orientation.

In GTP II the commercialization of smallholder farming will continue to be the major source of agricultural growth. In this second phase GTP plan agricultural transformation agenda is a set of interventions that unlock the agricultural sector challenges and transformation from a subsistence oriented, low output smallholder farming to a high performing sector. Despite the improvement in productivity, the agricultural extension contribution to crop productivity face challenges including; subsistence farming leaves little marketable surplus; majority of farmers are smallholders with low input , low output farming, traditional and outdated farming techniques, heavy dependent on unreliable rainfall, and limited mechanization (ATA, 2017).

2.3. Agricultural Transformation Agency (ATA)

Despite a series of intervention through agricultural development programs and initiatives effects made so far found unsatisfactory. Then the government of Ethiopia in collaboration of other stakeholders initiated an agricultural transformation agenda. Thus, in 2010, Regulation 198/2010 established the ATA, an autonomous federal organ having its own legal personality. ATAs two founding objectives are to: 1) identify systemic constraints to agricultural development; and 2) ensure effective agricultural development activity by helping establish strong linkages among institutions (FDRE, 2010). The ministry of Agriculture (MOA) introduced the Transformation Agenda in 2013, during the country's first Growth and Transformation Plan (GTP I), a medium-term country-level strategy to reduce poverty between 2010 and 2015 (Getachew & Man, 2019).

In the period of 2002/3-2011/12, agriculture allocated an average of 15% of the government development budget to investment in provision of agricultural extension service which is given at a high priority consideration in the agricultural sector (Kassahun and Colin, 2014). Agricultural growth that improves productivity on small farms has recognized as effective in reducing poverty and hunger which intern raising rural living standards. The small scale farmers' priority in the GTP plan shows an improvement in production and productivity, however, economic growth, in and of itself, is insufficient and it must be supplemented by economic transformations that enhances smallholder farmers' ability to grow and diversify their livelihoods and for this to occur the agriculture sector itself must transform (Getachew & Man, 2019). Agricultural transformation as described by economist Peter Timmer, has been the main pathway out of poverty for all societies. Beyond growth and development, the agriculture sector would require something more fundamental: transformation (Timmer, 2017).

The ATA was created to improve the performance of key stakeholders to achieve agricultural transformation targets set in Ethiopia's Five year Growth and Transformation Plan. Strengthening marketing system is one of the focus area in enhancing the productivity and production of smallholder farmers (GTP I, 2010).

The ATA's one of primary areas of focus is transformation agenda, which is owned largely by Ministry of agriculture (MoA) and its affiliate institutions. Increased crop and livestock production and productivity; and commercialization of smallholder agriculture and market development are among four strategic objectives of ATA transformation agenda (ATA, 2016).In collaboration with ATA and MOA, Agricultural Commercialization Cluster (ACC) initiative, which is owned mainly by regional governments and regional bureau of agriculture (RBoAs) established aimed at commercializing smallholder farmers in strategic commodities and high potential geographies across the country (ATA, 18). ATA facilitates market linkage for products in the ACC intervention Woreda as by coordinating contract farming where buyers and producers sign agreement before the harvest is done. The ATA leads the selection of commodities the basis of their potential value. Wheat, maize, and malt barley are among the most highly prioritized crops (ATA, 2017).

2.4. The Agricultural Commercialization Clusters (ACCs) in Ethiopia

The agricultural commercialization cluster initiative is one of the main policy interventions in the agricultural sector in Ethiopia, introduced during the first Growth and Transformation Plan as a mechanism to integrate the agricultural transformation agenda across the four major agricultural regions of the country: Amhara, Oromia, SNNP and Tigray. The ACC initiative aims to improve commercial opportunities for smallholder farmers, income through expanding the quantity and quality, timely and easily accessible of inputs chemical fertilizer, improved seeds, and extension and advisory services, and facilitating training and output market linkages of smallholder farming business (Louhichi *et al.,* 2019).

According to the ATA, the ACC approach is modeled on successes from countries around the world that deployed geographically focused strategies to transform their agriculture sectors and drive rural industrialization (Hickell, 2016). In regional office, ATA is principally involved in the organization of the Agricultural Commercialization Clusters, which generally includes the identification of input providers, connecting with potential buyers, helping extension agents with demonstration plots, and assisting cooperatives in the establishment of seed multiplication (Getachew and Man , 2019).

The ACC initiative prioritized 10 strategic commodities: Wheat, Maize, Sesame, Malt Barley, Teff, Tomato, Onion, Mango, Avocado, and Banana. The program includes 252 Woredas from Amhara, Oromia, SNNP and Tigray. Maize is one of the ten prioritized crop commodities considered as the primary crop. The concept of the Agricultural Commercialization Clusters (ACC) Initiative was also introduced during GTP I as a mechanism to integrate Transformation Agenda interventions along value chains for specific geographies and commodities. The ACC initiative contains clearly defined geographic clusters specializing in priority commodities. The ACC supports regions to maximize production and productivity while integrating commercialization activities in order to move smallholder farmers away from a subsistence model and to improve their livelihoods.

2.5. Theoretical concept of cluster and cluster farming

2.5.1. Definition of cluster and cluster farming

Clusters are defined based on two key attributes: their geographic and spatial distribution, and their economic sector (Porter,1990). Porter (1990) defines a cluster as a group of firms engaged in a similar or related economic activity within the national economy. Porter established the foundations of economic cluster theory in 1990, defined a cluster as a group of firms engaged in similar economic activities. Clusters are defined as geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (universities, standards agencies, trade associations) in a particular field that compete but also cooperate (Porter, 2000).

Schmitz (1992) defines a cluster as a geographic and sectoral agglomeration of enterprises. Accordin to FAO (2017) and Gálvez-Nogales (2010) clusters are geographic concentration of industries that create 'value networks' that aggregate vertical relationships along value chains with horizontal relationships among producers. Feser (2004) considers three dimensions of clusters: life cycle (existing, emerging, and potential), linkages (buyer-supplier or labor pool), and geography (regional or statewide).

An agro-based cluster is simply a concentration of producers, agribusinesses and institutions that are engaged in the same agricultural or agro-industrial subsector, and interconnect and build value networks when addressing common challenges and pursuing common opportunities (FAO, 2010).CRS defines clustering as a group of small growers who commit to work together for collective marketing (CRS, 2006).

A cluster approach is a sub-system farming aiming at sustainable productivity of smallholder farmers and transforming the country's agricultural sector by changing the traditional way of farming. For this reason in Ethiopia in general and in the study area in particular farmers are organized according to their proximity to their adjacent farms. These clusters are established in which farmers are expected to apply full package recommended by agricultural research recommendation, willing to share knowledge to other farmers and permit their farm for field day. In the study area Dera Woreda, geographic based cluster farming started in 2009 E.C mainly focusing on maize crop. Clusters established consist of 30 to 60 farmers, total land area 15ha to 30ha with a minimum farm size 0.25ha per farmer. These clusters enable farmers and expected to practice new approaches, appropriate input and application, ploughing, line sowing, recommended agronomic practices, crop protection, post-harvest and benefited from market linkage, consequently increase productivity and commercialization (DWAO, 2019).

2.5.2. The role of clusters farming

Agricultural clusters are increasingly being recognized as an efficient way to develop and stabilize agriculture and agro-industry and to create an environment that improves the competitiveness of agribusiness, particularly small- and medium-scale companies. Promotion of clusters is one of the tools to alleviate constant productivity and market pressures, through enhancing agriculture competitiveness and innovation capacity (Gálvez-Nogales, 2010).

Clustering improves knowledge sharing environment and members' productivity which is leads to a high rate of innovativeness, which in turn enriches the knowledge base. Malmberg and Maskell (1997) mention that the cluster contributions to knowledge and information are due to geographic proximity between companies enhances social interactions and decision-making speed. Clustering enable better motivation of cluster participants, specialization and outsourcing, improves trust and understanding, improves decision-making speed, and an increased level of innovation and hence increases productivity (Porter, 1998, 2000; Bozarth *et al*., 2007 and Niu, 2009).

Clusters have various advantages relative to other approaches: better integration of actors in the agricultural value chain, promoting vertical and horizontal links between local agricultural enterprises, promote the diffusion of innovation, and enhance access to markets and information. Cluster policies are argued to be crucial for small-scale farmers and agribusiness, as they enable them to engage in higher productivity, more market-oriented and higher value-added production. Cluster promotion is a valuable tool to support agricultural enterprises in countries and help them link to global agricultural value chains in a more efficient and sustainable manner that can ignite a virtuous cycle of development by enabling economies of scale, rapid transmission of information, and adoption of new technologies that enhance long-term competiveness of industries. Thus, cluster-based approaches which improve innovation and the creation of value networks can help break the poverty cycle (Gálvez-Nogales, 2010).

Clusters allow smaller groups to achieve larger-scale economies and diffuse costs related to skills training, research and knowledge dissemination, certification and quality standards processes, which can be quite expensive and involve a higher risk for farmers acting individually. A cluster allows stakeholders to discuss key strategic barriers and facilitators of an industry's competitiveness and strategize effective solutions cohesively. In the process, trust is built along the value chain together with the ability to coordinate and cooperate (FAO, 2017).

Clusters facilitate technology adoption through creating market access. Access to market information affects adoption of improved seed, inorganic fertilizers, and crop diversification positively. This is again conceivable because the availability of market information will reduce transaction costs to farmers in the search to find markets for farm produce and inputs (Ahmed *et al.*, 2017 and Phiri *et al.*, 2004). Farmer clusters play an important role in successful technology adoption among group members. There are significant difference between adoption efforts of individual and group (Lin & Lu, 2005). Group assist farmers to obtain latest technologies and also allow them to enjoy economic of scale, it helps establish networks with suppliers and provides guidelines for natural resource management (FAO, 2017). Farmers' group has been found to support fellow farmers in the group in adoption of new technologies.

The benefit of clusters was seen as an improvement in productivity as well as farmers income (Rola-Rubzenetal, 2013). Farmers can benefit from participating in farmers cluster as it allows them to achieve scale economies and share costs related to training, information sharing, and certification and technology application. A cluster allows stakeholders to discuss key strategic barriers and facilitators of an industry's competitiveness and strategize effective solutions cohesively. In the process, trust is built along the value chain together with the ability to coordinate and cooperate (Felzensztein, 2009 and FAO, 2017). It also functions as a production and financial planning tool for groups of farmers in a particular area (Montiflor, 2008).

Two cluster farming approaches are identified in Philippines: an area based and a commodity based approach. In the former approach, farmers come together based on proximity of farms and trading posts, whereas in the later approach, farmers plant the same vegetable and consolidate their product to achieve a larger volume of more consistent quality produce to deliver in bulk to save on transportation and transaction costs, and to increase income. Cluster farming means individual growers committing to work together for collective production and marketing (Mendoza, 2006 and Montiflor, 2012).

In Ethiopia, clusters seek to enable farmers to sell their products at a competitive price to viable markets and increase agricultural productivity in a sustainable manner. Boosting the agricultural productivity and market orientation of smallholder farmers is a high economic development priority for the country and greatly contributes to increasing farmers' income and creating new jobs in agro-processing. The clusters can become geographic "innovation hubs" to move from subsistence farming toward productive, inclusive environmentally sustainable, and commercial forms of farming. Clusters enable increase productivity and strengthen value chains for priority commodities in Agricultural Commercialization Clusters, better input usage, higher yields, and more marketed surplus are essential to move subsistence farmers into commercial operations with greater incomes (Action Agenda, 2020).

2.6. Smallholder farmers, agricultural Productivity and its Measurement

2.6.1. Smallholder farmers and Agricultural productivity

There is no general agreement on definition of small farms and smallholder farmers. Broadly defined, smallholders are farmers operating under structural constraints such as access to sub-optimal amounts of resources, technology and markets (FAO, 2017). According to Dixon *et al*. (2003) smallholders refers to the limited resource endowment of farmers compared to those of other farmers in the sector. World Bank Rural Strategy defines smallholder farms as those with a low asset base, operating less than two hectares of cropland (World Bank, 2003).

According to CSA (2014), the average land holding size of smallholder farm is 1.17 hectares per farm household. This shows Ethiopia fulfils the conventional meaning of small farms, less than two hectares per household). Capital, inputs and technology; heavy dependence on household labour; subsistence orientation; and exposure to risk such as reduced yields, crop failure and low prices are resource constraints to Ethiopia smallholders' farmers (Betre, 2006 and Mahelet, 2007).

Ethiopian smallholder farms accounts for 96 percent of total area cultivated land and generated 95 percent of total production for the main crops including cereals, pulses, oilseeds, vegetables, root crops, fruits, and cash crops. Five major cereals that includes wheat, teff, maize, sorghum, and barley are the main crops in Ethiopia's agriculture and food economy, accounting for about three-quarters of total area cultivated and 29 percent of agricultural GDP in 2005/06 (14 percent of total GDP). Smallholder farms production is subsistence mostly for own consumption with little surplus for market. According to Alemayehu *et al*. (2012), 40 percent of the smallholders cultivate more than 0.90ha and the medium-sized farms account for three-quarters of total area cultivated.

Agricultural productivity gains can help reduce rural poverty by raising real income from farming and keeping food prices from increasing excessively by improving the availability of food. Though Ethiopia increased its crop production in the first decade of the 2000s, major investments in productivity increasing technologies are required to overcome land and water constraints that will make increasingly difficult to achieve crops and livestock production gains in the highlands (Dorosh, 2012). Taffesse, Dorosh and Sinafikih (2012) also argued that limited suitable land is available in Ethiopia especially in high lands for farther expansion of crop cultivation; therefore, future cereal production growth should focus on increasingly from yield improvements.

According to FAO (2018), Ethiopia show improvement of agricultural production since 2000 however, use of modern inputs such as knowledge input and productivity levels remain low, indicating further productivity growth potential through improving use of fertilizer and improved seeds, in which current adoption rates is quite low (Dercon and Gollin, 2019).

2.6.2. Measurement of agricultural productivity

Productivity fundamentally affects the income of households; therefore, studying and understanding productivity is very crucial (Fulginiti & Perrin, 1998). Agricultural productivity is defined in several ways: general output per unit of input, farm yield by crop or total output per hectare, and output per worker. Productivity is also commonly defined as a ratio of a volume measure of output to a volume measure of input use (OECD, 2001b). Crop yield per area is amount of crop harvested per amount of land planted is the most commonly used impact indicator agricultural productivity indicators (Diskin, 1997, 1999). In most economics literature, agricultural productivity is expressed as to the amount of output obtained from given levels of inputs in an economy.

To measure productivity, a formula of harvested crop yield per hectare as indicated in Diskin (1999) is:

$$\text{productivity} = \frac{\text{crop output}(\ qt)}{\text{area planted(ha)}}$$

2.7. Agricultural Commercialization

2.7.1. Concepts and definition of agricultural commercialization

Rise in urbanization and economic growth since the 1980s drives greater attention to smallholder commercialization as part of the agricultural transformation process (Pingali, 2001). In addition, smallholder's resource allocation decisions towards markets and the consequences of commercialization on smallholder welfare becomes an importance focus area (Moti *et al*., 2009).

There are different concepts in relation to what agricultural commercialization actually means. According to Jayne *et al*. (2011), commercialization is the more intensive use of technologies to increase greater output per unit of land, and to create surplus, which intern helps increase market participation. Von Braun (1995); Pingali (1997) and Hazell *et al*. (2007) defined agricultural commercialization as degree of output market participation, which mainly focused on cash incomes. Agricultural commercialization is the proportion of agricultural production that is marketed and a shift from production dominantly for domestic consumption to production dominantly to market oriented (Govereh *et al*., 1999 and Sokoni , 2008).

Agricultural commercialization, as an agricultural transformation process is farmers shift from mainly consumption oriented subsistence production towards market oriented production systems. The process involves progressive substitution of subsistence with commercial practices (Pingali and Rosegrant, 1995 and Goletti, 2005). This involves increased integration of farmers into production for the market participation in input and output markets uptake of and investment in efficient technologies as well as strong formal linkages with other value chain actors (von Braun and Kennedy, 1994; Pingali and Rosegrant, 1995). According to von Braun *et al*. (1994 and 1995) and Pingali (1997) agricultural commercialization considers both the input and output sides of production, and the decision-making behavior of farm households in production and marketing simultaneously. Commercialization is not only the selling of output but it also includes product choice and input use decisions that are based on profit maximization principle (Pingali and Rosegrant, 1995 and Olwande *et al*., 2015).

Commercialization improves farm productivity and farm income at micro-level, and it improves food security and allocative efficiency at macro level (Timmer, 1997). Smallholder commercialization occurs when a farmer participates in agricultural markets either as a seller or buyer. This can be achieved when a portion of the agricultural produce from the farmers is marketed and/or when part of the inputs are acquired from the agricultural markets (Pingali, 1997 and Osmaniand H., 2015). Smallholder commercialization can occur in two ways; either by increasing productivity and marketed surplus of the food crops or by focusing on cash crops (Osmani and Hossain, 2015).

2.7.2. Measuring the level of commercialization

There are different indicators used for measuring the level of commercialization. In most literature, a farm household is assumed to be commercialized if it is producing a significant amount of cash commodities, allocating a proportion of its resources to marketable commodities, or selling a considerable proportion of its agricultural outputs (Strasberg *et al.* 1999).

Focusing on commercialization in its static form, various authors have used different yardsticks in measuring the level of agricultural commercialization at household level. According to Von Braun *et al.* (1994), output and input side commercialization is among the indices. This index measures proportion of agricultural output sold to the market and input acquired from market to the total value of agricultural production. Crop output market participation indicator is calculated as the proportion of the value of crops sold at the market and the total value of crop production. Commercialization of agriculture (output side) is Value of agricultural sales in markets/ agricultural product value (von Braun *et al.*, 1994; Gabremadhin *et al.*, 2007; 2010). Crop input market participation indicator is defined as the share of purchased inputs value to the total value of inputs used for production. Commercialization of agriculture (input side) is Value of inputs acquired from market/ agricultural product value (von Braun *et al.* 1994 and Gabremadhin *et al.*, 2010).

Following the above literatures the output commercialization the study uses the household maize commercialization index (HCI) which measures the ratio of the gross amount of crop sales by household i in year j to the gross amount of all crops produced by the same household **i** in the same year **j** expressed as a percentage:

$$HCI = \frac{gross\ amount\ of\ maize\ crop\ marketed\ in\ previous\ year}{gross\ amount\ of\ crop\ produced\ in\ previous\ year} \times 100$$

Regarding commercialization level, the household commercialization index (HCI) is classified into three categories. This study used classification of commercialization adopted by Samuel and Sharp (2008) and Tadele *et al*. (2017). Accordingly, less commercialized farmers are farmers who sold up to 25% of maize produce, semi-commercialized farmers who sold maize output between 25% and 50% and commercialized farmers are those farm households who sold more than 50% of what they have produced.

2.8. Empirical evidence on the impact of cluster farming in farm productivity, and commercialization

There are almost no impact studies on maize yield and commercialization in study area and in Ethiopia, and very few studies on specific crop maize impact study in other countries. Most studies focused on determinants affecting maize yield and commercialization, as cluster farming in Ethiopia relatively introduced recently to the country. This empirical review depends on mostly other countries studies and indirect impact of collective action farming (cluster farming) few studies in Ethiopia.

Impact of cluster farming on farm productivity

A study by Araya and Sung-Kyu (2019) on impact of agricultural crop packages on farmers' productivity was analysed using propensity score matching method. This study result is in confirmation their finding which shows participation in the agricultural package programs impact in boosting crop productivity of the smallholder farmers. Cluster farming through its benefit in acquiring and using full packages, proper inputs and agronomic practices improve maize productivity and hence household commercialization.

According to Porter (1998, 2000); Bozarth *et al*. (2007) and Niu (2009), clustering increases in the cluster members' productivity as the result of better motivation of cluster members, specialization and outsourcing, enhanced trust and understanding enhanced decision-making speed, and an increased level of innovation.

A study in Nigeria using Ordinary least square (OLS) to examine the effect membership of group farming cooperatives on food production and productivity of farmers showed membership of group farming cooperative helped to increase food production and productivity (Adekunle, 2018).

A study in Cameron on the development of palm oil clusters showed negatively and significantly impacted palm oil production (Thierry *et al.*, 2017). In Ethiopia a study of a comprehensive analysis aiming to assess the impact of scaling up the ACC initiative on smallholders' performance in Ethiopia, using the farm household model specifically from model farmers in the areas (clusters) covered by the ACC initiative. The study by Louhichi e*t al*.(2019) findings confirm the relatively positive effects of the agricultural commercialization clusters(ACCs) initiative in increasing staple crop productivity and production, and enhancing farm performance, income, consumption and reducing poverty. This finding however, assumes all farms in the four regions studied are assumed to adopt the ACC package and to perform like the 'model farmers'.

A study in evaluating the impacts of clustering vegetable farmers in the southern Philippines on production and income performance of cluster and non-cluster farmers comparison of production levels of farms before and after clustering shows the volume of production increased (Rola-Rubzen, 2013).

A study by Mwaura (2014) in Uganda using translog production function and propensity score matching was used to assess the impact of farmer's group membership on banana and cassava yield. There finding shows a significant yield increment of farmers membership in group as the result of better technology adoption.

A study by Tolno *et al.* (2015) in middle Guinea using probit model and henchman- two stage approaches shows a positive a significant impact of farmers' group organization on transformation of smallholder farming, increasing potato productivity and income and thereby reducing poverty.

Impact of cluster farming on commercialization

A study in Tanzania showed organizations such as farm cluster helps to overcome asymmetrical and inadequate information problem, market information system reducing informational asymmetry between buyers and sellers of agricultural commodities. Farmers' organizational impact on income of vegetable farmers was studied using propensity score matching model where income was used as the dependent variable. A unit increase in market information increases the likelihood of farmers' market access by 4.1% at 10% significant level implying that vegetable farmers who have access to market information are likely to access market. Agricultural market information enhances market performance by improving farmers knowledge through providing assistance in planning production to meet market demand and negotiate better on market prices hence contribute to their income (Magesa *et al.*, 2014).

Another study by Fischer and Qaim (2011) investigated the determinants and impacts of cooperative organization, using the example of smallholder banana farmers in Kenya. They employed propensity score matching. Their findings pointed to a positive income effects for active group members. Study in Bangladesh using Pearson's correlation analysis and regression analysis reveal a significant positive relationship between commercialization and household welfare, with key variables like market access and internal farming activities positively and significantly contributing to improved household income and farm outputs. The regression result further predicts a 16.9 % improvement in household welfare if farmers actively work on commercialized farms with better market access and internal farm activities (Tanvir, 2017).

A study in evaluating the impacts of clustering vegetable farmers in the southern Philippines on production and income performance of cluster and non-cluster farmers comparison found that, the comparison of production levels of farms before and after clustering shows the volume of production increased. Cluster farmers had higher incomes than non-cluster farmers. Moreover, farmers increased their income by about 47% after clustering (Rola-Rubzen, 2013).

2.9. Conceptual framework of the study

The conceptual framework of the study is the system of concepts, assumptions, expectations, beliefs, and theories that supports and informs the research and it is a key part of the research design (Robson, 2011). It is the key factors, concepts, or variables and the presumed relationships among them (Moon, 1999). Moon (1999) suggests that conceptual framework can be deriving from three interrelated areas; the works of writers and researchers, their own experience and observations, and the act of reflecting on reading, experience and developing research assumptions.

The conceptual framework in figure 1 illustrates the interrelationships in the study, the key variables involved and how they are interrelated. Participation in cluster farming, maize productivity and commercialization is affected by factors related to household characteristics, ownership of asset and institutional characteristics. Household characteristics include sex, age, educational status, household size, off-farm income and family size; ownership of assets includes farm land and livestock holding. Institutional characteristics includes access to credit, cooperative membership, distance to extension office and distance to market, road distance (Assefa and Gezahegn, 2010; Solomon *et al.*, 2011).

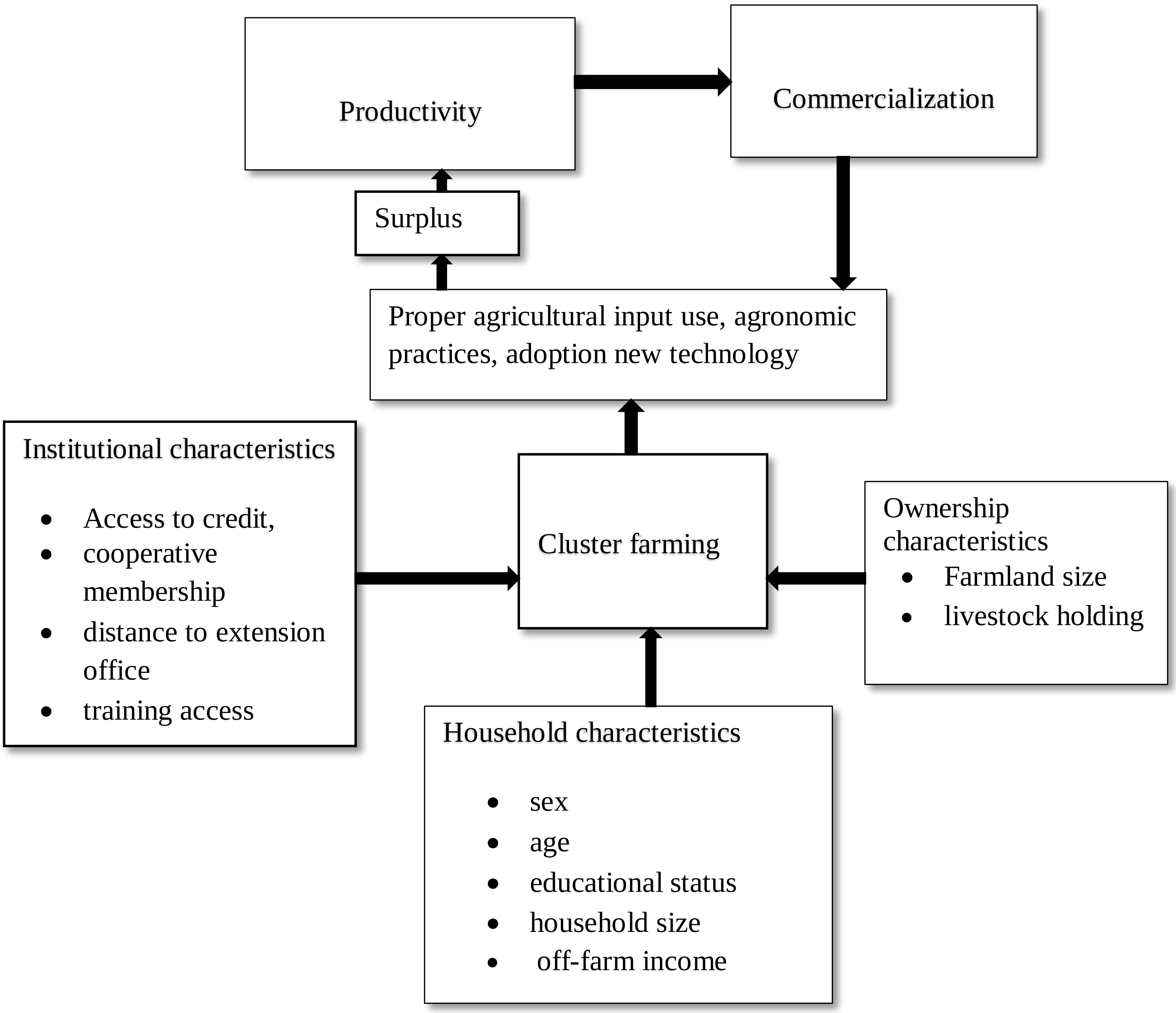


Figure 1. Conceptual framework of the study

In this study, smallholder farmers participate in cluster farming, they have a better access to improved seed, fertilizer, credit access, cooperate, share knowledge and learn each other and facilitate adoption of new technologies, which intern leads to productivity rises. Productivity rise in agriculture will create surplus and can have a positive effect on transforming smallholder farmers to commercialization. Technology adoption tends to increase agricultural productivity, and agricultural productivity influence farmers tendency of market participation or commercialization, and finally, commercialization gives economic power for the farmers to adopt technology (Nega and Senders, 2006; Malumfashi and Kwara, 2013 and Ahmed, 2017). A study by McArthur and McCord (2017) to analyze the impact of agricultural inputs on economic growth, supported for the positive and notable contribution of fertilizer use, adoption of modern seeds and access to water as the factors influencing agrarian productivity.

Cluster farming enables farmers to apply full crop package practice including land selection and preparation/plouging frequency, proper use of inputs (row planting, seeding rate, method of sowing), crop management and protection/agricultural practice, post- harvest and market linkage. This achieved through proper extension services, better training access, market linkage, market access and better cooperation and organization.

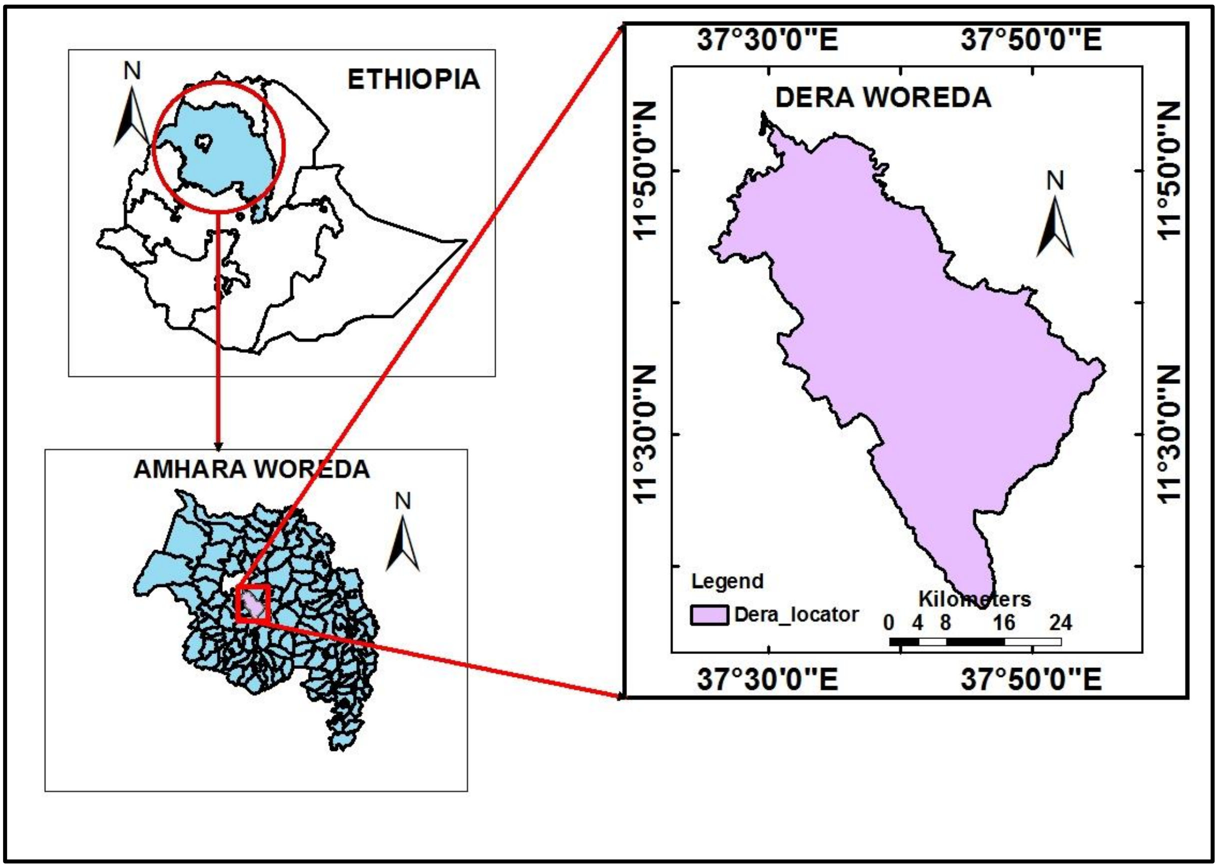
According to Jayne *et al*. (2011) to commercialization refered as the more intensive use of technologies to increase greater output per unit of land, and to create surplus, and to create a surplus, that helps increase market participation and enhances farmers' livelihoods. The higher the amount of surplus, the more commercially oriented a farmer is.

CHAPTER 3. MATERIALS AND METHODS

3.1. Description of the study area

The study was conducted in Dera district of south Gonder Zone in Amhara Regional state. The Region as a whole and the study area in particular is known for its agricultural production predominantly in smallholder agricultural activity. Dera district is one of the 11 districts in South Gondar Administrative Zone. It is bordered on the south by the Abbay River which separates it from the West Gojjam Zone, on the west by Lake Tana, on the north by Fogera, on the northeast by East Este, and on the east by West Este (DWAO, 2019).

Dera district is found 42 km from Bahir Dar, which is the capital city of Amhara Regional State and about 79 km from Debre Tabor, which is the city of South Gondar zone. The Woreda lies between 37° 25′ 45″ E–37° 54′ 10″ E longitude and 11° 23′ 15″–11° 53′ 30″ N latitude with an area of 152,524.13 ha (Ebrahim Esa, 2013).



Source of data: Own constructed using GIS

Figure 2. Location map of Dera Woreda

The total population of the woreda is 297502, from which 267337 and 30165 lives in rural and urban areas respectively. To total surface area of the district is 149724.2ha or 149.24 km^2. The district characterized under Woina Dega agro-ecological zone with an average rainfall ranging from 1000 to 1500 mm and its annual temperature is between 13 and 30 °C. The woreda agro ecology includes 15% dega and 85% woina-dega. The district altitude ranges between 1656 to 2600 m.a.s.l. Flat land accounts for 35%, mountain 20%, gorges 15% and undulating 27%. Major cereal crops in Dera Woreda include Teff, Maize, Figer Millet, Wheat, Barley and Rice (DWAO, 2019).

3.2. Method of data collection

The data for study is collected from both primary and secondary sources. Cross-sectional data collected from the survey of randomly selected sample farmers. To address the impact of cluster farming on farmers' productivity and commercialization both qualitative and quantitative data were used.

To collect primary data household survey, key informant interview and direct field observation is used. The information collected focused on household characteristics, farm production, productivity, and commercialization of cluster farming participants and non-participant status of the area.

To collect household survey semi-structured questionnaire that includes open and closed ended questions is prepared. The field observation also carried out to have a general view about the study area. Key informant interview from Woreda agriculture office experts, development agents, regional agriculture office, regional/ woreda ATA office officials and other stakeholders administered to obtain additional information. Secondary data collected to enhance the concept of agricultural cluster, its role in improving agricultural productivity and commercialization from reports of regional and woreda office, journals, reports, books.

3.3. Sampling technique and sample size

Multistage sample procedure adopted to collect the data. In the first stage, Dera Woreda purposefully selected from south Gondar Woreda due to its maize potential agro-ecologic woreda and implemented maize cluster farming. There are a total of 36 Kebeles in the woreda and 24 kebeles practicing cluster farming (DWAO, 2019). In the second stage, based on the proportion of kebeles that undertake cluster farming, four kebeles selected. Then using stratified random sampling Kebeles stratified into two strata: cluster farming and non-cluster farming participants. In total, 203 respondents (120 respondents under non-cluster farming and 83 cluster-farming participants) selected using systematic random sampling. Total sample size of smallholder farmers is determined using the simplified formula provided by Yamane (1967). The total number of maize cultivators is 28126, with level of precision equal to 7% used to obtain a sample size required to represent the true population. The total number of population in the study kebele is 6777.

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

$$n = \frac{6777}{1 + 6777(.07)^2} = 203$$

Where, n = sample size, N = population size, e = level of precision.

Table 1. Distribution of respondents used in the study

Study kebele	**Total maize producer**	**Sample**		**Total**
		CLFP	NCLFP	
Korata	1945	22	35	57
Geregera	1802	19	35	54
Wonchit	1589	22	26	48
Emashenkoro	1441	20	24	44
Total	6777	83	122	203

3.4. Method of data analysis

Both descriptive and econometric tools used to analyze the data collected for this study. Descriptive statistics such as mean, standard error, frequency, and percentage applied to describe the characteristics of the respondents and results presented by tables and figure. In the econometric part, this research applied propensity score matching and inverse probability regression adjustment (IPWRA) models to quantify important empirical results. The the captured respondents data in the questionnaire is analyzed using STATA version 15.1 software.

3.5. Model specification and selection of variables

The study focused on crop productivity and commercialization of farmers. The dependent variable includes cluster farming participation while the outcome variables are maize crop productivity (yield) and commercialization of maize crop in 2019/20 G.C. or 2011/12 E.C. cropping year. The independent/explanatory variables that are included in the study selected after consulting related research, literature review on impact of agricultural cluster farming on agricultural productivity and commercialization.

3.5.1. Econometric model

The important consideration in assessing impact of cluster farming approach on farm productivity and commercialization of farmers is what will happen if the cluster farming users are not participated in cluster farming approach. In this case, we need to determine the productivity and commercialization of farmers who are not cluster farming participants. These productivity and commercialization are outcomes of farmers in the absence of cluster participation are its counterfactual, is the key in impact evaluation. One of the major problem here is the yield impact of cluster users is assessed only by comparing, actual (observed) and counterfactual (unobserved).

Two methods used to measure the impact of agricultural cluster farming approach on farm productivity and commercialization. There are cluster farming approach participants and non-participants (control groups). It is assumed that the non-cluster farming (control groups) share the same pre-intervention characteristics to cluster participants, propensity score matching will be used to assess the impacts of cluster farming approach on farm productivity and commercialization. This study also used inverse probability weighing regression adjustment (IPWRA) approach to identify the impacts of cluster farming on maize productivity and commercialization. IPWRA estimate is used to predict outcomes (yield and commercialization). Because IPWRA estimators have the double-robust property, only one of the two models must be correctly specified for the IPWRA estimator to be consistent.

Propensity score matching (PSM)

It is difficult directly compare control (comparison) and treated individuals in observational study designs since selection bias becomes a problem and in such case it is common to use propensity score matching to reduce the selection bias in estimation of treatment effects with observational data sets. Developed by Rosenbaum and Rubin (1983), matching is often performed based on the probability of being assigned to the program participation given observed conditioning variables, known as the propensity score. Propensity score matching as a method is increasingly common estimation method in the evaluation of the impact of economic policy interventions (Rosenbaum and Rubin, 1983; Caliendo and Kopeinig , 2008; Imbens and Wooldridge, 2009).

Propensity score matching (PSM) is a very commonly used approach among the quasi-experimental evaluation methods with its basic principle is to construct a comparison group by matching participants with similar non-participants based on their predicted probability of participating in the intervention. Propensity score matching is calculated based on the range of observed characteristics, a robust impact evaluation methodology and can help to remove selection bias and provide valid results. As in the case of the other quasi-experimental methods, it can be applied based on existing data sources and no random assignment of the intervention is necessary, however, matching can only be conducted on observable characteristics. Hence, the risk remains that selection bias due to unobservable characteristics driving program participation can affect the evaluation result (ILO, 2018).

From the above we can understand participation in cluster farming is not random and may correlate with observable household and farm characteristics. PSM is a quasi-experimental approach, which creates a comparison group from untreated observation by matching treatment observations to one or more observations from untreated sample, based on observable characteristics. In PSM estimation Treated (cluster farming participants) units matched to untreated (non-cluster farming participants) units with a similar propensity score. The PSM is the likelihood of a participant in the intervention given their observable characteristics. This probability is obtained from the participation equation: a probit or logit regression in which the dependent variable (in these case outcomes) is dichotomous, taking the value1 for those who took in intervention and 0 otherwise (White and Raitzer, 2017).

The main purpose of using matching is to find a group of non-treated (cluster farming participants) similar to the treated (cluster farming non-participants. After obtaining a good match is found with the predicted probabilities of participation of households, the next step is to check whether the treatment brought about a difference in the indicators of impact.

According to Caliendo and Kopeinig (2008), there are various matching algorisms, used in impact evaluation study including the nearest neighbor matching, caliper and radius matching, stratification and interval matching, kernel and local linear matching In this research nearest neighbor matching, caliper radius matching, and kernel and local linear matching are applied to to estimate average treatment effect on treated (ATT). In the nearest neighbor matching, each treated farmer is matched with a comparable farmer that has the closest propensity score. In kernel and local linear matching, a treated farmer is matched with a weighted average of all controls, using weights that are inversely proportional to the distance between the propensity scores of treated and control groups. In case of the caliper matching, information is used only from the nearest neighbor within the caliper distance.

The average treatment effect on the treated (ATET) is given by the difference in mean outcome of matched members and non-members that have common support conditional on the propensity score. The mean impacts of joining cluster farming will, therefore, following Imbens and Wooldridge (2009), the average treatment effect on the treated (ATT) is defined as:

$ATT = E[Y(1) - Y(0) = 1]$…………………………………………………………..1

Where Y (1) and Y(0) are outcome indicators of maize productivity and commercialization of treated and untreated households, respectively. T is a treatment indicator.

Simple comparison of productivity and commercialization level of farmers with and without treatment status introduces bias in estimated impacts due to self-selection bias. The magnitude of self-selection bias is formally presented as:

$E[\,Y(1) - Y(0) \mid T = 1\,] = ATT + E[\,Y(0) \mid T = 1 - Y(0) \mid T = 0\,]$……………2

By creating comparable counterfactual households for treated households, PSM reduces the bias due to observables. Once households are matched with observables, PSM assumes that there are no systematic differences in unobservable characteristics between treated and untreated households. Given this assumption of conditional independence and the overlap conditions, ATT is computed as follows:

$$E[\,Y(1) \mid T = 1, p(x)\,] - E[Y(0) \mid T = 0, p(x)]$$

In order to determine if matching is likely to effectively reduce selection bias, it is crucial to understand under what conditions it is most likely to work. The validity of the result of the PSM method depends on the satisfactions. Two conditions must be satisfied to implement this estimator (Heinrich, *et al*., 2010). The two assumptions are:

1. **Conditional Independence Assumption (CIA):** states that outcomes of the CLFP and NCLFP are independent of the treatment status or after controlling for observable characteristics. The treatment assignment is "as good as random". This property is also known as unconfoundedness or selection on observables. Conditional independence (CIA) states that there exists a set X of observable covariates such that after controlling for these covariates, the potential outcomes are independent of treatment status:

   $$(Y1, Y0) \perp D|X$$

   The CIA is crucial for correctly identifying the impact of the program, since it ensures that, although treated and untreated groups differ, these differences may be accounted for in order to reduce the selection bias. This allows the untreated units to be used to construct a counterfactual for the treatment group.

2. **Common support condition (CSC):** in order to calculate the difference in mean outcomes for each value of X, for each possible value of the vector of covariates X, there must be a positive probability of finding both a treated and an untreated unit to ensure that each treated unit can be matched with an untreated unit. Common support states that for each value fo X, there is a positive probability of being both treated and untreated:

   $$0 < P(D = 1|X) < 1$$

   If some units in the treatment group have combinations of characteristics that cannot be matched by those of units in the comparison group, it is not possible to construct a counterfactual, and therefore, the impact for this subgroup cannot be accurately estimated. This is commonly known as the common support or overlap condition. CSC entails the existence of sufficient overlap in the characteristics of the treated and untreated units to find adequate matches (common support).

However, ATT from PSM can still produce biased results in the presence of mis-specification in the propensity score model (Robins *et al.,* 2007; Wooldridge, 2007, 2010). A potential remedy for such misspecification bias is to use inverse probability weighing regression adjustment (IPWRA).

Inverse probability weighing regression adjustment (IPWRA)

The IPWRA estimator derived by Cattaneo (2010) and Cattaneo *et al*. (2013) differs from most matching estimators in that it estimates both a treatment model and an outcome model. The treatment model is similar to most matching models. It estimates the probability of the treatment variable (CLFP in this case) being associated with each of a number of characteristics.

IPWRA implicitly compares every unit to every other, while placing higher weights on observations that have a similar likelihood of being in the treatment or comparison group and lower weights on observations that are dissimilar. Because more observations are included in the model that compares a treatment unit to its hypothetical counterfactual, statistical precision is increased (Guush *et al*., 2017). IPWRA provides efficient estimates by allowing the modelling of both the outcome and the treatment equations (Wooldridge, 2010 and StataCorp, 2017). This allows us to control for selection bias at both the treatment and outcome stages. Thus, the IPWRA estimator has the double-robust property, which means that only one of the two models is correctly specified to consistently estimate the impact (Guush *et al.,* 2017 and StataCorp, 2017). IPWRA enable consistent estimation of treatment parameters when the outcome model, the treatment model, or both are correctly specified. For this reason, the IPWRA is called also known as Wooldridge's "doubly robust" estimator (Wooldridge, 2010). In other words IPWRA estimators are considered to be "doubly robust" for the method allows greater flexibility of the model being incorrectly specified (Wooldridge, 2007, 2010).

Hirano *et al*. (2003) also have shown that doubly robust estimators (which include IPWRA) exhibit a lower bias than estimators without the double robustness property. King and Nielsen (2016) point out those IPWRA estimators are less prone to mis-matching on irrelevant observables.

3.6. Definition of Variables and Working Hypotheses

Different variables expected to affect households' participation decision, level of crop productivity and level of commercialization in the study area.

Dependent variables

The dependent variable for the first stage of the selection equation model is cluster farming participation decision (CLFP), which a dummy variable is taking a value 1 if the household participates in cluster farming and 0 otherwise.

Participation in cluster farming

The independent variables that are hypothesized to affect the farmers' decision to participate in cluster farming, productivity and level of commercialization are combined effects of various factors such, household characteristics , ownership of assets and institutional factors. Based on review of literatures on factors influencing participation in cluster participation (decision to join cluster farming) level of productivity and commercialization the following variables are identified, hypothesized and are presented as follows:

Decision to participate in cluster farming

Dependent variable

Cluster farming participation (CLFP): The dependent variable in this model is a dummy (binary) variable representing farmers' cluster farming participation; taking a value of 1 if farmers are participant in maize cluster farming and 0 if not.

Independent variables

Sex of household head (Sexhh): It is a dummy variable 1 if sex of the household head is male and 0, otherwise. Male headed households would have better opportunity to participate in cluster farming activities because females are overburden in household care. Male farmers have the tendency of working in groups compare to female farmers due to man-power of male farmers and time consumed in group farming that female farmers will not be able to spare because of the time needed to raise their families. Sex of the household head being female expected to negatively influence the level productivity (Addisu *et al*., 2019). Male headed households have better access to information and hence may expect a positive benefit of cluster farming on improving productivity and commercialization of maize. Leykun and Jemma (2014) and Tekalign (2014) found that male-headed households have a better access to information which provided them with better ability to manage their farms and produce more output for market as compared to female headed households. Sex of the household may have an effect on participation intensity, because of the traditional division of labor and different responsibilities in food and cash crop production (Pandolfelli *et al*., 2007). Hence, male households positively related to participant in cluster farming.

Age of household head (Agehh): Age of the household head hypothesized to influence decisions by smallholder farmers to join cluster farming positively. On one hand, older age farmers participate in cluster farming anticipating benefit from collective farming such as cluster farming. In addition older farmers are reluctant to accept new information and improved technologies; take risks age can influence participation negatively or positively. Older farmers are often viewed as less flexible, and less willing to engage in a new or innovative activity due to fear of risk whereas young farmers may be more risk averse to implement new technologies on their farm. Hence, the influence of age on participation decision is ambiguous (Asres *et al*., 2013). Therefore, age of household hypothesized to affect CFP either positively and negatively.

Family size (Famsize): The number of working age who can help their household head in farming by providing labour services at lower prices as compared to market price. Family size used as a proxy for the availability of family labor, which may be relevant for attending group meetings, and for transporting maize produce to the collection center or selling markets. The higher the number of people in the household, the greater will be the possibility to participate in the cluster farming.

Education level of household head (Eduhh): Farmers with more education are aware of more sources of information, and be more efficient in evaluating and interpreting information about innovations than those with less education. Education might have positive contribution for cluster participation as farmers select the program due to their ability to understand the cost and benefit of participation in the program as well as easily understand how to implement new technologies (Doss and Morris, 2001). Thus, it is hypothesized that producers with more education are more likely to participate in CLF than farmers with less education. According Ferris *et al*. (2014) studies, farmers that receive training through formal education and farm-based extension services are more likely to invest in new technologies, build their market linkages, and improve their production and incomes in a more sustainable manner and exploited the existing market opportunities. Educations motivate and let smallholders to use and exploit the marketing information (Jemal, 2008).

Farmer's cooperative membership(Coopmemb): Farmers' organization help them to participate in group activities, as they may tend to share ideas on profitable enterprises and adopt them as well as engage in market activities of inputs acquiring or selling of produce and thereby improve their profits. Cooperative is a form of social network where ideas and innovations are being discussed (Prakash, D. 2000). It is also a platform for connections among farmers, therefore there is a high tendency that a member of other forms of cooperative are likely to participate in cluster farming compared to non-member of any cooperative society. Farmers experience in cooperation working is a social capital that enables farmers to share knowledge and information. It is expect that households with group experience (past experience in collective action) to have a higher probability of participating in in cluster farming than those work individually.

Credit access (credit): farmers will join cluster farming participation expecting better and easy access to credit to improve their productivity and commercialization. Farmers who have access to credit are more likely to participate in an agricultural project. It is not uncommon for agricultural projects to either provide production credit to farmers or implement activities that are aimed at linking farmers to production credit. Farmers who require production credit are therefore more likely to participate in these projects in order to take advantage of these credit facilities (Etwire *et al*. 2013). Therefore, the need to access credit from being cluster farming participant expected to increase the probability of becoming a member of cluster farming.

Farm size (Farmsize): Refers to the total land size in hectare. Larger farms are not only wealthier but also have a higher capacity to expand agricultural production, marketable surplus to sell the product and to access farm input easily. Efa *et al*. (2016) reported that the larger area allocated to production increases the quantity of produce. Land is the prerequisite to produce any crop. Large farms are indication of wealth and higher capacity to expand agricultural production that in turn forces the farmer to sell the product and to access farm input easily. Therefore, the size of the land holding hypothesized to affect cluster participation positively.

Total livestock ownership (TLU): This refers to the total number of animals possessed by the household measured in tropical livestock unit (TLU). Livestock considered as another capital which is liquid and a security against crop failure. In addition, livestock is used for ploughing (ox, horse), threshing, transporting and hence increase production and marketable surplus. Therefore, this variable is hypothesized to have a positive impact on farmers' participation in CLF. Tadele *et al*. (2017) found that the positive effect of livestock ownership on the level of commercialization due to significant effect on production. Therefore, livestock ownership is hypothesized and related positively to cluster farming participation.

Farming experiences (Fexp): Here farming experience is number of years' experience of the farmers is likely to have a range of influences on adoption. Experience expected to improve farmers' involvement in cluster farming production. A more experienced grower may have a lower level of uncertainty about the technology's performance and may expect more benefit in participating from cluster farming. Farmers with higher experience appear to have often full information and better knowledge and will able to evaluate the advantage of the technology access in CLF. On the other hand, farmers with lower farming experience have higher probability of being a member of a group farm in this case CLF can be attributed to the fact that, farmers who have lower farming experience are likely to limited knowledge in the production of some crops, and also not likely to have access to sufficient farm inputs, they therefore join cluster farming to help in access to inputs and trainings by the government or interaction and activities on the farm by the group members Hence, it is hypothesized to affect participation positively or negatively.

Availability of training (Mprotrain): Farmers need obtain required skill through training. They may face difficulty to understand and apply production improvement technology. Therefore, those farmers who got training are more willing to apply improved productive technologies than those who didn't get training and hence will be interested to participate in cluster farming. Training enables farmers to foresee the benefits of new approaches or programs. Maize production training is dummy variable measured as 1 if farmers got specific training on maize production and 0 otherwise.

Distance to extension office in minutes (Distext): The farmers who are near to the extension office get more contact with the extension agent or information center and better understand the benefit of cluster farming participation. The longer walking minutes from household head home to extension office, the lesser frequency of extension contact. Extension services reflected by the number of extension contacts either through farm visits made or training sessions received prior to and during production season influence crop productivity (Anyiro and Oriaku, 2011). This is because farmers who get in touch with the extension agent are likely to get the right information on not only a technology but also its profitability.

Frequency of extension contact can affect productivity and commercialization positively. Addisu *et al.* (2019) and reported that technical advice provided for farmers by development agent, experts of agriculture and researchers on tef production and tef marketing enhance the level of tef commercialization. Girma (2015) showed that extension contact and advice significantly and positively influence crop commercialization and marketed surplus of tef, respectively. The distance to extension office is a continuous variable and related to cluster farm participation negatively.

Off-farm activity participation(OFFfarm activity participation(OFFfarm): Off-farm income can also enhance agricultural production by relaxing liquidity and credit constraints to purchase productivity enhancing agricultural technologies such as improved seed, fertilizer, machineries, and hiring labor (Anriquez and Daidone, 2010). This is particularly true in developing countries where farmers are facing credit constraints (Stampini and Davis, 2009). Contrary to this, Alejandro *et al.* (2009) found participation in off-farm activities has an adverse effect on the agricultural output and the use of family labour on the farm. This is because if the income from the off-farm activities is more attractive than the agriculture, farmers might give less attention for the agriculture and they might devote more family labor and time for off-farm activities. Therefore, off-farm engagement is hypothesized affecting cluster participation both negatively and positively.

Definitions of explanatory variables and development of hypothesis of productivity

Outcome variable

Yield of crop (qt/ha): the dependent variable is maize crop yield in quintals(qt) per hectare(ha) that is produced in 2011/12 E.C. meher season cropping calendar.

Independent variable

Age of household head in years (Agehh): Age of cluster farm members is expected that the more mature a farmer, the better understanding of co-operative benefits. It is expected that older member of the household, which are necessary for the welfare of the household and produce more, take major decisions. It is expected relationship between market participation and age is positive with increased production comes from older farmers (Sebatta *et al.*, 2014). It is expected that increase in age will have a positive impact on productivity and market participation. Thus, age of members is assumed to have positive effect on productivity.

Sex of household head (Sexhh): Male farmers have the tendency of working in groups compare to female farmers due to man-power of male farmers and time consumed in group farming that female farmers will not be able to spare because of the time needed to raise their families. Sex of the household head being female expected to negatively influence the level productivity (Addisu *et al*., 2019).

Family size (Famsize): Household size is among the important socio economic characteristics which influence crop productivity because a fairly large family size implies more family labour available for the household farm activities (Ozor and Cynthia, 2010; Ogundari, 2008). Family size hypothesized to affect productivity positively.

Educational level in years (Eduhh): Education level is very useful in technology adoption for improved crop productivity. As Ozor and Cynthia (2010) assert, an increase in educational status of farmers positively influence the adoption of improved technologies and practices. It is assumed that formal education would positively affect the productivity of members to enable them adopt new technologies.

Farm size (Farmsize): The larger farm will enable the farmer to produce more and increase the quantity to supply to the market. Efa *et al.* (2016) reported that the larger area allocated to production increases the quantity of produce. The larger area allocated for maize crop will enable the farmer to produce more and increase the quantity to supply to the market. Efa *et al*. (2016) reported that the larger area allocated to production increases the quantity of produce. Farm size is expected that large farm size will be positively related to productivity. Farm size is expected to be positively related to productivity.

Number of plot (NoPlot): Land fragmentation has both positive and negative effects. Land fragmentation enables access to soil growing conditions and micro climate variations that reduce the risk of crop failure. In addition holding with several plots facilitates crop rotation and the ability to diversify crop type and fragmentation avoids the risk of production failure. Land fragmentation helps in risk spreading (flooding, diseases and pests and output variation); crop rotation flexibility/diversity and seasonal labour spreading. On the hand land fragmentation restricts agricultural modernization (mechanization, irrigation, agronomic practices); inhibits improvement of the land and heightens risk of abandonment of some parcels; and creates economic and production problems because of increased time, work, and organization required by the parcels' distance (Lusho and Papa, 1998; P., and Van Hung *et al.,* 2007). Hence number of plots is hypothesized negatively and positively to productivity.

Access to credit (Credit): Households with access to credit may help farmers in obtaining the capital required for adopting the higher profit production technologies and therefore increase productivity (Wachira, 2012). According to Oladeebo (2008), availability of adequate and timely credit help farmers in expanding the scope of operation and adoption of new technology as well as enhancing the purchase and use of some improved inputs. Therefore, credit is expected to have a positive sign on productivity.

Total livestock ownership (TLU): Total livestock ownership (TLU) refers to the total number of animals possessed by the household measured in tropical livestock unit (TLU), wealth which is measured in terms of tropical livestock unit. Livestock is considered as another capital which is liquid and a security against crop failure. In addition, livestock is used for ploughing (ox, horse), threshing, transporting and hence increase production and marketable surplus. More livestock ownership also that being owner of more livestock increases the level of adoption of improved agricultural technology (Leake and Adam, 2015). Therefore, this variable is hypothesized to have a positive impact on farmers' productivity.

Distance to extension office in minutes (Distext): The longer walking minutes from household head home to extension distance the lesser frequency of extension contact. Extension services reflected by the number of extension contacts either through farm visits made or training sessions received prior to and during production season influence crop productivity (Anyiro and Oriaku, 2011). This is because farmers who get in touch with the extension agent are likely to get the right information on not only a technology but also its profitability. Frequency of extension contact can affect productivity and commercialization positively. Addisu *et al*. (2019) and reported that technical advice provided for farmers by development agent, experts of agriculture and researchers on tef production and tef marketing enhance the level of tef commercialization. Girma (2015) showed that extension contact and advice significantly and positively influence crop commercialization and marketed surplus of tef, respectively. Hence, the distance to extension office is a continuous variable and related to maize productivity negatively.

Farmers' cooperative membership(COOPMemb): Farmers' organization help them to participate in group activities, as they may tend to share ideas on profitable enterprises and adopt them as well as engage in market activities of inputs acquisition or selling of produce and thereby improve their profits. Consequently, organized farmer groups are promoted as useful avenues for increasing farmer productivity (Lenis, 2012). Cooperative institution provides necessary inputs, market information and buys their produce at better prices. In this study, it is expected those farmers who are members of local cooperative more likely produce maize and more marketable surplus in the study area.

Farming experience (FEXP): This variable measures the number of years a farmer has been engaged in farming. It can be hypothesised that farmers with more experience are likely to allocate resources efficiently which then can result to higher crop yield and hence more revenue from the output sales. Thus, there is a positive correlation between farm performance and farming experience. According to Aman and Tewodros (2016) farm experience affect adoption and intensity adoption of improved varieties positively. Hence experience is expected positively affecting maize productivity.

Number of plot (NoPlot): Land fragmentation has both positive and negative effects. Land fragmentation enables access to soil growing conditions and micro climate variations that reduce the risk of crop failure. In addition holding with several plots facilitates crop rotation the ability to diversify crop type and fragmentation avoids the risk of production failure. Land fragmentation helps in risk spreading (flooding, diseases and pests and output variation); crop rotation flexibility/diversity and seasonal labour spreading. On the hand land fragmentation restricts agricultural modernization (mechanization, irrigation, agronomic practices); inhibits improvement of the land and heightens risk of abandonment of some parcels; and creates economic and production problems because of increased time, work, and organization required by the parcels' distance (Lusho and Papa, 1998, and P., Van Hung *et al.*, 2007). Hence lesser plot numbers may face with crop rotation problem and higher numbers of plots allows a chance to flexible choice of crop and allocate maize land for cluster. Hence it is hypothesized both negative and positive effect.

Off-farm activity participation(OFFfarm): Off-farm income can also enhance agricultural production by relaxing liquidity and credit constraints to purchase productivity enhancing agricultural technologies such as improved seed, fertilizer, machineries, and hiring labor (Anriquez and Daidone, 2010). This is particularly true in developing countries where farmers are facing credit constraints (Stampini and Davis, 2009). Contrary to this, Alejandro *et al*.

(2009 found participation in off-farm activities has an adverse effect on the agricultural output and the use of family labour on the farm. This is because if the income from the off-farm activities is more attractive than the agriculture, farmers might give less attention for the agriculture and they might devote more family labor and time for off-farm activities. Off-farm engagement is hypothesized affecting maize productivity both positively and negatively.

Training (Mprotrain): Training is one of the means by which farmers acquire new knowledge and skill. It is a dummy variable which have a value of 1 if the famer had been participated in training/demonstration and 0, otherwise. Farmers who participated on training their probability of adoption and intensity of adoption of new technologies increase (Wuletaw and Daniel, 2015), which has an effect on productivity and commercialization improvement. Hence, access to training is expected to positively influence adoption of improved maize, increase in yield and commercialization of maize.

Definitions of explanatory variables and development of hypothesis on maize commercialization

Outcome variable

Household Commercialization index (HCI): It is a limited outcome variable, which is measured as the ratio of the gross value of maize crop sales to gross value of maize crop produced by the household in 2011/12 meher season production year, expressed in percentage.

Independent variables

Sex of the household(Sexhh): Male farmers have the tendency of working in groups compare to female farmers due to labor of male farmers and time consumed in-group farming that female farmers will not be able to spare because of the time needed to raise their families. For example in Addisu *et al*. (2019), sex of the household head being female found to negatively influence the level tef commercialization significance. Therefore, sex is hypothesized to affect maize commercialization negatively.

Age of household head in years (Agehh): It is expected that major decisions be taken by older member of the household, which are necessary for the welfare of the household. It is expected relationship between market participation and age is positive with increased production comes from older farmers (Sebatta *et al*., 2014). It is expected that increase in age will have a positive impact on market participation.

Family size (FamsizeNO): It is total number of persons in a household. Family size expected to influence the level of household commercialization negatively. The probable reason is that as the number of adult people increases the level of consumption of adults will increase to the extent that it will have noticeable negative impact on the available output with the consequences of limited produce available for sale due to increased consumption and diseconomies of scale (Adam and Dawit, 2015 and Girma, 2015).

Farm size (Famsize): The larger farm will enable the farmer to produce more and increase the quantity to supply to the market. Efa *et al*. (2016) reported that land size cultivated has a positive significant outcome on being transition and commercial farmer and the larger area allocated to production increases the quantity of produce available for sale.

Distance to extension office in minutes (Distext): the lesser the distance of the extension office to household home the more extension contact. Frequency of extension contact can affect productivity and commercialization positively. Addisu *et al*. (2019) and reported that technical advice provided for farmers by development agent, experts of agriculture and researchers on tef production and tef marketing enhance the level of tef commercialization. Girma (2015) showed that extension contact and advice significantly and positively influence crop commercialization and marketed surplus of tef.

Cooperative membership (Coopmemb): farmers' membership to cooperative can contribute to the practice of crop output market participation by facilitating better information access to credit services (Rehima *et al*., 2013, and Stephen *et al*., 2017).). Organizations such as cooperative institution provide necessary inputs, market information and buy their produce at a better price. In this study, those farmers who are members of local cooperative are more likely produce maize and more marketable surplus in the study area. Hence being a member of cooperatives is hypothesized positively with commercialization.

Livestock ownership (TLU): the number of livestock is expressed by tropical livestock unit (TLU). Tadele et al. (2017) found that the positive effect of livestock ownership on the level of commercialization due to significant effect on production. Therefore, livestock ownership is hypothesized and related positively to commercialization.

Education level of the household head (EDUhh): Education level of household head improves level of commercialization. According to Tadele *et al*. (2017), the level of formal education of the household head increased the level of wheat commercialization that attending formal education improves the productivity and amount of tef marketed by adopting improved agricultural technologies.

Distance to nearby market (MarketDist): distance to the nearest market output hypothesized negatively affects commercialization of produce. The greater the distance to the market, the more severe the logistical problems such as transport and transport cost. Remote located farmers are likely to poor performance. It is a continuous variable measured in walking minutes. Access to market and availability of market are bound to reduce marketing costs on matters such as transport and other transaction costs and offer favourable price for produce (Anyiro and Oriaku, 2011, and Wachira, 2012). In Solomon *et al*. (2011) and Afework and Lemma (2015) distance from the nearest market affects adoption of improved agricultural technology negatively and significantly which intern reduces yield and commercialization. According to Dangia *et al*. (2019), distance from nearest market measured in minutes of travelling was found to have negative and significant influence on maize market participation at 1% significance level. Therefore, it is hypothesized that market distance is inversely related to maize commercialization.

It also indicates that the shorter the distance from the household to the nearest market, the higher the probability of adopting new technology. Hence, market distance is hypothesized negatively affect productivity and hence commercialization.

Total maize produced by the household (**Mprodntotal):** This is a continuous variable measured in quintal(qt) that indicate the total volume of maize produce by the farmer in 2019/20 cropping season. The increased of crop production per household determines both probability of participation in crop market as a seller and the extent of market participation once the participation decision has been made. This is because most of the crops marketed by smallholders are surplus product after satisfying household subsistence requirement and increased production means more surpluses to sell. Gebremedhin *et al*. (2009) also found the same effect of increased crop production on smallholder market integration. According to Martey *et al*. (2012), an increase in the production of cassava was observed to increase farmer market participation in Ghana. Therefore, the total production of maize was hypothesized to positively influence both the volume of produce and commercialization

Farming experience (FEXP): This variable measures the number of years a farmer has been engaged in farming. It can be hypothesised that farmers with more experience are likely to allocate resources efficiently which then can result to higher crop yield and hence more revenue from the output sales. Thus, there is a positive correlation between farm performance and farming experience and hypothesized to affect commercialization positively.

Off-farm activity participation(OFFfarm): Off-farm income can also enhance agricultural production by relaxing liquidity and credit constraints to purchase productivity enhancing agricultural technologies such as improved seed, fertilizer, machineries, and hiring labor. This is particularly true in developing countries where farmers are facing credit constraints (Stampini and Davis, 2009). There are also cases (such as Goodwin and Mishra (2004), Chang and Wen (2011), and Kilic *et al*. (2009) in which participation in off-farm activities has an adverse effect on the agriculture. They argued that if the income from the off-farm activities is more attractive than the agriculture, farmers might give less attention for the agriculture and they might devote more family labor and time for off-farm activities. Off-farm engagement is hypothesized affecting maize commercialization negatively or positively.

Access to market information (Mktinfo): access to market information hypothesized to positively influence crop output commercialization. Market information is very important in farming because farmers will get market prices and search for potential buyers. Market information presents the farmers with all the options which are available for them to choose from to get higher returns (Asefa *et al*., 2019), helps to increase utilization of yield enhancing farm inputs such as fertilizers and improved varieties, which eventually increases commercialization levels (Ochieng *et al.*, 2015, and Chauke *et al.*, 2016). Access to information set as a dummy variable, where a household with access to information takes the value of 1 and a household that has no access to information takes a value of 0. Access to information hypothesized to affect commercialization positively.

Training (Mprotrain): Training is one of the means by which farmers acquire new knowledge and improved crop management practices. It is a dummy variable, which have a value of 1 if the famer had been participated in training/demonstration and 0, otherwise. Farmers who participated on training their probability of adoption and intensity of adoption of new technologies increase (Wuletaw and Daniel, 2015), which has an effect on productivity and commercialization improvement. Hence, access to training is expected to positively influence adoption of improved maize, increase in yield and commercialization of maize.

Summary definition of Variables and Hypotheses

Participation of cluster farming, maize productivity and commercialization are affected by factors including sex, age, educational status, household size, off farm income and family size; ownership of assets like farm land, livestock holding, institutional characteristics such as access to credit, cooperative membership, access to extension service and distance to market, road distance (Assefa and Gezahegn, 2010, and Solomon *et al*., 2011).

Accordingly, some of the common predictors expected to influence participation in cluster farming of households in the study area are presented in table 2 below.

Table 2. Summary description of explanatory variables used in participation decision

Variable	Description and unit of measure of the variables	Expected sign
Dependent variable		
CLFP	Participation of farmers in maize cluster farming or not: Dummy: No = 0 and Yes = 1	+/−
Outcome variable	Maize yield in qt/ha, commercialization index in percent	+
Explanatory variable		
Sexhh	Sex of the household head: 1 if the household is male; 0 otherwise.	+
Agehh	Age of the household head: continuous, number	+/-
Eduhh	Education status of the household head: 1 illiterate, 2 adult education/read write,3 primary education, 4 secondary	+

Table 3. Summary description of explanatory variables used in participation decision Cont'd…

Variable	Description and unit of measure of the variables	Expected sign
FamsizeNo	Number of family in a household: members	+
TLU	Total number of livestock in TLU: tropical livestock unit	+
Farmsize	Total land size of a household : hectare(ha)	+
FEXP	Number of years the household head cultivated maize: years	+
DIstEXT	Walking distance between the house of the respondent and extension office: walking minutes	_
MproTrain	Training access by the household head: No=0, Yes=1	+
Credit	Access to credit by the household head :No=0, Yes=1	+
COOPMemb	the household is membership of agricultural cooperatives :No=0, Yes=1	+
OFFfarm	Engaged in off-farm income participation: No =0, Yes=1	-/+

CHAPTER 4. RESULTS AND DISCUSSION

This chapter discusses both results of descriptive and econometric model output. Under descriptive analysis, household head characteristics, maize productivity and commercialization related variables are analyzed by t-test and chi-square, and econometric analysis carried out using logit, propensity score matching (PSM) and inverse probability weighing regression adjustment (IPWRA).

4.1.Descriptive statistics

4.1.1. Result and discussion of maize yield, and commercialization

Before dealing with the econometrics results, it is important to provide information regarding the sample respondents and variables used in the econometrics model. To analyze the collected data, descriptive statistics, inferential statistics and econometric model were used. The descriptive statistics (mean and percentage), inferential statistics (t-test and chi-square tests) were used. Accordingly, table 3, 4, 5 and 6 presents the descriptive statistics of variables used for this study.

Result and discussion of dummy and categorical variables

The results of the descriptive statistics reviles that CLFP and NCLFP are statistically significant different in terms of marital status, education level, access to improved seed, proper/correct input use and practices, training access, cooperative membership, participating in off-farm activities, maize yield, commercialization, age, fertilizer amount, market distance, road distance, distance to extension**,** perceived fertilizer price is high, perceived seed price high and post-harvest loss.

Out of 203 sample household heads, male and female household heads accounts for 87.19 % and 12.81% respectively. The majority of households in the sample are headed by males. Among female headed households, 38.46% and 61.54 % are CLFP and NCLFP respectively, while 58.76 % and 41.24% male are CLFP and NCLFP, respectively. The result shows there is no significant difference between the two variables in terms of sex.

Based on the marital status indicated in Table 3, out of the 203 total household heads, married and not married accounts for 80.3% and 19.7% respectively. Single and households shares 62.50 % and 37.50% are CLFP and NCFPs respectively. The majority of household heads are married couples of NCFPs which accounts for 64.42%. Statistical difference between CLFP and NCFP is observed in terms of marital status at 1% significant level.

Table 4. Demographic characteristic of maize producer sample

Variables	Categories	% of sample proportion	% distribution		χ^2
			Cluster farm participants	Cluster Non-participants	
Sex	Male	87.19	58.76	41.24	0.788
	Female	12.81	38.46	61.54	
Marital status	Single and others	19.70	62.50	37.50	
	Married	80.30	35.58	64.42	0.002***
Education	Illiterate	60.59	32.52	67.48	
	Adult/traditional/read and write	23.15	51.06	48.94	0.018**
	Primary	12.81	53.85	46.15	
	Secondary and above	3.45	71.43	28.57	

Source: Own calculation using the survey data, 2019. ***, **, and * significant at 1% and 5% probability level, respectively.

In terms of education level of household head about 60.59%, 23.15%, 12.81% and 3.45% of household heads are illiterate, adult education/read and write, primary education and secondary and above education level. This shows that the majority (60.59%) of the household heads are illiterate. Of this about 32.52% and 67.48% are illiterate of CLFP and NCFP respectively. In addition, 51.06% and 48.94% of adult education stage are CLFP and NCLFP respectively. There is a statistical difference at 5% level between CLFP and CFP in terms of education level that CFP are relatively better in education level.

Household heads responds working with cooperation in CLFP and NCLFP accounted for 32.54% and 67.49 respectively. Working in cooperation helps to monitor crop pests, sharing knowledge, and experience and increase bargaining power. Among those who work in cooperate one each other 60.61% and 39.39 % respondents are CLFP and NCLFP, showing the majority farmers work in cooperation are CLFP. Among respondents who do not work in cooperation the majority 68.61% are NCLFP. As indicate in table there is significant difference between CLFP and NCLFP in cooperation farming engagement at 1% significant level. This shows that cluster farm participation encourages working in cooperation.

Nearly 81% of the respondents use improved maize seed while the rest 19% were not the user of improved seed. Concerning the proportion, among non-users of improved seed the majority 76.92% are not CLFP, while from users 45.12% and 54.88 are CLFP and NCLFP respectively. The result shows that three is 5% significant level difference between CLFP and NCLFP in the use of improved seed. The result further indicates NCLFP are dominated by improved seed non users.

With regard to access to fertilizer 87.68 % use fertilizer while 12.32 % did not apply fertilizer (table 4). Among the users 41.57% are CLFP and 58.43% are NCLFP. Among the total households who do not applied fertilizer, 23% and 77% were CLFP and NCLFP respectively. This figure indicates majority that did not apply fertilizer are NCLFP. The result indicates there is no significant level difference in accessing fertilizer between CLFP and NCLFP.

Proper input management is also another variable under consideration in describing the households. From the total household heads 52.71% applied a proper input management including applying correct amount of inputs (seed and fertilizer) and perform better agronomic practices (method of sowing, spacing, and time of fertilizer application, chemical use and application. From those who applied proper input management 54.21% and 45.79% accounts for CLFP and NCLFP respectively. Among farmers that were not applied proper management the majority 73.96% are non-cluster participants. Access to fertilizer and placing maize in row alone cannot give a guarantee for high yield, but also correct use of inputs and agronomic practices such as spacing between rows and seed, amount of seed and fertilizer and weeding also is equally important. Farmers are not practicing the correct spacing during sowing reasoning that it was tiresome and consumes labour. This problem also reported by key informants. The result indicates significant difference in terms of in applying proper input management between CLFP and NCLFP at 1% significant level. This shows that cluster participants are better in proper input and agronomic practice application.

Table 5. Institutional/resource characteristics of sample maize producer respondents (dummy variables)

Variables	Categories	% sample proportion	% distribution		χ^2
			CLFP	NCLFP	
Farming with cooperation	Yes	32.51	60.61	39.39	0.000***
	No	67.49	31.39	68.61	
Access to improved seed	Yes	80.79	45.12	54.88	0.012**
	No	19.21	23.08	76.92	
Access to fertilizer	Yes	87.68	41.57	58.43	0.596
	No	12.32	36.00	64.00	
Proper input management	Yes	52.71	54.21	45.79	0.000***
	No	47.29	26.04	73.96	
Cooperative membership	Yes	69.95	52.82	47.18	0.005***
	No	30.05	26.23	73.77	
Off – farm participation	Yes	79.80	44.44	55.56	0.040**
	No	20.20	26.83	73.17	
Training access	Yes	59.61	54.55	45.45	0.000***
	No	40.39	20.73	79.27	
Credit access	Yes	58.13	45.76	54.24	0.096*
	No	41.87	34.12	65.88	
Market information	Yes	31.53	46.88	53.13	0.239
	No	68.47	38.13	61.87	
Selling price of maize	Yes	37.44	40.79	59.21	0.983
	No	62.56	40.94	59.06	
Sell maize to cooperatives	Yes	19.70	55.00	45.00	0.043***
	No	80.30	37.42	62.58	
Stakeholder role	Yes	18.23	70.27	29.73	000***
	No	81.77	34.34	65.66	

Source: Own calculation using the survey data, 2019. ***, **, and * significant at 1, 5, and 10% probability level, respectively.

Table 5 Institutional/resource characteristics (Continued)…

Variables	Categories	% sample proportion	% distribution		χ^2
			CLFP	NCLFP	
Perceived fertilizer price high	Yes	82.76	32.74	67.26	000***
	No	17.24	80.00	20.00	
Perceived seed price high	Yes	88.67	38.33	61.67	0.038**
	No	11.33	60.87	39.13	
Post-harvest loss	Yes	78.33	55.97	44.03	0.084*
	No	21.67	29.55	70.45	
Market linkage	Yes	26.60	38.89	61.11	0.727
	No	73.40	41.61	58.39	
Contract selling	Yes	10.84	45.45	54.55	0.943
	No	89.16	40.89	59.11	

Source: Own calculation using the survey data, 2019. ***, **, and * significant at 1, 5, and 10% probability level, respectively.

Concerning cooperative membership, about 69.95% of the farmers are members in cooperation while 30.05% are not participant in farmers cooperation. Table 4 indicated 47.18% and 52.82% of the sampled household heads are members of farmers' cooperatives which are CLFP and NCLFP respectively. On the other hand, from non-member of cooperatives 73.77% are NCLFP, indicating majority of NCLP. The result indicates significantly more numbers of NCFP are not in cooperative membership at 1% significant level. Participation at cooperatives enhances the information exchange and experience sharing among farm households on the use of improved agricultural technologies and agronomic practices.

About 79.80% of the respondents are engaged in off-farm activities. Among this 44.44% and 55.64% are CLFP and NCFP respectively. Of those from 20.20% non-participant in off-farm income 26.83% CLFP and 73.17% are NCLFP. The result shows more NCLFP participated in off-farm activities and there is a 5% level of significant difference between CLFP and NCLFP.

The results of the study also indicated that in terms of training access, among the total respondents 59.61% had access to training. About 54.55% and 45.45% of those who have training access were CLFP and NCLFP, respectively. In addition among respondents who had no access to training 20.73% and 79.27% are among CLFP and NCLFP, showing CLFP are more accessed with training. The result indicated there were 1% statistically significant differences between CLFP and NCLFP in terms of training access.

Credit access is also another factor under consideration in this study. Among the total respondents, 58.13% had access to credit and the rest 41.87% had no access to credit. Of those accessed with credit, 45.76% and 54.24% were CLFP and NCLFP, respectively. In addition, about 34.12% and 65.88% of those who do not have access to credit were CLFP and non-participants, respectively. The result indicates significant difference in terms of access to credit at 10% significant level. These shows NCLFP were constrained by credit access by than CLFP.

Stakeholder linkage and role found positively and significantly related to cluster farm participation, showing participants are more benefited from linkage formed in the cluster. This linkage includes market linkage, training, organizing farmers. On the other hand market linkage has positive but no significant between cluster farm participant and non-participants.

Majority of the maize farmers are not selling their produce to cooperatives. From the respondents 80.30% reported that they are not selling maize to cooperatives, of which 62.58% and 37.42% are NCFP and CLFP respectively. From 19.70% who sold maize produce to cooperatives the CLFP and NCLFP accounted for 55% and 45% respectively. The result also shows significantly (5%) more NCLFP are not participating in selling maize to cooperatives.

The above table 4 also shows that 81.77% of the respondents feel the stakeholders do not played their role in improving productivity and commercialization of maize. Among these the majority 65.66% are NCLFP and the rest 34.34% are CLFP. Those 18.23% who feel stakeholder play role 70.27 % and 29.73% accounted for CLFP and NCFP. The result shows that significant (1% level) more number of NCLFP do not feel stakeholders play their role, while CLFP relatively feel that the stakeholders help in maize productivity and commercialization improvement.

Fertilizer price is becoming increasingly a challenge to improve maize productivity in the study area. About 82.76% of the respondents perceived fertilizer cost is high, of which 32.74% are cluster farm participants and 67.26% are non-cluster farm participants. Key informants also support the farmers' responses of high price of fertilizer. There is a 1% significant level difference between CLFP and NCLFP, result shows the NCLFP are more affected by the high price.

The increasing price of seed is another issue reported by the responds showing 88.67% of the respondents affected by high improved seed price. Among this 61.67% and 38.33% accounts for NCLFP and CLFP, respectively. From those which reported high seed price is not a main problem 60.87% and 39.13% are from CLFP and NCLFP respectively. The result shows difference at 1% level significant between CLFP and NCLFP are affected by high price of seed. Significant proportion of NCLFP is affected by the high seed price.

The result in table 5 further indicated that 78.33% total respondents, post-harvest harvest loss is reported by the respondents and statistical difference at 10% significant level. Farmers faced with post-harvest losses such as loss during shelling, during piling (shagata) transporting and storage. During storage the maize crop also exposed to weevil, which decrease the quality of maize produce and hence reduce marketability. From the total respondents affected by post-harvest loss, problem distribution of CLFPs and NCLFP were 44.03 and 55.97, respectively. This implies that households participated in CLF tend to have relatively lower post-harvest loss than their counter part.

One of the most importance roles of cluster farming is creating market linkage between maize producers and buyers. Majority of the respondents are not satisfied with market linkage. 74.38% of the respondents lack market linkage, but there is no statistical significance difference in proportion between participants and non-participants. It is indicated that there is weak market ling between producers and consumers. Though one of cluster farming participation is advantage of market linkage, it is not playing the intended role as expected, both participants and non – participants reported they are not benefited from market linkage.

With rising cost of seed and fertilizer it is becoming more difficult to grow maize if selling price improving and contractual farming is not put into practice.

Contractual selling/agreement which guarantees farmers for their produce is weak the study area. Majority, 89.16% of the farmers do not sell their produce through a predetermined seller and it is statistically insignificant difference between CLFP and NCLFP.

Result and discussion of continuous variables

Table 5 provides the mean values of households who were classified as members and non-members of the cluster farming. The result indicate that CLFP and NCLFP were statistically significant different in terms of maize yield, commercialization, fertilizer amount, market distance, road distance, distance to extension and extension visit frequency while other household characteristics such as family size, farm experience, total livestock unit, total farm size number of plot were not statistically different between cluster farm participants and non-participants.

Maize yield is an outcome variable that is considered in the study. Among the total respondents, the mean yield of maize is 43.31qt/ha. The cluster farming participants and non-participants average maize yield is 48.21 qt/ha and 39.91qt/ha respectively with a mean difference of 8.26qt/ha. Statistical analysis showed 1% level of significant mean difference between maize yield owned by cluster farm participants and non-participants. The result showed cluster farm participants maize productivity is significantly higher than non-participants.

The overall average level of commercialization of maize producers in the study area is 34.51%. The average value of maize commercialization of maize producers in the study areas is in semi-commercial level. The result farther showed that the mean commercialization of cluster farm participants and non-participants is 42.21% and 29.28%, respectively with a mean difference of 12.79%. Statistical analysis showed 1% level of significant mean difference between maize commercialization between cluster farm participants and non-participants at 1% significant level.

The result showed that CLFP are more commercialized than NCLFP although it is not grown into commercialized level. This degree of commercialization in the woreda is considerably higher than national average which is about 25% as reported by IFPRI (2010).

The average age of the sampled household heads is 43.85 years with an average age distribution of CLFP and NCLFP were 42.84 and 44.54 years, respectively. The results indicate no statistically significant difference between CLFP and NCLF participants and showed CLFP age is slightly younger than NCFP. The average family size for the study area is 5.8 per household; with 5.87 and 5.76 is the mean family size of participants and non-participants respectively. The result indicate that participants and non -participants were not statistically different in terms of family size.

Farming experience of the total sample households mean is 25.86 years. The mean of the farming experience of cluster farm participants is 26.40 years, while that of non-participants is 25.49 years. The statistical analysis showed that absence of significant mean difference between farming experiences of cluster farming participant household heads and non-participants.

The mean livestock holding of the total sample households is 3.90. From this the cluster farming participants and non-participants average livestock holding is 3.94 and 3.87 TLU respectively. Statistical analysis showed absence of significant mean difference between livestock holding owned by cluster farm participants and non-participants.

The average farm size of households is 1.48, 1.54 and 1.44 ha for all households, CLFP and NCLFP respectively. The average land holding by CLFP is slightly higher than NCLFP but the result showed absence of significant mean difference between farm size owned by cluster farm participants and non-participants. The sample respondents, on average had 4.19, 4.18 and 4.19 plots for all households, CLFP and NCLFP respectively. The result shows almost no difference in terms of number of plots per household. Regarding fertilizer amount the mean amount for the whole sample is 1.75 qt/ha, while for CLFP and NCLFP, 1.86 qt/ha and 1.68qt/ha showing CLFP applied more fertilizer than their counter parts. The result showed a 5% level of significance difference between CLFP and NCLFP.

Table 6. Characteristics of maize producer respondents (continuous variables)

Variables	CLFP	NCFP	Combined	Mean difference	T-test
	Mean	Mean	Mean		
Outcome variable					
Maize yield	48.21	39.91	43.31	-8.31	-5.26***
	(1.36)	(.92)		(1.56)	
Maize commercialization	42.07	29.28	34.51	-12.79	-4.58***
	(2.57)	(1.49)		(2.80)	
Explanatory variables					
Age	42.84	44.54	43.85	1.70	1.01
	(.985)	(0.85)		(1.31)	
Family size	5.87	5.76	5.80	-.11	-0.42
	(0.2)	(.17)		(.26)	
Farming experience	26.4	25.49	25.86	-.91	-0.69
	(1.00)	(0.85)		(1.32)	
Total livestock unit	3.94	3.87	3.90	-.07	-0.33
	(.15)	(.13)		(.20)	
Total farm size	1.54	1.44	1.48	-.09	-1.13
	(.07)	(.05)		(.08)	
Number of plot	4.19	4.18	4.19	-.01	-0.05
	(.17)	(.12)		(.21)	
Fertilizer amount	1.86	1.68	1.75	-.18	-2.53**
	(.04)	(.05)		(.07)	
Market distance	63.86	76.29	71.21	12.44	2.0364**
	(4.15)	(4.19)		(6.11)	
Road distance	26.04	34.72	31.17	-9.91	1.75*
	(2.98)	(3.57)		(5.04)	
Distance of extension office	27.78	31.28	29.85	3.5	1.87*
	(1.65)	(1.06)		(1.87)	

Source: Own calculation using the survey data, 2019. ***, **, and * significant at 1, 5, and 10% probability level, respectively. Standard errors are reported in parentheses

The sample respondents, on average, travel about 71.21 minutes for the total sample and 63.86 and 76.29 minutes to reach the nearest market by CLFP and NCLFP respectively. The average market distance for CLFP is smaller for CLFP. The statistical analysis shows that there is a 5% difference between CLFP and NCLFP in terms of nearby market distance.

The result on table 5 show on average 31.17 walking minutes takes to reach from home to main road. On average the walking distance from home to main road is 27.8 and 31.28 minutes for CLFP and NCLFP. The result shows relatively CLFP are near to the man road. The statistical analysis shows there is a 10% significant level difference between participants and non-participants.

Another important variable used in the study is road distance in walking distance in minutes. Average household's home distance from main road is 29.85 minutes and distribution of CLFP and NCLFP is 26.04 and 34.72, respectively. The result shows a 10 % level of significance difference between CLFP and NCLFP. Households that participate in CLF found near to main road than non-participants.

The average household distance of extension office to household home extension visit number of sample respondents is 29.85. The average walking distance distribution of CLFPs and NCLFP is 27.78 and 31.28, respectively. This implies that households participated in CLF are relatively near to the extension office implying, tend to have higher extension visit than their counter part. The result further indicated that distance extension office to household head home shows statistical difference between CLFP and NCFP at 10% significant level.

Level of commercialization of maize producers

Regarding commercialization level, the study classified commercialization into three categories. This study used classification of commercialization adopted by Samuel and Sharp (2008) and Tadele *et al*. (2017). Accordingly, less commercialized farmers are farmers who sold up to 25% of maize produce, semi-commercialized farmers who sold maize output between 25% and 50% and commercialized farmers are those farm households who sold more than 50% of what they have produced.

Table 6 indicates subsistence and less commercialized farmers' accounts for 36.95%. From this 24% CLF and 76% of NCLFP respondents maize commercialization index is zero to 25% indicating that they are fully subsistent to less commercialize. The statistical chi-square test shows compared to CLFP, more number of NCFP farmers are subsistence and less commercialized, significantly less commercialized at a level of 1%. The descriptive result also shows 40.86% of sampled households are semi-commercialized, from this 43.37% and 56.63% are CLFP and NCFP, respectively. There is no significant difference in size of commercialization level between CLFP and NCFP. From the total gross value of maize produced 22.17% of the sample respondents sold 50% and above that shows less number of farmers are commercialized. The majority (64.44%) are CLFP where as 35.56% are NCFP. There is a 10% significant difference between CLFP and NCFP that cluster farm participants are more commercialized than non-cluster farm participants.

Table 7. Level of commercialization of maize producers in dera woreda

Level of commercialization	CLFP (%)	NCFP (%)	% proportion	χ^2
Subsistence and less commercialized	24	76	36.95	0.000*
Semi-commercialized	43.37	56.63	40.89	0.2311
Commercialized	64.44	35.56	22.17	0627*
Total			100	

4.2.Econometric model analysis and result

Prior to running the logit model, the hypothesized explanatory variables were checked for the existence of multi-collinearity and heteroscedasticity. The situation where the independent variables are highly inter-correlated is referred to as multi-collinearity (Maddala, 1992). Before running the model all the hypothesized explanatory variables were checked for the existence of multi-collinearity problem. The technique of variance inflation factor (VIF) is employed to detect the problem of multi-colinearity among the explanatory variables.

As a rule of thumb, if the VIF of a variable exceeds 10, there is a multi-colinearity problem. Twelve explanatory variables were tested for VIF. The VIF for each independent variable is less than the critical value of 10 indicating non-existence of multi-collinearity (Gujarati, 2009). The VIF values displayed have shown that all of twelve explanatory variables have no serious multi-colinearity problem. The results are also free from heteroscedasticity as indicated by the small values of the Chi^2 3.79 generated by the Breusch–Pagan/Cook Weisberg heteroscedasticity test (Appendix 2).

4.2.1. Decision to participate in cluster farming

This sub-section presents the result of the logit regression model, which is used to estimate the propensity score for matching the CLFP with NCLFP. The propensity scores for each observation is calculated using logit model to predict the conditional probability of participation in cluster farming approach. The dependent variable in the logit model is coded as 1 if the household head is a member of cluster farming participant (CLFP) and 0 for non-members.

A result presented in Table 7 below shows the estimated model appears to perform well for the intended matching purpose. The pseudo-R^2 value is 0. 0.2091, a low R^2 value shows that maize farming participant households do not have much distinct characteristics overall and as such a good match between CLFP and non-participants of intervention becomes easier. The objective of matching procedure is to get similar probability participating or not participating under consideration within a given explanatory variables.

The result of the logit model, presented in table, indicated that age of the household head, education level, farming experience, distance of extension office, training access, cooperative and off-farm engagement are the significant variables that determine smallholders' decision to joining agricultural cluster farming, whereas sex of the household head, farm size, total livestock unit, family size and credit is not significantly affect cluster farm participation.

As indicated in the table, the age of the household head determines the probability of participation decision negatively at level of 1% significance. The negative sign shows that an increase in the age of household head decreases the likelihood for the household to participate in cluster farming. The possible reason for this is participating in agriculture in cluster farming as it is new approach, requires intensive use of new technologies, improved agronomic practices and older farmers are reluctant to adopt this new approach, technologies and improved practices required in the cluster farming. This result is consistent with studies reported by Genius *et al*. (2006); Asres *et al*. (2013) who found negative and significant impact of household head age on the probability of joining the extension program indicating older farmers are reluctant to accept new information and improved technologies. Guo et al.

(2015) and Odountan *et al*. (2020) whose work similarly analyzed the result of the age of farmers on agriculture. Barrett (2007) also found that younger people participated more in the market because they are more receptive to new ideas and are less risk-averse than older people are.

Educational status of the household head was expected to affect the decision of the household to participate in cluster farming. It was hypothesized that if the household head becomes literate the probability of participation in cluster farming will increase. As it was hypothesized the econometric result showed positive and significant relationship between the educational status of the household head and the decision to participate in maize cluster farming participation at 5% significance level. Significantly more CLFPs are engaged in adult and/or traditional and primary level education.

This result is in consistence with Asres *et al*. (2013) Aman et al. (2014 whose study showed that more educated farmers has a better probability in participating a development intervention program in their study, extension program. Farmers with more education are aware of more sources of information, more efficient in evaluating and interpreting information new programs than those with less education. Educated farmers may adopt technologies early and increase productivity and market surplus. It is also evident that educated farmers have tendency to accept agricultural technologies which leads produce more surplus for market. Yallew (2016) also found education has a positive and significant impact on probability of participation in market increment.

Experience expected to improve farmers' involvement in cluster farming production. Farming experience is positively related with cluster farming participation at 1% level of significant. Farming experience is number of years' experience of the farmers is likely to have a range of influences on adoption. Farmers may have more experience, resource, or authority that would allow them more possibilities for trying a new technology. A more experienced grower may have a lower level of uncertainty about the technology's performance and may expect more benefit in participating from cluster farming. Farmers with higher experience appear to have often full information and better knowledge and will able to evaluate the advantage of the technology access in CLF.

The results also indicate that distance to the extension office has an inverse relationship with the probability of joining cluster farming membership with a level of significance 10%. This is because when the distance of extension office is close to the household head, the cost of time and labor that the farmer spends to communicate with development agents will be reduced. The farmers who are near to the extension office get more contact with the extension agent or information center and better understand the benefit of and hence, higher probability to participation cluster farming. Similar result of Abebaw and Belay (2001) and Menale *et al*. (2013), shows the distance can affect the availability of new technologies, information, credit institutions, etc. The further away the extension office and output markets are, the less likely a farmer will adopt and use improved maize technologies. Those farmers who are close to the extension office will also have more knowledge about the cluster farming and their benefits.

It indicates that as farmers near to the office their probability to participate in cluster farming increased. Farmers accessed with extension have the profanity gaining information and knowledge about new approaches and initiated to adopt technologies. For instance positive and statistically significant effects of extension on technology adoption and household welfare are reported by Tesfamicheal *et al*. (2017). Similar result by Yallew (2016) shows negative and significant relationship between distance to agricultural extension service centre and households' decision to participate in maize output market.

Distance of extension office from household home is a proxy for information, communication and knowledge sharing. Farmers who are near to the office get in touch with the extension agent are likely to get the right information on a technology and its profitability. In addition Addisu *et al*. (2019) and Girma (2015) reported similar result that technical advice provided for farmers by development agent, experts of agriculture and researchers on tef production and tef marketing improve participation and enhance the level of tef commercialization. The distance to extension service centres increase the frequency of contact with the agents decrease, so that they will lack knowledge on production and will face shortage of inputs and hence, couldn't produce market surplus.

	Number of observation	= 203	
Logistic regression			
	LR $chi^2(14)$	= 57.42	
	Prob > chi^2	= 0.0000	
Log likelihood	= -108.61044	Pseudo R^2 = 0.2091	

Table 8. Result of the logit model of factors affects decision in participation in cluster farming

Cluster farm participation	Coef.	Std.Err
Sex of the household head	-.0283199	.55375
Age of the household head	-.1036234	.0348462***
Family size	.0922852	.1161838
Tropical livestock unit	-.1048433	.1515957
Farm size	.1382956	.3643027
Farm experience	.1010046	.0358114***
Distance of extension office	-.0239843	.0140507*
Training access	1.435104	.3920812***
Credit access	.4359377	.3763241
Coop Membership	.7571637	.4266888 *
Off farm income	.9731607	.4465926**
Education status		
Adult education/Read write	.8068214	.4032358**
primary education	1.205106	.5526568**
secondary education	1.34611	1.058016
_cons	-.9540831	1.314209

Source: Own calculation using the survey data, 2019. ***, **, and * significant at 1, 5, and 10% probability level, respectively.

Access to training positively influenced participation in CLF at 1% level of significance. Training improves in farmers' managerial and technical skills and hence encourages farmers to participate in CLF. Training can be theoretical and practical demonstration, on input use (fertilizer seed and chemical application), weeding and are found to most important by the farmers. The importance of training on adoption of new technology was also reported by Wuletaw and Daniel (2015) and found that farmers participate in agricultural trainings facilitate adoption of new improved maize technologies. The study showed that those farmers who participated in training have the probability of participating in cluster farming.

Being a member cooperative increases the probability cluster farm participation significantly with 10% level. The result shows beneficial impact of cooperative membership is stronger for more cluster members. Farmers who are a member of cooperatives hive higher probability to participate in cluster farming. Farmers' cooperative and farmers' organization are required to enable smallholder farmers collectively accessing agricultural inputs, credit, information and marketing of their produce. In the study area CLFPs sell their produce to cooperatives than that of NCFP. This is due to cooperative membership delivers better information and on market and credit access. This result is also confirmed by Rehima *et al*. (2013), Stephen *et al*. (2017) and Assefa *et al*., (2019). Furthermore, a study by Geremew (2012) also confirmed this result that institutional services like producer cooperatives and credits are the key factors in influencing both farmers decision to participate in sesame production and the level of production participation.

Participating in off-farm activities found to be related positively with probability of cluster participation significant at 5 percent significant level. An increase in off-farm engagement increases the probability of joining cluster farming. The result is in opposite from what was hypothesized first. The possible justification is off-farm income can also enhance agricultural production by relaxing liquidity and credit constraints to purchase productivity enhancing agricultural technologies such as improved seed, fertilizer, machineries, and hiring labor.

New intervention approaches such as cluster farming participation requires investment on improved inputs, accepting application of full package, those farmers who have no financial shortage encouraged to join cluster farming. Having the time to earn some extra resources without affecting the farming activities, participation in off/non-farm activities can promote the adaptations and adoption of new technologies (Olalekan and Simeon, 2015). This is particularly true in developing countries, like Ethiopia, where farmers are facing credit (Stampini and Devis, 2009). Azumah *et al*. (2016) also argue that farmers' access to finance from off-farm activities improves their ability to buy basic inputs and these increases their probability, which can lead farmers to participate in cluster farming. The above result further indicates off-farm activities should be lucrative, otherwise taking time on off-farm activities will not add beneficial increment in total production.

4.2.2. Estimating propensity scores and common support condition

After implementing the logit model for cluster farming participation, the researcher estimated the propensity scores. After estimating values of propensity score for CLFP and NCLFP the next step in propensity score matching technique is the common support condition. Only observations in the common support region matched with the other group considered and others should be discarded from further analysis.

Based on the predicted propensity scores, the common support assumption is tested. The magnitude of the propensity score ranges between 0 and 1. The total sample estimated propensity ranges between .016688 and .9891495 with mean score of .408867. The propensity score for CLFP is between .0915287 and .9891495 with a mean of .5595038 and the propensity scores for NCFP ranges between .016688 and .9016634 with a mean of .3046766. Using the rules of minima-maxima (Caliendo and Kopeinig, 2008), the common support is in the region, where the values of propensity scores of both treatment and comparison groups can be found, is given in the range between .0915287 and .9016634. Observations whose propensity scores lie outside this range are discarded from analysis.

The kernel density estimate in figure 3 showed the distribution of the total sample households, cluster farm participants and non-participants sample household estimated propensity scores. The figure shows, in CLFP most of the observation distributed at the center and only few numbers fall out of the common support region. Considering of non-cluster farm participants (NCLFP), most of the observation aligned to the left side.

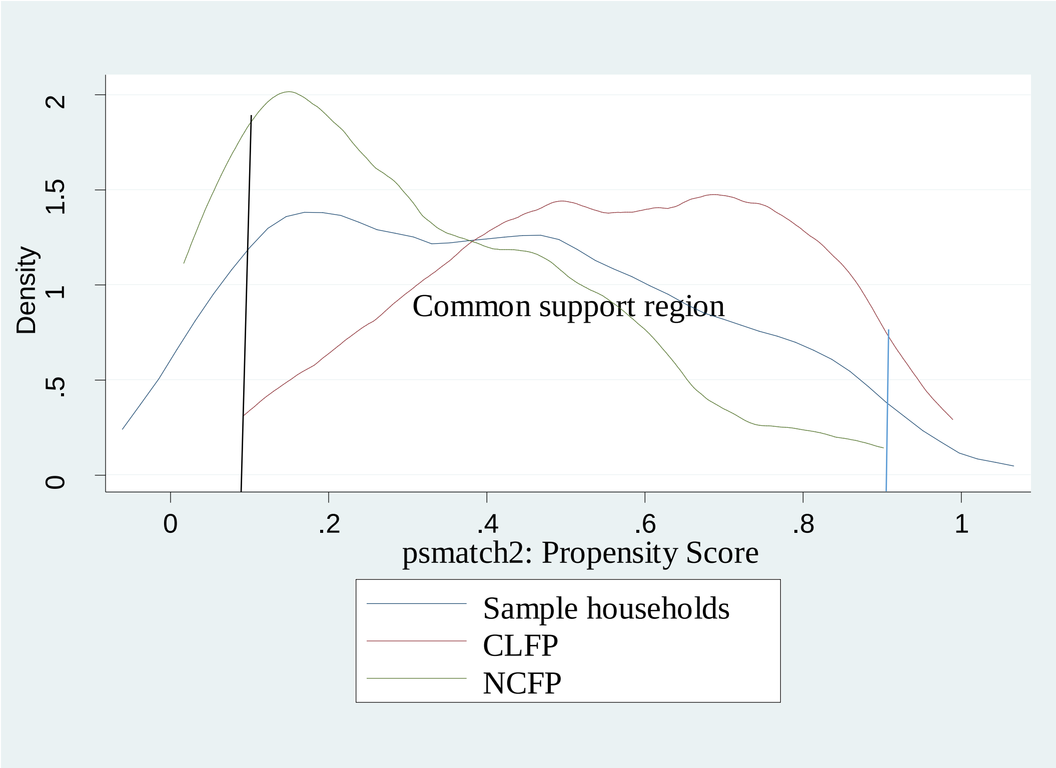


Figure 3. Density of propensity score distribution before matching

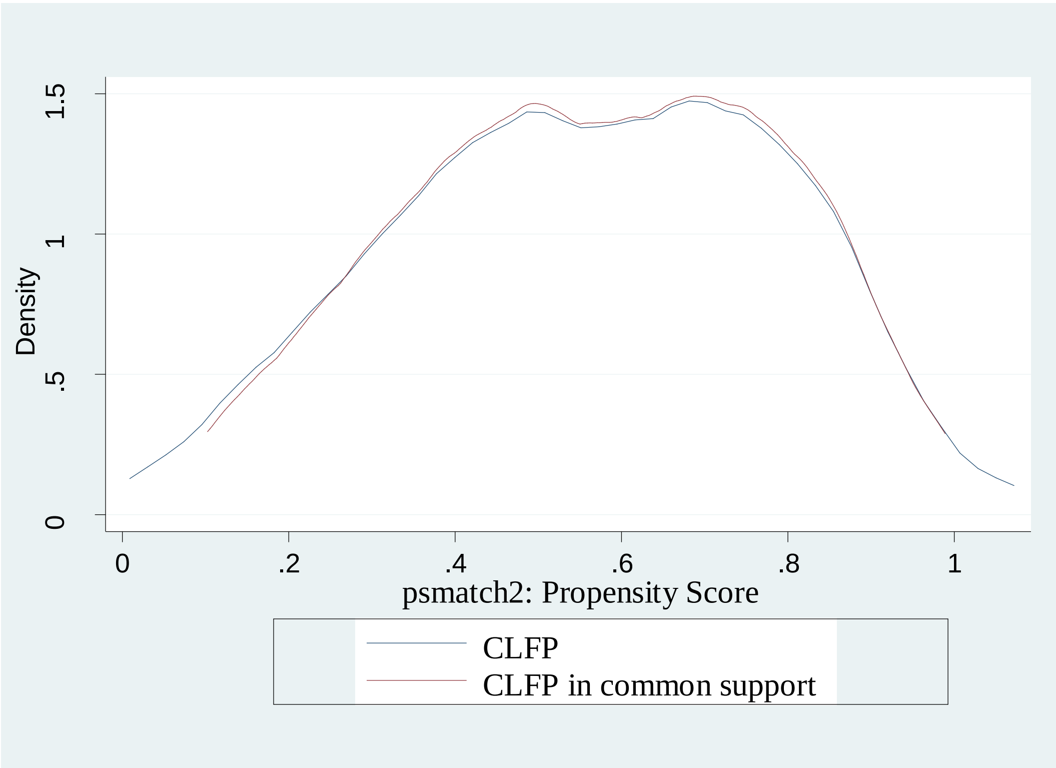


Figure 4. Kernel density of propensity scores of cluster farm participants (CLFP)

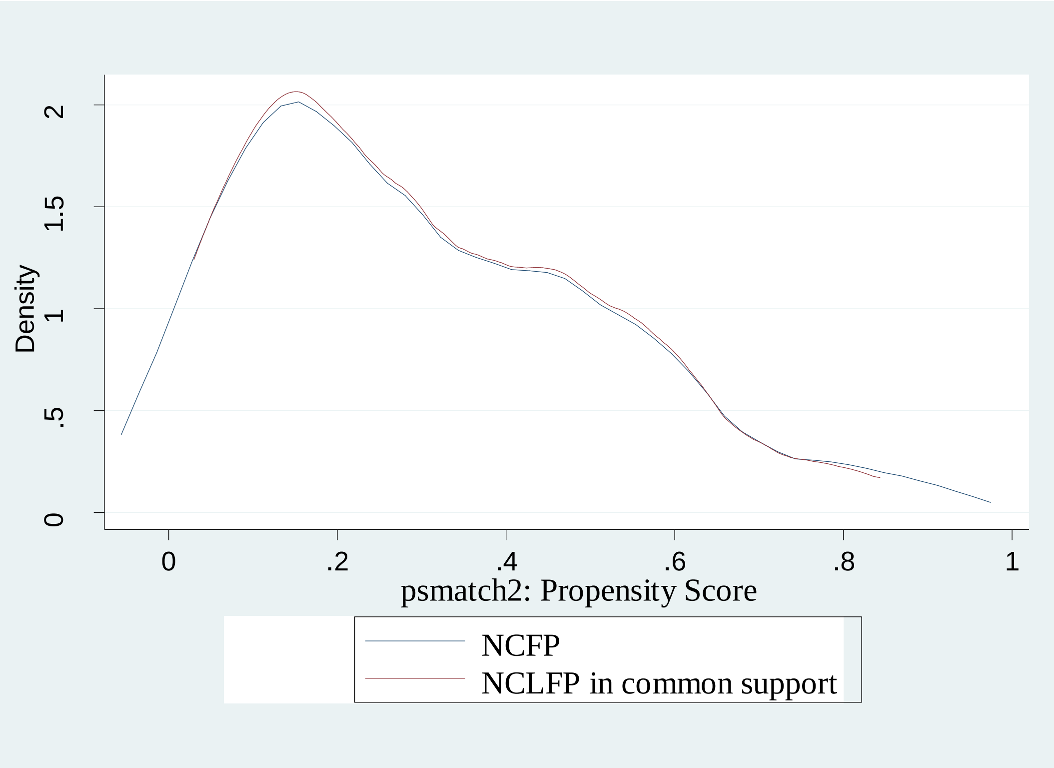


Figure 5. Kernel density of propensity scores of non-cluster farm participants (NCFP)

Furthermore, figures 4 and 5 above showed that the distribution of estimated propensity scores before and after the imposition of the common support condition for CLFP and NCFP households, respectively. As depicted in these figures, most of the CLFP households has propensity scores around 0.6 while majority of the NCFP households has propensity scores around 0.3. Therefore, the common support region, which is also examined using the density distribution for the two CLFP and NCLFP in line graphs suggests that there is a high chance of obtaining good matches.

4.2.3. Choice of matching algorithm and matching

Alternative matching estimators can be employed in matching the treatment and comparison groups in the common support region. Since we do not condition on all covariates but on the propensity score, it has to be checked if the matching procedure is able to balance the distribution of the relevant variables in both the control and treatment group. The basic idea of all approaches is to compare the situation before and after matching and check if there remain any differences after conditioning on the propensity score. If there are differences, matching on the score was not (completely) successful (Caliendo and Kopeinig , 2005).

The final choice of a matching estimator can be done by taking selection criterion either of Joint significance and Pseudo-R^2, standardized bias balancing test, matched sample size and t-test (Rosenbaum and Rubin, 1983;Caliendo and Kopeinig , 2005).

Table 9. Chi-square test for the joint significance of variables

Matching method	Sample	Pseudo R^2	LR chi^2	P>chi^2	Matched sample size
Kernel	Unmatched	0.210	57.64	0.000	182
	Matched	0.019	4.25	0.997	
Caliper	Unmatched	0.210	57.64	0.000	145
	Matched	0.087	17.33	0.299	
NN	Unmatched	0.208	57.64	0.000	182
	Matched	0.016	3.46	0.999	

Source: own calculation

As stated in Dehejia and Wahba, (2002), low pseudo R^2 value and a large matched sample size is a preferable matching algorism. Accordingly, joint significance and Pseudo-R^2, reduced from 0.210 to 0.019, 0.087 and 0.016 for kernel, caliper and NN respectively, as indicated in table 8 above, showed low pseudo-R^2 and the insignificant likelihood ratio tests indicates that both groups have the same distribution in covariates after matching.

Another selection criteria balancing test and is the most commonly adopted is the mean absolute standardized bias method recommended by Rosenbaum and Rubin (1983), in which the standardized difference should be smaller than 20% to prove the success in the matching procedure. In testing the balance of propensity score and covariates this kind of test is carried so as to know whether there is a statistical significant difference in the mean values of covariates between CLFP and those of NCFP. In this study, the mean bias after matching ranges between 0.9 and 16.6% which is smaller than Rosenbaum and Rubin (1983) recommended value of 20%. The t-values in the balancing test regression show that there should not be a statistical difference of the mean of covariates between CLFP and NCFP i.e. after matching all of the covariates are balanced.

Table 10. Characteristic difference between CLFP and NCLFP before and after matching

Variable	Before matching (N=203)				Kernel matching(N=180)			
	Treated	Control	%bias	t-test	Treated	Control	%bias	t-test
_pscore	.5595	.30468	117.5	8.27	.53975	.50292	17.0	1.11
Sexhh	.87952	.86667	3.8	0.27	.88608	.8832	0.9	0.06
Agehh	42.843	4.542	-18.6	-1.30	43.291	42.989	3.3	0.22
FamsizeNo	5.8675	5.7583	6.0	0.42	5.8608	5.6757	10.2	0.65
TLU	3.9365	3.8694	4.7	0.33	3.9711	3.8867	6.0	0.39
Farmsize	1.5352	1.4406	15.9	1.13	1.5148	1.4973	2.9	0.20
FEXP	26.398	25.492	9.8	0.69	26.19	25.27	10.0	0.65
DIstEXT	27.783	31.283	-26.1	-1.87	28.367	29.374	-7.5	-0.46
MproTrain	.79518	.45833	73.9	5.08	.78481	.76028	5.4	0.37
Credit	.6506	.53333	23.9	1.67	.64557	.60855	7.5	0.48
COOPMemb	.80723	.625	41.1	2.82	.81013	.84291	-7.4	-0.54
OFFfarm	.86747	.75	30.1	2.06	.86076	.85548	1.3	0.09
Education status								
Adult/Read write	.28916	.19167	22.8	1.62	.3038	.28042	5.5	0.32
1^0 education	16867	.1	20.1	1.44	.1519	.14353	2.5	0.15
2^0 education	.06024	.01667	22.7	1.68	.03797	.03564	1.2	0.08

Source: Own survey result

In all of the matching algorisms the t- test shows before matching, education, cooperative membership and off-farm engagement variables were significant, but there is insignificant difference between cluster farm participants and non-participants after matching. Therefore, the above matching indicates it is possible to compare the mean outcome of yield and commercialization between CLFP and NCLFP.

4.2.4. Impact of cluster farming on maize yield and commercialization

Table 10 reports the estimation results for the average treatment effect on the treated (ATT) of the outcome variable using PSM techniques under three matching estimators namely caliper, kernel and nearest neighbor. The impact estimates indicate that CLFP has a positive and significant impact on household maize yield (qt/ha) and maize commercialization (index). The main reason for this is that working in a group creates cooperation among the farmers and enables them to access market information, sharing experiences, improves technology adoption and improved agricultural practices and hence improves in productivity. Cluster farming increase use of agricultural technology, improves productivity enhance market participation as a result of surplus brought increase in productivity which in turn leads to the active market participation.

4.2.4.1.Impact of cluster farming on maize yield

The PSM method is employed in estimating the impact of cluster participation on maize productivity. The impacts are estimated using alternative estimators to ensure robustness. As indicated in table 10 all the matching estimators show that participation in cluster farming approach has a positive and statistically significant effect on maize productivity. The possible justification is that cluster farming enables farmers work in cooperation, share information and knowledge, increased use of improved maize varieties and mineral fertilizers, improved agronomic practices and increased extension services.

The study result in consistent with results reported in Nigeria on effect membership of group farming cooperatives on food production and productivity of farmers showed, membership of group farming cooperative helped to increase food production and productivity (Adekunle, 2018). This study result in conformity with result impacts of clustering vegetable farmers in the Philippines on production and income performance of cluster and non-cluster farmers shows increase in the volume of production higher incomes than non-cluster farmers (Rola-Rubzen , 2013).

The mean maize yield ATT result showed 48.11qt/ha using kernel algorism, nearest neighbor and using caliper matching algorism. Regarding the difference in yield between participants and non-participants, CLFP found to increase by 8.03 qt/ha(20.03%), 8.46/ha(21.34%) and 8.32/ha(21.12%) higher yield than their counterparts using kernel, nearest neighbor and caliper matching algorism, respectively. In all of the three algorisms average maize yield is significantly higher for cluster farm participant members than non-members with a significant level of 1%.

Table 11. Average treatment effect of CLF participation on household maize yield and commercialization different algorithms

Matching algorithm	Outcome Indicators	Mean outcomes		ATT difference	Percent change
		CLFP	NCFP		
Kernel	Yield	48.11	40.08	8.03 (1.86)***	20.03
Nearest N.		48.11	39.65	8.46(2.07)***	21.34
Caliper		48.11	39.72	8.39 (1.73)***	21.12
	Commercialization				
Kernel		41.49	30.13	11.36 (3.31)***	37.70
Nearest N.		41.49	29.57	11.92(3.59)***	40.31
Caliper		41.49	29.94	11.55(2.97)***	38.58

Source: Own calculation
Note. *** Denote significance 1% levels. Standard errors are in parentheses.

On both estimation cluster participation in the study area increased maize yield. The result showed that maize yield is higher than average average yield in Ethiopia 32.3 q/ha in 2013 (Tsedeke *et al*., 2017), 37 qt/ha (CSA, 2017) and 36 qt/ ha (FAO, 2017), 39.44qt/ha in 2017/18 cropping season (CSA, 2018). In addition, the cluster farm participants has higher productivity of maize compared to the regional average yield 39.83qt/ha (CSA, 2018).

4.2.4.2.Impact of cluster farming on maize commercialization level

Regarding level of maize commercialization the mean difference between participants and non-participants is also expressed by average treatment effect on the treated (ATT). The mean level of commercialization is 41.49% for all of the three methods (table 10). The mean ATT difference of maize that is commercialized is significantly higher for those with CLFP on average 11.36%, 11.92% and 11.55%, using kernel, nearest neighbor and caliper, respectively. There is a maximum of 40.31% change in increment commercialization of CLFP compared to their counterparts. The result is statistically significant at 1%, consistent with the supporting idea that clusters farming which is among collective action, increase productivity surplus and hence commercialization of smallholder farmers.

The above result supports the result of descriptive analysis level of commercialization. According to the classification by Samuel and Sharp (2008) and Tadele *et al*. (2017), the study area level of commercialization is categorized under semi-commercialized. The result is in consistent with findings of Yallew (2016) who found on his study the degree of commercialization of maize product in Guangua district of Awi Zone (Amhara region) an average of medium commercialization level.

As an indicator, the result is in consistent with other studies in Ethiopia. ATA (2018) report showed that there is an increase in productivity of malt barely in 2018 after smallholder farmers are participated in agricultural commercialization cluster. Louhichi *et al*. (2019) also showed the relatively positive effects of the cluster farming in increasing staple crop productivity and production, marketing decision, enhancing income, consumption and reducing poverty.

The above discussions indicate that cluster farm participation improves productivity and commercialization. This is due to that when farmers organized they can overcome problems related to production and marketing/commercialization by cooperating, learning each other to obtain collective strength that they do not have individually, accessing more credit, training and extension advice.

On their study Abera (2009) and Fischer Qaim (2012) on smallholder agricultural commercialization and collective action in Kenya found a positive and significant influence of membership in a group on the level of commercialization. The authors stated that membership to a farmers' group improves access to banana technology, training and output markets and consequently increasing expected profits.

4.2.5. Inverse probability weighted regression adjustment (IPWRA)

The PSM method is usually built on a strong assumption that observable characteristics determine selection to treatment and control groups (i.e. CIA). Thus, matching estimators are often prone to selection bias. This study used the inverse-probability-weighted-regression-adjustment estimator (IPWRA) to further check the robustness of treatment effect estimates.

IPWRA provides efficient estimates by allowing the modelling of both the outcome and the treatment equations (StataCorp, 2017). This allows us to control for selection bias at both the treatment and outcome stages. Thus, the IPWRA estimator has the double-robust property, which means that only one of the two models is correctly specified to consistently estimate the impact (StataCorp, 2017). IPWRA estimators use a model to predict treatment status, and they use another model to predict outcomes. Because IPWRA estimators have the double-robust property, only one of the two models must be correctly specified for the IPWRA estimator to be consistent.

This study also used IPWRA approach to identify the impacts of cluster farming on maize productivity and commercialization. In order to achieve this objective, the study applies the*'teffects IPWRA'* command in STAT 15.1 and estimates the model. Average Treatment Effect for Treated (ATET) are estimated to investigate the impacts of CLFP. Sex, education, age, family size, total livestock unit, number of plots, farm experience, training, access to improved seed, access to fertilizer, distance of main road to household head resident, distance of extension office to household residence, access to credit, cooperative membership and engage in off- farm are the covariates in outcome equations used in maize yield include. Outcome equation variables used for commercialization include sex, education status of the household head, age of the household head, family size, total livestock unit, farm size, farm experience, training, access to improved seed, access to fertilizer, total maize produce, market information, distance to nearby market, distance of extension from home, access to credit, cooperative membership and engage in off farm (appendix 5). The treatment model adopts same variables used in PSM treatment model estimation.

To check the robustness of the study results from PSM findings, the researcher employed IPWRA that address misspecification bias. Table 11 below report the mean differences of treatment effect estimates for cluster farming participation on maize productivity and commercialization using PSM and IPWRA estimation techniques. Table 11 shows thean outcome yield of CLFP and NCFP is 42.22 qt/ha and 41.63qt/ha, respectively. Participation in CLF increases maize yield by about 6.59 qt/ha or 15.83% change using the IPWRA specifications. It can be seen from the figure impact of CLF participation is robust for both estimation strategies, showing the important role of CLFP on maize productivity and commercialization outcome indicators.

The mean commercialization level of CLFP and NCFP is 42.07% and 27.89%., respectively. In addition CLFP increases household maize commercialization by 14.18% or 50.84% change using IPWRA specification. The result from IPWRA estimation shows that cluster farming positively affects maize productivity and commercialization at 1% level of significant.

These positive and significant results showing the consistency of the result compared with PSM result showed on table 10. These results achieved possibly due to collective farming/cluster farming are recognized as channels for the better extension, credit access , dissemination of information to rural farmers; hence they are expected to enhance smallholders' knowledge of improved technologies and management practices leading to higher adoption and maize productivity, which intern creates surplus for commercialization.

Agro-clusters could stimulate farmers to earn more benefits in terms of output improvements. Cluster farming improves farmer's cooperation as it is indicated in the descriptive analysis implying that cooperation of farmers will increase production surplus for commercialization. There is a similar finding Wardhana *et al*.(2017) , indicates farmers could take some advantages from agro-clusters, such as knowledge and information exchange and more opportunities of cooperation, in order to boost their productivity; and thus increase farmers' income through commercialization.

Table 12. Average treatment effects on treated (ATT) using inverse probability weighted regression adjustment (IPWRA) model

Outcome indicators	Mean outcomes		ATT Difference	Percent
	CLFP	NCFP	CLFP vs NCFP	change
Maize yield(qt/ha)	48.22	41.63	6.59(1.67)***	15.83
Maize commercialization (HCI %)	42.07	27.89	14.18(2.04)***	50.84

Source: own survey result

Robust standard errors are reported in parentheses, *** represent statistical significance at the 1% levels.

The estimation results in table 11 showed that the mean difference maize yield and maize commercialization positively and significantly higher in favor of cluster farm participants. It can be seen easily from the above results which verify that the result of the study is robust across the two estimation approaches and showed consistent findings.

In all of the estimation methods, CLFP has higher level of commercialization but not transformed into commercialized level.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

Ethiopian agriculture is dominated by smallholder farmers who accounts for 96 percept of total area cultivated land and generated 95 percept of total production for the main crops. Ethiopian agriculture is dominated by smallholder subsistence which is constrained by low yields, low productivity and lack of access to markets. Enhancing productivity and commercialization among smallholder farmers is widely perceived as a key strategy for rural development, poverty reduction, and food security. Commercialization of smallholder farming is getting priority in in Ethiopia in general and Amhara region in particularas it has benn reflected in the policy agenda in Ethiopia. Recently agricultural cluster farming approach is being practiced as an effort to change and improve smallholder subsistence farming productivity and income by transforming subsistence farming to market oriented farming. This current agricultural cluster program focused on increasing agricultural productivity and income through market-oriented approach.

The study has assessed the factors affecting cluster farming participation, the impact cluster farming participation on maize productivity and commercialization of farm households using primary data from Dera woreda, in south Gonar, Amhara Regional State. The study carried out to evaluate the impact of the cluster farming intervention program as government spends substantial amount of investment, understanding its effects on the beneficiaries (farmers) is very important. The study utilized cross-sectional data farm household level collected in 2019. A multistage sampling procedure is applied to select a total of 203 respondents from four kebeles in the study area. The method of analysis employed both descriptive and econometrics methods. The impact of cluster farming participation is estimated by applying propensity score matching (PSM) and inverse probability weighted regression adjustment (IPWRA). In the first step PSM is applied to estimate the decision to cluster farming participation (CLFP) and average treatment effects (ATT) on outcome variables yield and commercialization is estimated both PSM and inverse-probability weighted regression adjustment.

The results of the descriptive statistics reviles that CLFP and NCLFP are statistically significantly different in terms of marital status, education level, access to improved seed, proper/correct input use and practices, cooperative membership, participating in off-farm activities, maize yield, commercialization, fertilizer amount, market distance, road distance, distance to extension office**,** perceived fertilizer price, perceived seed price and post-harvest loss.

The descriptive result also shows average productivity of maize in the study area for total households, cluster farm participants and non-participants is 43.31qt/ha, 48.21qt/ha and 39.91 qt/ha respectively with a mean difference of 8.31qt/ha (39.39% change). The result indicates cluster farm participants produce more maize than their counterparts and with significance mean difference between the two at 1% level.

The results from the descriptive analysis revealed that the from total sample households 34.51% of maize produce is sold. This result shows the level of commercialization is medium. Cluster farm participants sold 42.07% while non-participants sold 29.28% of maize produce with a mean difference of 12.73 % (43.48% changes). The significantly more of the subsistence and less-commercialized farmers are non-cluster farm participants. CLFP are more commercialized than NCLFP and significantly higher to NCFP. Cluster farm participants sold more maize compared to non-cluster farm participants and there is significant difference between them at 1% level however, they also not commercialized yet.

It can be easily understand that participation in cluster farming resulted in an increase in maize productivity and commercialization of the participant farmers than those of non-participants. The study can conclude cluster farming is effective in improving maize productivity and maize commercialization.

Econometric analysis is done using propensity score matching (PSM) and inverse probability weighted regression adjustment (IPWRA). The econometric result analysis showed education level (adult/traditional and primary education level), farmer experience, training access, cooperative membership and off-farm activity engagement affected participation positively whereas age of household head and distance of extension office negatively and significantly influenced cluster farm participation decision.

Before addressing the impact of cluster farming participation on maize productivity and commercialization, estimating propensity scores and common support condition, choice of matching algorithm and balancing test is done by taking selection criterion either of joint significance and Pseudo-R^2, standardized bias balancing test, matched sample size and t-test criteria's, in order to obtain the reliability of the study and its result.

The mean maize productivity (ATT) result showed 48.11qt/ha using kernel algorism, nearest neighbor and using caliper matching algorism. Regarding the difference in productivity between participants and non-participants, the mean maize productivity of CLFP and NCFP is 48.22qt/ha and 41.63qt/ha, respectively. CLFP found to increase by 8.03 qt/ha (20.03%), 8.46/ha (21.34%) and 8.32/ha (21.12%) higher productivity than their counterparts using kernel, nearest neighbor and caliper matching algorism, respectively. In all of the three algorisms average maize productivity is significantly higher for cluster farm participant members than non-members with a significant level of 1%.

The mean level of commercialization is 41.49% for all of the three methods. The mean ATT difference of maize that is commercialized is significantly higher for those with CLFP on average 11.36%, 11.92% and 11.55%, using kernel, nearest neighbor and caliper, respectively. There is a maximum of 40.31% change in increment commercialization of CLFP compared to their counterparts. The result is statistically significant at 1%, consistent with the showing cluster farming participation significant role in commercialization of smallholder farmers.

The results of PSM are compared with IPWRA results to check the consistency of the result across the two estimation methods. The result of the study shows participation in CLF increases maize productivity by about 6.59 qt/ha or 15.83% change using the IPWRA specifications. This shows impact of CLF participation is robust for both estimation strategies, showing the significant role of CLFP on enhancing maize productivity. The mean commercialization level of CLFP and NCFP is 42.07% and 27.89%., respectively. In addition CLFP increases household maize commercialization by 14.18% or 50.84% change using IPWRA specification. The result from IPWRA estimation shows that cluster farming positively affects maize productivity and hence commercialization at 1% level of significant.

The result showed that maize productivity in the study area is higher than average yield in Ethiopia 32.3 q/ha in 2013 (Tsedeke *et al*., 2017), 37 qt/ha (CSA, 2017) and 36 qt/ ha (FAO, 2017), 39.44qt/ha in 2017/18 cropping season (CSA, 2018). In addition, the cluster farm participants has higher productivity of maize compared to the regional average yield 39.83qt/ha (CSA, 2018).

Cluster farm participation helps farmers to increase productivity and commercialization in the study area. The overall commercialization level of the study area is categorized under medium level of commercialization classification, and yet it is not transformed to commercialized level.

The impact estimation from the propensity score matching suggests that cluster farming participants have significantly higher yield and commercialization than non-cluster participants. The result of this study indicated that cluster farming approach is effective in improving maize productivity and commercialization. The result from the inverse probability weighted regression adjustment also confirms the result from propensity score matching. Hence, cluster farming has a positive and significant effect on improving maize yield and commercialization. It also indicates cluster farming is on the right path in transforming subsistence smallholder production farming to market oriented farming.

5.2. Recommendation

Based on the findings of the study, the following recommendations were forwarded:

- Educational status of the household head positively and significantly affected households' decision to join in cluster farming. This indicates that education has influence on farmers' productivity and commercialization. Adult education and primary level education impacted the participation decision of farmers. Therefore, investing and strengthening the formal education and encouraging informal education also should be given priority by the government. Therefore, the government and other stakeholders required to enhance their effort in increasing educational level of participants, non- participant farmers both to informal adult education/tradition, training and awareness creation.

- Distance of extension office from farmer home is found negatively and significantly affected cluster farming participation. It is known from literature that strengthening the extension system can also help in providing relevant information, which in turn can help farmers make informed choices. The nearer extension office the more extension participation of farmers in cluster farming, suggesting that encouraging farmers to participate cluster farming can enhance productivity and thereby commercializing households. Therefore, positive impact of extension on farmers' participation, productivity and commercialization could be reinforced if, for instance, extension office is expand and outreached to farmers.

- Experience in maize cultivation and farming found to be positively and significantly influenced cluster farm participation and hence, government focus in field day and experience sharing will encourage others to join cluster farming

- Training found to be positively and significantly affected cluster farming participation and hence productivity, which intern creates surplus and commercialization. Therefore agricultural office and other stakeholders such as ATA, NGO strengthen their effort to address the training demand and interest of the farmers. The farmer training should be designed and focused on method of sowing, improved input use and agronomic practices, marketing and post - harvest technology and management. Access to fertilizer and seed use cannot give a guarantee for high yield, but also correct use of inputs and agronomic practices is equally important. Therefore, access farmers with training, credit, improved farm machinery and implements to apply the input technologies and improved agronomic practices successful promotion, adoption and scaling up properly.

- The study shows beneficial impact of cooperative membership is stronger for cluster farm participants. Farmers who are a member of cooperatives hive higher probability to participate in cluster farming. Therefore, positive impacts cooperative services on farmers' productivity and commercialization realized if strong market linkage is created between producers and consumers through cooperatives. Thus, strengthening, expanding, and supporting cooperatives are recommended. Creating awareness to farmers about the benefits cooperatives and hence built confidence in the market linkage between the farmers and buyer (cooperative).

- Participating in off-farm activities found to be related positively and significantly with probability of cluster participation. An increase in off-farm engagement increases the probability of joining cluster farming. Hence, the government and other stakeholders encourage off-farm activities that enhance farm activities which support higher farm productivity commercialization. The off-farm activities recommended should lucrative farm activities that can add total production. Therefore, the government and other stake holders should search for potentials of for off- farm activities in the study area, deliver training, credit access and infrastructure to enhance off-farm/non-farm activities that have a positive impact on participation and improving maize productivity and commercialization.

- Effort has to be made to tackle factors that are impeding non-cluster farm participant's households from participating in cluster farming.

- Cluster farming is found positively and significantly increased maize yield and commercialization. This implies the government policy is on the right path to transform smallholders from subsistence oriented to market oriented farming system, evidenced by proving to have an encouraging result in enhancing the maize productivity and commercialization of cluster farming participants. Therefore it is important to strengthen the existing clusters, scale up the experience, and encourage participation of farmers by raising awareness through field visits, experience sharing, training, strengthening education, cooperatives and off-farm income.

- Finally, this study focused on only one woreda in one zone in Amhara region, with relatively small sample; hence the results cannot be generalized at the regional and national level. Hence to get more representative figure about cluster farming participation decision and its impact on maize yield and commercialization at regional and national level it is necessary to conduct similar studies using more representative locations and wider sample size coverage.

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APPENDIX

Appendix 1. VIF test result (estat VIF)

Variable	VIF	1/VIF
Sexhh	1.23	0.310638
Agehh	3.21	0.315802
FamsizeNo	1.51	0.616280
TLU	1.63	0.675106
Farmsize	1.41	0.720369
FEXP	3.25	0.799285
DIstEXT	1.18	0.806360
MproTrain	1.26	0.816444
Credit	1.16	0.853612
COOPMemb	1.26	0.881162
OFFfarm	1.03	0.883454
Eduhh		
Read write	1.08	0.924312
Primary	1.17	0.852469
Secondary	1.19	0.840082
Mean VIF	1.54	

Appendix 2. Breusch-Pagan / Cook-Weisberg test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of CLFP

$chi^2(1)$ = 3.79

Prob > chi^2 = 0.0516

Appendix 3. Treatment result of PSM of Maize yield and commercialization

Nearest neighbour

Variable	Sample	Treated	Control	Difference	S.E.	t-test
Maize yield	Unmatched	48.2148594	39.9097222	8.305	1.58	5.26
	ATT	48.1118143	39.650211	9.0583685	2.07	4.10
	ATU	39.9620462	46.7561056	6.79405941		
	ATE			7.52592593		
Maize commercialization	Unmatched	42.07027	29.2795756	12.7906944	2.79	4.58
	ATT	41.4850163	29.5698992	11.9151171	3.59	3.52
	ATU	29.5311732	38.0193069	8.48813367		
	ATE			.99219863		

Caliper

Variable Sample	Treated	Controls	Difference	S.E.	T-stat
HHcommerce Unmatched	42.070	29.280	12.791	2.793	4.580
ATT	41.485	29.937	11.548	2.969	3.890
ATU	29.161	40.595	11.434	.	.
ATE		11.496	.		.

Variable Sample	Treated	Controls	Difference	S.E.	T-stat
Myieldha Unmatched	48.215	39.910	8.305	1.580	5.260
ATT	48.112	39.724	8.388	1.726	4.860
ATU	40.078	49.058	8.980	.	.
ATE		8.657		.	.

Kernel

Variable	Sample	Treated	Control	Difference	S.E.	t-test
Maize yield	Unmatched	48.2148	39.9097	8.305137	1.579602	5.26
	ATT	48.11181	40.084725	8.0270887	1.856916	4.32
	ATU	39.96204	47.096999	7.1349530		
	ATE			7.5265014		
Maize commercialization	Unmatched	42.0702	29.279575	12.790694	2.792870	4.58
	ATT	41.48501	30.126143	11.358872	3.311452	3.43
	ATU	29.53117	39.650996	10.119822		
	ATE			10.663628		

Appendix 4. Inverse probability weighing regression adjustment (IPWRA) result- maize yield

teffects ipwra (Myieldha Sexhh Agehh FamsizeNo TLU Farmsize NOPlot FEXP MproTrain Impseed Fertilizer ROADDIST DIstEXT Credit COOPMemb OFFfarm i.Eduhh) (CLFP Sexhh Agehh FamsizeNo TLU Farmsize FEXP MproTrain DIstEXT Credit COOPMemb OFFfarm i.Eduhh), atet aequations

Iteration 0: EE criterion = 1.208e-25

Iteration 1: EE criterion = 9.977e-30

Treatment-effects estimation Number of obs = 203

Estimator : IPW regression adjustment

Outcome model: linear

Treatment model: logit

Appendix 4. Treatment-effects estimation of maize yield Using IPWRA

Myieldha	**Coef.**	**St.Err.**	**t-value**	**p-value**	**[95% Conf**	**Interval]**	**Sig**
ATET CLFP(Yes vs No)	6.589	1.672	3.94	0	3.312	9.867	***
POmean CLFP No	41.625	1.088	38.27	0	39.494	43.757	***
OMEO Sexhh	-6.181	3.148	-1.96	.05	-12.351	-.011	**
Agehh	.259	.187	1.38	.167	-.108	.626	
FamsizeNo	.952	.632	1.51	.132	-.288	2.191	
TLU	1.154	.893	1.29	.196	-.596	2.903	
Farmsize	.424	1.94	0.22	.827	-3.378	4.225	
NOPlot	.362	.82	0.44	.658	-1.244	1.969	
FEXP	-.223	.2	-1.12	.264	-.615	.169	
MproTrain	4.569	1.517	3.01	.003	1.597	7.542	***
Impseed	6.941	1.786	3.89	0	3.441	10.442	***
Fertilizer	1.647	2.154	0.76	.445	-2.575	5.87	
ROADDIST	.021	.023	0.93	.353	-.024	.066	
DIstEXT	.024	.104	0.23	.815	-.18	.229	
Credit	4.116	1.738	2.37	.018	.709	7.523	**
COOPMemb	-4.499	2.072	-2.17	.03	-8.56	-.438	**
OFFfarm	6.224	2.539	2.45	.014	1.247	11.201	**
1b.Eduhh	0	.	.	.	.	.	
2.Eduhh	1.647	1.901	0.87	.386	-2.079	5.372	
3.Eduhh	-1.854	1.965	-0.94	.345	-5.705	1.997	
4.Eduhh	7.215	3.396	2.12	.034	.558	13.871	**
Constant	12.006	8.133	1.48	.14	-3.935	27.947	

**** p<.01, ** p<.05, * p<.1*

Appendix 4. Treatment-effects estimation of maize yield Using IPWRA continued cont'd…

OME1 Sexhh	-7.05	3.958	-1.78	.075	-14.808	.708	*
Agehh	.03	.156	0.19	.847	-.276	.336	
FamsizeNo	1.422	.866	1.64	.1	-.275	3.118	
TLU	-.465	.899	-0.52	.605	-2.227	1.298	
Farmsize	-.172	1.542	-0.11	.911	-3.195	2.851	
NOPlot	-.399	.714	-0.56	.577	-1.798	1.001	
FEXP	-.119	.161	-0.74	.457	-.434	.195	
MproTrain	.049	2.676	0.02	.985	-5.196	5.294	
Impseed	7.321	2.384	3.07	.002	2.648	11.994	***
Fertilizer	10.376	3.361	3.09	.002	3.787	16.964	***
ROADDIST	-.072	.053	-1.36	.175	-.176	.032	
DIstEXT	.129	.069	1.87	.061	-.006	.264	*
Credit	9.185	1.914	4.80	0	5.433	12.937	***
COOPMemb	8.367	2.905	2.88	.004	2.673	14.062	***
OFFfarm	-6.07	3.242	-1.87	.061	-12.424	.284	*
1b.Eduhh	0	.	.	.	.	.	
2.Eduhh	-.474	2.572	-0.18	.854	-5.514	4.566	
3.Eduhh	.05	2.493	0.02	.984	-4.837	4.937	
4.Eduhh	5.791	6.348	0.91	.362	-6.652	18.233	
Constant	26.497	7.728	3.43	.001	11.351	41.643	***
TME1 Sexhh	-.028	.518	-0.05	.956	-1.043	.986	
Agehh	-.104	.039	-2.65	.008	-.18	-.027	***
FamsizeNo	.092	.111	0.83	.406	-.126	.31	
TLU	-.105	.143	-0.73	.465	-.386	.176	
Farmsize	.138	.34	0.41	.684	-.527	.804	
FEXP	.101	.041	2.47	.014	.021	.181	**
MproTrain	1.435	.404	3.55	0	.644	2.226	***
DIstEXT	-.024	.015	-1.57	.116	-.054	.006	
Credit	.436	.388	1.12	.262	-.325	1.197	
COOPMemb	.757	.406	1.86	.062	-.039	1.553	*
OFFfarm	.973	.413	2.35	.019	.163	1.783	**
1.Eduhh illiterate	0	.	.	.	.	.	
2Adult/read/write	.807	.4	2.02	.044	.022	1.591	**
3. 1^0 education	1.205	.594	2.03	.043	.041	2.369	**
4. 2^0 education and above	1.346	1.009	1.33	.182	-.632	3.325	
Constant	-.954	1.36	-0.70	.483	-3.619	1.711	
Mean dependent var		43.305	SD dependent var			11.772	

**** p<.01, ** p<.05, * p<.1*

NB. POmean= potential outcome mean, ATET= Average treatment effect on treated, OMEo= the regression result of outcome mean for control groups, OME1= the regression result of the outcome mean for the treatment group, TME1= the treatment outcome model result

Inverse probability weighing regression adjustment (IPWRA) result- maize commercialization

. teffects ipwra (HHcommerce Sexhh Agehh FamsizeNo TLU Farmsize FEXP Mprodntotal Mktinfo DIstEXT Credit MarketDist COOPMemb OFFfarm i.Eduhh) (CLFP Sexhh Agehh FamsizeNo TLU Farmsize FEXP MproTrain DIstEXT Credit COOPMemb OFFfarm i.Eduhh), atet aequations

Iteration 0: EE criterion = 3.019e-25

Iteration 1: EE criterion = 1.015e-29

Treatment-effects estimation Number of obs = 203

Estimator : IPW regression adjustment

Outcome model : linear

Treatment model: logit

Appendix 5. Inverse probability weighing regression adjustment (IPWRA) result- maize commercialization

HHcommerce	**Coef.**	**St.Err.**	**t-value**	**p-value**	**[95% Conf**	**Interval]**	**Sig**
ATET CLFP(Yes vs No)	14.202	2.948	4.82	0	8.424	19.981	***
POmean CLFP No	27.868	2.039	13.67	0	23.872	31.864	***
OME0 Sexhh	1.86	8.203	0.23	.821	-14.218	17.938	
Agehh	-.313	.426	-0.74	.461	-1.148	.521	
FamsizeNo	1.002	1.287	0.78	.436	-1.52	3.525	
TLU	-.926	1.229	-0.75	.451	-3.334	1.482	
Farmsize	9.931	5.493	1.81	.071	-.834	20.697	*
FEXP	-.038	.455	-0.08	.933	-.929	.853	
Mprodntotal	-.409	.338	-1.21	.226	-1.07	.253	
Mktinfo	1.968	4.364	0.45	.652	-6.585	10.521	
DIstEXT	.14	.172	0.82	.414	-.196	.477	
Credit	1.844	4.565	0.40	.686	-7.104	10.791	
MarketDist	-.013	.053	-0.25	.802	-.117	.091	
COOPMemb	-3.025	5.211	-0.58	.562	-13.238	7.188	
OFFfarm	-14.86	4.16	-3.57	0	-23.013	-6.707	***
1. Eduhh Illiterate	0	.	.	.	.	.	
2. adult/Read write	-1.153	3.26	-0.35	.724	-7.542	5.237	
3.1^{0} education	3.151	5.153	0.61	.541	-6.948	13.25	
4.2^{0} education	2.124	12.619	0.17	.866	-22.609	26.857	
Constant	42.939	14.048	3.06	.002	15.406	70.473	***

Appendix5. Inverse probability weighing regression adjustment (IPWRA) result- maize commercialization cont'd…

HHcommerce	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
OME1 Sexhh	-.01	6.291	-0.00	.999	-12.339	12.32	
Agehh	-.333	.325	-1.02	.306	-.969	.304	
FamsizeNo	-.533	1.587	-0.34	.737	-3.643	2.577	
TLU	-2.147	2.213	-0.97	.332	-6.486	2.191	
Farmsize	4.408	3.708	1.19	.235	-2.86	11.675	
FEXP	.054	.285	0.19	.85	-.504	.612	
Mprodntotal	.194	.238	0.81	.415	-.273	.661	
Mktinfo	3.679	5.424	0.68	.498	-6.952	14.31	
DIstEXT	-.187	.162	-1.15	.249	-.506	.131	
Credit	11.609	5.635	2.06	.039	.564	22.653	**
MarketDist	-.117	.055	-2.14	.033	-.225	-.01	**
COOPMemb	4.243	5.827	0.73	.466	-7.177	15.663	
OFFfarm	-30.268	6.961	-4.35	0	-43.91	-16.625	***
1.Eduhh illiterate	0	.	.	.	.	.	
2Adult/read/write	1.757	5.158	0.34	.733	-8.353	11.866	
3. 1^0 education	5.837	6.897	0.85	.397	-7.682	19.356	
4. 2^0 education and above	.504	9.043	0.06	.956	-17.219	18.227	
Constant	80.245	17.875	4.49	0	45.211	115.279	***
TME1 Sexhh	-.028	.518	-0.05	.956	-1.043	.986	
Agehh	-.104	.039	-2.65	.008	-.18	-.027	***
FamsizeNo	.092	.111	0.83	.406	-.126	.31	
TLU	-.105	.143	-0.73	.465	-.386	.176	
Farmsize	.138	.34	0.41	.684	-.527	.804	
FEXP	.101	.041	2.47	.014	.021	.181	**
MproTrain	1.435	.404	3.55	0	.644	2.226	***
DIstEXT	-.024	.015	-1.57	.116	-.054	.006	
Credit	.436	.388	1.12	.262	-.325	1.197	
COOPMemb	.757	.406	1.86	.062	-.039	1.553	*
OFFfarm	.973	.413	2.35	.019	.163	1.783	**
1.Eduhh illiterate	0	.	.	.	.	.	
2Adult/read/write	.807	.4	2.02	.044	.022	1.591	**
3. 1^0 education	1.205	.594	2.03	.043	.041	2.369	**
4. 2^0 education and above	1.346	1.009	1.33	.182	-.632	3.325	
Constant	-.954	1.36	-0.70	.483	-3.619	1.711	
Mean dependent var		34.509	SD dependent var			20.507	

**** p<.01, ** p<.05, * p<.1*

Appendix 6: Household Survey questionnaire

Dear respondent,

Your response to this questionnaire will serve as source of information to the research paper to be done for thesis entitled ***'Impact of cluster farming on farmers' productivity and commercialization, a case of Dera Wereda, South Gondar, Ethiopia'***. Any response you provide here is strictly confidential and will used only for the research purpose. Your honest response and correct (genuine) answer is very important for the reliable research outcome to benefit of the farmers, Wereda and the region. Thank you in advance for your kind cooperation and dedicating your time.

PART I: General Information

Date of interview -------------------

Kebele…………………Agro-ecology :dega……. Weyna dega…… kola…….

Part II. Household characteristics

1. Gender of the household head 1.Male. ………….. 0. Female
2. Age of household head …………………..Years
3. Marital status
    1. Single and others (Widowed, Separated 2. Married
4. Level of education of the farmer
   1.illiterate 2. Adult education 3.Primary education 4. Secondary education and above
5. Family size, Total…………………….

Sex	Number
Male	
Female	

Part III. Cluster farming participation

6. Do you participate in maize cluster farming?
    1. Yes ……………………………. 0. No ……………………
7. How do you define cluster farming

……………………………………………………………………………………………
…………………………………………………………………………………………

8. Is there any benefit you received after CLF participant?
    1. Yes…… 0.No……..

9. How did you become a cluster farming participant? What encouraged you to participate?
    a. By government selection/intervention
    b. By my own initiation
    c. Other (please specify)…………..
10. What were the criteria to become a cluster farming participant?

……………………………………………………………………………………………
…………………………………………………………………………………………..

Part IV. Agricultural production and input use

11. What is the total size of livestock you owned?

Animal	Number
Ox	
Cow	
Donkey	
Horse	
Sheep	
Goat	
Hen	

12. Total land size in ha (Timad)…………….. No of plots ………………………

13. Give the actual area allocated and yield to different crop in the last meher farming season(2011/12)

Crop	Area in ha or timad	Yield
maize		
teff		
wheat		
millet		
Others(specify)		

14. Farming experience in full years (head of household's) ______years

15. How far is your maize plot form your home?........................... minutes or ……….. km

16. Did you use improved maize seed varieties in year 2011/12 cropping season?

    1. Yes...... 0. No................

17. If your answer is no for Q 16, why not using improved seed?

……………………………………………………………………………………………….

18. If yes for question 16 how much quantity maize seed per timad do you apply during sowing?

    a. Quantity and unit ……………………………
    b. Name of improved maize seed/variety ……………………..

    27. If you use improved seed, where do you buy/ get the seeds?

19. Did you use maize row planting method in 2011/12 meher season?

    1. Yes………… 0. No………..

20. If you say no for question 19, why not practiced row planting?

………………………………………………………………………………………………

……………………………………………………………………………………………….

21. Did you apply fertilizer for maize production in 2011/12?

    1. Yes………………… 0. No ……………………………..

22. If your answer is no for question 21, why?

....

....

23. If yes for question 21 what is the type, quantity, application method and application time of fertilizer used for maize production in 2011/12?

Fertilizer Type	Quantity and unit	Application type	Application time
NPS			
Urea			
Compost			
Other (specify)			

24. Did you utilize chemical inputs like herbicides, pesticides in production of maize in 2011?
1. Yes……………….. 0. No…………………….
24. If you say yes for question 24, how much input used in 2011/12 season?
1. Herbicides……….litre
2. Pesticides…….liter
1.
25. Do you get inputs supplied to you at the time when required?
1. Yes …… 0. No ……………………..

Part V. Market access and Institutional Characteristics

26. How much of maize did you harvest/produced 2011/12 E.C?
Amount in quintal…………………….. or local unit……………….
27. Did you sell maize to market from 2011 /12 production year?
1. Yes …….. 0. No ………………………
28. If you no for question 27 please explain why
....
29. If yes for question 27 what is quantity of maize sold in 2011/12?
Quantity of maize sold……. Quintal or local unit…………
30. Distance to the nearest market in km………………….. or in minutes…………………….
31. How did you sale your maize produce?
1. Directly to the purchaser/traders 2. Through brokers 3. Cooperatives 4. Others
32. In general, how do you evaluate the average sales price of maize in 2011/12?
1. Lower 2. Fair 3. Higher
33. How far is the nearest market where you buy your farming inputs?
…… km or……….walking minutes
34. Distance from household head residence to nearest all weather road
km ………. or minutes ……
35. Where do you sell your maize?
- ✓ Local buyer
- ✓ Cooperatives
- ✓ Local warehouse
- ✓ Town market
- ✓ Other (specify)

36. Who provided you a better price when you sale maize?
- ✓ Local buyer
- ✓ Cooperatives
- ✓ Traders at local warehouse
- ✓ Others (specify)………………………………………………

37. Do you have access to market information?

    1. Yes …………….. 0. No……………….

38. Have you ever received training on maize production?

    1. Yes ……. 0. No ………

39. If your answer for question 38 is yes , specify the type of training and the organization responsible for the training

Training type	**Organization**

40. Has the training been helpful in terms of gaining knowledge about production of maize?

    1. Yes ……. 0. No…………….

41. How far is your home from extension office?

    Distance ……………..km or ………………….walking minutes

42. Did you apply recommended inputs and agricultural management practices for maize correctly? 1. Yes 0 . No
43. Do you have the access to get credit?

    1. Yes 0. No

44. Have you participated in off-farm / non-farm activities? 1. Yes 0. No.
45. Are you a member or farmers' cooperative?

    1. Yes………. 0. No……….

46. How do you evaluate the stakeholder's role for maize productivity and marketing?

----

47. Did you learn from other farmers? 1. Yes ……… 0.No…..
48. Do you work with cooperation with others? 1. Yes 0. No
49. Did you perceive fertilizer price is high? 1. Yes 0. No
50. Did you perceive seed price is high? 1. Yes 0. No
51. Did you faced with post-harvest loss? 1. Yes 0. No
52. Did you market linkage problem for your maize produce 1. Yes 0. No.
53. Did you engaged in contract farming/ selling for maize produce? 1.Yes 0. No

Key informant interview guide

1. What are major crops produced in the area?
2. What is the total size of land area in the wereda covered by cluster farming?
3. How many hectare of land is potentially suitable for production of maize in the Wereda?
4. What is the total land covered by farmers production cluster for the following crops in 20011/12 Ethiopian calendar cropping season?

Crop	Cluster area in 2011/12(ha)
Maize	
Teff	
Wheat	
Other	

5. What is the number of farming/ploughing frequency recommended by the maize package?
6. What is the recommended amount of fertilizer, seed type, fertilizer and application time and method?

Fertilizer type	Amount	
	For 1 Timad	For 1 ha
NPS		
Urea		
DAP		
Compost		
Other (please specify)		

Fertilizer type	Application type	Application time
NPS		
Urea		
DAP		
Compost		

7. What is the recommended amount of maize seed type and amount per ha ?

Seed type………………………………

For row planting/sowing: seed amount per ha…………

Broadcast sowing: seed amount per/ha……………..

8. What is cluster farming?
9. Why form cluster farms?
10. When was the cluster formed?
11. How was the cluster formed and organized?
12. What was (were) the motivation/s to form the cluster?
13. What is the average size of these farms?
14. Who organized these clusters?
15. Why some farmers are not participating in cluster farming?
16. What was your agency's role/support in the FPC?
17. How do you see the linkage of these stakeholders/actors?
18. What is the benefit of cluster farming?
19. How does the cluster consolidate maize products? Who consolidates it?
20. What are the disadvantages of cluster farming?
21. Who is the primary buyer of maize from the farmers?
22. How do the cluster farmers and individual farmers control quality of maize produce?
23. Is there any contractual agreement/contract farming for maize produce?
    - If not why?
24. What would you consider to be the most essential elements for the success of the CLF?
25. What is your recommendation about sustainability of the cluster farming?
26. What is your assessment on improved technology use in the cluster farming?
27. Do farmers get enough support from development agents? What type of support?
28. What is your view on credit access for your maize production/farmer?
29. Do farmers get fertilizer, improved seed and chemicals according to their request? If no discuss why?

30. Do farmers have access to maize market information (when, what amount, to whom, at what price to sale)?
31. What are the existing good opportunities that encourage maize production and marketing in your area?
32. What efforts done to integrate the smallholder farmers with the market?
33. What are the major off-farm/non-farm activities farmers engaged in the study area?
41. Whom do you think benefits more from the maize commercialization?
    1. Producers
    2. Cooperatives
    3. Union
    4. Processor/industry
    5. Wereda traders
    6. Kebele traders
    7. Consumers
    8. Others
    9. I do not know
34. Did market linkage process helpful for farmers? 1.Yes 0. No
35. How do you see the integration or link of stake holder in improving productivity and commercialization of maize ?
36. What are the stakeholders who support maize cluster farming? What is their role in maize production and marketing?

____

____

Specific suggestion

Please forward your specific suggestion to improve the performance of farmers' production clusters.____

Thank you very much for taking your time!