Addis Ababa University

College of Development Studies
Center for Rural Development

Impact of Large-Scale Agricultural Investments on local Development in Gambella Region, Ethiopia

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Center for Rural Development (CRD)
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Addis Ababa University

Impact of Large Scale Agricultural Investments towards Local Development in Gambella, Ethiopia

A Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Arts (MA Degree) in Development Studies, Rural Livelihood and Development

By Fasica Seyoum Teka (GSR/2892/08)
Interim Advisor – Bamlak Alamirew (Ph. D.)

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Approved By Board of Examiners: Signature Date

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Addis Ababa University
School of Graduate Studies

I hereby declare that this thesis entitled "*Impact of Large Scale Agricultural Investments towards Local Development in Gambella, Ethiopia*" has been carried out by me under the supervision of Bamlak Alamirew (Ph. D.), in partial fulfillment of the requirement for the degree of Master of Arts (MA Degree) in Development Studies (Rural Livelihood and Development). I further declare that this work has not been submitted to any university or institutions for the award of any degree or diploma, and that all source of materials used for this thesis have been duly acknowledged.

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Contents

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List of Figures

List of Tables

Acronym

ADLI	Agricultural Development Led Industrialization
AfDB/ADB	African Development Bank
ATT	Average Treatment on the Treated
ATE	Average Treatment Effect
BBM	Broad Base Mechanism
CBE	Commercial Bank of Ethiopia
CSA	Central Statistics Authority
CSR	Corporate Social Responsibility
DBE	Development Bank of Ethiopia
EDHS	Ethiopian Demographic and Health Survey
EPRDF	Ethiopian Peoples Republic Democratic Front
FAO	Food and Agriculture Organization
FFYDP	First Five Years Development Plan
GDP	Gross Domestic Product
GER	Gross Enrolment Rate
GER	Gross Enrolment Rate
GPE	Global Partnership for Education
GTP	Growth and Transformation Plan
HHH	House Hold Head
IEG	Imperial Ethiopian Government
IFDC	International Fertilizer Development Corporation
IRIN	
LSAI/LAI	Large Scale Agricultural Investments
MoA	Ministry of Agriculture
MoSFD	Ministry of State Farm Development
MMR	Maternal Mortality Rate
NER	Net Enrolment Rate
PCA	Principal Component Analysis
PMAC	Participatory Monitoring & Action Consultation

PSM	Propensity Score Matching
SFYDP	Second Five Years Development Plan
SNNPRS	Southern Nations, Nationalities and Peoples' Regional State
SSSA	Soil Science Society of America
SWC	Soil and Water Conservation
TFYDP	Third Five Years Development Plan
TNC	Trans National Corporations
TNLA/TLA	Transnational Land Acquisition
TYPP	Ten Years Perspective Plan
WB	World Bank
WHO	World Health Organization
U5CMR	Under Five Child Mortality Rate

Impact of Large Scale Agricultural Investments towards Local Development in Gambella, Ethiopia

By: Fasica Seyoum

Abstract

Large scale agricultural investments (LASI) have grabbed the local as well as international investors' attention following the 2007/08 world food crisis. LSAI's are believed to bring local development opportunities for the rural community in developing countries. Governments of developing countries including Ethiopia have been trying to convince local and international investors to engage in the sector hoping to alleviate their local development issues thereby acquiring foreign currency. The justification given by the GoE to the leasing of large tracts of arable lands both to domestic and foreign investors is that it is the key for triggering modernization in the agricultural sector and part of country development strategy to ensure food security. Therefore the study is conducted to investigate the impact of large scale agricultural investments towards local development in Gambella, Ethiopia. Primary data collected from household survey and secondary data from government offices were used. The analysis was done descriptively as well as econometrically using STATA 13 and SPSS 23 software. The econometric analysis of the study is conducted using PSM (Propensity Score Matching). The findings of the study, showed that large scale agricultural investments have a positive and significant impact towards local development expressed in terms of employment, technology transfer and infrastructure development. This implies, if properly administered, LSAI's could bring local development to the local community.

Key words**: - Large Scale Agricultural Investments; Local Development; Employment; Technology Transfer; Infrastructure Development**

CHAPTER – I
Introduction

1.1. Background of the study

Almost everyone agrees on the fact that developing countries subsistent agriculture needs to transform itself and improve the livelihood of the majority of the population depending on the sector as well as contribute to the national economy in a better way. This view that higher investments especially in the agricultural sector are necessary to foster rural development and to reduce poverty related problems like unemployment, poor technology and infrastructure is shared by the international community. To do this, many believe that, investment on agriculture is inevitable. Radical transformation for developing countries through injection of capital investment is a daunting task. Thus, they seek for private investments locally as well as through FDI. This fact with other international pressures from food crisis and capital accumulation has opened the door for expansion on scale agriculture and land acquisitions throughout the world. This paper is thus a review of different papers on the impact of large-scale agricultural investments towards job creation, technology transfer and infrastructure development to the local people.

There are two dominant drivers for the expansion of large-scale agricultural investments across the world. The first, as put by Getnet, 2012, is developing countries governments' effort to shift the structure of agriculture from smallholder subsistence production to the commercialization of land and large scale production. The main objective from this side is agricultural modernization and rural transformation.

The second driver, as agreed by most researchers, is the food crisis in 2007/08 and secure financial returns. " Two big global crises –the world food crises and the broader financial crises – have evolved two additional more economically and politically driven motives – food security and secure financial returns" – GRAIN, 2008

It is abundantly clear that putting agricultural land to the private investors and on the international market, changing land and property laws, and arbitrarily encouraging foreign investments without social safety nets poses serious risk in terms of domestic food security, effects on potential land reform, and social and political stability.The sector is polarized by a diverging opinion in the past two decades. Promoters of the sector such as the World Bank believe it brings local developments such as employment, technology transfer, market options, farm inputs, livelihood improvements,

infrastructure and the likes. On the other side, scholars and rights groups argue that the sector didn't deliver what it has promised bringing trouble to the rural pastoralist and agrarian community.

Large Scale Agricultural Investment (LSAI) in Ethiopia has a long but poor performing history dating from the times of the Imperial period. During the 1950's, very little of Ethiopia's investment or operational expense budgets were aimed directly at agriculture. Although not involving large amounts of funds, Stress was placed on encouraging large-scale, plantation-type farm operations under various forms of ownership and management. This was especially important in irrigated areas for cotton, rice, and sugar cane. By most measures, the Ethiopian commitment to agricultural development during the 1950's was very modest. Agriculture received less than five % of total public investment during this period. Agriculture was pretty much left to develop-as-it-will.

On his Ethiopian Agricultural Development Strategies review in in the period of 1950-1970, Dale noted that the first Ethiopian Five-Year Economic Development Plan covering the years 1957-61 stressed infrastructure and did little more than attempt to lay out a few general agricultural goals.

The Second Five-Year Plan covering 1962/63 to 1966/67 attempted some implementation in agriculture, and stressed two types of activities: (1) increasing output through further encouragement of large-scale public, private, and cooperative farms, and (2) promotion of peasant agriculture through land reform, community development, extension, cooperatives, and credit. Over half of the proposed five-year investment budget (which was about $100 million U. S.) was planned for large-scale farm activities. Research, credit for large farmers, institutional development and technician training also received attention in the Plan. Ethiopia was only able to mobilize sufficient resources during the SFYP period to fund 42% of these planned expenditures in agriculture. Modern farming in Ethiopia had initially blossomed in the 1960s and early 1970s during which professionals in agriculture and other entrepreneurs joined hands and started a significant number of small-scale and medium sized modern farms. Elias N. Stebek, 2011

The Third Five-Year Plan (1969-1973) stressed concentration of activities for achieving output increase in agriculture. This included major emphasis on commercial agriculture, foreign capital, and private enterprise activities supporting government. Fund wise, about 60% of the capital expenditure in agriculture will be for commercial farms, another 10% for subsistence units and the remainder spent on general service activities.

During the Derg regime, private-owned capitalist farms that existed during the imperial period were confiscated. A total of 75,000 ha of land developed by private owners for large-scale farming was converted to state ownership (Ofcansky & Berry 1991). During this period, capitalist farming stagnated but state farming and producers' cooperatives were promoted. In essence, other than changing title deeds of previously existing privately-owned large-scale farms, the Derg was not against the role of large-scale farms. In a hope to increase domestic food supply, provide raw materials for domestic industries, and generate the much-needed foreign currency through production of agricultural export commodities, the Derg regime chose large-scale farming as its one of the agricultural development strategies. In 1988, the size of large-scale state-owned farms increased to 216,000 hectares from a historic claim of over 176, 708 hectares transferred from the Imperial regime. Although the regime didn't get the chance to implement it, in its ten-years plan, the Derg planned to increase the size of large-scale farms to 468,000 hectares by 1994. (Bruce, 1998; Ofcansky & Berry, 1991; Maru 2016)

The current regime (EPRDF), after a series of development plans that focus mainly on improvement of small holder agriculture, now has given attention to expansion of LSAI's in Ethiopia. The justification given by the GoE to the leasing of large tracts of arable lands both to domestic and foreign investors is that it is the key for triggering modernization in the agricultural sector and part of country development strategy to ensure food security. Following the expansion of the sector after 2007/08, it has become the center of controversy and has received both criticism and praise from different direction (Maru 2011; Dessalegn 2011; Moges 2010; Oxfam 2009; IFPRI 2009; AfDB 2012; Getnet 2012; World Bank 2016; Aarts 2009)

Therefore, this research project has made an assessment of the impact of large scale agricultural investment towards local development in Gambella region of Ethiopia.

1.2. The Research Problem

While discussing on the impact of large scale agricultural investments, many researches worldwide debate on the negative impacts they have and some of them include expropriation/eviction of local poor farmers from their lands, coming into direct conflict with land reform efforts in many developing countries, jeopardizing local food security and livelihoods of the rural poor, destruction on the environment and wildlife, and the threat they bring to social and political stability are the major problems raised. IFPRI, (2009), Lucie, (2009), AfDB, (2012), Shepherd et.al, (2009), Oxfam, (2009), IFPRI, (2009) (FAOSTAT, 2005)

On the other hand pro LSAI's and promoters of the sector confer the positive local development impacts including employment generation, rural infrastructure development, technology spillovers or technology transfers, generation of foreign currency to developing countries, supply of sufficient inputs to the local industry and import substitutions. World Bank, (2016), Verie Aarts, (2009), AfDB, (2012), Shephard, (2009) +15714316718

Based on the latest United Nations estimates, the current population of Ethiopia is more than 102 million as of November 2016. The country is the 13th populous country in the world and second in Africa next to Nigeria. According to the same source more than 80% (82.4 million) of the total population lives in the rural areas.

According to the 2015 annual report of National Bank of Ethiopia, the country has recorded a rapid performance of 10.2% economic growth in 2014/15, continuing the double-digit growth trend of the last decade with a broad contribution of all sectors. Accordingly, industry grew by 21.6%, services by 10.2% and agriculture by 6.4%. Their contributions to the annual growth were 3.0%, 4.7% and 2.5%, respectively.

The report further claims while agriculture remained a dominant sector, its share in GDP slightly declined from 40.1% in 2013/14 to 38.8% in 2014/15. The share of industry scaled up to 15.2% from 13.8% while that of service sector remained at 46.6% over the same period, revealing a gradual structural transformation, measured by change in share of major economic sectors. Despite the policy attention given to the sector, agriculture still remains to grow below the growth rate of the other sectors. This might show gradual structural transformation, but not rural transformation where more than 80% of the total population is living.

While there are many literatures dealing with large scale agricultural investments and the surrounding community (mostly the rural community) separately, rigorous impact assessment on the interaction between them and the impact one inflicts on the other seems less common. Even though very few studies are available (for example, Bamlak et.al, 2010; Dessalegn Rahmeto, 2011; World Bank, 2016), the focuses of the studies concentrated on commercial farm's impact in increasing productivity of selected crops, input use, employment generation, land grab issues. Most studies conducted on the effect of commercial farms on the surrounding smallholding farms mainly focus on land grab issues, their impact on small holders' productivity, impact on input use of smallholders, environmental impacts, market access to small holders, credit facilities, resource competitions, impact on the overall economy of the country, and the likes.

To the knowledge of the researcher, there are no previous studies that attempted to explicitly deal with the impact of large-scale agricultural investment on local development specifically focusing on infrastructural development along with job creation, and technology transfer.

Accordingly, Bamlak et al (2010) had shown the contribution of land transfers to international investors on employment generation and food security. But, the time this study was made is during the initial stages of the investments and it would be wrong not to try to see the impact after starting operations. Besides, employment opportunity contributions of LSAI' in Gambella hasn't been seen when this area was the center of attention by the media for the last decade. Another study by the World Bank (2016) pursued on impact of commercial farms used regression model and selected crop productivity, employment opportunity, input use (fertilizer & seed), and drought resilience as variables to measure the impacts of commercial farms on the surrounding rural communities. The World Bank is seen as one of the International Financial Institutions (IFI's) catalyzing for the expansion of large scale agricultural investments all over the world and are considered to have a biased opinion about the sector. Desalegn, (2011) looks the sociological and future food security threats in a qualitative research mainly concerned with the dispossession and displacement of smallholders and the local poor. It doesn't look at the impact of the already established operational farms. The study was made when most investments were in pre-operational stages and the impact afterwards need to be addressed.

Thus, with the broadness of the concept of local development, this research has assessed the impact of large-scale agricultural investment (LAI) towards local development measured in terms of job

creation, technology transfer and infrastructure development to the local people in Gambella region using quantitative method of analysis and primary data. The enormity of the primary data collected and the care given to the quality of the data enables to see the fact on the ground better and clearer. In addition to its use as an additional knowledge on the issue, this research is expected to help in programme designing for rural transformation and poverty reduction efforts of the region. The model selected – Propensity Score Matching - as believed by many to be the best impact analysis methods, gives the research an extra edge and another perspective to the previously made researches. The timing of the research is also a good advantage because most of the investments have started operations giving an additional strength to show the impacts.

1.3. Study Objectives

The General objective of the study is to assess the impact of large-scale agricultural investments towards local development in Gambella Region, the specific objectives of the study are to:

- ★ Investigate the impact of large-scale agricultural investments (LAI) towards employment generation in the study area.
- ★ Examine the impact of large-scale agricultural investments (LAI) towards technology transfer to the community in the study area.
- ★ Analyze the impact of large-scale agricultural investments (LAI) on infrastructure development in the study area.

1.4. Significance of the study

Ethiopian agriculture covers a significant portion of the GDP (38.8%), employment (73%), generation of foreign currency, supply of raw material for the industry (70%) and most importantly for being the major source of food. Understanding the sector briefly helps in devising policies that would improve not only the agricultural production but also the livelihood of the rural community thereby tackling poverty reduction.

Recognizing the impact of large scale agricultural investments on local development, especially to the rural poor, which is said to be around 80% of the total population of Ethiopia, would help improve the benefits to both the community as well as the economy as a whole.

Thus, In addition to being reference for further studies in the sector, generation of knowledge will be the core significance of this study. It can also give an additional insight to policy makers and administrative measures on large scale agricultural land allocation, and the agricultural sector as a whole.

1.5. Scope and Limitation of the Study

As it is stated in many literatures made in different countries, commercial farms are suspected of posing many impacts both positive as well as negative. The research in trying to find out the impact of large scale agricultural investments on local development, it only has analyzed the impact of large scale agricultural investments on job creation, technology transfer and infrastructure development from the broad local development concerns.

To better understand the impacts of LAI's it was great to stratify communities in the study area based on their origin or history of settlement. Choice of crop production and agricultural technologies varies among the different communities in the region. For instance in Itang woreda the Nuers are known for their cattle rearing practice, whereas in Abobo woreda the Anuak do not practice cattle rearing. But both communities have matching controls to analyze the counterfactual for what would have happened in the absence of LSAI's. The settler in Abobo woreda, who came from different parts of the country during the socialist regime for its fertile agricultural land, have a very different socio economic features with a different choice of crop production and livelihood structure. Impact Analysis for these communities is not made due to the fact that the methodology applied in this research requires a socio-economically similar treatment and control groups and these communities do not have control areas to match them.

On the other hand, impacts of large scale agricultural investments were supposed to be analyzed by stratifying based on their land holding of the investments as large, medium and small. This could have shown the magnitude of the impact by the size of the farms but still time and budget were the limiting factors.

CHAPTER - II

Literature Review

2.1.Review of Theoretical Literature

2.1.1. Large Scale Agriculture

Large-scale Agriculture also goes by the name industrial farming, unlike small-scale farms, utilizes various industrial methods to maximize production. Thus, it's not only about the size of a farm spans, but also the methods of production. Some describe them by their purpose of establishment. Beyene, (2016) defines Large Scale Agricultural as Large Scale Commercial Farm holdings – and refers them as farms that include state and private commercial farms mainly established for the purpose of profit making by selling agricultural products. Beyene, differentiates these farms in terms of size of land holding, use of labor and farm machinery, farming system, use of farm inputs, and operating objectives. According to Beyene, these forms of farms hold more than 5 hectares of land, use hired labor and new high-tech farm machineries and use modern farm inputs at recommended rates. Because the main operating objectives of large scale agricultural farming is profit maximization through market sales, they practice capital intensive and profit oriented modern production system.

2.1.2. The Concept of Job creation/Employment

Employment, in this context, is the opportunity to have a contractual arrangement between an employer (LSAI) and an employee (member of the community) that specifies work for pay. In other words, job creation is the process by which the number of jobs has increased in response to investments in the specific area.

From the evaluation of GTP I, the government of Ethiopia has identified unemployment as the major development challenge along with poverty. Thus, one of the major development objectives of the Government in GTP II is generating employment for the expanding labor force. In promoting large-scale farms in Ethiopia, the government expects large scale investments to create job opportunities to the community in the area, which are said to have high rates of unemployment. If large-scale land deals are made by a win-win approach, they are believed to help provide jobs. (GTP II, 2016); (Verie Aarts, 2009)

Job opportunities, could improve rural livelihoods. Another possible benefit for the rural poor is the creation of a potentially large farm and off-farm employment. Effective contract negotiation and adjunct policy measures are useful tools to enhance these positive spillover effects. The absence of these spillover effects could result in the creation of an enclave of modern agriculture and traditional smallholder agriculture will remain sidelined. Thus, contract negotiations should address these gaps. (AfDB, 2012)

In principle, LSAIs can have both positive and negative impacts on the economic status and livelihoods of local populations. For instance, they can contribute to poverty reduction and the improvement of local livelihoods by generating local employment opportunities (Otsuka & Yamano, 2006). Depending on the labor intensity of cultivation methods, LSAIs can possibly benefit rural populations by creating employment opportunities

2.1.3. Agricultural Technologies

Agriculture is the cultivation of land and breeding of animals and plants to provide food, fiber, etc. Technology permits innovations like conservation tillage, a farming process which helps prevent land loss to erosion, reduces water pollution, and the likes. Agricultural crop production depends on the successful implementation of the soil, water, and nutrient management technologies. (longdom.org, 2018)

Modern farming technology is used to improve the wide types of production practices employed by farmers. It makes use of hybrid seeds of selected variety of a single crop, technologically advanced equipment and lots of energy subsidies in the form of irrigation water, fertilizers and pesticides. This study has identified agricultural investments that are believed to boost production from many agricultural technologies introduced throughout the world. These technologies are fertilizer, agrochemicals, improved seed, mechanization technologies, cultural practice technologies & improved livestock.

A research by EDRI in 2017 have shown that mechanization is low, but some important dynamics are changing the farming environment. For example, about a quarter of wheat production is harvested by combine-harvesters, and there is a speedy emergence of commercial service providers for plowing, harrowing and harvesting. This is having a large effect on labor productivity, although to date, there is no or little effect on yields.

Fertilizers are any material of natural or synthetic origin (other than liming materials) that are applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants. Typically, fertilizers are composed of nitrogen, phosphorus, and potassium compounds. They also contain trace elements that improve the growth of plants. The primary components in fertilizers are nutrients which are vital for plant growth. Plants use nitrogen in the synthesis of proteins, nucleic acids, and hormones. (Jariwala, 2016)

According to Soil Science Society of America (SSSA), Fertilizers have been used since the start of agriculture. Mostly fertilizers are categorized as organic and inorganic fertilizers based on their chemical composition. Organic fertilizers contain only plant or animal-based materials that are either a byproduct or end product of naturally occurring processes, such as manures, leaves, and compost. Inorganic fertilizer, also referred to as synthetic fertilizer, is manufactured artificially and contains minerals or synthetic chemicals.

There are many constraints that hamper agricultural productivity in Ethiopia. Among the key factors, soil fertility depletion is one. Ethiopian soils have been subjected to severe degradation caused by natural and man-made factors. The use of chemical fertilizer and improved seeds is quite limited despite Government efforts to encourage the adoption of modern, intensive agricultural practices. (IFDC, 2015)

Urea and DAP are the two common fertilizer sources that have been in use for the past four decades in Ethiopia. But recently, different blended fertilizers and micro-nutrients are also being used. Five blending facilities are built and Ethiopian farmers have therefore started use of tailored fertilizer sources since 2015. (IFDC, 2015)

Agrochemicals according to this study are herbicides, pesticides, fungicides and nematocides that are used to protect agricultural production and productivity from weeds, pests, and other crop damaging factors. It also includes chemicals in animal husbandry, such as antibiotics and hormones. Pesticides are natural or synthetic substances that kill or, otherwise, control unwanted organisms. Almost half of the usage of pesticides around the world usually involve in agriculture. (The Ethiopian Herald, Aug 24, 2017)

According to a study by Beyene (2016), Chemical pesticides are used intensively in the fast-changing agricultural sector of Ethiopia. The research also indicated that there is

considerable increment in the intensity of chemical pesticide usage. And another IRIN – 2002 statement says Ethiopia loses as much as 40 percent of its crop production each year due to pests and weeds. Thus, for a country hit by frequent food shortages, it is vital to tackle the problem of crop loss by encouraging farmers to use improved agricultural technologies like agrochemicals.

Improved Seed is one of the major findings of modern day agriculture and have greater importance for boosting agricultural production. Improved seeds, selected for local conditions, offer farmers a better chance to harvest lucrative crops. Higher genetic purity, higher physical purity, possession of good shape, size, color, etc., according to specifications of variety, higher physical soundness and weight, higher germination (90 to 35 % depending on the crop) and higher physiological vigor and stamina are the major characteristics of good quality seed.

Land Management Technologies that are selected to be seen in this study are SWC or Soil and Water Conservation technology, draining water from farmland using BBM technology and constructing flood diverting ditches in farm lands. From observation and discussions with farmers in the region, flood is not only a major problem to small holder farmers, but also to commercial farms. A national program called Sustainable Land Management (SLM) was launched in 2008 to reduce land degradation, improve agricultural productivity of smallholder farmers, and protect or restore ecosystem functions and diversity in agricultural landscapes. SLM consists of three parts: 1) watershed management; 2) rural land certification and administration; and 3) project management.

Mechanization Technologies are agricultural machineries used to mechanize the work of agriculture, which increases farm productivity. In modern times, powered machinery has replaced many farm jobs formerly carried out by manual labor or by working animals. Mechanization covers all levels of farming and processing technologies, from simple and basic hand tools to more sophisticated and motorized equipment that improve labor productivity or replace it. This study focuses mainly on the use of tractors, combine harvesters, threshers, and the likes. Agricultural mechanization reduces the drudgery of the human beings and draught animals, enhance the cropping intensity, precision and timelines of efficiency of utilization of various crop inputs and reduce the losses.

Improved Agricultural Practices of both in crop production and livestock production are seen in detail in this study. Improved agricultural practices in crop production include Intercropping, Crop rotation, Row planting, Irrigation use, Composting and use, Minimum tillage (hoeing & planting), Residue retention on farm, Planting agro forestry on farmland, Split fertilizer application, point fertilizer application, repeated (timely) weeding, Timely harvesting and trashing, Regular pest/disease monitoring, Post-harvest loss (by weevils, rodents, moister) management and Engaging on improved seed production.

Whereas; improved agricultural practice in livestock production include maintaining manageable livestock number, storing animal feed for dry season, Pasture management through cut and carry system, Pasture management through rotational grazing, developing water for the livestock (pond, well, cisterns and roof ware harvesting), and Engaging on market-oriented livestock types.

A 2016 World Bank report on Ethiopia claims that increased proximity to Large-scale Agricultural Investments (LAI) had positive spillovers on input use and yield through the nature and magnitude of spillovers are highly crop-specific. There is strong evidence of significant increases in fertilizer use, yields, and to a lesser extent also use of improved seed in closer proximity to large farms. For all cereals except sorghum, larger commercial farm areas with the same crop in the proximity increases small holders' resilience to drought.

Although he doubts the technologies used by the foreign projects are compatible with the needs of small farmers, Getnet (2012), discusses that the government of Ethiopia expects LSAI's to provide opportunities for technology transfer.

Improved Livestock refers to livestock production with better productive animals raised in an agricultural setting to produce products such as meat eggs, milk and the likes. Due to an increasing worldwide population has seen an increase in demand for more animal products leading for increased production and productivity simultaneously. Selective breeding has long been used by farmers to improve the quality of livestock. Ethiopia has a large livestock population, a relatively favorable climate for improved, high yielding dairy cattle breeds and regions with less animal disease-stress that make the country to have a substantial potential for livestock development. The government has drafted policies to improve animal breed to benefit the community. Much attention is given to enhance dairy, poultry and meat production in GTP

II. Though the country has huge livestock resources, there are a lot of constraints impacting productivity, milk and meat production. In Gambella, extended livestock management is predominantly practiced and the average milk productivity is about 1.6 litres/day per lactating cow, which is lower than the national average (1.85 litres/day) estimated in 2011 (CSA 2011).

2.1.4. Infrastructure Development

Infrastructure in this study is the basic physical structures and facilities needed by a community for their day to day life, including roads, Health services, Schools, Irrigation facilities, Drinking water points and the likes. Basically, these public goods are built by the government, but in an economically weak countries like Ethiopia public goods are expected from private investors like LSAIs. This expectation is not as an obligation but as part of CSR and most of the time they are built mainly for business purpose thereby serving the community living the surrounding. In some cases, some investments agree to build public infrastructures for using natural resources which were owned by the community.

Getnet, (2012) – Although the contract signed between investors and the government do not oblige investors to undertake social investments, the government and other large-scale farming promoters expect these investments to benefit local communities through the construction of infrastructure and social assets such as health posts, schools, and access to clean water. These developments might be intended for the project but as the same time could also serve the community. The other reason might be due to the fact that investors want the local communities to see them in a favorable light and are expected to observe socially responsible business practice.

2.2. Review of Empirical Literature

2.2.1. Large Scale Agricultural Investments

Globalization has accelerated economic integration and resource sharing across global borders. This phenomenon is exacerbated by limited availability of natural resources such as water and arable land. Companies are increasingly crossing borders in order to exploit comparative advantages of certain places and gain access to such scarce resources. Similarly, the recent global financial crisis and escalating food price have initiated a new trend of Transnational Land Acquisition (TLA) for outsourced food production. Africa became the new frontier for global food production. Up to 50m hectares of land has either changed hands or is

in the process of being sold in 2009 in Africa for 10 to 99 years (Vidal 2010). This trend is the highest compared to annual average expansion of agricultural land of less than four million hectares before 2008 (WB 2010: VI). Host countries mostly involved in this business in Africa are Ethiopia, Sudan, Kenya, Nigeria, Tanzania, Malawi, Congo, Zambia, Uganda, Madagascar, Zimbabwe, Mali, Sierra Leone, and Ghana (Cotula et. al, 2009)

The world as a whole has been making progress towards improved food security and nutrition. This is clear from the substantial increases in per capita food supplies achieved globally and for a large proportion of the population of the developing world. – (AfDB, 2012)

While there is little evidence of significant recent changes in agrarian structure in land scarce countries (Lipton 2009), many land-abundant countries are characterized by rising investment in large-scale farming based on a nonfamily corporate model, a trend that can but need not be accompanied by growing concentration of production and land ownership. The largest operations, most of them in developing or transition countries, share three characteristics. With operational units that often exceed 10,000 ha, they are bigger than the largest farms in comparable land abundant regions in developed countries. Such large operational units are often horizontally integrated into corporations controlling hundreds of thousands of hectares with the largest now approaching a million ha of good crop land and sales of over $1 billion annually. Often, they are vertically integrated with processing and marketing activities and export logistics. Associated business models depart substantially from that of family farming characteristic of developed countries and often separate ownership, management and labor. At the same time, there are contrasted by big inter-regional differences in commodity orientation and characteristics related to institutional and policy context. To illustrate the diversity of conditions, we review the evidence on establishment and evolution of large farms across different regions. - (Deininger & Byerlee, nd)

The growing international interest in investing in African farmland has attracted considerable attention recently. Media reports over the past few years spotlighted the scale of land acquisitions and laid the foundation for the analytical investigation that followed. The distinctive feature of these land deals that has attracted the attention of the media and the global research establishment is the speed of the acquisitions, the transparency (lack thereof) of the terms and the scale of the acquisitions and implied investment. - (AfDB, 2012)

A study by Deninger et. al. (2011) notes that 29 million of the 56 million hectares of land (51.8%) sought after by foreign investors lobally is located in sub-Saharan Africa. Though countries with abundant uncultivated land attracted the most interest, some of these countries were also with poor records of rural land tenure, lack of institutions protecting vulnerable groups, and the absence of a culture of disclosure.

Cross-country investments in Africa have been highlighted in some media reports. Libyan investments in Mali, Mauritius' investments in Mozambique, Egypt's investment in Ethiopia are cases in point. – (AfDB, 2012)

In Africa after independence, many countries attempted to 'modernize' their agricultural sector through large-scale farming, providing subsidized credit, machinery, and land. These efforts almost universally failed (Eicher & Baker, 1992). Policy distortions against (export) agriculture and low public investment in rural areas reduced investment incentives and precluded realization of Africa's agricultural potential. Elimination of many of these interventions over the past two decades allowed agricultural growth to accelerate and paved the way for renewed investor interest in the continent. Still, attempts to jumpstart agricultural growth via large-scale farming face many challenges and awareness of the lessons from past investments are important for future development strategies.

One of the largest and most well-documented cases of large scale farming in Africa has been mechanized sorghum and sesame production in Sudan. Given its large land resources, financing from the Gulf aimed, after the 1970s oil price spikes, to transform the country into a regional breadbasket through favorable access to land and subsidized credit for machinery. Schemes attracted civil servants and businessmen who mostly hired managers for farms 1,000 ha or larger, with some companies operating 100,000 ha or more. While some 5.5 million ha were 'officially' converted to arable land according to official statistics, up to 11 million ha were informally encroached upon (Government of Sudan 2009). Partly due to the tenure insecurity this created, investment was low and most of Sudan's mechanized farms rely on low-level technology. In an agro-ecological environment comparable to Australia, where yields are 4 t/ha, sorghum yields are only 0.5 t/ha and have been stagnant or declining. Land rights by traditional users, both small-scale farmers and pastoralists, have been violated, and encroachment by mechanized farms has contributed to serious conflict (Johnson, 2003). These

problems were not unique to Sudan. Efforts to introduce mechanized rain-fed wheat in Tanzania on some 40,000 ha, of land that had previously been prime grazing grounds for pastoralists illustrate the challenges. After a $45 million investment, wheat production was deemed unprofitable, and production is declining (Lane & Pretty, 1991; Rogers, 2004). Nigeria's large-scale mechanized irrigated wheat schemes of the 1970s and 1980s have now largely been abandoned (Andrae & Beckman, 1985).

Structural issues arising from long-standing neglect of technology, infrastructure, and institutions were a key contributor to disappointing performance of commercial cultivation of bulk commodities, where Africa should have a comparative advantage. Past success with commercial agriculture was thus limited to higher-value crops such as cotton, cocoa, and coffee produced by smallholders, and more recently horticultural exports where medium and large farms are important (World Bank 2009a). Plantation crops such as sugarcane in Southern Africa (often aided by preferential access to developed country markets), and oil palm for domestic markets in West Africa have also had some success. Policy distortions and gaps in technology, infrastructure, and institutional arrangements that made bulk commodity production difficult also affect smallholder performance. After policy reforms of the 1990s agricultural growth in sub-Saharan Africa has recently accelerated. With few exceptions, almost all the expansion has been through smallholders. However, there have been intermittent efforts to revive large-scale farming, especially in recent years, particularly for crops related to biofuels. These industries are not yet globally competitive but aim at import substitution or exports into markets where African countries have preferential access. (Deininger & Byerlee, nd)

Ethiopian Large scale agriculture can be reviewed from the agrarian structures of the three political regimes, the imperial regime, the derg regime and the EPRDF regime. The well put lecture notes of (Getnet Alemu, 2016) have been used as a review for the Ethiopian large scale agriculture for the three regimes.

During the imperial regime following the land tax legislation of 1942 and 1944, a landlord-tenant relationship has prevailed in the south, central and south-eastern parts of the country, while in the northern part of Ethiopia land was remained under "rist" tenure. Based on this land tenure system the agrarian structure prevailing during the Imperial period can

simply be identified with owner cultivators of smallholdings in the north, and landless tenants and landlords in the south. Since second half of 1960s, commercial farms began to emerge constituting not more than 7% of agricultural production.

Table 1 - the status of agriculture in the economy during the imperial regime

Period	Share in total agriculture			Agri share from GDP	Rural population (share)	Labor force (agriculture share)
	Agric	fores	Fish/hunt			
1961-64	94.2	5.5	0.3	62.2	-	92.7
1965-69	94.3	5.4	0.3	56.5	92.9	91.8
1970-74	94.5	5.3	0.2	52.8	91.2	90.8

Source: UK Essays, 2016

Policies and strategies of the imperial regime include the Ten-year program of industrial development -1945-55 and the three Five-year Development Plans: FFYDP (1958-62), SFYDP (1963-67), TFYDP (1968-73). The classical growth theory, in combination with donors' preference, had a significant influence on Ethiopia adopting an import substitution industrialization growth strategy.

The ten years development program chose the industry as the main engine of growth and it was initiated with the help of the US technical project mission. This program neglected the agricultural sector and agriculture was expected to contribute in providing wage goods, raw materials for industry and export crops. The rural agrarian community was aimed to be the market for industrial output, source of capital and labor transfers, Source of employment for a considerable part of the workforce.

Again the first five years development plan (1958-62), neglected the agricultural sector and the document puts it as "no need to bring about a fundamental change in the present methods of production, nor is it desirable to give up the kind of tools now in use". (IEG, 1957:20) But it was soon formally acknowledged that cereal production could not meet the growing demand of the population" and the government was forced to import grains.

It was on the second five years development plan that the government explicitly acknowledged that the production targets cannot be fulfilled by the subsistence sector, and hence that large scale and mechanized agricultural undertakings have to be established. Out of

the 250.00 million Birr, which was allocated for investment in agriculture in the SFYDP, 127.7 million was earmarked for the construction of large-scale Agricultural Investments (LAI), 38.7 million for the surveying of possible additional commercial farms and 5.2 million (2.08%) for peasant agriculture (IEG, 1962:117). It was during this time that state farms in the awash valley sprout.

In the third five year development plan it was planned that the share of industry in GDP should double within five years (IEG, 1968:136-7). But for agriculture, it was recommended that there is a simultaneous need to develop modern commercial agriculture because there is no quick solution to the peasant problem, and because only a modest growth of output from peasant agriculture can be expected in the five years ahead. This activity provides considerable opportunity for a rapid production increase, and immediate impact on the entire economy, if given the required allocation of capital and expertise. The rapid development of commercial agriculture is the only way to get the relatively quick increase needed in agricultural exports. It is from the agricultural sector that the rapid gains are expected in output and availability of surpluses, both for consumption domestically, particularly in the cities and towns as well as for export" - (IEG, 1968:190-1). Again this development policy emphasized only the instrumental role of agriculture.

Then comes the Derg Regime with the renowned land reform in 1975 and the agrarian structure has changed into Own cultivators, state farms, and producer co-operatives. Own cultivators account for about 95% of production. The same with the imperial period the agricultural sector was contributing by providing wage goods, raw materials for industry and export crops. It also has created market for industrial output, and was the main source of capital and labor transfers. Agriculture was also source of employment for a considerable part of the workforce.

With the declaration of the National Democratic Revolutionary Program (fast industrialization as a prerequisite for socialism) came the expansion of producer co-operatives and state farms in agriculture, in order to produce marketable surplus, which was necessary for the industrialization process.

The assumption was that, as with the three five-year plans during the Imperial regime, surplus generation would only be possible if there was a shift from the dominant small holder

peasant agriculture to limited large-scale production and from private to state ownership. This strategy in agriculture had the blessing of the Soviet Union, which endorsed the state farms as a central focus of the agricultural investment strategy.

When state farms was formally launched in May 1977, the main objectives were to alleviate the country's food problems, produce raw material for the industrial sector, and produce export crops in order to generate foreign exchange (MoSFD, 1989:9).

In the 1984-94 Ten Years Perspective Plan (TYPP) it was clearly stated that agriculture would be the foundation of the economy, which had to finance the long-term industrialization program, while industry continued to be the priority sector (PMAC, 1984:20).

To enable agriculture to play this role, TYPP adopted similar strategies adopted in previous development programs. According to the plan, peasant agriculture was not considered as a viable undertaking. Rather, viable strategies included the expansion of state farms and producer co-operatives. To this end, policy instruments gave preferential treatment to state farms and producer co-operatives (PMAC, 1984:52). The left over resources after greasing the industry goes to smallholder farmers and producer cooperatives. Peasant agriculture was discriminated. Implementation of land reform that brings all land under state control facilitates the expansion of state farms and marketing and pricing policies of agricultural produce.

Two years after the land reform, the government imposed a compulsory procurement policy on the produce of the peasantry, while at the same time expanding state farms (which increased in their size of cultivated area by 158 per cent, from what they had stood at in 1978, and by 51 per cent from what they had stood at in 1980) with the aim of extracting the required marketable surplus (PMAC, 1984:160). Yet State farms and producer co-operatives were required to sell only to the state owned AMC at a price fixed by the government (which was 4-5 Birr per quintal above what private holding peasants received as an official farm-gate purchase price).

The EPRDF or the Post 1991 agricultural policy gave priority to peasant agriculture and pursued the same policy as the derg regime on land. Later in 1995, the overall development strategy was declared to be agricultural development led industrialization (ADLI). The agricultural sector is considered as the leading economic sector and the development of the

other economic sectors hinges upon the achievements in the agricultural sector. After a decade, the government reveals its commitment to the industrial sector and vowed industrialization will be the end product of ADLI. With regard to agriculture the government issued comprehensive rural and agricultural development policy. The main focus of the agricultural policy is smallholders. Large scale commercial farming is left for the private sector from both local and international investors.

(James Keeley et. Al., 2014), note that Ethiopia is an important case in the international debate on large-scale land acquisitions. It challenges assumptions about foreign dominance of land investment, or that large-scale land deals are primarily for food crops for export. It is a case where land deals for plantation agriculture are central to government agricultural strategy, but also where allocations have been subject to controversy in terms of impacts on rights and livelihoods at the local level.

Land acquisition for large scale commercial farming is taking place in different parts of Ethiopia; most significantly in Gambella region. The Ethiopian government has identified close to 3.5 million hectares of fertile agricultural land for investment purposes. Among others, investors from Saudi Arabia and India are mainly participating in agricultural investment in different parts of the country. Despite potential development opportunities (employment, guaranteed market outlets, revenue generation, technology transfer, investment in infrastructures and productivity rise), a major worry arises whether such aggressive TNLA creates local economic linkages and spill-overs.

Except for unskilled labor employment, minimal linkages exist with the local economy, hitherto. Enclave's formation is the next possible consequences of weak or no economic linkage with the local economy. If weak linkages result from the inability of TNCs to utilize local opportunities or is associated with lack of available market potential in the locality lacks research attention. Moreover, little has been understood and documented on the current status of investment projects, opportunities they created and associated challenges the face in formulating market linkages. Likewise, the potential of the local economy and the prevailing constraints to establish linkages (such as Contract Farming) with Transnational Corporations (TNCs) are not sufficiently addressed.

In Gambella region, there are eight Indian companies that begun operations among which Karuturi, BHO Agro Plc, Ruchi Group and Saber Plc have started large scale operation (MoA 2012). Ministry of Agriculture (MoA) has provided 27,000 hectares of land to BHO Agro Plc to grow edible oil crops. Ruchi Group, the second Indian firm has started cultivating soya bean on its allotted 25,000 hectares of land. In 2008, Karuturi became the first Indian company to lease 300,0003 hectares of land (to be provided after full cultivation), for the production of palm, cereals, rice and sugar cane. Several companies and governments have so far made land deals with the central government which is not stated in the official land provision documents. Saudi Star Plc, a Saudi based corporation owned by Al-Amoudi has been given 10,000 hectares of land in Abobo area which is expected to expand to 129, 000 ha4 of land after few years. (Indian Ocean Newsletter, 2010). The region has an estimated area of 2,580,201 hectares, and population density of 9.57 people per square kilo meter (CSA, 2007). Merely considering the above figures, close to 30 percent of the total land area are either delivered or identified for agricultural investment purposes. This number is highly significant as most of the investors are situated and interested in producing on already fertile lands. Moreover, around 40% of the community in the region constitute pastoralists and that might inhibit movement especially in areas where agricultural development takes place.

The main interest of large scale farms in Gambella region is to grow high value export commodities (including cash crops) such as rice, soya beans, cotton, sugar and tea. Palm-oil and other pulses are also attracting a good deal of interest. Some investors are currently growing maize as a second or third crop but this is largely for bio-fuel purposes rather than as food for the local market (Desalegn, 2012). Except for two companies, all other investors have a lease period of 50 years, and almost all have been committed to pay a rental fee of 30 to 35 Birr [less than two USD] per hectare per year (depending on the use of irrigation water). All investment projects, small or large, require securing access to sources of water for irrigation without which many of them will not be sustainable. The government announced that it offers at least 3 million hectares of fertile land and still showing interest to provide more of its most fertile lands to foreign and local investors. MoA emphasizes the fertility and abundance of land in Ethiopia stating that from approximately 74 million hectares of fertile land only 15 percent is under cultivation at the moment. TNLA is taking place in parts of the region where agriculture is practiced as a major livelihood which may be the basis for CF to happen.

Effects of Large-scale Agricultural Investments (LAI)

Negative Effects of Large-Scale Farming

1. **Security of Land Holdings**

Expropriation/Eviction of local poor farmers from their lands depriving them of farm lands which they could cultivate. Although it is often stated that deals take place on idle or unused land, in practice this seems to be untrue. - (Oxfam, 2009) Displacement of people (even without prior notification let alone their consent) and the loss of natural resources that form an indispensable basis of their livelihoods may further jeopardize the welfare of the poor by depriving them of the safety-net function that this type of land and water use fulfils. (IFPRI, 2009) Many researchers believe that biggest problem of farmers in poor countries is land ownership. Selling or leasing land to investors when poor farmers lack enough land to cultivate is an unfair scenario. Displacement of people whose livelihoods depend on access to some of these resources (since demand tends to focus on higher value land-better access to irrigation potential and proximity to markets) – (AfDB, 2012)

2. **Threat to Land Reform Agendas**

Under the Ethiopia's constitution, the state owns all land and provides long-term leases to tenants. On average, 83% of the rural households cultivate less than two hectares per household and 52% less than one hectare. (FAOSTAT, 2005) Commercial land deals are coming into direct conflict with land reform efforts in many developing countries. – (Shepherd et.al, 2009)

3. **Jeopardizing Local Food Security and livelihoods of the rural poor**

With the ongoing scenario of transferring land to investors, (Dessalegn Rahmeto, 2011) fears that the country's agrarian structure will change significantly, and the shift from small-scale to large-scale farming, dominated by foreign capital and enjoying privileged status, will pose a serious threat to the long-term sustainability of the rural economy, the livelihoods of peasants and pastoralists, and to the goals of achieving food security. The new agricultural system will progressively marginalize smallholders. There are no formal or informal obligations on the part of investment projects to contribute to the food security needs of the country.

Dessalegn Rahmeto – 2011 also discusses why the Gulf nations are keen to acquire land in Africa and Ethiopia is to be able to grow food crops for export to their home markets to ensure food security for their population. Additionally, Dessalegn discusses Indian companies rush to acquire land in Ethiopia is partly for their own country's food needs and partly for the export market. It is thus paradoxical that the government of one of the most vulnerable countries in the world is handing over vast land and water resources to foreign investors to help the food security offorts of their home countries, or to gain profits for their companies, without making adequate safeguards and without taking into account the food security needs of its own people. In Ethiopia investors both foreign and local receive more incentives to export their products. (Getnet, 2012) says the shift towards large-scale agriculture is thus driven by the priority for exports and foreign earnings at the expense of domestic food security. Production by foreign investors may be destined solely for foreign markets. The implications of arrangements that do not take food security requirements of a country into consideration may be potentially costly. (AfDB, 2012)

4. Threat to Equitable land distribution

The troubling inequity in land ownership due to the feudal structure of power has served as a barrier to social and economic progress for the poor for years. (Shepherd et.al, 2009) The either explicitly or implicitly and widely accepted ideas that the land distribution in rural Ethiopia is highly equitable and the 1975 land reform has created this equitable distribution are proven wrong. According to a study by Bereket Kebede, the reform of 1975 has not created a highly equitable distribution of land as generally accepted; the level of inequality is ether equal or higher than those found in other African countries. Hence the widely held consensus that land is more equitably distributed in Ethiopia doesn't seem to hold. And the other thing is that even 20 years after radical land reform programme the hang-over rom older tenure system is substantial. (Bereket, nd.) This scenario of evicting of smallholders to create room for foreign as well as local large scale arming might exacerbate the situation. This might need further study.

5. Environmental and ecological Effects

The ecological sustainability of land and water resources slated for commercial farming is another important issue. Intensive agricultural production can threaten biodiversity, carbon stocks, and land and water resources. Converting forests and rangelands to mono-cropping reduces diversity in flora, fauna, and agro biodiversity, as well as aboveground and subsurface carbon stocks. In addition, long-run sustainability problems such as salinity, waterlogging, or soil erosion if they are inappropriately designed are also issues to be given due attention. (IFPRI, 2009) Without sustainable water, waste and pesticide management the commercial agriculture sector will create long term ecological effects. (Lucie, 2009) The impact on the environment and wildlife of the investment project is also becoming quite apparent and is likely to be aggravated as the projects become fully operational. (Getnet, 2012) In the absence of strict environmental regulations, large-scale production tends to employ methods whose environmental and social impacts tend to be suspect (large scale use of chemical fertilizers and pesticides). (AfDB, 2012)

6. Threat to social and political stability

Conversion of land to large scale farms or plantations operated by foreign labor causes loss of local land rights and generates little employment for local skilled or unskilled labor. Such projects are likely to generate the greatest local opposition. For instance the scale, the terms, and the speed of land acquisition have provoked opposition in Mozambique and Madagascar. Mozambicans have resisted the settlement of thousands of Chinese agricultural workers on leased lands—a situation that would limit the involvement of local labor in the new agricultural investments. In Madagascar, negotiations with Daewoo Logistics Corporation to lease 1.3 million hectares for maize and oil palm reportedly played a role in the political conflicts that led to the overthrow of the government in 2009. (IFPRI, 2009)

Positive Effects of Large Scale Farming

1. Job Creation

In promoting large-scale farms in Ethiopia the government expects large scale investments to create job opportunities to the community in the area, which are said to have high rates of unemployment. But a study by the World Bank, one of the promoters of large scale commercial farming, found that there is no impact of large farms on local labor demand,

except possibly on imports of casual labor. (World Bank, 2016) If large-scale land deals are made by a win-win approach, they are believed to help provide jobs. (Verie Aarts, 2009)

Job opportunities, could improve rural livelihoods. Another possible benefit for the rural poor is the creation of a potentially large farm and off-farm employment. Effective contract negotiation and adjunct policy measures are useful tools to enhance these positive spillover effects. The absence of these spillover effects could result in the creation of an enclave of modern agriculture and traditional smallholder agriculture will remain sidelined. Thus, contract negotiations should address these gaps. (AfDB, 2012)

2. Development of Rural Infrastructure

Although the contract signed between investors and the government do not oblige investors to undertake social investments, the government and other large-scale farming promoters expect these investments to benefit local communities through the construction of infrastructure and social assets such as health posts, schools, and access to clean water. These developments might be intended for the project but as the same time could also serve the community. The other reason might be due to the fact that investors want the local communities to see them in a favorable light and are expected to observe socially responsible business practice. (Getnet, 2012) Shephard, 2009 believes that through creating a win-win situation between host countries and investors, foreign agricultural investments can provide key resources for agriculture, including development of needed infrastructure and expansion of livelihood options for local people.

3. Positive spillovers – Technological

A 2016 World Bank report on Ethiopia claims that increased proximity to Large-scale Agricultural Investments (LAI) had positive spillovers on input use and yield through the nature and magnitude of spillovers are highly crop-specific. There is strong evidence of significant increases in fertilizer use, yields, and to a lesser extent also use of improved seed in closer proximity to large farms. For all cereals except sorghum, larger commercial farm areas with the same crop in the proximity increases small holders' resilience to drought. Although he doubts the technologies used by the foreign projects are compatible with the needs of small farmers, Getnet-2012, discusses that the government of Ethiopia expects Large-scale Agricultural Investments (LAI) to provide the opportunity for technology transfer.

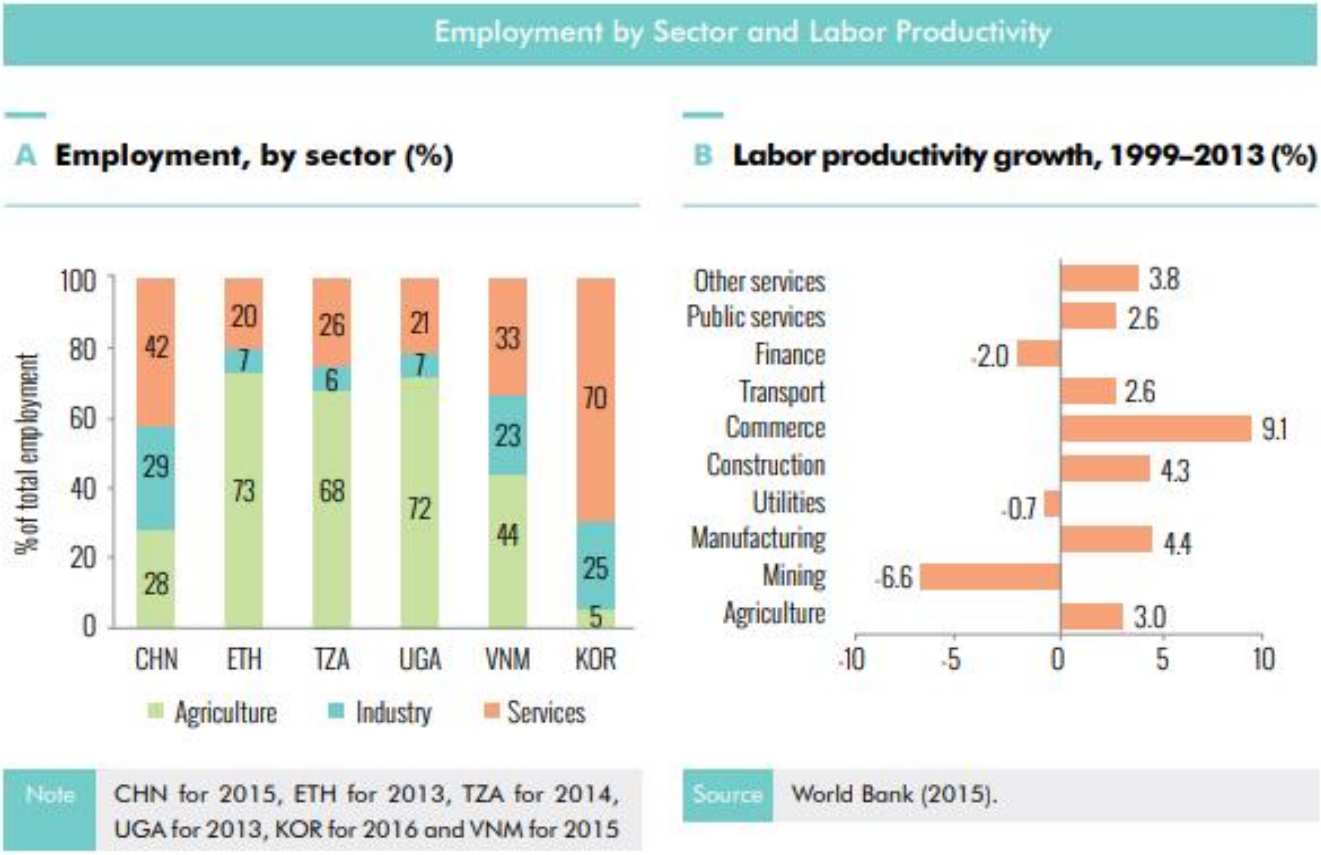
4. Increasing Foreign Currency Earnings & Supply of inputs for domestic industry

As stipulated in many policy documents of the Ethiopian government and as put by Getnet-2012, foreign large scale agricultural investments are expected to produce export crops and increase the country's foreign earnings as well as produce raw materials for the domestic industry. Foreign direct investment may bring macro-level benefits (government revenues, employment, and foreign exchange), development of rural infrastructure, and poverty-reducing improvements such as construction of schools and health posts. Foreign direct investment in agriculture can enhance the efficiency of a nation's agricultural production by developing investment intensive areas such as irrigation and infrastructure. In African countries the urgent need for development in rural areas and the lack of greater fiscal space to support capital intensive projects could facilitate large scale land acquisitions. Nevertheless, the overriding consideration in these decisions should be the spill-over from foreign investment onto domestic smallholder production in terms of productivity enhancing technological transfers and, possibly, integration of domestic producers into the supply chain. The absence of these linkages, and failure of governments to create them during the course of the investments, amplifies the costs from resource competition (land and water). Thus, the decision to allow large scale land acquisitions should be backed by policy measures to ensure that dualism in agriculture does not take root. (AfDB, 2012)

2.2.2. Job Creation/Employment

According to the United Nations more than 41 % of Ethiopia's population of 100 million is under 15, while the African Development Bank (ADB) estimates as many as a third of young people in cities have no job. World Data Atlas says in 2017, employment to population ratio for Ethiopia was 78.2 %. Over the last 13 years, employment to population ratio in Ethiopia was decreasing on average by 0.08 % each year, although before that, it grew from 73.7 % in 1999 to 80 % in 2005. Employment to population ratio is the proportion of a country's population that is employed. Ages 15 and older are generally considered the working-age population. The same source also said in 2017, unemployment rate for Ethiopia was 5.2 %. Before unemployment rate of Ethiopia started to increase to reach a level of 5.2 % in 2017, it went through a trough reaching a low of 5 % in 2015.

Figure 1 - Employment by Sector and Labor productivity of selected countries



A household survey made by Baumgartner et al in 2015 showed that 90% of the household heads responded that the potential benefits of large-scale agricultural investment, specifically of Saudi Star, outweigh the potential negative aspects. They further developed a mathematical programing model to simulate the impacts of the emerging LSAI on the livelihood strategies and income of the local population to find out that Agriculture accounts for 22.3%, subsistence gathering and hunting together account for more than 40%, and business activities account for another 18.5% for the indigenous community. Initially wage employment contributes 13.3% of annual income. For the settler group farming is the major livelihood source, accounting for 43% of gross revenue. Business activities are secondary with a share of 37.5%, subsistence gathering of fuel wood and other forest products contributes about 7%, and wage employment contributes 12.1% of gross income.

2.2.3. Agricultural Technologies

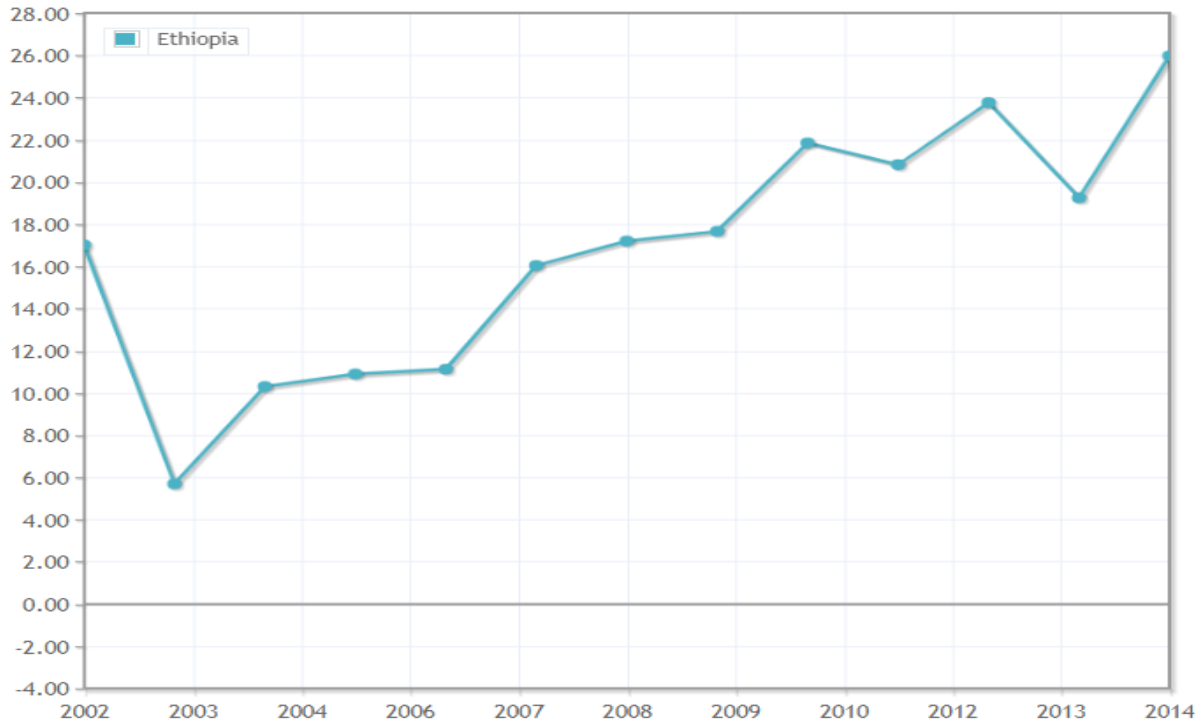
Ethiopia ranks 122nd on worlds fertilizer consumption raking based on kilograms per hectare of arable land. This FAO ranking puts Qatar, Malaisia and China as the top leading consumers. According to an assessment of fertilizer consumption and use by crop in Ethiopia made by IFDC – 2015, until 216, Urea and DAP have been the only fertilizer sources in Ethiopian agriculture for more than a decade. None of these are locally produced and should be supplied by imports to meet demand. N and P consumption steadily increased from 1980 /81 to 2014/15. Mean fertilizer consumption in Ethiopia has risen from 132,522 MT (1995/96) to 858,825 MT (2014/15) period. Even though the amount of fertilizer imported increases every year, Ethiopian farmers still lag far behind other developing countries in fertilizer use. The average intensity of fertilizer use in the country (which is roughly less than 40 kilograms per hectare) remains much lower than elsewhere (e.g., 54 kg/ha in Latin America, 80 kg/ha in South Asia, and 87 kg/ha in Southeast Asia). Going by the recommended usage dosages of N, and P for different crops, tef, wheat, maize and barley are the main consumers of fertilizers.

The share of sub-Saharan Africa in world consumption of nitrogen is 1.5 percent, phosphate 1.9 percent and potash 1.4 percent. The growth rate in demand for nitrogen, phosphate and potash for fertilizer is expected to be 4.6, 2.3 and 9.4 percent, respectively, between 2014 and 2018. South Africa, Nigeria, Kenya and Ethiopia are the major users of fertilizers in sub-Saharan Africa. – (FAO, 2018)

The government on its GTP II has stipulated that the application of fertilizer based on soil laboratory results to ensure compatibility of soil types will be implemented as a system in all parts of the country to increase crop productivity. Accordingly, a target is set to increase the supply of fertilizer from 1,223,309 metric tons in 2014/15 to 2,062,106 metric tons by the end of the plan period.

A study by Taddesse and Asferachew in 2008 found that 84.4% of Ethiopian farmers depend only on farming as a sole livelihood, 94.3% of the farmers used pesticides as part of their agriculture input and 28.7 % of the farmers use DDT for Agriculture. Although chemical pesticide use in Ethiopia was historically low, recent developments in increased food production and expansion in floriculture industry have resulted in higher consumption of chemical pesticides.

FIGURE 2 - Ethiopian Fertilizer consumption (kilograms per hectare of arable land)



Source: FAO 2015

The supply of improved seeds in 2014/15 was only 1.514 million quintals, which accounted for about 42% of the target set for the year. But the government in its GTP II has set a target to increase the amount of improved seed supply from 1,873,778 quintals in 2014/15 to 3,559,924 quintals by the end of the plan period. The difference in the supply of improved seeds in 2015/14 is due to the rejection of some improved seeds produced in a number of multiplication farms owing to poor quality and the failure to collect all improved seeds produced by smallholder farmers. (GTP II, 2015)

About 60-70% of seed used by Ethiopian smallholder farmers is saved on-farm and exchanged among farmers, and the remaining 20-30% is borrowed or purchased locally. The informal seed system (either self-saved seed or farmer-to-farmer seed exchange) accounts for 90% of the seed used by smallholder farmers, while the share of improved seed is less than 10% (Atilaw & Korbu, 2011).

In 2017 Agricultural Transformation Agency reported that Ethiopia's average annual national seed supply of improved varieties for most food crops covers less than 10% of the total agricultural land area, as compared to 25% in many other African nations.

2.2.4. Infrastructure Development

According to the revenue and expenditure projections of GTP II, total government expenditure is projected to reach ETB 2.2998 trillion (ETB 1.3133 trillion for capital expenditure and ETB 0.9864 trillion for recurrent expenditure) during the plan period. Given the government's focus on infrastructure expansion; capital expenditure on infrastructure sector accounts for about 48.4 percent of the total capital expenditure. Within this, drinking water, irrigation and energy, road, railway infrastructures are projected to account for 23.3 percent, 21.6 percent, 2 percent and 1.5 percent, respectively for the plan period.

Road infrastructure has a significant impact on the socio-economic well-being of a country. Insulated and inaccessible intern rural areas can be made open through construction of roads. In addition to this, it also contributes to stimulate the productivity of the agricultural sector. Road infrastructure can also reduce distances between different points and would advantage access to economic and social infrastructures (markets, schools, hospital).

The road system in Ethiopia forms and ensures approximately 90% of the countries' traffic. Government has taken road infrastructure development seriously in the last couple of decades. During the GTP I period, the federal and regional road network has increased from 48,800 km in 2010 to 63,604 km (with a net increase of 14,804 km) in 2015. In addition to this, 46,810 km all-weather woreda roads have been constructed. As a result, the total road network of the country has more than doubled during the GTP I period reaching 110,414 km by the end of the plan period. As a result, the proportion of rural kebeles connected to all-weather roads increased from 39% in 2009/10 to 76% by 2014/15 and the average time required to reach the nearest all weather roads declined from 3.7 hours to 1.7 hours.

In the strategic directions of GTP II Road is believed to be the backbone for the country's accelerated economic growth and social development. In the plan period, upgrading and improving the existing main roads and construction of express roads that link to the main corridors will continue. In the plan period, all rural kebeles will be linked to all-weather roads and main roads. Transport infrastructure network which helps accelerate economic growth in the years to come, will be increased both in terms of quantity and quality. In GTP II, the total road length is planned to increase from 110,414 km in 2014/15 to 220,000 km by 2019/20. It is planned to upgrade 560 km trunk roads, 3,765km of link roads and 15,000km of rural roads.

As a result, the average time that takes to reach the nearest all-weather road is planned to decline from 1.5 hour in 2014/15 to 0.8 hour by 2019/20, reduce the proportion of areas further than 5km from all-weather roads from 36.6% to 13.5%, increase road density from 100.4km/1000km2 to 200km/1000km2, increase roads in acceptable conditions (fair to good) from 70% in 2014/15 to 80% by 2019/20. Besides, it is planned to increase the ratio of asphalt (paved road) roads from 13% in 2014/2015 to 16% by 2019/20.

Public Health Infrastructures according to WHO are formal and enduring structures that support public health. These include: institutions and capacity, knowledge (of public and professional) and Commodities (physical infrastructure). According to this study, health infrastructure refers to clinics, pharmacies, medical labs and related medical services.

During the GTP I period, 38,000 health extension workers have been deployed all over the country. Primary health care service coverage has increased to 98 % by 2014/15. Deliveries attended by skilled health personnel has increased from 16.8 % in 2009/10 to 60.7 % by 2014/15. Similarly, postnatal care coverage has increased from 36.3 % in 2009/10 to 90 % by 2014/15. Regarding improvement of maternal and child health, under five mortality rate has decreased from 204/1000 in 1989/90 to 64/1000 by 2014/15, while maternal mortality ratio has decreased from 1400/100000 in 1989/90 to 420/100000 by 2014/15. Yet the health sector is still the primary development issue of the country.

Major Health sector development Targets in GTP II are: -

a) The national nutrition strategy which aims at producing healthy and productive citizens by fulfilling their nutrition demand will be implemented with due consideration by the relevant stakeholders. In this regard, special emphasis will be given to ensuring household food security, maternal and child care, render health services accessible and create healthy environment.
b) Reduce maternal mortality rate (MMR) from 420/100,000 live births in 2014/15 to 199/100,000 live births by 2019/20.
c) Reduce under 5 child mortality rate (U5CMR) from 64/1000 live births in 2014/15 to 30/1000 live births by 2019/20.
d) Reduce infant mortality rate from 44 in 2014/15 to 20 per 1000 live births by 2019/20.
e) Increase contraceptive prevalence rate from 42 % in 2014/15 to 55 % by 2019/20.

f) Increase deliveries attended by skilled health personnel from 60.7 % in 2014/15 to 90 % by 2019/20.
g) Expand primary health care service coverage from 98 % in 2014/15 to 100 % by 2019/20, ensuring universal coverage in primary health care. This would be achieved by improving access to quality health services and implementing preventive health policy and by strengthening implementation of nutrition program.
h) Increase life expectancy from 64 in 2014/15 to 69 by 2019/20.

The Education System in Ethiopia according to a 2018 report of Global Partnership for Education (GPE), has expanded from having 10 million learners a decade ago to more than 25 million today. To bolster up this upward trend, the country has developed a sector plan for 2015/16 to 2019/20 – The Education Sector Development Program V (ESDP V).

Pre-primary education enrolment rate has increased from 4.8% in 2009/10 to 39% by 2014/15, while the primary education net enrolment rate (NER) has increased from 82.9% to 96.9% during GTP I period. Gross enrolment rate (GER) of secondary education first cycle (grade 9-10) has also been increased from 39.7% in 2009/10 to 40.5% by 2014/15. The gross enrolment rate (GER) of Preparatory secondary education (grade 11-12) has also been increased from 6% in 2009/10 to 11.2% by 2014/15. The primary education special need gross enrolment rate (GER) has increased from 2.1% in 2009/10 to 4.4% by 2014/15. Similarly, the gross enrolment rate of functional adult education has increased from 36% in 2009/10 to 74.4% by 2014/15. Primary education (1-8) completion rate has increased from 47.8% in 2009/10 to 52.18% by 2014/15. Undergraduate enrolment in regular programs in both public and private higher education institutions has increased from 207,179 (public 190.043, private 17,136) in 2009/10 to 418,738 (public 375, 416; private 43,323) by 2014/15. In the same period, the overall undergraduate enrolment in all programs (regular, evening, summer and distance) of higher education institutions has increased from 420,387 to 755, 244. Enrolment in postgraduate program (both public and private institutions) has increased from 14,272 in 2009/10 to 33,915 by 2014/15.

In GTP II period it is planned to increase pre-primary education gross enrolment rate (GER) and primary education (grade1-8) net enrolment rate from 39% and 96.9% in 2014/15 to 80%and 100% by 2019/20, respectively. Similarly, it is targeted to increase the general secondary education enrolment rate from 40.5% in 2014/15 to 79% by 2019/20 and to narrow the gap in general

education participation between rural, urban and regions. It is also planned to increase adult education enrolment rate to 95% by the end of the plan period. Additionally, on the basis of the school classification standards, 60% of the primary schools and 75% of the secondary schools will become Level 3 and above by the end of the plan period. It is planned to increase the completion rate of primary education (1-8 grade) from 52.2% in 2014/15 to 74% by 2019/20.

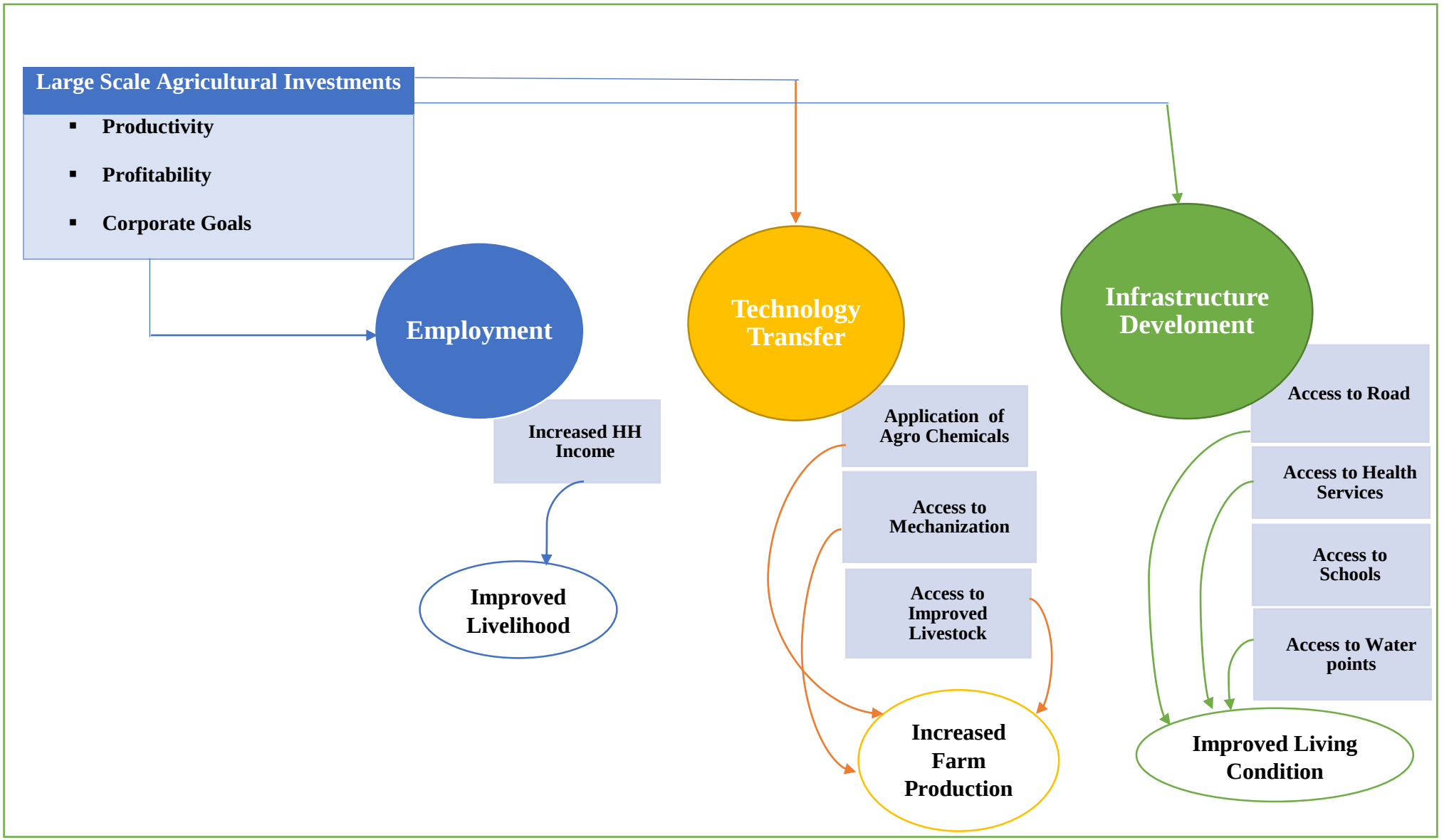
Irrigation structures: According to (Gebremedhin & Asfaw, 2015) – moden irrigation wa introduced in Ethiopia in the 1950's at the Rift Valley Basin for the production of commercial crops. Given the country's irrigation potential and the urgent need for reducing dependence on rain fed agricultural development systems, efforts need to be made to expand irrigation. one of the strategies during the GTP I plan period was to improve irrigation facilities on small holder farmers to achieve 8% average real agricultural GDP growth and an estimated 2.34 million hectares of land is developed through small scale irrigations schemes. it was planned to undertake feasibility studies and design works on 746,335 hectares of large and medium scale irrigation schemes. Achievements stood at 857,933 ha, which exceeded the planned target by about 15 percent. During the same period, construction works on 658,340 ha of irrigation schemes was planned but only 283,408 hectares was developed.

During GTP II it is planned to increase the area of land covered by irrigation from 2.34 million hectare in 2014/15 to 4,143,000 hectares by the end of 2019/20. Parallelly to develop 1,743,000 hectare additional irrigated land during the plan period and providing access to at least one alternative water point for 80% of smallholder farmers (semi-pastoralists) of which 50% are users of the full irrigation farming package.

2.3. Conceptual Framework

The conceptual framework below depicts the relationship between large scale agricultural investments towards local development expressed in terms of employment, technology transfer and infrastructure development. The main objectives of large scale agricultural investments as believed by everyone being generation of income by profitability, production and other corporate goals, they are also expected improve household income of the nearby community from the employment created, improve agricultural productivity from accessing technologies such as agrochemicals, improved seed, fertilizer, mechanization

FIGURE 3 - CONCEPTUAL FRAMEWORK

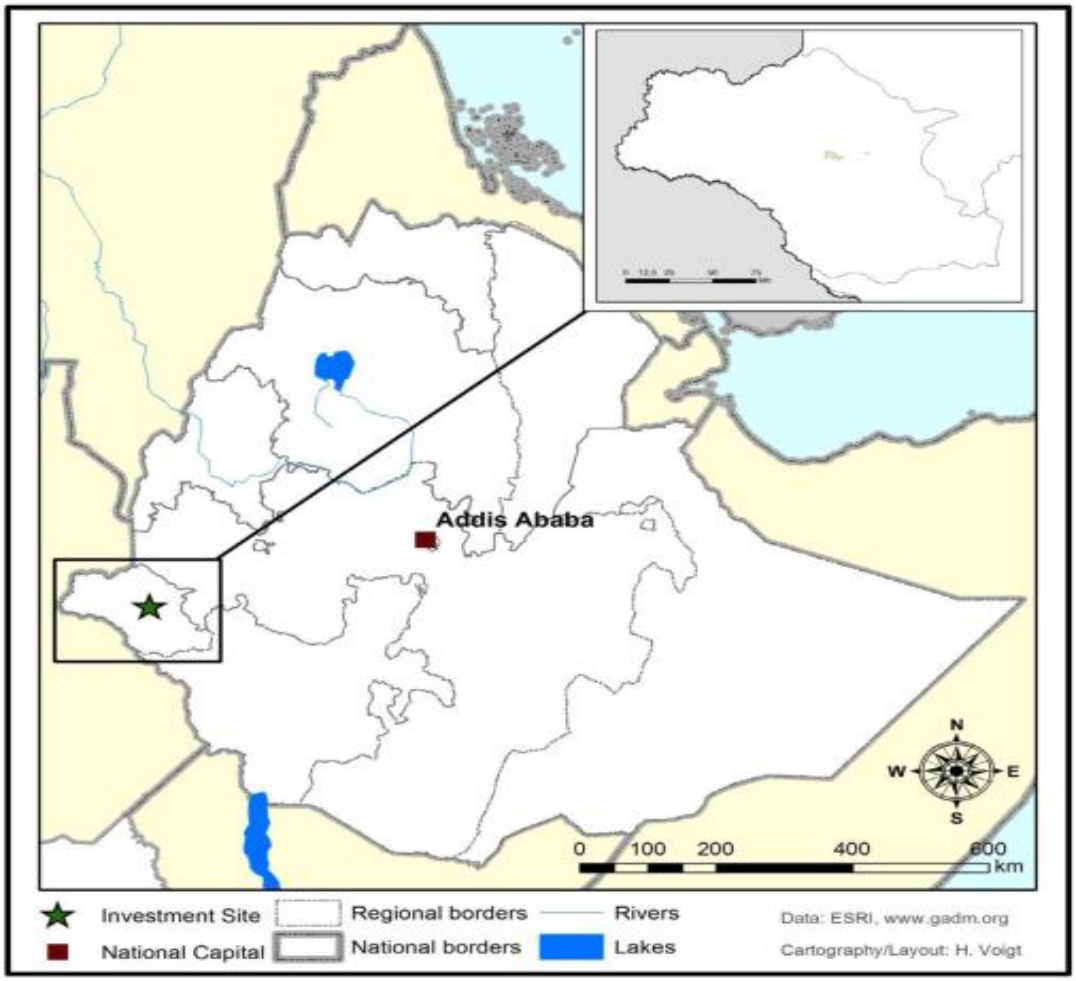


CHAPTER - III
Research Method

3.1. Description of the Study Area

Study Area is Gambella National Regional State that is located in the south-western part of Ethiopia and borders two other regions - Oromia to the North and East and the Southern Nations, Nationalities and Peoples' Regional State (SNNPRS) to the South - and the country of Sudan to the west. In the regional many languages are spoken: Nuer 39.72%, Anuak 27.47%, Amharic 8.44%, Oromiffa 6.45%, Majang 5.75%, all other primary languages 12.17%. According to a 2013 CSA survey, the region has a land area of 29,783 sq. km. The agricultural area irrigated is estimated to be less than 1%. CSA 2017 population projection shows that there are 435,999 people.

Figure 4 : Geographic Location of Gambella region & its Administrative weredas



Source: Baumgartner et. Al., 2015

The rationale behind selecting the area (Gambela region, Abobo & Itang Districts) for the study is due to the fact that the region attracts many investors for having abundant fertile arable land and reliable water source from rivers flowing in the region - Alwero, Akobo, Baro and Gilo. There are many large scale agricultural investments undertaken and are still being operating in the region in the last decade. There are success stories as well as failure stories which are being reported in the media that appeal further study in the area. Large scale agricultural investments in the region have been controversial and debated in local as well as international Medias.

According to a December 20, 2016 Fortune newspaper, a report presented to the Prime Minister's Office reveals that Massive loans poured over the years into Large-scale Agricultural Investments (LAI) in the Gambella Regional State have results with 84% spending on the intended purposes, but with disappointing results of productivity that is a fraction of the investments.

The report comes after an investigation into allegations of mismanagement of loans, favoritism and impropriety on the part of recipients surfaced last year. Out of a total of 600 developers in Gambella, 200 of them received loans from the DBE and the Commercial Bank of Ethiopia (CBE) to finance 206 projects, and before the DBE suspended loans to the commercial farming sector earlier this year. They were issued with close to five billion Birr in loans, to be disbursed over a certain period of years. Of that amount, DBE provided 2.76 billion Br, while CBE's share was 587 million Br. (Prime Minister's Office, 2016)

The 229,755 hectares of land conceded to Large-scale Agricultural Investments (LAI) developers in eight weredas of the Gambella Regional State, close to half of them began their initial operations and preparations with investments worth two billion Birr remain in project phase. The investigative report passed verdict on the sector saying "Productivity in private farming is not profitable; takes longer years to recover the loans; and its contribution to the national economy is insignificant". (Prime Ministers' office, 2016)

3.2. Research Design

Mixed method of research, employing the combination of quantitative and qualitative approaches, is employed in order to utilize the strength of both approaches. Primary data has been collected directly from field for both quantitative and qualitative analysis purpose. Propensity score matching (PSM) technic and matching with regression are employed to see the relationships between the local community and LSAI's for the quantitative approach.

3.3. Data Sources & Collection Instruments

Both Primary and secondary data sources are exploited to get adequate information on both qualitative and quantitative data.

3.3.1 Primary Data

Household Survey: the major source of Primary data was household survey by interviewing households in kebeles selected for both treatment (kebele's within 20km radius of LSAI'S) and control (kebele's 20km far from LSAI's). Primary data on employment opportunities they get from LSAI's, whether they use technologies like seed, fertilizer and agro chemical, if they have ever benefited from infrastructures built by LSAI's, demographic and soci-economic, benefits they get and challenges they face due to LSAI's and similar information have been collected from 504 households in both Kebele's with investments in their vicinity (treatment) and kebele's with no investment in their vicinity (control) of both Abobo and Itang Woreda's.

Semi structured interviews that allow enumerators to get the correct answer for each specific question in the questionnaire were constructed and translated into Amharic for ease of explaining the question to the respondent. 20 high school teachers and DA workers from the woreda agricultural offices were hired as enumerators after getting permission from the school and the woreda offices. They were given a two-day training on the objectives of the study, on how to keep the quality of information, the confidentiality and ethical procedures to be followed while interviewing. While supervising, the researcher was making sure enumerators were clinical thereby giving additional support.

Key Informant Interview: Key informant interviews from LSAI management & government agencies have also been conducted. Open ended unstructured questionnaire was used to interview top level managers of LSAI's and Wereda administrators. Used telephone interview for some informants who were not available at the site during the field survey.

Personal Field Observation: The researcher while supervising enumerators and driving through the villages has collected useful information and made informal discussions with residents of the villages on who constructed infrastructural developments. It was also a good opportunity to understand the socio-economic comparisons of communities across woredas and kebeles.

3.3.2 Secondary Data

Secondary data were collected from administrative offices of both woreda's. Additional secondary sources include published and unpublished journals, other government documents and websites.

3.3.3 Ethical Principles

No compromise has been taken on ethical issues in doing this research. Not only data collectors, but also respondents were also explained briefly about the research and its importance. A two days training has been delivered to data collectors on how to collect a data that is free of bias and of course the sensitivity of the issue under study. Respondents were granted the promise of protecting their identity and personal information by not taking their personal details in the questionnaire.

3.4. Sampling Procedures and Sample Size

Gambella Region was chosen for this study because of its attraction of large scale agricultural investors compared to other regions of the country. From the Eight districts of the region (Abobo, Gambella Area, Gog, Itang, Dima, Mengeshi, Godere and Lare) again two districts were chosen based on their relative availability of large scale agricultural Investments. Abobo and Itang districts have a relatively higher number of investments (Abobo 545 and Itang 467) whereas Gambella Area district holds 392 investors. Thus, the study is made in Abobo and Itang Districts of Gambella Region.

Baumgartner et. Al, (2015) used distance from investment as "nearby" for distance less than eight Km (1Hr), "intermediate" for distance between eight and 15 Km (1 – 2 Hrs) and "far" for distance more than 15 Km (>2Hrs). Referencing this, the study has set 20 km distance to be the radius of impact (treatment) and those outside 20Km distance to be non-impact (control).

The next step was to identify kebeles based on their proximity to LAI's. According to this study kebeles within the radius of 20 Kilo Meter are treatment kebele's whereas; kebele's 20 Kilometer away are control kebele's. Accordingly, four treatment and four control kebeles from Abobo district and two treatment and two control kebeles from Itang district were chosen.

The formula used for the sample size determination is developed by Robert V. Krejcieve of University of Minnesota, Duluth. This formula was derived for the determination of sample sizes specifically for research activities.

$$S = \frac{Z^2 NP(1-P)}{e^2(N-1)+Z^2P(1-P)}$$

Where: S = required sample size

Z^2 = degree of freedom at the desired confidence level (Z = 1.96)

N = the population size

P = the population proportion

e^2 = the degree of accuracy expressed as a proportion (0.05)

Propensity score matching requires similarity in socio-economic characteristics of both control and treatment groups. In Abobo district there are 1,533 households, from which 188 of them are settlers who have a different socio-economic characteristic compared to the indigenous society. The study focused only on the remaining 1,345 indigenous households because the 188 kebeles are all located within the premise of LSAI's and do not have control kebeles with similar socio-economic characteristics. Thus, from the 1,345 households, 682 (51%) are found in kebele's with Investments. With the sampling formula below 299 households are randomly selected. This will be 43.83% of the total households in kebeles with investment. This means that 43.83% of households of each of the four randomly chosen will be interviewed. Shown as in the table below a total of 167 households from Abobo district will be collected as treatment households.

Given: *Z=1.96; N=1,345; P=0.51 or (51%) and e=0.05*
Solution: Sample size from Treatment Kebeles of Abobo District will be:

$$S\,[Treatment] = \frac{Z^2 NP(1-P)}{e^2(N-1)+Z^2P(1-P)} = \frac{(1.96)^2 1345(0.51)(1-0.51)}{(0.05)^2(1345-1)+(1.96)^2(0.51)(1-0.51)} = 299/682 = 43.83\%$$

Therefore: 43.83% of households in Perpengo, Pukedi, Terkudi and Ochokchala kebeles are randomly selected as treatment households for survey in Abobo district.

From the 1,345 households in Abobo district, 663 (49%) households are found in kebeles with no LSAI's. Thus, using the same formula, the sample size proportion will be calculated as:

Given: *Z=1.96; N=1,345; P=0.49 or (49%) and e=0.05*

Solution: Sample size from control Kebeles of Abobo District will be:

$$S\,[control] = \frac{Z^2NP(1-P)}{e^2(N-1)+Z^2P(1-P)} = \frac{(1.96)^2 1345(0.49)(1-0.49)}{(0.05)^2(1345-1)+(1.96)^2(0.49)(1-0.49)} = 299/663 = 47.22\%$$

Therefore: 47.22% of households in Tegni, Dumbong, Potelam and Terchuri kebeles are randomly selected as control households for survey in Abobo district.

In Itang district there are 23 kebeless with 7,504 households in them. From these only 17% or 1,289 households are in eight kebeles that have large scale agricultural investments. Due to budget constraints, random selection of only one kebele for both treatment and control households has been done in Itang District. Watgach Kebele, that holds 345 households, has been selected for survey of treatment survey. Thus, using the selected sampling formula,

Given: *Z=1.96; N=7,504; P=0.1718 or (17.18%) and e=0.05*
Solution: Sample size from Itang District for Treatment will be:

$$S\,[Treatment] = \frac{Z^2NP(1-P)}{e^2(N-1)+Z^2P(1-P)} = \frac{(1.96)^2 7504(0.1718)(1-0.1718)}{(0.05)^2(7504-1)+(1.96)^2(0.1718)(1-0.1718)} = 213/1289 = 17\%$$

Therefore: 17% of 340 households in Watgach kebele (65 households) are randomly selected as treatment households for survey in Itang District.

The same way from the remaining 15 kebeles that do not have LSAI's in Itang district, Bazyel kebele has been randomly selected as a control kebele. Again using the selected sampling formula:

Given: *Z=1.96; N=7,504; P=0.8282 or (82.82%) and e=0.05*
Solution: Sample size from Itang District for control will be:

$$S\,[Control] = \frac{Z^2NP(1-P)}{e^2(N-1)+Z^2P(1-P)} = \frac{(1.96)^2 7504(0.8282)(1-0.8282)}{(0.05)^2(7504-1)+(1.96)^2(0.8282)(1-0.8282)} = 963/6215 = 16\%$$

Therefore: 16% of 585 households in Bazyel kebele (94 households) are randomly selected as control households for survey in Itang District.

Thus, a total of 158 households are interviewed from Itang district making the total number of households this study used from both districts 502. While cleaning the data, data from six households (two from Abobo and four from Itang) has been rejected due to quality issues making the total number of households used for analysis 496.

Table 2 - Selected Kebele's of Treatment & Control Areas by Number of HH's

Abobo District			Itang District		
Kebele	**No. of HHs**	**Remark**	**Kebele**	**No. of HHs**	**Remark**
Perpengo	83 x 0.438 = 36	Investment	Watgach	340 x 17% = 64	Investment
Pukedi	81 x 0.438 = 35	Investment	-	-	-
Terkudi	153 x 0.438 = 67	Investment	-	-	-
Ochokchala	66 x 0.438 = 29	Investment	-	-	-
Subtotal	**383 > 167**			**65**	
Tegni	186 x 0.472 = 88	No Investment	Bazyel	585 x 16% = 94	No Investment
Dumbong	54 x 0.472 = 26	No Investment	-	-	-
Potelam	67 x 0.472 = 32	No Investment	-	-	-
Terchuri	65 x 0.472 = 31	No Investment	-	-	-
Subtotal	**372 > 177**			**94**	
Total	755 > 344			158	502
Rejections	-2			-4	
Clean Data	**342**			**154**	**496**

Source: own construction, 2018

3.5. Method of Data Processing & Analysis

Both SPSS and STATA 13 were utilized to encode, process and analyze the data generated from household survey. Analysis involves both descriptive statistics and econometric analysis tools.

3.5.1. Descriptive Statistics

Demographic and socio-economic characteristics of households surveyed are analyzed using descriptive statistics such as the mean, median, percentage, standard deviation and the likes. Association of dependent and independent variables, significance tests and similar supporting analysis could also be included in the descriptive statistics part of this study. Qualitative data collected by KII's and personal field observations are also furnished with different descriptive statistics in addition to narrative interpretations.

3.5.2. Econometric Analysis

Based on the surveyed data type, ease of analysis and interpretation, Propensity score matching (PSM) econometric analysis tools have been found to be appropriate for the study. The objectives of the study - investigating the impact of LSAI'S on local development measured in terms of employment, technology transfer and infrastructure development demand the use of PSM with its corresponding matching techniques, common support graphs and statistical tests.

3.5.3. Model Specification

Propensity Score Matching (PSM): There is an international debate on whether LSAI's have impacted the local community. The major objectives of this paper being to investigate if LSAI's in Gambella region have impact towards local development. To this end, PSM would be the ideal model because it uses information from a pool of households that do not reside within the vicinity of LSAI's to identify what would have happened to those households that reside within LSAI's vicinity in the absence of the investments. By comparing how outcomes differ for HH's within investment areas relative to observationally similar households in areas where there is no investment, it is possible to estimate the effects of LSAI's towards employment generation.

Household's opportunity to get impacts of local development from different sources makes the study assume non-random assignments due to self-selection and led to the use of PSM. Thus, households living within 20 km radius of LSAI's are taken as treated group and those living 20km away from LSAI's as control groups. A 2016 World Bank study explains that 10km is the longest distance a person can travel to be affected by such treatments. Considering this and poor availability of transportation, this study set a 20km distance to be considered as control area.

Since dependent variables of local development selected for this study (employment, technology transfer and infrastructure development) are count variables that show the number of HH members affected by LSAI, the first step in this analysis is to match them using propensity scores and comparing them in their probability of getting affected. PSM depends on "Conditional Independence" and "Presence of Common Support.

Conditional Independence assumption describes the set of explanatory variables are not affected by the treatment; the outcome variable for both treated and control groups are independent of the treatment.

$$\left(Y_i{}^T, Y_i{}^C\right) \perp T_i \,|X_i\,.$$

Where:-

- Y_i^T and Y_i^C Stands for one of the local development variables those who got the opportunity and those who didn't respectively for the i[th] household.
- T stands for treatment or more specifically affected by local development; and
- X stands for the set of covariates which affects the probability of the household member getting affected.

Presence of Common Support states that every household have perfect predictability about the probability of either being impacted or not.

$$0 < \mathrm{P}\ (T_{\mathrm{i}} = 1 | X_{\mathrm{i}}) < 1$$

The common support assumption approves that HHs who got the impact of local development due to LSAI's have a comparison group who do not get the impact; based on propensity score distribution shown by a graph. Impact of LSAI's towards local development to those HHs who got the impact in the community can be calculated as:

$$\mathrm{ATT} = E(Y_i^T \big| T_i = 1) - E(Y_i^C | T_i = 1)$$

$$= E\{\left(Y_i^T - Y_i^C\right) | T_i = 1)\}$$

$$= E\{\left(Y_i^T - Y_i^C\right) | T_i = 1, P(x))\}$$

$$= E\{\left(Y_i^T \big| T_i = 1, P(x) - E(Y_i^C)\right) | T_i = 0, P(x))\}$$

The first step in **Estimating Propensity Score** must be choosing observable covariates that are believed to affect the outcome variable based on cofounds assumption. This assumption states that "the outcome variable must be independent of treatment conditional on the propensity score" (Spermann, 2009). Rereading empirical literature of this study helped in selecting covariate variables. This way variables affecting both treatment and outcome variables are included in the model. After this, tests below have been run as below.

Common Support Range is a psgraph command run in stata to produce a graph that shows if HHs in both control and treatment have similar propensity scores. If the graph shows overlapping it shows that there are non-treated HHs which are similar with treated HHs that can be used to compare average treatment effect on treated and matching is possible.

Matching Algorithms

This study chose to use three types of matching algorithms after analyzing the involved trade-offs with each algorithm for a better and clearer interpretations. These methods are 1. Nearest Neighbor Matching 2. Kernel Matching and 3. Caliper Matching.

Nearest Neighbor Matching is a solution to a matching problem that involves pairing a given point with another, 'closest' point. Setting up a nearest neighbor analysis involves choosing the criteria for 'closeness'-this could be a list of properties, the value of one particular property, or a propensity score-as well as a definition of 'distance' as it relates to the given property.

Kernel Matching is no-parametric matching estimator that uses weighted averages of all individuals in the control group to construct the counterfactual outcome. (Caliendo & Kopeing, 2005). Smith & Todd (2005) noted, that kernel matching can be seen as a weighted regression of the counterfactual outcome on an intercept with weights given by the kernel weights.

Caliper Matching bad matches due to the far distance of the nearest neighbor can be avoided by imposing a tolerance level on the maximum propensity score distance (Caliper). This way bad matches are avoided and hence the matching quality rises. Applying caliper matching means that those HH from the comparison group is chosen as a matching partner for a treated HH that lies within the caliper ('propensity range') and is closest in terms of propensity score. (Caliendo & Kopeing, 2005)

Assessment of Matching Quality

This study used statistical tests (mean bias test & T test) to check quality of the matching in order to ensure the distribution of the explanatory variables to be balanced at both in control and treated group. **T-test** is used to determine whether there is a significant difference between the means of the control and treatment group. This is done before and after matching and if P>0.01 the null hypothesis not be rejected, at 5% significance level and this shows the matching method is good. Whereas; **Mean Bias Test** describes the mean value of both the treatment and non-treated group, divided by the square root of the average sample variance in the treatment group and not matched non-treatment group. Matching is said to be acceptable is mean bias of the propensity score is less than 5 after matching (Rosenbaum and Runin, 1983).

CHAPTER - IV
Results and Discussions

Here in this part of the study, results of both descriptive and econometric analysis made using the methods discussed in the previous sections are interpreted and discussed thoroughly. Thus, the effect of LSAI's towards employment, technology transfer and infrastructure development in Gambella region are presented.

To understand the demographic and socio-economic characteristics of households both in the investment areas and those outside the investment areas, descriptive analysis has been made with proper statistical tools.

4.1. Demographic Characteristics

Demographic characteristics of households in the study area, Abobo and Itang woreda's of Gambella region, are discussed thoroughly below. Percentage, mean and numerical expressions of demographic features of households in both treated and control areas.

Table 3 - Demographic Characteristics of HH's in the study Area

		Mean	Frequency/ Number	In %
Family Size		6	-	-
Age of the HH Head		40	-	-
HH Head Type/Sex	Male Head	-	343	69%
	Female Head	-	153	31%
Marital Status of the HH Head	Married	-	355	72%
	Single	-	4	1%
	Divorced/Separated	-	39	8%
	Widowed	-	98	20%

Source: Own construction, 2018

Compared to a less than three world average, the mean household size in the study area, is more than double with six members. According to a 2016 Ethiopian Demographic and Health survey (EDHS), The average household size in Ethiopia is 4.6 members. The maximum number of household size in the study area is 19 whereas the minimum is one. The same survey depicts that one-quarter of households in Ethiopia are headed by women. Hence, this study has tried to accommodate households from both male headed (69%) and female headed (31% households.

The mean household age being slightly above 40 years in the study, the minimum age was 20 years and the maximum 70 years. 50% of household heads in the study area are within the age range of 30 to 50 years. Whereas those with in the age range of 20 to 35 years are 36%. The remaining are above 50 years, the maximum being 70 years. This implies that almost 86% of household heads in the community are in a working age group.

With the majority or 72% of the households are married, divorce in the study area represents 20% and eight percent of the households are either separated or widowed. Less than one percent of the households are unmarried or single. Polygamy in Gambella region, especially in Itang woreda is common. The table below shows that more than 25% of the married male households have more than one wife.

Table 4 - Demographic Characteristics of HH's by Marital Status

For male HH, number of wives	Freq.	Percent	Cum.
One	249	74.33	74.33
Two	68	20.3	94.63
Three and above	18	5.37	100
Total	**335**	**100**	

Source: Own construction, 2018

The table below demonstrates the gender distribution of households who got employment opportunities in LSAI's. Accordingly, from only 9% of the households who got employment opportunity in total of both the treatment and control areas, 72% of those were male households and only 28% households represent female employees. Employment opportunity in LSAI's for households that are within investment areas accounts 20%.

Table 5 - Demographic Characteristics of HH's by Gender and Employment Opportunity

Has any member of your family been employed in LSAI's?		Count	Percent
No	Male Head HH	297	66.0%
	Female Head HH	153	34.0%
Yes	Male Head HH	33	71.7%
	Female Head HH	13	28.3%

Source: Own construction, 2018

4.2. Socio-Economic and Institutional Characteristics

To avoid biases due to differences in socio economic characteristics of the control and treatment groups of the survey, it is conducted only on the native communities. In Abobo Wereda there are many settlers who came from different parts of the country due to villagization program of the derg regime. These households observationally have a totally different socio-economic characteristics compared the native communities. Unfortunately, all of the settler households lie in areas with higher LSAI activities and there were no settler households in areas where there are no LSAI's. From the researchers' observation these households have multiple livelihood system that include farming, small business, payed employment and the likes. It was clearly visible that these households have a different socio-economic characteristic and have to be avoided.

Native households in Abobo region are Anuaks and in Itang woreda are Nuers in ethnic. Both communities depend on the Alwero river fish resource, the rain forest primitive gathering, hunting, and primitive farming. The Anuak are mainly crop dependent people with fishing and hunting as their supplementary income sources. While the Nuer are largely livestock dependent.

Table 6 - HH's that are engaged in Crop Production by HH type

Did your HH produce any crop during the last year (Jan.2016-Jan.2017)?		Freq.	Percent
No	Male Head	5	50.0%
	Female Head	5	50.0%
Yes	Male Head	325	66.9%
	Female Head	161	33.1%

Source: Own construction, 2018

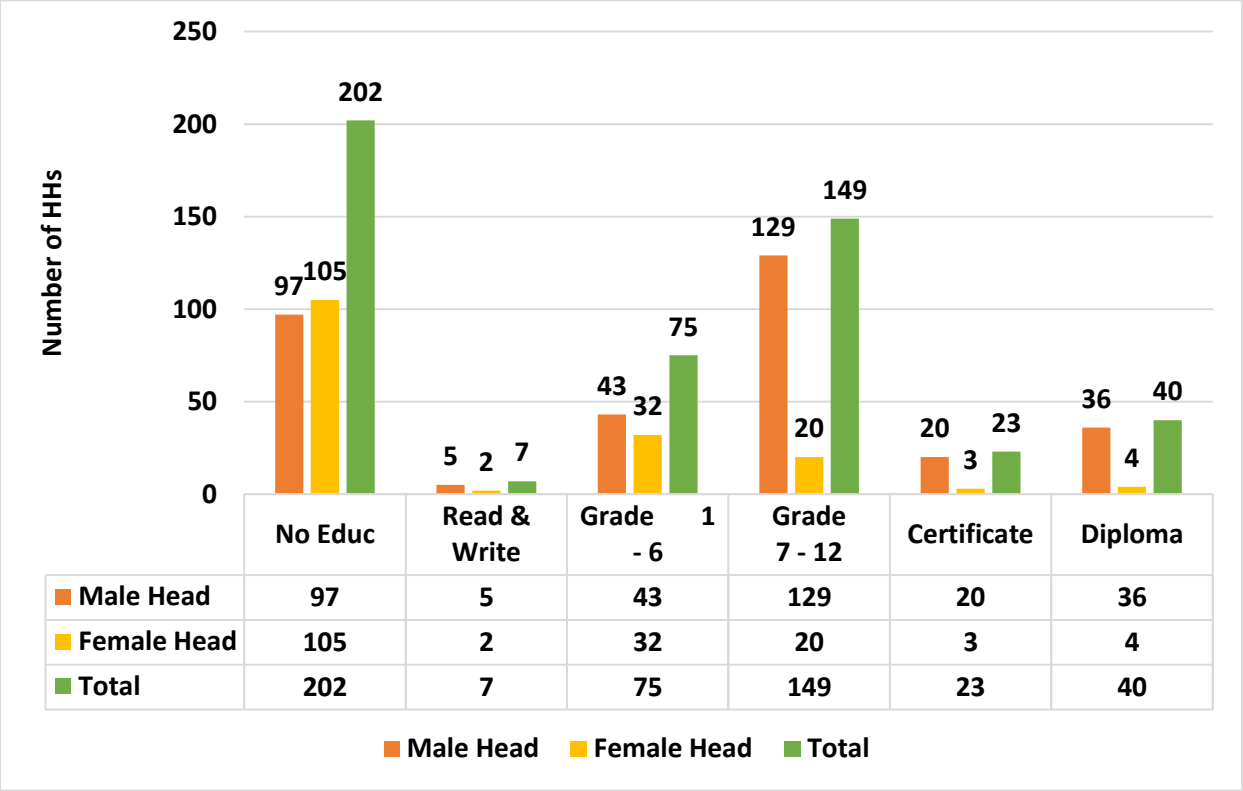
With 98% of the households being engaged in crop production, subsistence agriculture seems the major livelihood source in addition to fisheries and hunting. The river is rich with different species of fishes and the rain forest provides them with wild edibles, herbs, perennial vegetables and most importantly wild animals.

A household survey made by Baumgartner et al in 2015 showed that 90% of the household heads responded that the potential benefits of large-scale agricultural investment, specifically of Saudi Star Agricultural Development plc, outweigh the potential negative aspects. They further

developed a mathematical programing model to simulate the impacts of the emerging LSAIs on the livelihood strategies and income of the local population to find out that Agriculture accounts for 22.3%, subsistence gathering and hunting together account for more than 40%, and business activities account for another 18.5% for the indigenous community.

Initially wage employment only contributes 13.3% of annual income. For the settler group farming is the major livelihood source, accounting for 43% of gross revenue. Business activities are secondary with a share of 37.5%, subsistence gathering of fuel wood and other forest products contributes about 7%, and wage employment contributes 12.1% of gross income.

Figure 5 - House hold heads Highest Education Level by HH Type



	No Educ	Read & Write	Grade 1 - 6	Grade 7 - 12	Certificate	Diploma
Male Head	97	5	43	129	20	36
Female Head	105	2	32	20	3	4
Total	202	7	75	149	23	40

Source: Own construction, 2018

Regarding educational background, 41% of the households in the study area are illiterate and there is no one with an educational background above diploma. From the educated 15% are within the range of grade 1 to 6, 30% are within the range of grade 7 to 12, barely 2% of the total population finished high school. Only five percent and eight percent of the households have certificate and diploma respectively. With this educational background of the HHs in mind, let's see employment in LSAI's by type of employment in the table below.

Table 7 - Employment in Category of employment and Investment Area

Type of Profession	Abobo Woreda				Itang Woreda				Total			
	With Investment		Without Investment		With Investment		Without Investment		With Investment		Without Investment	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Causal/daily laborer	22	49%	1	100%	-	0%	-	0%	22	49%	1	100%
Guard	20	44%	-	0%	-	0%	-	0%	20	44%	-	0%
Technical operation (tractor driving, machine operation....)	3	7%	-	0%	-	0%	-	0%	3	7%	-	0%
Total	**45**		**1**		**0**		**0**		**45**		**1**	

Source: Own construction, 2018

The data in the table above confirms that skilled employment is unimaginable in a community where the majority is illiterate and where there are no higher education records. 49% and 44% of those who got employment opportunity in LSAI's are casual laborers and guards respectively. Only seven percent of them are engaged in Technical operation activities like tractor driving, machine operation and the likes.

Table 8 - Agricultural Technology Skills by Investment Areas

		Abobo				Itang				Total			
		Investment		No Investment		Investment		No Investment		Investment		No Investment	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigation skills	No	153	97%	185	100%	69	99%	84	100%	222	98%	269	100%
	Yes	4	3%	0	0%	1	1%	0	0%	5	2%	0	0%
Fertilizer/improved seed application skills	No	149	95%	185	100%	66	94%	84	100%	215	95%	269	100%
	Yes	8	5%	0	0%	4	6%	0	0%	12	5%	0	0%
Pesticides and herbicides skills	No	151	96%	185	100%	60	86%	84	100%	211	93%	269	100%
	Yes	6	4%	0	0%	10	14%	0	0%	16	7%	0	0%
Conservation skills	No	133	85%	185	100%	65	93%	84	100%	198	87%	269	100%
	Yes	24	15%	0	0%	5	7%	0	0%	29	13%	0	0%

Source: Own construction, 2018

Agricultural technology skill in investment areas have a slightly better record than areas with no investment. As it can be seen from the table above, HHs areas with no investment have responded not to have agri-technology skills. A 2%, 5%, 7% & 13% agri-technologies in Irrigation, Fertilizer & Improved seed, Agrochemical & environmental conservation is seen in investment areas. Although the figures are small it still shows the difference. Data in the annex shows trainings on technology use and supply of technological inputs is also higher in investment areas.

Agricultural Technology use is analyzed descriptively by comparing households in kebeles where there are LSAI's and there are no LSAI's as shown in the table below. Use of technologies such as improved seed, agro-chemicals, mechanization & improved livestock production are better in areas where there are LSAI's. Whereas; use of technologies such as fertilizer, improved agricultural practice & improved land management are better in areas where there are no LSAIs. Irrigation use is so minimal in both areas especially in areas where there are no LSAI's and only 2% of the surveyed households in areas with LSAIs say they use irrigation for crop production.

Table 9 - Agricultural Technology use by Areas with and Without LSAIs

Do You Use		Yes		No	
		Count	%	Count	%
Fertilizer for Crop production?	Investment	14	5%	252	95%
	No Investment	16	7%	213	93%
Improved Seed for Crop Production?	Investment	76	33%	151	67%
	No Investment	68	25%	201	75%
Agrochemicals for Crop Production?	Investment	55	24%	172	76%
	No Investment	47	17%	222	83%
Improved Agricultural Practice for Crop Production?	Investment	127	56%	100	44%
	No Investment	153	57%	116	43%
Agricultural Mechanization for Crop Production?	Investment	13	6%	214	94%
	No Investment	0	0%	269	100%
Irrigation for Crop Production?	Investment	2	1%	225	99%
	No Investment	0	0%	269	100%
Improved Livestock Production?	Investment	46	20%	181	80%
	No Investment	38	14%	231	86%
Improved Land Management Technology?	Investment	83	37%	144	63%
	No Investment	88	33%	181	67%

Source*: Constructed from own survey data, 2018*

Even if the scale is small, households in areas with LSAIs have access to infrastructures compared to households in areas with no LSAIs. Road infrastructure stands out as an exception with higher accessibility for households in areas with LSAIs. About 68% of households in areas with LSAIs said they have access to road infrastructure due to LSAI's. From KIIs regarding infrastructure development due to LSAI's, it is understood that in Terkudi kebele of Abobo woreda Saudi star agricultural development has constructed intra village roads for the community. From key informant interviews made with the managers of Saudi it is understood that more than 28km road from the gates of the farm to Abobo town is upgraded every year by the company.

The other difference is 69% of HHs in areas with LSAIs said they purchase agricultural products from LSAI farms. On the other hand, only 8% of the households sell their farm products to employees of LSAIs. Again, Saudi star agricultural development plc has built grain mills in two kebeles of Abobo woreda and gave it to the community as part of their corporate social responsibility. From a key informant interview with regional government administration, it is understood that Saudi Star agricultural development has handed over 26 120HP Massey Ferguson Tractors for the regions' Agriculture bureau to be distributed to all weredas in the region as gesture of development partnership with the community. Terkudi kebele students also receive educational materials from Saudi Star and an investor called Argaw every year for the last three years.

4.2.1. Large Scale Agricultural Investments

A study conducted by the federal government of Ethiopia on the performance of Agricultural Investments in Gambella region shows 623 investors have been granted 630,518 hectares of land in total since 2009. 70% of the land transfer was done by the regional administration whereas the remaining 35% is transferred by the federal government. 190,012 hectares or 30% from the total transfer was made to foreign investors. As shown in the table below Itang, Gambella area and Abobo woredas are the top three investor attractions with 70% land transfer being from these three woredas. Itang and Abobo woredas – the selected woredas for this study – transferred 329,814 hectares of land for 269 investors in total. This accounts 52% of regional land transfer.

Table 10 - Number of Investors and Land Transferred in Ha. by Woreda's

Woredas	Number of Investors					Land Transferred in Ha.			
	Total No. of Investors	By Regional		By Federal		Total Transferred	By Regional	By Federal Office	
		Local	Foreign	Local	Foreign			Local	Foreign
Gambella Area	200	200	-	-	-	119,038	119,038	-	-
Itang	146	144	-	-	2	236,664	109,664	127,000	-
Lare	6	6	-	-	-	5,400	5,400	-	-
Abobo	123	121	-	-	2	93,150	74,150	19,000	-
Gog	35	33	-	-	2	62,250	31,250	31,000	-
Dima	95	57	-	37	1	95,370	54,570	10,000	30,800
Godere	13	12	-	-	1	10,072	7,060	3,012	-
Mengesh	5	5	-	-	-	8,574	8,574	-	-
Total	**623**	**578**	**-**	**37**	**8**	**630,518**	**409,706**	**190,012**	**30,800**

Source: GoE – Study on Agricultural Investment Activities in Gambella Region, 2016

Private agricultural investment grew gradually until 2011 and for unforeseen reason decline in 2012 until the government started to promote it by allowing banks to give agricultural loans as well as incentivizing the sector by applying tax holiday and duty-free privileges. This again boosted the investment activity until 2016. For land given by the federal government land rent price for irrigated land is Birr 158 and for rainfed land is Birr 111. Whereas; for land given by the regional administration was very small and varies for woreda to woreda until the regional administration decided to use the federal rate and the same at all weredas.

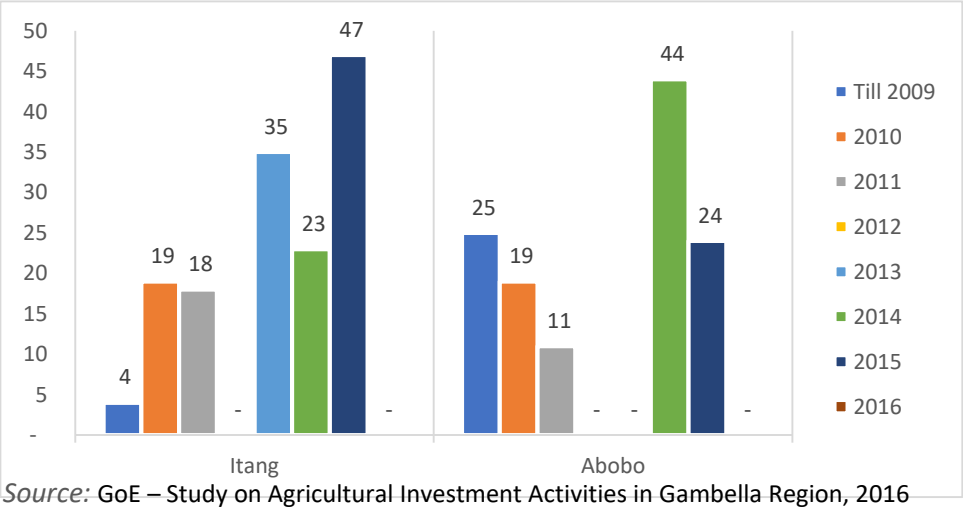
There are 25 native investors who took land for large scale agricultural development. Five of them have started cultivation and & are slashing bush for development until 2016. Among those who started development two have accessed bank loans from Development Bank of Ethiopia.

Table 11 - Agricultural Investment by Years

Year	Itang	Abobo	Total
Till 2009	4	25	29
2010	19	19	38
2011	18	11	29
2012	-	-	-
2013	35	-	35
2014	23	44	67
2015	47	24	71
2016	-	-	-
Total	**46**	**123**	**269**

Source: GoE – Study on Agricultural Investment Activities in Gambella Region, 2016

Figure 6 - Agricultural Investment by Year & Woreda



Source: GoE – Study on Agricultural Investment Activities in Gambella Region, 2016

From the total land transferred to both local and foreign investors only barely 16% has been developed and cultivated with crops. Only Mengesh woreda has a 99% total development performance record from the total transferred area in percentage. Whereas; Gog and Itang woredas have the list performance with 6% and 9% respectively. Abobo woreda with 14,449 hectares of land is the first in the rank of area cultivated with only 21% of land transferred to investors. Gambella area and Itang woredas sit in the second and third rank of areas cultivated with 14,332 and 14,037 hectares at 25% and 9% performance respectively. Due to poor development performance of two biggest investors (Karaturi and BHO), the government has revoked their land rights and this is one of the reasons for the lower development performance seen in the woreda.

Table 12 - Development Performance of LSAI's in Gambella Region - 2016

Woreda	Total Land Transferred in Ha.	Developed/ Slashed land in Ha.	Cultivated Land in 2015/16 in Ha.	Land Not Developed in Ha.	Land Expected to be Developed in 2015/16 in Ha.	Performance in %
Gog	62,250	8,103	3,104	49,667	52,770	5.88%
Abobo	93,150	9,557	14,449	53,376	67,825	21.30%
Gambella Area	119,038	30,303	14,332	43,049	57,381	24.98%
Itang	236,664	12,177	14,037	138,903	152,940	9.18%
Lare	5,400	89	836	1,004	1,840	45.45%
Dima	95,370	6,783	8,455	51,199	59,653	14.17%
Godere	10,072	755	1,598	4,291	5,890	27.14%
Mengesh	8,574	286	7,200	74	7,274	98.98%
Total	**630,518**	**68,054**	**64,011**	**341,562**	**405,573**	**15.78%**

Source: GoE – Study on Agricultural Investment Activities in Gambella Region, 2016

4.2.2. Impact of Large-Scale Agricultural Investments towards Employment

Estimating Propensity Score Matching

After selecting covariates that are believed to affect the outcome variable, a probit regression was run to measure the effect of LSAIs towards employment by estimating propensity scores. Result of probit regression made as shown in Annex 1 - Results of Probit Regression and ATT using Nearest Neighbor Matching Algorithm for Employment, there are twelve variables that affect household's probability of getting employment opportunity in LSAIs. Here propensity score describes the probability of the non-treated (those who are in kebeles with no LSAIs) groups to be treated (be in kebeles with LSAIs). The covariates or the variables that are believed to affect the outcome variable include sex, household type, household head sex, Household size, number of

wives for male household heads, household head literacy level, household head occupation, agricultural land holding, agricultural land size, involvement household heads in crop production, involvement of household head in small business, involvement of household head in out grower scheme with LSAIs and availability of LSAIs.

Checking overlapping or Presence of Common Support

ATT is only defined in the region of common support checking the overlap and the region of common support between treatment and comparison group is an important step. After running a psgraph visual analysis of the density distribution of the propensity score in both groups is the straight forward an easy way to do it. The assumption of a common support is that while using psm model, matching is possible only if there are households with similar propensity score in both groups. The graph below is the result of the psgraph clearly showing the existence of common support between those who got employment and those who didn't. This means that the covariates observed in the treatment group are also observed in the control group. There are no off-support households in both groups on both groups.

Figure 7 - Common support Graph for Employment

Source: Own Survey data, 2018

Matching and Estimating ATT for employment

As discussed in the methodology part of the research, matching and estimating average treatment effect on treated (ATT) is done using the three chosen matching algorithms – Nearest neighbor matching, Kernel Matching and Caliper matching. This way the counterfactual for households in kebeles where there are no LSAIs could be found.

Using nearest neighbor matching group households from the comparison group are chosen as a matching partner for a treated household that is closest in terms of propensity scores. Hence, the result on table 13 below shows that households in kebeles with LSAI's have a 0.28947 chance of being employed in LSAI's. The treatment (Large scale agricultural investments) have a positive effect in creating employment opportunity for households residing in their neighborhood.

Table 13 - Result of ATT for Employment

Algorithm	Variable	Sample	Treated	Controls	Difference*	S.E.	T-stat
Nearest Neighbor	emp	Unmatched	.289473684	.005494505	.283979179	.04602812	6.17
		ATT	.289473684	0	.289473684	.049949067	5.80
Kernel	emp	Unmatched	.289473684	.005494505	.283979179	.04602812	6.17
		ATT	.273333333	.003953239	.269380094	.047603003	5.66
Caliper	emp	Unmatched	.289473684	.00549450	.283979179	.04602812	6.17
		ATT	.275167785	0	.275167785	.047482476	5.80

Note: S.E. does not take into account that the propensity score is estimated
Source: Own Survey data, 2018

Kernel matching uses weighted averages of all households in the control group to construct the counter factual outcome. Result on table 13 above for kernel matching algorithm shows a positive ATT meaning Large Scale Agricultural Investments have a 0.269380094 unit of employment opportunity for households in their surrounding compared to households in kebeles with no LSAIs.

Caliper matching algorithm uses comparison group as matching partners for a treated household that lies within the caliper ('propensity range') and is closest in terms of propensity score. The Caliper can be found by dividing the standard deviation of propensity score by four. In this case the standard deviation is 0.1294237. Dividing this by four gives the caliper > 0.032355925. Using this caliper or propensity range, average treatment effect on the treated was estimated and the result as shown in table 13 above is positive. LSAIs have a 0.275167785 unit of employment generation for households in their neighborhood than households in areas with no LSAIs.

The results from Nearest Neighbor and Kernel algorithms have the largest and the smallest positive average treatment effect of the treatment on the treated group in getting employment opportunity respectively. In any case the matching algorithms produced a positive ATT means that Large Scale Agricultural Investments create employment opportunities for the nearby HHs.

Noting that employment being the most frequently cited benefit arising from LSAIs, Zhan et al, 2015 reported that investments studied in Asia employed around 7,000 people in total. This refers to direct employment by the investor, the number of indirect jobs created being difficult to assess. As an indication of the possible scale of further job creation, two rice producers in Cambodia employed 12,500 and 30,000 contract farmers, respectively (though these farmers may not work exclusively for these investors).

A 2017 World Bank study reads as -many investors in the survey generated formal job opportunities in rural communities for the first time. 60% of 54 employees interviewed across all investments for this supplementary report had no previous formal work experience. For over 80% of female employees, the job with the investor was their first experience with formal employment. World Bank, 2017

Checking Matching Quality or Effect of Estimation

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. (Caliendo & Kopeing, 2005). Mean Bias and pstest procedures were used in assessing matching qualities.

The decision rule for **mean bias** matching quality assessment procedure is that the acceptable mean bias of the propensity score should be less than 5 after matching. After running this test for the three matching algorithms employed in this research, 5.1 for nearest neighbor matching algorithm, 3.7 for kernel matching algorithm and 4.9 for caliper matching algorithm has been recorded as shown in the tables below. From this we can conclude that Kernel and caliper matching algorithms were the only matching algorithms with acceptable matching qualities. This implies after matching the value of covariates used to estimate the propensity score is similar between treated and control groups.

Table 14 - Result of Mean Bias for Employment using the three Matching Algorithm

Algorithm	Sample	Ps R2	LR chi2	p>chi2	MeanBias*	MedBias	B	R	%Var
Nearest Neighbor	Unmatched	0.051	23.62	0.014	11.3	10.8	53.7*	0.85	20
	Matched	0.008	3.26	0.987	5.1	5.9	20.6	1.24	20
Kernel	Unmatched	0.051	23.62	0.014	11.3	10.8	53.7*	0.85	20
	Matched	0.004	1.60	0.999	3.7	3.5	14.6	0.89	0
Caliper	Unmatched	0.051	23.62	0.014	11.3	10.8	53.7*	0.85	20
	Matched	0.009	3.64	0.979	4.9	5.9	21.8	0.63	30

* if B>25%, R outside [0.5;2]

Source: Own Survey data, 2018

The other procedure used to assess matching quality in this study is **pstest/t-test** that uses a two-sample t-test to check if there are significant differences in covariate means for both groups. Before matching differences are expected, but after matching the covariates should be balanced in both groups and hence no significant differences should be found. The decision rule for this procedure is that the matching is acceptable if p value of covariates after matching should be greater than 0.05 (at 5% significant level).

As it can be seen from Annex 2 p values of all covariates are greater than 0.05. Thus, we can conclude that nearest neighbor matching algorithm has reduced covariates mean differences for both groups and the matching quality was good to calculate ATT on the treated.

The same way from Annex 6 - Results of PS test for employment using Kernel Matching Algorithm, we can see that p values of all covariates are greater than 0.05 and we can conclude that kernel matching algorithm has reduced covariates mean differences for both groups and the matching quality was good to calculate average treatment effect on the treated.

Again from Annex 8 the same result as the other matching algorithms, there are no covariates with p values less than 0.05 and we can conclude that caliper matching algorithm has reduced covariates mean differences for both groups and the matching quality was good to calculate average treatment effect on the treated.

4.2.3. Impact of Large-Scale Agricultural Investments towards Technology Transfer

As already stated in the literature part of the study technology refers to the use of agricultural technologies such as improved seed, fertilizer, agrochemicals, irrigation, improved agricultural practices, improved land management, agricultural mechanization, usage of improved livestock, improved livestock management, and the likes. But this study has chosen application of agrochemicals from crop production, use of improved livestock from animal production aspects and additionally agricultural mechanization variables will be analyzed to measure the impact of LSAI's towards technology transfer.

Estimating Propensity Score Matching for Technology Transfer (Agrochemicals Application, Agricultural Mechanization & Improved Livestock)

28 covariates that affect a households' probability of using the selected technologies were selected and regression has been run to measure impact of LSAI's towards these technologies by estimating propensity score. These variables are sex, number of females for male HHHs, Ethnicity, HH size, HHH age, HHH marital status, HHH religion, HHH highest education level, HHH occupation, Size of agricultural land, fertility of agricultural land, land use, land right, land source, land investments, land distance from home, crop production, employment, LSAI market benefit, LSAI road benefit, loss of ecology due to LSAI's, Use of improved seed, fertilizer, improved livestock, improved livestock management, and improved agricultural practice. Results of regression using the three matching algorithms, nearest neighbor, kernel and Caliper for the selected output variables are shown in the Annexes - **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**

Checking Overlapping/Presence of Common Support

The graphic illustrations of common support in FIGURE 8, FIGURE 9 and FIGURE 10 show there are overlap between treatment and comparison groups implying that there are households with similar propensity score in both groups of all the three outcome variables under study. Thus, matching is possible since the covariates of all the three outcome variables observed in the treatment groups are also observed in the control groups.

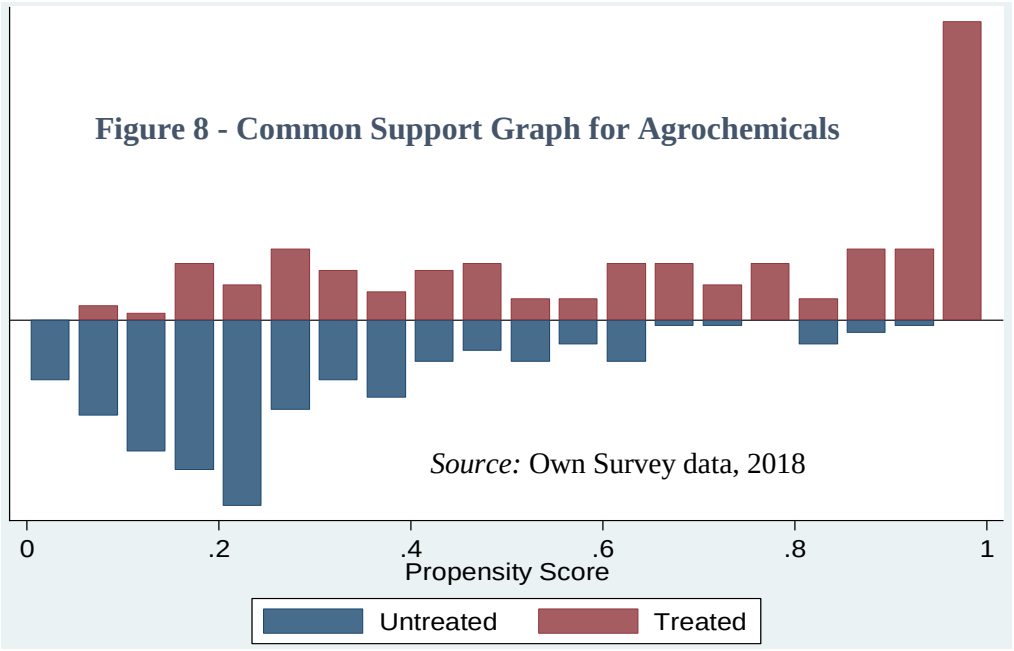


Figure 8 - Common Support Graph for Agrochemicals
Source: Own Survey data, 2018
0
.2
.4
.6
.8
1
Propensity Score
Untreated
Treated

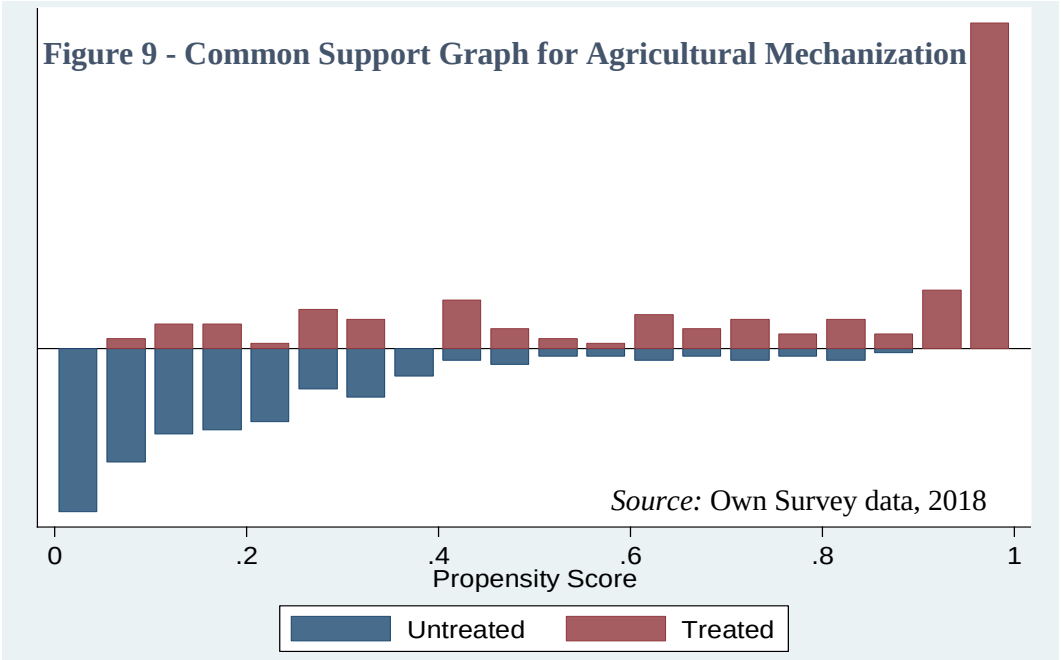


Figure 9 - Common Support Graph for Agricultural Mechanization
Source: Own Survey data, 2018
0
.2
.4
.6
.8
1
Propensity Score
Untreated
Treated

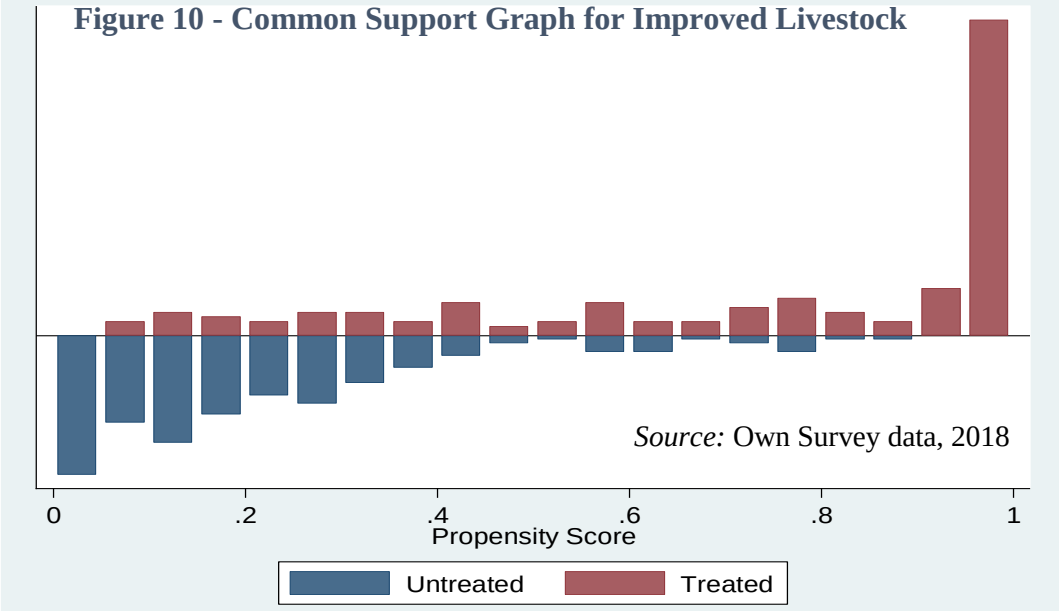


Figure 10 - Common Support Graph for Improved Livestock
Source: Own Survey data, 2018
0
.2
.4
.6
.8
1
Propensity Score
Untreated
Treated

Matching and Estimating ATT for Agrochemicals

The result from nearest neighbor matching algorithm as shown in TABLE 15, is positive and households in treatment groups have a 0.197368421 unit of agrochemicals usage for crop production compared to households in control group. Although it is statistically insignificant, the analysis on average treatment effect on treated using nearest neighbor matching algorithm confirms large scale agricultural investments have a positive effect towards the use of agrochemicals for crop production to the nearby households.

Table 15 - Result of ATT for Agrochemicals Using the three Matching Algorithms

Algorithm	Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Nearest Neighbor	Chemicals	Unmatched	.256578947	.220994475	.035584472	.046900557	0.76
		ATT	.256578947	.059210526	.197368421*	.13107611	1.51
Kernel	Chemicals	Unmatched	.256578947	.220994475	.035584472	.046900557	0.76
		ATT	.284552846	.116971767	.167581079*	.098391972	1.70
Caliper	Chemicals	Unmatched	.256578947	.220994475	.035584472	.046900557	0.76
		ATT	.264705882	.098039216	.166666667*	.073980097	2.25

Note: S.E. does not take into account that the propensity score is estimated.
Source: Own Survey data, 2018

The kernel matching algorithm has also produced a positive ATT result with a 0.167581079 unit of agrochemicals usage in crop production for households who are in kebeles with LSAIs. Again, we can conclude that existence of LSAIs has a statistically insignificant positive effect towards agrochemicals usage for crop production on households in their vicinity compared to households that are in kebeles where there are no LSAIs.

With a standard deviation of 0.4045803 divided by four to run Caliper matching algorithm, proved that LSAI's have a statistically significant positive effect towards technology transfer on households in their surrounding with a 0.1667 unit compared to households that are in kebeles where there are no LSAIs. Although the results from Nearest Neighbor and Kernel matching algorithms have a slightly larger ATT score, the results were statistically insignificant. Whereas, the result from Caliper matching algorithm have produced a statistically significant and positive ATT score. Regardless of the level of effect, the result from matching by Caliper matching method showed that LSAIs in Gambella region have effect towards usage of agrochemicals in crop production to the surrounding community.

Deininger et al. (2015) have recently used survey data of large-scale and small-scale farmers in Mozambique to study spillover effects. The authors find evidence of some spillovers to small-scale farmers in terms of adoption of farming practices, fertilizer and pesticides, but also negative impacts on farmers' subjective well-being.

According to a study in Tanzania by Raoul Herrman, participation in the sugarcane out grower scheme is also associated with a higher adoption rate of fertilizer (80%) and pesticides (65%), most of which is financed through own savings (90%).

Zaehringer et al's 2018 study on how LSAI's affect land use and the environment on the western slopes of Mount Kenya? Empirical evidence based on small-scale farmer's perceptions and remote sensing, noted that two households near LSAI, a floriculture enterprise, said they had started to irrigate their crops and use chemicals and crop rotation.

Checking Matching Quality or Effect Estimation for Agrochemicals

Referring TABLE 16, it can be concluded that the matching does not have an acceptable mean bias result and the quality of matching is poor with 9.1 mean bias result for Caliper matching algorithms that produced a positive and statistically significant result. Meaning that the value of covariates used to estimate propensity score is not similar between treated and control groups after matching.

Table 16 - Result of Mean Bias for Agrochemical usage using Nearest Neighbor Matching Algorithm

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.332	152.46	0.000	19.4	12.3	139.4*	5.09*	38
Matched	0.058	15.98	0.889	9.1	7.6	57.5*	1.20	13

* if B>25%, R outside [0.5; 2]

Source: Own Survey data, 2018

On the other hand, pstest/t-test is also employed to check the quality of matching algorithms used and reference to the pstest table for Caliper matching ANNEX 12, only two (HHH age and Land Use) out of the 25 covariates in the matching, have p values with less than 0.05 which have a 0.039 and 0.044 matched p values respectively. In conclusion, Caliper matching algorithm has failed to reduce two of the 25 covariates mean differences for both groups and the matching quality was poor to calculate average treatment effect on the treated for agrochemicals despite the appositive and statistically significant ATT result from the matching analysis.

Matching and Estimating ATT for Agricultural Mechanization

The result from nearest neighbor matching algorithm as shown in TABLE 17, is statistically significant and a positive ATT. Households in treatment groups have a 0.065789474 unit of agricultural mechanization usage for crop production compared to households in control group. The analysis on average treatment effect on treated using nearest neighbor matching algorithm confirms large scale agricultural investments have a positive and statistically significant effect towards the use of agricultural mechanization for crop production to the nearby households.

Table 17 - Result of ATT for Agri-Mechanization by Nearest Neighbor Matching Algorithm

Algorithm	Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Nearest Neighbor	Mechanization	Unmatched	.065789474	0	.065789474	.01848287	3.56
		ATT	.065789474	0	.065789474*	.020174933	3.26
Kernel	Mechanization	Unmatched	.065789474	0	.065789474	.01848287	3.56
		ATT	.013513514	0	.013513514*	.013513514	1.00
Caliper	Mechanization	Unmatched	.065789474	0	.065789474	.01848287	3.56
		ATT	.013888889	0	.01388889*	.01388889	1.00

Note: S.E. does not take into account that the propensity score is estimated.
Source: Own Survey data, 2018

The kernel matching algorithm has also produced a positive ATT result with a 0.013513514 unit of agricultural mechanization usage in crop production for households who are in kebeles with LSAIs. Again, we can conclude that existence of LSAIs has a positive effect towards agricultural mechanization usage for crop production on households in their vicinity compared to households that are in kebeles where there are no LSAIs except it is statistically insignificant in this case.

With a standard deviation of 0.1599196 divided by four to run Caliper matching algorithm, LSAI's have a positive effect towards technology transfer on households in their surrounding with a 0.013888889 unit compared to control areas except for it is statistically insignificant.

Although the results from Kernel and Caliper matching algorithms have a positive ATT score, the results were statistically insignificant. Whereas; the result from Nearest Neighbor matching algorithm have produced a statistically significant and positive ATT score. Regardless of the level of effect, the result from matching by Nearest Neighbor matching method showed that large scale agricultural investments in Gambella region have effect towards usage of agricultural mechanization in crop production to the surrounding community.

A study in Tanzania by Bruntrup et al in 2016 said that investors also can be observed bridging the finance gap between smallholders and financial institutions by providing cash loans themselves through appendix institutions or by linking farmers to bigger financial institutions while serving as guarantor. Technology transfers also occur and happen mainly through one of two models: (i) renting/provision of large machinery, (ii) provision (through loans or grants) of small technological innovations.

In addition, lessons of case studies in seven countries on LAIs and inclusion of small farmers by Perrine Burnod (Ciral) and Jean-Philippe Colin (IRD) – 2012 pointed that in Burkina Faso access to credit was a factor which has improved cotton farmers investment capacities for mechanization.

Checking Matching Quality or Effect Estimation

Referring TABLE 18, it can be concluded that the matching does not have an acceptable mean bias result with 44.3 mean bias result for Nearest Neighbor matching algorithms that produced a positive and statistically significant effect towards the use of agricultural mechanization in crop production to the local farmers. Matching quality was poor and the values of covariates used to estimate propensity score is not similar between treated and control groups after matching.

Table 18 - Result of Mean Bias for Agri-Mechanization using Nearest Neighbor Matching Algorithm

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.481	220.92	0.000	23.0	12.2	143.5*	19.19*	38
Matched	0.434	179.31	0.000	44.3	33.4	137.4*	12.84*	63

* if B>25%, R outside [0.5; 2]

Source: Own Survey data, 2018

In addition to mean bias test, pstest/t-test is also employed to check the quality of matching algorithms used. In reference to the pstest table for Nearest Neighbor matching on ANNEX 20 Eighteen out of the 25 covariates in the matching have p values with less than 0.05. In conclusion, Nearest Neighbor matching algorithm has failed to reduced covariates mean differences for both groups and the matching quality was poor to calculate average treatment effect on the treated for agricultural mechanization despite a appositive and statistically significant average treatment effect on the treated result from the matching analysis.

Matching and Estimating ATT for Improved Livestock Usage

Estimation result of average treatment on the treated using nearest neighbor matching algorithm has produced a positive result with a 0.118421053 unit of a statistically insignificant improved livestock usage for households in kebeles with investments than households living in kebeles without LSAI's as shown on TABLE 19 below.

Table 19 - Result of ATT for Improved Livestock Usage by the three Matching Algorithms

Algorithm	Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Nearest Neighbor	Improved Livestock	Unmatched	.151315789	.055248619	.096067171	.032546229	2.95
		ATT	.151315789	.032894737	.118421053*	.165299703	0.72
Kernel	Improved Livestock	Unmatched	.151315789	.055248619	.096067171	.032546229	2.95
		ATT	.223529412	.083011034	.140518378*	.062641091	2.24
Caliper	Improved Livestock	Unmatched	.151315789	.055248619	.096067171	.032546229	2.95
		ATT	.213333333	.08	.13333333*	.06230099	2.14

Note: S.E. does not take into account that the propensity score is estimated.
Source: Own Survey data, 2018

Unlike nearest neighbor matching algorithm, estimation of ATT using kernel matching algorithm has produced a positive and a statistically significant result with a 0.140518378 unit of improved livestock usage for households in kebeles with investments than households living in kebeles without LSAI's as shown on table 19 above.

Again, after finding the standard deviation for the use of Caliper matching algorithm and running regression, estimation result of ATT for development of infrastructures has produced a positive and statistically significant result with a 0.133 unit of improved livestock usage for households in kebeles with investments than households living in kebeles without LSAI's as shown below.

In comparison from the two matching algorithms with a statistically significant ATT result, Kernel matching algorithm has a relatively larger ATT score. The two algorithms have proved one thing in common – that large scale agricultural investments have a positive effect on usage of improved livestock with a statistical significance and the community benefits from them compared to similar areas with no investments in their neighborhood.

A study made in Kenya by Zaehringer et al said at two of the floriculture LSAIs they studied, employees had learned about livestock keeping along with integrated pest management, crop rotation, and the use of organic manure. The study in the result part discussed about the perceived impacts of LAIs on small-scale farmers' and few respondents had changed the cattle breed to increase milk production (3%) due to LAI'.

Checking Matching Quality or Effect Estimation

Mean bias tests run for the assessment of matching quality for Kernel and Caliper matching algorithms on TABLE 20 show results with 12.2 and 7.6 respectively. The mean bias test declares both matching algorithms (Kernel and Caliper) have a poor matching quality although they have a significantly positive ATT.

Table 20 - Result of Mean Bias for Improved Livestock by Kernel Matching Algorithm

Algorithm	Sample	Ps R2	LR chi2	p>chi2	MeanBias*	MedBias	B	R	%Var
Kernel	Unmatched	0.475	218.21	0.000	22.3	11.8	142.3*	18.99*	38
	Matched	0.075	17.72	0.912	12.2	11.2	65.6*	0.80	28
Caliper	Unmatched	0.475	218.21	0.000	22.3	11.8	142.3*	18.99*	38
	Matched	0.051	10.69	0.998	7.6	7.4	53.8*	0.98	19

* if B>25%, R outside [0.5;2]

Source: Own Survey data, 2018

Unlike mean bias tests, results of t-test on the two matching algorithms Kernel and Caliper matching algorithms have p values above 0.05 (at 5% significant level) declaring that the matching quality is good enough on reducing covariates mean differences for both groups. Thus, we have two matching algorithms with acceptable matching quality and they are good to estimate ATT. See ANNEX 24 and ANNEX 25 for mean bias test and T-test results.

4.2.4. Impact of Large-Scale Agricultural Investments towards Infrastructure Development

Infrastructure development could be a very broad theory and could include a lot of issues. But this study focuses only on some of basic infrastructures in day to day human life. Specifically, health service, education service or school, road and irrigation infrastructures have been selected for this study. Similar to technology transfer, households have been asked if they use these infrastructures due to large scale agricultures in both treated and control groups. Using the variables from this data, an infrastructure index variable has been created using Principal Component Analysis (PCA).

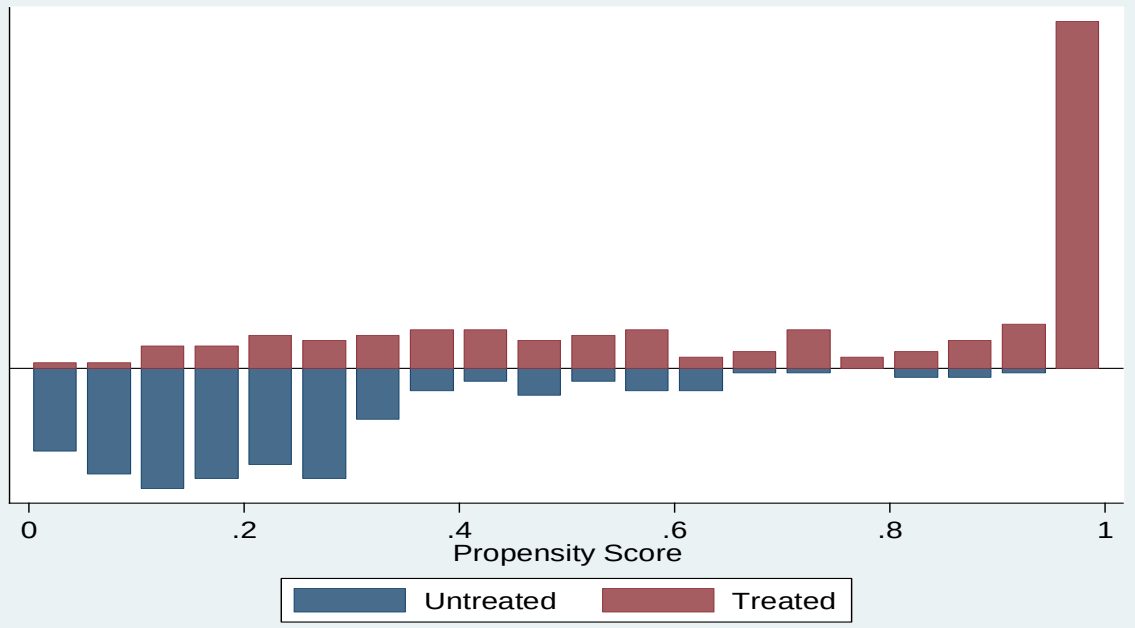
Estimating Propensity Score Matching

In order to minimize biases of the PS model and increase the precision of the estimated exposure effect, more than 20 covariates have been selected and regression has been run to measure the effect of LSAIs towards infrastructure development by estimating propensity score. The covariates include sex, number of wives for male HHs, HH size, HHH marital status, HHH highest education level, HHH occupation, Agricultural land distance from home, Crop production, employment status, market benefit due to LSAI, Fertilizer use, improved seed use, agrochemical use, improved livestock use, improved agricultural practice, improved livestock management and improved land management.

Checking Overlapping/Presence of Common Support

The PS graph on FIGURE 11 shows that there is common support among treatment and comparison groups of the matching model. Availability of similar propensity scores in both groups means matching is possible. The graph also shows that there are no off-support households.

Figure 11 - Common Support Graph for Infrastructure Development



Matching and Estimating ATT

Estimation result of average treatment on the treated using nearest neighbor matching algorithm has produced a positive result with a 0.703094017 unit of infrastructure development benefits due to LSAIs for households in kebeles with investments than households living in kebeles without LSAI's as shown on TABLE 21 below.

Table 21 - Result of ATT for Infrastructure Dev't Using Nearest Neighbor Matching Algorithm

Algorithm	Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Nearest Neighbor	Infrastructure	Unmatched	.364683967	-.33841005	.703094017	.099051738	7.10
		ATT	.364683967	-.33841005	.703094017*	.10811969	6.50
Kernel	Infrastructure	Unmatched	.364683967	-.33841005	.703094017	.099051738	7.10
		ATT	.125743946	-.33841005	.464153996*	.119774537	3.88
Caliper	Infrastructure	Unmatched	.364683967	-.33841005	.703094017	.099051738	7.10
		ATT	.142488051	-.33841005	.480898101*	.127006701	3.79

Note: S.E. does not take into account that the propensity score is estimated.
Source: Own Survey data, 2018

Similar to NN matching algorithm, estimation of ATT using kernel matching algorithm has also produced a positive result with a 0.464153996 unit of infrastructure development benefits due to LSAIs for households in kebeles with investments than households living in kebeles without LSAI's as shown on TABLE 21 above.

Again, after finding the standard deviation for the use of Caliper matching algorithm and running regression, estimation result of ATT for development of infrastructures has produced a positive result with a 0.480898101 unit of infrastructure development benefits due to LSAIs for households in kebeles with investments than households living in kebeles without LSAI's as shown on 21 above.

In comparison Nearest neighbor matching algorithm has the largest ATT score and kernel and Caliper matching algorithms are follow second and third respectively. The three algorithms have proved one thing in common – that large scale agricultural investments affect infrastructure development positively and the community benefits from them compared to similar areas with no investments in their neighborhood.

Other studies have also suggested in an indirect way existence of LSAI's have become the means for infrastructure developments because governments invest on these infrastructures to attract FDIs. Some positive developments such as employment generation, increased government revenues and the construction of much needed social and other infrastructure to the benefit of local communities have been recorded as the consequence of some of the projects. - Ellen Aabo & Thomas Kring, 2012

Checking Matching Quality or Effect Estimation

Mean bias tests run for the assessment of matching quality for Nearest Neighbor, Kernel and Caliper matching algorithms on TABLE 22 show an acceptable results with 42.2, 12.4 and 13.0 respectively. The mean bias test shows all the three matching algorithms involved have a poor matching quality

Table 22 - Result of Mean Bias for Infrastructure Development using the three Matching Algorithms

Algorithm	Sample	Ps R2	LR chi2	p>chi2	MeanBias*	MedBias	B	R	%Var
Nearest Neighbor	Unmatched	0.416	191.02	0.000	24.7	12.3	134.3*	23.06*	38
	Matched	0.368	154.02	0.000	42.2	23.9	125.1*	13.01*	50
Kernel	Unmatched	0.416	191.02	0.000	24.7	12.3	134.3*	23.06*	38
	Matched	0.054	14.39	0.703	12.4	12.9	55.3*	1.35	25
Caliper	Unmatched	0.416	191.02	0.000	24.7	12.3	134.3*	23.06*	38
	Matched	0.043	9.92	0.907	13.0	10.0	49.1*	0.92	13

* if B>25%, R outside [0.5;2]

Source: Own Survey data, 2018

To be sure of the quality of the matching algorithms it has been checked the after matching p values of each covariates on all the three matching algorithms. The same way as mean bias test, in this checking procedure, Nearest Neighbor matching algorithm has nine covariates with p values less than 0.05 (at 5% significant level) meaning it should be rejected for a bad matching quality. But all covariates in both Kernel and Caliper matching algorithms have p values above 0.05 (at 5% significant level) we can take them as an able algorithm in reducing covariates mean differences for both groups. Thus, we have two matching algorithms with acceptable matching quality and they are good to estimate ATT.

CHAPTER - V

5. Conclusion & Recommendation

5.1. Conclusion

Following 2007/08 world food crisis, large scale agricultural investments budded throughout the world and Ethiopia was no exception. In this development, Gambella region has caught the attention of many local and foreign agricultural investors. The impacts these investments brought and feared to bring were research issues in the last decade.

Thus, this study set three objectives to investigate the impact of large-scale agricultural investments towards employment, technology transfer and infrastructure development in Gambella region of Ethiopia. This study came to understand that large scale agricultural investments in Gambella region have a positive impact towards employment, technology transfer and infrastructure development.

Households living in kebeles where large scale agricultural investments operate have job opportunities compared to those households living in kebeles where there are no LSAIs. Although the employment type is not a professional or expert level, large scale agricultural investments provide the option of payed employment to the rural households whose livelihood is mainly dependent on subsistent agriculture. They get jobs like tractor operator, assistant mechanic, guards, daily laborer on farm fields, office assistants and the like. This employment creation record is with no more than 30% of large-scale agricultural investments who took land and license to start operation in the last decade. Based on this finding, the researcher believes that the story would be different if all investors started to operate with their full potential.

Although the government of Ethiopia is promoting the use of agricultural technologies in every part of the country and even supplying improved farm inputs to all kebeles in the study area, results of this study show that households living in kebeles where large scale agricultural investments operate use agricultural technologies better than households living in kebeles where there are no LSAIs. In addition to this, a 2017 World Bank study confirmed that positive technology transfer from investors to the local farming community was reported, taking place mainly through training of employees and out growers, sharing of farming techniques, provisions of inputs (such as seeds, agrochemicals or fertilizers that can raise the productivity of local farmers), and in limited cases through sharing of tools and machinery.

Respondents of a study in Kenya by Julie G. Zaehringer et al – 2018, perceived LAIs as having a positive impact on their cropland management or because their nearby LAI had provided the opportunity to obtain an out-grower contract. Even though only a low percentage of local land users and their household members were directly involved with LAIs, a large majority of respondents favored the presence of LAIs nearby, as they are believed to contribute to the region's overall economic development.

Large-scale agriculture is characterized by the use of mechanized farming and improved agricultural inputs. The spillover on the surrounding smallholder farmers is one way of technology transfer in addition to direct support of LSAI's to the local community. Deininger et al, 2016 – supports this by saying that increased proximity to commercial farms had positive spillovers on input use and yield though the nature and magnitude of spillovers are highly crop-specific. There is strong evidence of significant increases in fertilizer use, yields, and to a lesser extent also use of improved seed in closer proximity to large (maize) farms in Ethiopia.

It is also concluded that rural households living in areas where there are large scale agricultural investments also benefit from the use of infrastructures such as roads, schools, health centers and the likes compared to households that live in areas where there are no LSAIs. For instance, large scale agricultural investments construct roads for their own use and the local community can also access it. From a key informant interview with kebele administrators and managers of Saud Star Agricultural Development plc, students in Terkudi kebele get full support of educational materials from Saudi Star every year and they don't start education until they get the support due to a strong dependence on the investment. In addition to this, those who are employed in the farms have medical benefits from the company's clinics and sometimes up to referral hospitals in Gambella city.

Finally, both the descriptive and econometric analysis results using propensity score matching confirm the positive impacts of large-scale agricultural investments towards employment generation to the local households, agricultural technology transfer and infrastructure developments in Gambella region of Ethiopia.

5.2. Recommendations

The study from the analysis, discussion and conclusions has drawn the following recommendations to various actors including promoters of LSAI's, policy makers, academicians and researchers.

- ★ As already discussed on the conclusion part above, employment opportunity is created for the community by large scale agricultural investments. But it is at a lower levels of employment status and this may be is attributable to many factors. As it is shown in the descriptive statistics part of the study the highest education level in the community is no more than high school completion. Thus, for the community to get middle level management or skilled job opportunities, their educational status should have to be improved. For this, the government should strengthen its effort of reaching rural areas with education infrastructures. In addition to these local government agencies can also arrange short term trainings for the local youth so that they get technical knowledge that is related to operations and labor demands of large-scale agricultural developments. For instance, trainings in mechanics, welding, masonry, construction, plumbing, and the likes are short term and would raise the employment to skilled manpower.

- ★ Coordinating an out-grower schemes between local farmers and large-scale agricultural investments will help to maximize the technology transfer benefits to the majority of the farmers in order to improve their productivity and thereby their livelihood. This will be a mutually benefiting scheme since it helps not only the farmers but also LSAIs production capacity. A 2016 World Bank study claimed that technology transfer was more noticeable in the presence of out-grower schemes. One way to incentivize technology transfer could be for investors to mainstream out-grower schemes into project design, identifying gaps in knowledge and specific training needs and gaps in capital requirements to adopt the requisite technologies.

- ★ Unlike earlier times, while approving large scale land requests, there should be a clearly set goal of corporate social responsibilities by investors that benefit the community in contract agreements. After this the community and local government agencies need to be made aware about these responsibilities of the investment so that close supervision and monitoring of the performance of these responsibilities in line with the rights and supports they get.

- ★ As stated in the descriptive analysis part of the study performance of large-scale agricultural investments is very low and this fact has been reported in many studies including a 2017 study made by the government on LSAIs of Gambella region. The poor performance of these investments needs to be researched thoroughly since it already has exploited public resources like forests, bank loans, and the like.
- ★ More researches in the sector has to be done to understand the impacts of LSAIs towards different socio-economic factors linking LSAIs to the community and to the country's economy. It requires institutional support and policies need to be reassessed.
- ★ The role of the government needs to broaden from only attracting investors to closely monitoring them, getting them inline, helping them help the rural community, creating awareness to the community about their rights, opportunities and obligations. For instance, by organizing trainings on agricultural improving technologies in collaboration with LSAI's and research institutes.

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7. Annexure

Annex 1 - Results of Probit Regression and ATT using Nearest Neighbor Matching Algorithm for Employment

Probit regression — Number of obs = 334; LR chi2(11) = 23.62; Prob > chi2 = 0.0144

Log likelihood = -218.35142 — Pseudo R2 = 0.0513

WithInvest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.6618076	.2377542	-2.78	0.005	-1.127797	-.195818
HH_type	.5012838	.4411957	1.14	0.256	-.3634439	1.366012
Male_no_of_wife	-.1516821	.1311568	-1.16	0.247	-.4087446	.1053804
HH_siz	.0832468	.0318203	2.62	0.009	.0208802	.1456133
HHH_Sex	-.228921	.6129058	-0.37	0.709	-1.430194	.9723524
HHH_Age	-.0086147	.0081714	-1.05	0.292	-.0246304	.007401
HHH_Marital_Status	.4080609	.2567939	1.59	0.112	-.0952458	.9113676
HHH_Education	-.0011314	.0020353	-0.56	0.578	-.0051205	.0028577
HHH_Occupation	.0086624	.0131687	0.66	0.511	-.0171477	.0344726
Land_Size	-.2127837	.0822901	-2.59	0.010	-.3740692	-.0514981
Crp_Production	-.0156899	.6169141	-0.03	0.980	-1.224819	1.19344
_cons	-.1519068	1.009337	-0.15	0.880	-2.130172	1.826358

There are observations with identical propensity score values.
The sort order of the data could affect your results.
Make sure that the sort order is random before calling psmatch2.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
emp	Unmatched	.289473684	.005494505	.283979179	.04602812	6.17
	ATT	.289473684	0	.289473684	.049949067	5.80

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support On suppor	Total
Untreated	182	182
Treated	152	152
Total	334	334

Annex 2 - Results of PS test for employment using Nearest Neighbor Matching Algorithm

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1703	-25.5		-2.29	0.022	0.55*
	M	1.0855	1.0658	5.9	76.7	0.65	0.517	1.27
HH_type	U	1.0329	1.0275	3.2		0.29	0.773	1.19
	M	1.0329	1.0329	0.0	100.0	0.00	1.000	1.00
Male_no_of_wife	U	1.2895	1.3297	-7.1		-0.64	0.521	0.87
	M	1.2895	1.25	7.0	1.8	0.63	0.528	1.02
HH_siz	U	6.4934	6.0495	17.4		1.59	0.112	1.20
	M	6.4934	6.1579	13.2	24.4	1.14	0.256	1.14
HHH_Sex	U	1.0132	1.0165	-2.7		-0.25	0.804	0.80
	M	1.0132	1.0132	0.0	100.0	0.00	1.000	1.00
HHH_Age	U	39.033	40.379	-13.0		-1.18	0.239	0.97
	M	39.033	37.822	11.7	10.1	1.04	0.299	1.08
HHH_Marital_Status	U	2.0592	2.022	11.3		1.05	0.293	2.96*
	M	2.0592	2.0329	8.0	29.3	0.67	0.503	2.26*
HHH_Education	U	36.625	40.973	-10.8		-0.98	0.327	0.90
	M	36.625	37.461	-2.1	80.8	-0.19	0.851	1.04
HHH_Occupation	U	5.6513	5.2198	7.3		0.67	0.503	1.07
	M	5.6513	5.7039	-0.9	87.8	-0.08	0.937	1.10
Land_Size	U	1.3053	1.5236	-23.7		-2.15	0.032	0.92
	M	1.3053	1.2895	1.7	92.8	0.17	0.869	1.41*
Crp_Production	U	.98684	.98901	-2.0		-0.18	0.857	.
	M	.98684	.98026	6.0	-203.3	0.45	0.653	.

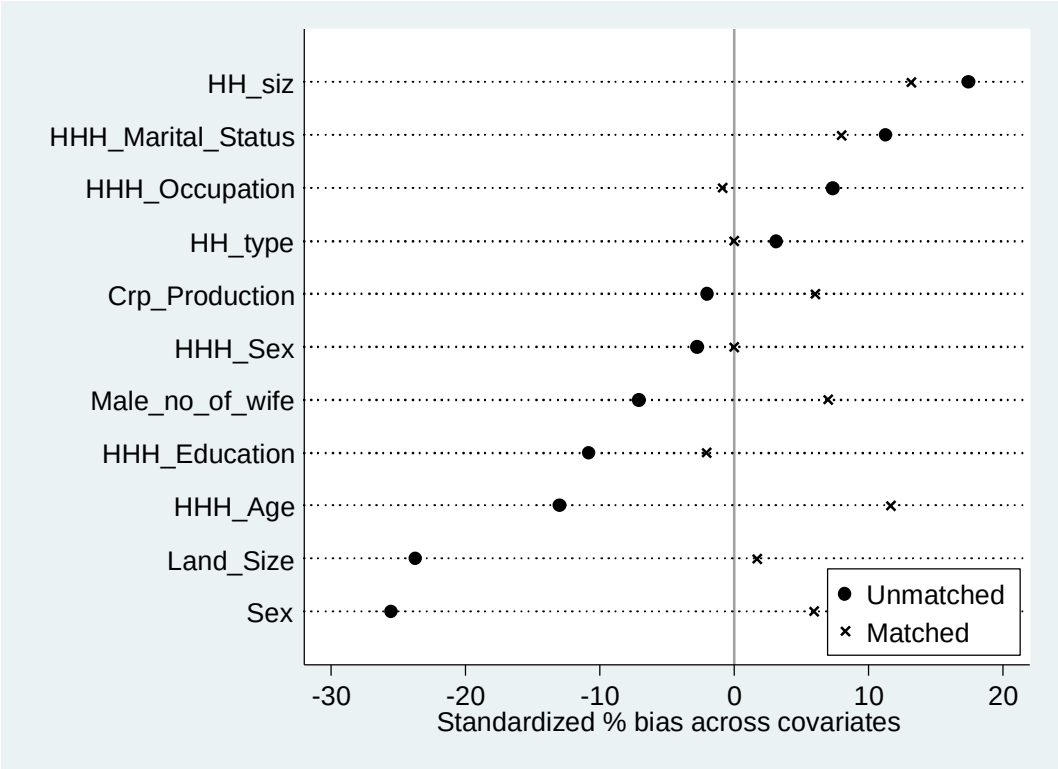
* if variance ratio outside [0.73; 1.38] for U and [0.73; 1.38] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.051	23.62	0.014	11.3	10.8	53.7*	0.85	20
Matched	0.008	3.26	0.987	5.1	5.9	20.6	1.24	20

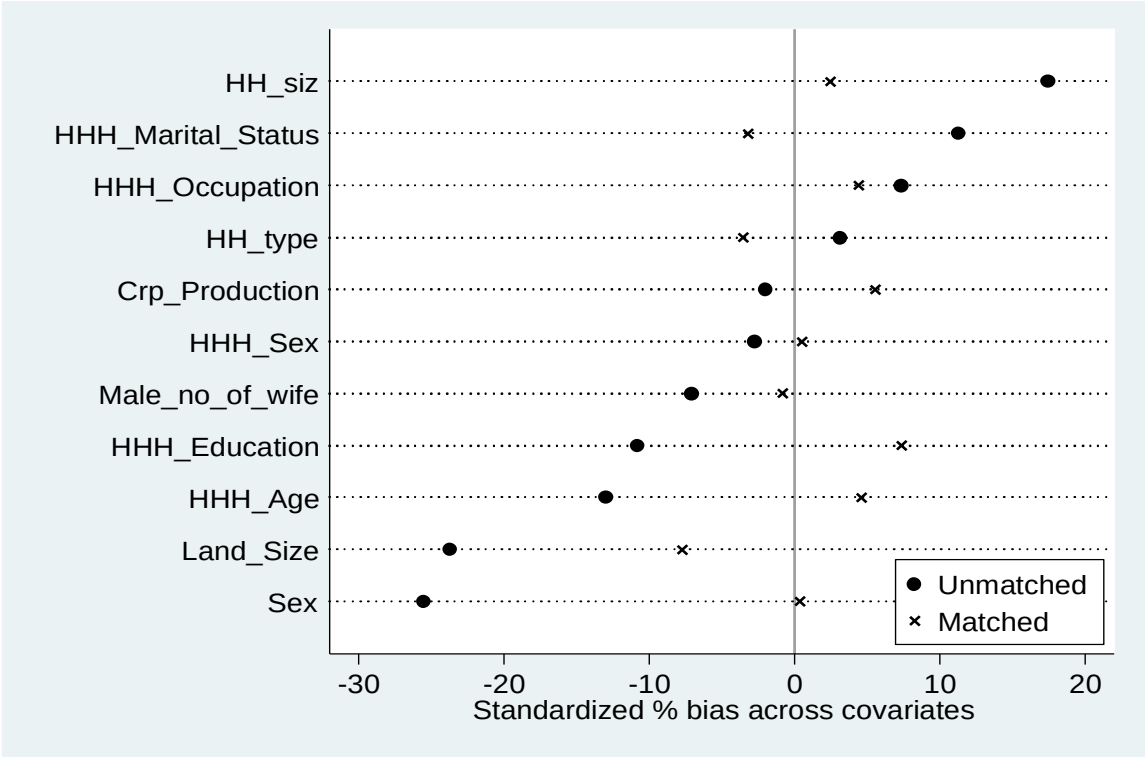
* if B>25%, R outside [0.5; 2]

Annex 3 - Results of graphs for Employment

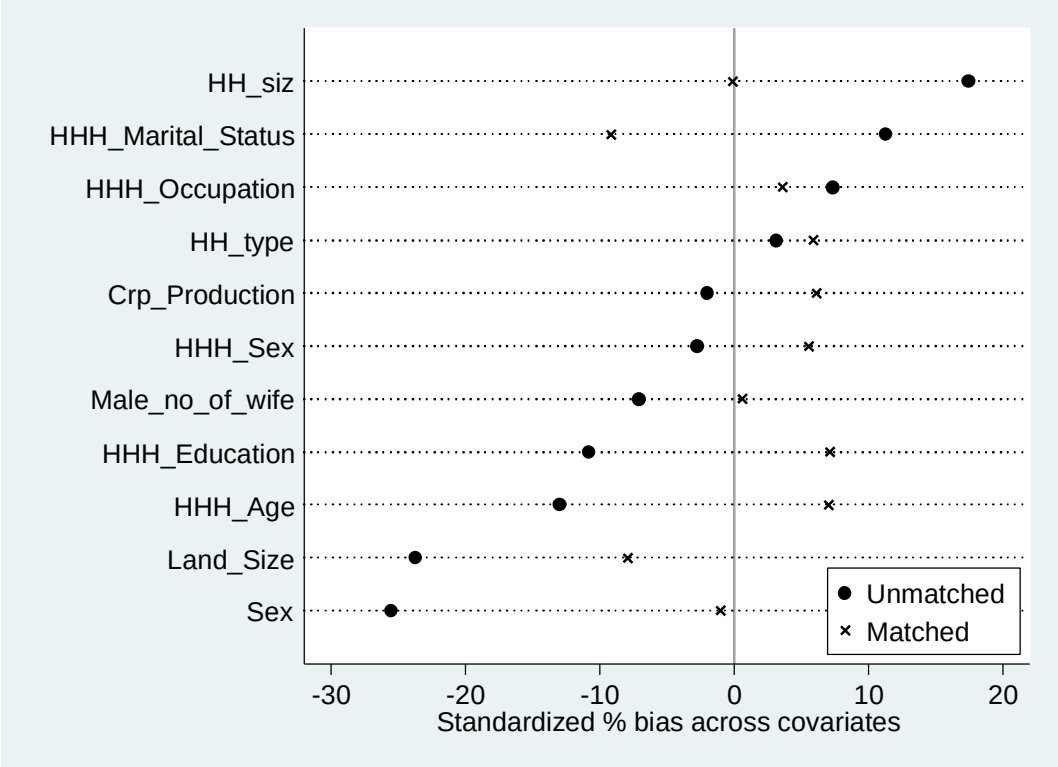
For Employment Using Nearest Neighbor Matching Algorithm



For Employment Using Kernel Matching Algorithm



For Employment Using Caliper Matching Algorithm



Annex 4 - Results of Probit Regression and ATT using Kernel Matching Algorithm for Employment

Probit regression — Number of obs = 334; LR chi2(11) = 23.62; Prob > chi2 = 0.0144

Log likelihood = -218.35142 — Pseudo R2 = 0.0513

WithInvest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.6618076	.2377542	-2.78	0.005	-1.127797	-.195818
HH_type	.5012838	.4411957	1.14	0.256	-.3634439	1.366012
Male_no_of_wife	-.1516821	.1311568	-1.16	0.247	-.4087446	.1053804
HH_siz	.0832468	.0318203	2.62	0.009	.0208802	.1456133
HHH_Sex	-.228921	.6129058	-0.37	0.709	-1.430194	.9723524
HHH_Age	-.0086147	.0081714	-1.05	0.292	-.0246304	.007401
HHH_Marital_Status	.4080609	.2567939	1.59	0.112	-.0952458	.9113676
HHH_Education	-.0011314	.0020353	-0.56	0.578	-.0051205	.0028577
HHH_Occupation	.0086624	.0131687	0.66	0.511	-.0171477	.0344726
Land_Size	-.2127837	.0822901	-2.59	0.010	-.3740692	-.0514981
Crp_Production	-.0156899	.6169141	-0.03	0.980	-1.224819	1.19344
_cons	-.1519068	1.009337	-0.15	0.880	-2.130172	1.826358

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
emp	Unmatched	.289473684	.005494505	.283979179	.04602812	6.17
	ATT	.273333333	.003953239	.269380094	.047603003	5.66

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	182	182
Treated	2	150	152
Total	2	332	334

Annex 5 - Summary of PScore

Variable	Obs	Mean	Std. Dev.	Min	Max
_pscore	334	.4553629	.1294237	.0638311	.8657355

Annex 6 - Results of PS test for employment using Kernel Matching Algorithm

Variable	Unmatched / Matched	Mean: Treated	Mean: Control	%bias	%reduct |bias|	t-test: t	t-test: p>|t|	V(T)/V(C)
Sex	U	1.0855	1.1703	-25.5		-2.29	0.022	0.55*
	M	1.0867	1.0854	0.4	98.6	0.04	0.970	1.01
HH_type	U	1.0329	1.0275	3.2		0.29	0.773	1.19
	M	1.0333	1.0394	-3.5	-11.4	-0.28	0.781	0.85
Male_no_of_wife	U	1.2895	1.3297	-7.1		-0.64	0.521	0.87
	M	1.2733	1.278	-0.8	88.4	-0.07	0.940	0.93
HH_siz	U	6.4934	6.0495	17.4		1.59	0.112	1.20
	M	6.38	6.317	2.5	85.8	0.22	0.823	1.01
HHH_Sex	U	1.0132	1.0165	-2.7		-0.25	0.804	0.80
	M	1.0133	1.0127	0.5	82.3	0.04	0.964	1.05
HHH_Age	U	39.033	40.379	-13.0		-1.18	0.239	0.97
	M	39.013	38.536	4.6	64.5	0.40	0.687	1.04
HHH_Marital_Status	U	2.0592	2.022	11.3		1.05	0.293	2.96*
	M	2.0333	2.0439	-3.2	71.6	-0.36	0.720	0.83
HHH_Education	U	36.625	40.973	-10.8		-0.98	0.327	0.90
	M	36.94	33.984	7.3	32.0	0.66	0.508	1.08
HHH_Occupation	U	5.6513	5.2198	7.3		0.67	0.503	1.07
	M	5.7133	5.455	4.4	40.1	0.38	0.704	1.07
Land_Size	U	1.3053	1.5236	-23.7		-2.15	0.032	0.92
	M	1.291	1.3623	-7.7	67.3	-0.74	0.463	1.22
Crp_Production	U	.98684	.98901	-2.0		-0.18	0.857	.
	M	.98667	.98059	5.5	-180.1	0.41	0.680	.

* if variance ratio outside [0.73; 1.38] for U and [0.72; 1.38] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.051	23.62	0.014	11.3	10.8	53.7*	0.85	20
Matched	0.004	1.60	0.999	3.7	3.5	14.6	0.89	0

* if B>25%, R outside [0.5; 2]

Annex 7 - Results of Probit Regression and ATT using Caliper Matching Algorithm for Employment

Probit regression — Number of obs = 334; LR chi2(11) = 23.62; Prob > chi2 = 0.0144

Log likelihood = -218.35142 — Pseudo R2 = 0.0513

WithInvest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.6618076	.2377542	-2.78	0.005	-1.127797	-.195818
HH_type	.5012838	.4411957	1.14	0.256	-.3634439	1.366012
Male_no_of_wife	-.1516821	.1311568	-1.16	0.247	-.4087446	.1053804
HH_siz	.0832468	.0318203	2.62	0.009	.0208802	.1456133
HHH_Sex	-.228921	.6129058	-0.37	0.709	-1.430194	.9723524
HHH_Age	-.0086147	.0081714	-1.05	0.292	-.0246304	.007401
HHH_Marital_Status	.4080609	.2567939	1.59	0.112	-.0952458	.9113676
HHH_Education	-.0011314	.0020353	-0.56	0.578	-.0051205	.0028577
HHH_Occupation	.0086624	.0131687	0.66	0.511	-.0171477	.0344726
Land_Size	-.2127837	.0822901	-2.59	0.010	-.3740692	-.0514981
Crp_Production	-.0156899	.6169141	-0.03	0.980	-1.224819	1.19344
_cons	-.1519068	1.009337	-0.15	0.880	-2.130172	1.826358

There are observations with identical propensity score values.
The sort order of the data could affect your results.
Make sure that the sort order is random before calling psmatch2.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
emp	Unmatched	.289473684	.005494505	.283979179	.04602812	6.17
	ATT	.275167785	0	.275167785	.047482476	5.80

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	182	182
Treated	3	149	152
Total	3	331	334

Annex 8 - Results of PS test for employment using Caliper Matching Algorithm

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1703	-25.5		-2.29	0.022	0.55*
	M	1.0872	1.0906	-1.0	96.0	-0.10	0.919	0.97
HH_type	U	1.0329	1.0275	3.2		0.29	0.773	1.19
	M	1.0336	1.0235	5.9	-85.7	0.52	0.603	1.41*
Male_no_of_wife	U	1.2895	1.3297	-7.1		-0.64	0.521	0.87
	M	1.2752	1.2718	0.6	91.7	0.05	0.958	0.90
HH_siz	U	6.4934	6.0495	17.4		1.59	0.112	1.20
	M	6.3758	6.3792	-0.1	99.2	-0.01	0.991	0.98
HHH_Sex	U	1.0132	1.0165	-2.7		-0.25	0.804	0.80
	M	1.0134	1.0067	5.5	-101.8	0.58	0.563	1.99*
HHH_Age	U	39.033	40.379	-13.0		-1.18	0.239	0.97
	M	38.953	38.225	7.0	45.9	0.60	0.550	0.96
HHH_Marital_Status	U	2.0592	2.022	11.3		1.05	0.293	2.96*
	M	2.0201	2.0503	-9.2	18.9	-1.03	0.305	0.35*
HHH_Education	U	36.625	40.973	-10.8		-0.98	0.327	0.90
	M	36.523	33.664	7.1	34.2	0.65	0.518	1.12
HHH_Occupation	U	5.6513	5.2198	7.3		0.67	0.503	1.07
	M	5.745	5.5336	3.6	51.0	0.31	0.755	1.11
Land_Size	U	1.3053	1.5236	-23.7		-2.15	0.032	0.92
	M	1.293	1.3658	-7.9	66.7	-0.75	0.456	1.22
Crp_Production	U	.98684	.98901	-2.0		-0.18	0.857	.
	M	.98658	.97987	6.1	-209.4	0.45	0.653	.

* if variance ratio outside [0.73; 1.38] for U and [0.72; 1.38] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.051	23.62	0.014	11.3	10.8	53.7*	0.85	20
Matched	0.009	3.64	0.979	4.9	5.9	21.8	0.63	30

* if B>25%, R outside [0.5; 2]

Annex 9 - Results of Probit Regression and ATT using Nearest Neighbor Matching Algorithm for Technology Transfer (Agrochemicals Application)

Probit regression — Number of obs = 333; LR chi2(25) = 152.46; Prob > chi2 = 0.0000

Log likelihood = -153.32336 — Pseudo R2 = 0.3321

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.3190956	.2598165	-1.23	0.219	-.8283266	.1901354
Male_no_of_wife	-.2101361	.160167	-1.31	0.190	-.5240576	.1037854
Ethnicity	-.8505859	.5831207	-1.46	0.145	-1.993481	.2923097
HH_siz	.0443816	.0376734	1.18	0.239	-.029457	.1182202
HHH_Age	-.0102929	.0100873	-1.02	0.308	-.0300636	.0094779
HHH_Marital_Status	.4560022	.3344553	1.36	0.173	-.1995183	1.111523
HHH_Religion	.168561	.1946551	0.87	0.387	-.2129561	.550078
HHH_Education	-.0007442	.0024667	-0.30	0.763	-.0055789	.0040905
HHH_Occupation	.0647478	.0434667	1.49	0.136	-.0204453	.149941
Land_Size	-.1156474	.1016594	-1.14	0.255	-.3148962	.0836015
Land_Frtility	.4059259	.258743	1.57	0.117	-.101201	.9130528
Land_Use	-.0143322	.4148384	-0.03	0.972	-.8274005	.7987361
Land_Right	.1202516	.300296	0.40	0.689	-.4683177	.7088209
Land_Srce	-.0532097	.0481463	-1.11	0.269	-.1475747	.0411552
Land_Invstmnt	-.1264858	.0692013	-1.83	0.068	-.2621179	.0091463
Land_Distance_frm_Home	.0200694	.0053319	3.76	0.000	.0096191	.0305197
Emplymnt	2.44644	.528431	4.63	0.000	1.410734	3.482146
LSAI_Benefit_mrkt	.9432547	.3846247	2.45	0.014	.1894042	1.697105
Loss_ecology	1.760359	.4132321	4.26	0.000	.9504391	2.570279
Fert	-1.23779	.451048	-2.74	0.006	-2.121828	-.3537524
Imprvd_Seed	.2680863	.2437106	1.10	0.271	-.2095776	.7457503
Improvedlivestock	.4619925	.3596755	1.28	0.199	-.2429585	1.166944
Imrovedagripractices	-.4219592	.2215836	-1.90	0.057	-.8562551	.0123368
Imrovedlivestockmgt	1.182771	.3781614	3.13	0.002	.441588	1.923953
Improvedlandmgt	.062563	.202601	0.31	0.757	-.3345277	.4596536
_cons	-.550901	1.368168	-0.40	0.687	-3.232462	2.13066

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Chemicals	Unmatched	.256578947	.220994475	.035584472	.046900557	0.76
	ATT	.256578947	.059210526	.197368421	.13107611	1.51

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support On suppor	Total
Untreated	181	181
Treated	152	152
Total	333	333

Annex 10 - Results of Probit Regression and ATT using Kernel Matching Algorithm for Technology Transfer (Agrochemicals Application)

Probit regression — Number of obs = 333; LR chi2(25) = 152.46; Prob > chi2 = 0.0000; Log likelihood = -153.32336; Pseudo R2 = 0.3321

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.3190956	.2598165	-1.23	0.219	-.8283266	.1901354
Male_no_of_wife	-.2101361	.160167	-1.31	0.190	-.5240576	.1037854
Ethnicity	-.8505859	.5831207	-1.46	0.145	-1.993481	.2923097
HH_siz	.0443816	.0376734	1.18	0.239	-.029457	.1182202
HHH_Age	-.0102929	.0100873	-1.02	0.308	-.0300636	.0094779
HHH_Marital_Status	.4560022	.3344553	1.36	0.173	-.1995183	1.111523
HHH_Religion	.168561	.1946551	0.87	0.387	-.2129561	.550078
HHH_Education	-.0007442	.0024667	-0.30	0.763	-.0055789	.0040905
HHH_Occupation	.0647478	.0434667	1.49	0.136	-.0204453	.149941
Land_Size	-.1156474	.1016594	-1.14	0.255	-.3148962	.0836015
Land_Frtility	.4059259	.258743	1.57	0.117	-.101201	.9130528
Land_Use	-.0143322	.4148384	-0.03	0.972	-.8274005	.7987361
Land_Right	.1202516	.300296	0.40	0.689	-.4683177	.7088209
Land_Srce	-.0532097	.0481463	-1.11	0.269	-.1475747	.0411552
Land_Invstmnt	-.1264858	.0692013	-1.83	0.068	-.2621179	.0091463
Land_Distance_frm_Home	.0200694	.0053319	3.76	0.000	.0096191	.0305197
Emplymnt	2.44644	.528431	4.63	0.000	1.410734	3.482146
LSAI_Benefit_mrkt	.9432547	.3846247	2.45	0.014	.1894042	1.697105
Loss_ecology	1.760359	.4132321	4.26	0.000	.9504391	2.570279
Fert	-1.23779	.451048	-2.74	0.006	-2.121828	-.3537524
Imprvd_Seed	.2680863	.2437106	1.10	0.271	-.2095776	.7457503
Improvedlivestock	.4619925	.3596755	1.28	0.199	-.2429585	1.166944
Imrovedagripractices	-.4219592	.2215836	-1.90	0.057	-.8562551	.0123368
Imrovedlivestockmgt	1.182771	.3781614	3.13	0.002	.441588	1.923953
Improvedlandmgt	.062563	.202601	0.31	0.757	-.3345277	.4596536
_cons	-.550901	1.368168	-0.40	0.687	-3.232462	2.13066

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Chemicals	Unmatched	.256578947	.220994475	.035584472	.046900557	0.76
	ATT	.284552846	.116971767	.167581079	.098391972	1.70

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support		
	Off suppo	On suppor	Total
Untreated	0	181	181
Treated	29	123	152
Total	29	304	333

Annex 11 - Results of Probit Regression and ATT using Caliper Matching Algorithm for Technology Transfer (Agrochemicals Application)

Probit regression — Number of obs = 333
LR chi2(25) = 152.46
Prob > chi2 = 0.0000
Log likelihood = -153.32336 — Pseudo R2 = 0.3321

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.3190956	.2598165	-1.23	0.219	-.8283266	.1901354
Male_no_of_wife	-.2101361	.160167	-1.31	0.190	-.5240576	.1037854
Ethnicity	-.8505859	.5831207	-1.46	0.145	-1.993481	.2923097
HH_siz	.0443816	.0376734	1.18	0.239	-.029457	.1182202
HHH_Age	-.0102929	.0100873	-1.02	0.308	-.0300636	.0094779
HHH_Marital_Status	.4560022	.3344553	1.36	0.173	-.1995183	1.111523
HHH_Religion	.168561	.1946551	0.87	0.387	-.2129561	.550078
HHH_Education	-.0007442	.0024667	-0.30	0.763	-.0055789	.0040905
HHH_Occupation	.0647478	.0434667	1.49	0.136	-.0204453	.149941
Land_Size	-.1156474	.1016594	-1.14	0.255	-.3148962	.0836015
Land_Frtility	.4059259	.258743	1.57	0.117	-.101201	.9130528
Land_Use	-.0143322	.4148384	-0.03	0.972	-.8274005	.7987361
Land_Right	.1202516	.300296	0.40	0.689	-.4683177	.7088209
Land_Srce	-.0532097	.0481463	-1.11	0.269	-.1475747	.0411552
Land_Invstmnt	-.1264858	.0692013	-1.83	0.068	-.2621179	.0091463
Land_Distance_frm_Home	.0200694	.0053319	3.76	0.000	.0096191	.0305197
Emplymnt	2.44644	.528431	4.63	0.000	1.410734	3.482146
LSAI_Benefit_mrkt	.9432547	.3846247	2.45	0.014	.1894042	1.697105
Loss_ecology	1.760359	.4132321	4.26	0.000	.9504391	2.570279
Fert	-1.23779	.451048	-2.74	0.006	-2.121828	-.3537524
Imprvd_Seed	.2680863	.2437106	1.10	0.271	-.2095776	.7457503
Improvedlivestock	.4619925	.3596755	1.28	0.199	-.2429585	1.166944
Imrovedagripractices	-.4219592	.2215836	-1.90	0.057	-.8562551	.0123368
Imrovedlivestockmgt	1.182771	.3781614	3.13	0.002	.441588	1.923953
Improvedlandmgt	.062563	.202601	0.31	0.757	-.3345277	.4596536
_cons	-.550901	1.368168	-0.40	0.687	-3.232462	2.13066

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Chemicals	Unmatched	.256578947	.220994475	.035584472	.046900557	0.76
	ATT	.264705882	.098039216	.166666667	.073980097	2.25

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	181	181
Treated	50	102	152
Total	50	283	333

Annex 12 – Results of Mean Bias test and t-test for Caliper Matching on Agrochemicals Usage

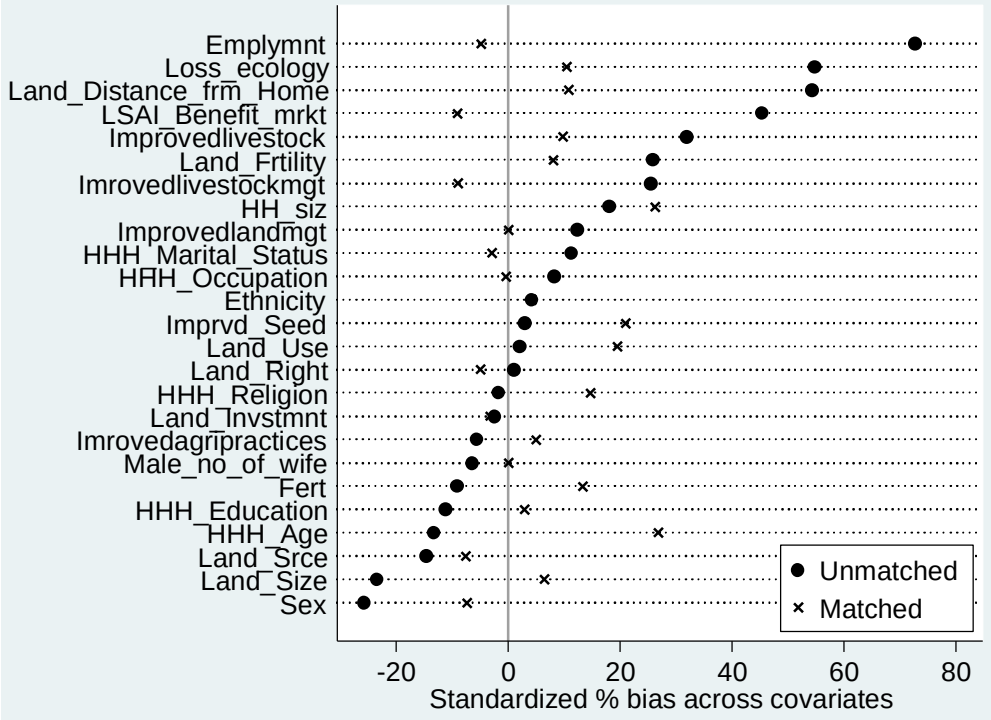
Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.1078	1.1324	-7.4	71.4	-0.54	0.592	0.84
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.3137	1.3137	0.0	100.0	0.00	1.000	0.86
Ethnicity	U	1.3289	1.3094	4.2		0.38	0.704	1.03
	M	1.4216	1.402	4.2	-0.3	0.28	0.777	1.01
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.3039	5.6373	26.2	-44.8	1.96	0.051	1.44
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	38.843	36.064	26.7	-102.0	2.07	0.039	1.45
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0392	2.049	-3.0	73.6	-0.27	0.788	1.36
HHH_Religion	U	3.0526	3.0608	-1.7		-0.16	0.874	1.04
	M	3.0882	3.0196	14.7	-742.9	1.10	0.273	1.52*
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	41.716	40.529	2.9	73.7	0.21	0.832	1.17
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	6.7451	6.7696	-0.4	94.9	-0.03	0.977	1.23
Land_Size	U	1.3053	1.521	-23.4		-2.12	0.035	0.92
	M	1.25	1.1902	6.5	72.3	0.52	0.600	1.37
Land_Frtility	U	1.2763	1.1657	25.8		2.37	0.018	1.64*
	M	1.2941	1.2598	8.0	69.0	0.53	0.595	1.18
Land_Use	U	1.0263	1.0221	2.1		0.19	0.851	0.47*
	M	1.0392	1	19.5	-830.1	2.03	0.044	.*
Land_Right	U	2.0526	2.0497	1.0		0.09	0.928	1.48*
	M	2.0588	2.0735	-5.0	-405.7	-0.31	0.759	1.37
Land_Srce	U	3.0197	3.3315	-14.7		-1.33	0.184	0.91
	M	3.049	3.2108	-7.6	48.1	-0.51	0.609	0.94
Land_Invstmnt	U	4.1776	4.2099	-2.4		-0.22	0.829	0.93
	M	4.1863	4.2304	-3.2	-36.5	-0.22	0.830	0.68
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	18	15.691	10.8	80.1	0.98	0.328	1.40
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.0098	.02451	-4.9	93.3	-0.81	0.421	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.09804	.12255	-9.1	80.0	-0.56	0.579	.
Loss_ecology	U	.17105	.01657	54.8		5.16	0.000	.
	M	.08824	.05882	10.4	81.0	0.80	0.423	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.07843	.04412	13.3	-45.0	1.02	0.309	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.29412	.19608	20.9	-598.8	1.63	0.105	.
Improvedlivestock	U	.15132	.05525	31.9		2.95	0.003	.
	M	.16667	.13725	9.8	69.4	0.58	0.561	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.55882	.53431	5.0	11.6	0.35	0.727	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.2549	.28922	-8.9	64.9	-0.55	0.584	.
Improvedlandmgt	U	.40789	.34807	12.3		1.12	0.263	.
	M	.39216	.39216	0.0	100.0	-0.00	1.000	.

* if variance ratio outside [0.73; 1.38] for U and [0.68; 1.48] for M

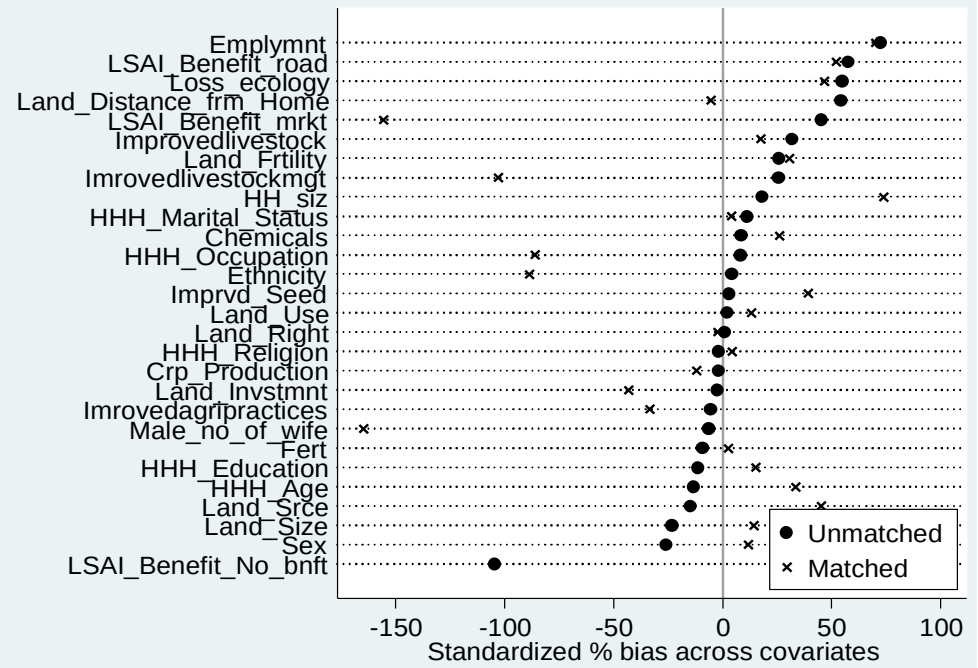
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.332	152.46	0.000	19.4	12.3	139.4*	5.09*	38
Matched	0.058	15.98	0.889	9.1	7.6	57.5*	1.20	13

* if B>25%, R outside [0.5; 2]

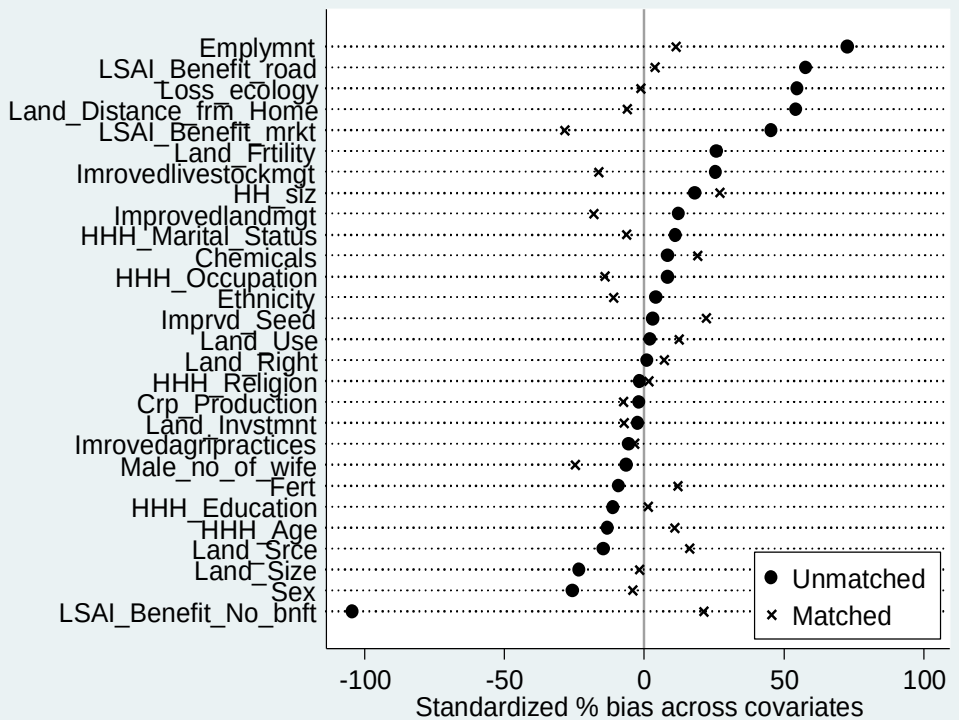
Annex 13 - PSgraph for Technology Transfer (Agrochemicals Application) for Caliper Matching Algorithm



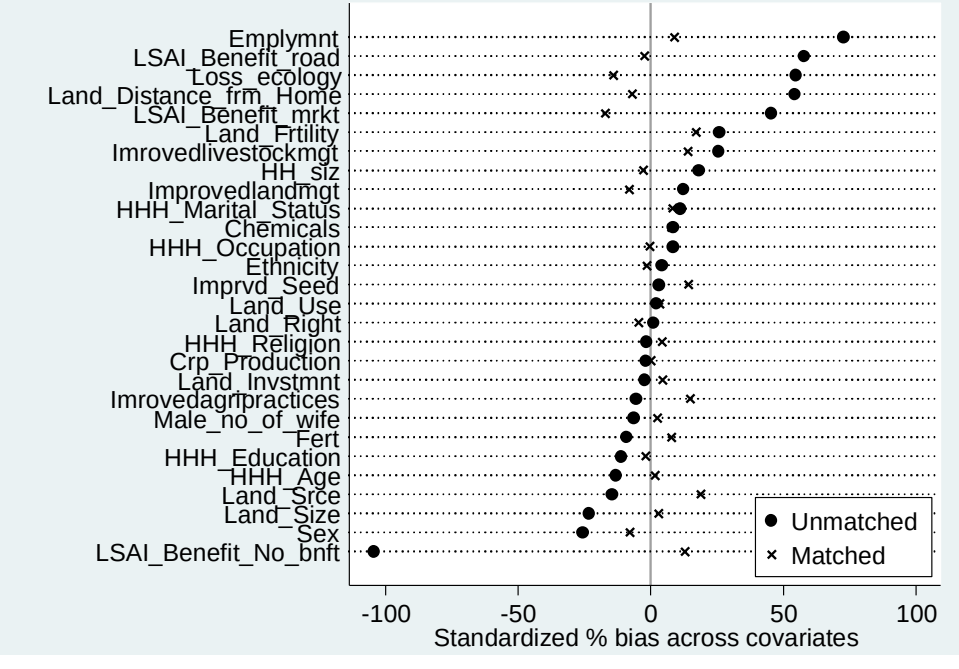
Annex 14 - PSgraph for Technology Transfer (Agricultural Mechanization) for Nearest Neighbor Matching Algorithm



Annex 15 - PSgraph for Technology Transfer (Improved Livestock) for Kernel Matching Algorithm



Annex 16 - PSgraph for Technology Transfer (Improved Livestock) for Caliper Matching Algorithm



Annex 17 - Results of Probit Regression and ATT using Nearest Neighbor Matching Algorithm for Technology Transfer (Agricultural Mechanization)

Probit regression — Number of obs = 333; LR chi2(29) = 222.58; Prob > chi2 = 0.0000

Log likelihood = -118.26151 — Pseudo R2 = 0.4848

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.8878375	.3477946	-2.55	0.011	-1.569502	-.2061725
Male_no_of_wife	-.1166892	.1789158	-0.65	0.514	-.4673577	.2339792
Ethnicity	-.817376	.6803608	-1.20	0.230	-2.150859	.5161066
HH_siz	.0660042	.0440926	1.50	0.134	-.0204156	.1524241
HHH_Age	-.0109616	.0118667	-0.92	0.356	-.0342199	.0122967
HHH_Marital_Status	.8606343	.357078	2.41	0.016	.1607742	1.560494
HHH_Religion	-.2777231	.2641856	-1.05	0.293	-.7955173	.240071
HHH_Education	-.0021182	.0029003	-0.73	0.465	-.0078026	.0035662
HHH_Occupation	.0732874	.0506324	1.45	0.148	-.0259502	.172525
Land_Size	-.0671192	.1209264	-0.56	0.579	-.3041305	.1698921
Land_Frtility	.4837353	.2976193	1.63	0.104	-.0995878	1.067058
Land_Use	-.1889252	.4672795	-0.40	0.686	-1.104776	.7269259
Land_Right	.7169088	.3505119	2.05	0.041	.0299182	1.403899
Land_Srce	-.1194359	.0595911	-2.00	0.045	-.2362322	-.0026395
Land_Invstmnt	-.0157575	.0857687	-0.18	0.854	-.1838611	.152346
Land_Distance_frm_Home	.0275803	.0062867	4.39	0.000	.0152585	.039902
Crp_Production	.5818796	1.082933	0.54	0.591	-1.54063	2.704389
Emplymnt	2.489997	.6612596	3.77	0.000	1.193952	3.786042
LSAI_Benefit_mrkt	-6.767109	208.7005	-0.03	0.974	-415.8127	402.2784
LSAI_Benefit_road	-.116137	.7644287	-0.15	0.879	-1.61439	1.382116
LSAI_Benefit_No_bnft	-7.982676	208.7008	-0.04	0.969	-417.0287	401.0633
Loss_ecology	1.967692	.5245977	3.75	0.000	.9394992	2.995884
Fert	-1.566593	.5250578	-2.98	0.003	-2.595687	-.5374981
Imprvd_Seed	.3916132	.3134559	1.25	0.212	-.2227491	1.005976
Chemicals	.6817283	.3335968	2.04	0.041	.0278907	1.335566
Improvedlivestock	.8101426	.3965864	2.04	0.041	.0328475	1.587438
Imrovedagripractices	-.4997569	.2600411	-1.92	0.055	-1.009428	.0099143
Imrovedlivestockmgt	.9897041	.43061	2.30	0.022	.1457241	1.833684
Improvedlandmgt	-.3125587	.2447108	-1.28	0.202	-.7921831	.1670658
_cons	5.906121	208.7095	0.03	0.977	-403.1569	414.9692

Note: 0 failures and 37 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Mechnization	Unmatched	.065789474	0	.065789474	.01848287	3.56
	ATT	.065789474	0	.065789474	.020174933	3.26

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support On suppor	Total
Untreated	181	181
Treated	152	152
Total	333	333

Annex 18 - Results of Probit Regression and ATT using Kernel Matching Algorithm for Technology Transfer (Agricultural Mechanization)

Probit regression — Number of obs = 333; LR chi2(29) = 222.58; Prob > chi2 = 0.0000; Log likelihood = -118.26151; Pseudo R2 = 0.4848

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.8878375	.3477946	-2.55	0.011	-1.569502	-.2061725
Male_no_of_wife	-.1166892	.1789158	-0.65	0.514	-.4673577	.2339792
Ethnicity	-.817376	.6803608	-1.20	0.230	-2.150859	.5161066
HH_siz	.0660042	.0440926	1.50	0.134	-.0204156	.1524241
HHH_Age	-.0109616	.0118667	-0.92	0.356	-.0342199	.0122967
HHH_Marital_Status	.8606343	.357078	2.41	0.016	.1607742	1.560494
HHH_Religion	-.2777231	.2641856	-1.05	0.293	-.7955173	.240071
HHH_Education	-.0021182	.0029003	-0.73	0.465	-.0078026	.0035662
HHH_Occupation	.0732874	.0506324	1.45	0.148	-.0259502	.172525
Land_Size	-.0671192	.1209264	-0.56	0.579	-.3041305	.1698921
Land_Frtility	.4837353	.2976193	1.63	0.104	-.0995878	1.067058
Land_Use	-.1889252	.4672795	-0.40	0.686	-1.104776	.7269259
Land_Right	.7169088	.3505119	2.05	0.041	.0299182	1.403899
Land_Srce	-.1194359	.0595911	-2.00	0.045	-.2362322	-.0026395
Land_Invstmnt	-.0157575	.0857687	-0.18	0.854	-.1838611	.152346
Land_Distance_frm_Home	.0275803	.0062867	4.39	0.000	.0152585	.039902
Crp_Production	.5818796	1.082933	0.54	0.591	-1.54063	2.704389
Emplymnt	2.489997	.6612596	3.77	0.000	1.193952	3.786042
LSAI_Benefit_mrkt	-6.767109	208.7005	-0.03	0.974	-415.8127	402.2784
LSAI_Benefit_road	-.116137	.7644287	-0.15	0.879	-1.61439	1.382116
LSAI_Benefit_No_bnft	-7.982676	208.7008	-0.04	0.969	-417.0287	401.0633
Loss_ecology	1.967692	.5245977	3.75	0.000	.9394992	2.995884
Fert	-1.566593	.5250578	-2.98	0.003	-2.595687	-.5374981
Imprvd_Seed	.3916132	.3134559	1.25	0.212	-.2227491	1.005976
Chemicals	.6817283	.3335968	2.04	0.041	.0278907	1.335566
Improvedlivestock	.8101426	.3965864	2.04	0.041	.0328475	1.587438
Imrovedagripractices	-.4997569	.2600411	-1.92	0.055	-1.009428	.0099143
Imrovedlivestockmgt	.9897041	.43061	2.30	0.022	.1457241	1.833684
Improvedlandmgt	-.3125587	.2447108	-1.28	0.202	-.7921831	.1670658
_cons	5.906121	208.7095	0.03	0.977	-403.1569	414.9692

Note: 0 failures and 37 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Mechnization	Unmatched	.065789474	0	.065789474	.01848287	3.56
	ATT	.013513514	0	.013513514	.013513514	1.00

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	181	181
Treated	78	74	152
Total	78	255	333

Annex 19 - Results of Probit Regression and ATT using Caliper Matching Algorithm for Technology Transfer (Agricultural Mechanization)

Probit regression — Number of obs = 333; LR chi2(29) = 222.58; Prob > chi2 = 0.0000

Log likelihood = -118.26151 — Pseudo R2 = 0.4848

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.8878375	.3477946	-2.55	0.011	-1.569502	-.2061725
Male_no_of_wife	-.1166892	.1789158	-0.65	0.514	-.4673577	.2339792
Ethnicity	-.817376	.6803608	-1.20	0.230	-2.150859	.5161066
HH_siz	.0660042	.0440926	1.50	0.134	-.0204156	.1524241
HHH_Age	-.0109616	.0118667	-0.92	0.356	-.0342199	.0122967
HHH_Marital_Status	.8606343	.357078	2.41	0.016	.1607742	1.560494
HHH_Religion	-.2777231	.2641856	-1.05	0.293	-.7955173	.240071
HHH_Education	-.0021182	.0029003	-0.73	0.465	-.0078026	.0035662
HHH_Occupation	.0732874	.0506324	1.45	0.148	-.0259502	.172525
Land_Size	-.0671192	.1209264	-0.56	0.579	-.3041305	.1698921
Land_Frtility	.4837353	.2976193	1.63	0.104	-.0995878	1.067058
Land_Use	-.1889252	.4672795	-0.40	0.686	-1.104776	.7269259
Land_Right	.7169088	.3505119	2.05	0.041	.0299182	1.403899
Land_Srce	-.1194359	.0595911	-2.00	0.045	-.2362322	-.0026395
Land_Invstmnt	-.0157575	.0857687	-0.18	0.854	-.1838611	.152346
Land_Distance_frm_Home	.0275803	.0062867	4.39	0.000	.0152585	.039902
Crp_Production	.5818796	1.082933	0.54	0.591	-1.54063	2.704389
Emplymnt	2.489997	.6612596	3.77	0.000	1.193952	3.786042
LSAI_Benefit_mrkt	-6.767109	208.7005	-0.03	0.974	-415.8127	402.2784
LSAI_Benefit_road	-.116137	.7644287	-0.15	0.879	-1.61439	1.382116
LSAI_Benefit_No_bnft	-7.982676	208.7008	-0.04	0.969	-417.0287	401.0633
Loss_ecology	1.967692	.5245977	3.75	0.000	.9394992	2.995884
Fert	-1.566593	.5250578	-2.98	0.003	-2.595687	-.5374981
Imprvd_Seed	.3916132	.3134559	1.25	0.212	-.2227491	1.005976
Chemicals	.6817283	.3335968	2.04	0.041	.0278907	1.335566
Improvedlivestock	.8101426	.3965864	2.04	0.041	.0328475	1.587438
Imrovedagripractices	-.4997569	.2600411	-1.92	0.055	-1.009428	.0099143
Imrovedlivestockmgt	.9897041	.43061	2.30	0.022	.1457241	1.833684
Improvedlandmgt	-.3125587	.2447108	-1.28	0.202	-.7921831	.1670658
_cons	5.906121	208.7095	0.03	0.977	-403.1569	414.9692

Note: 0 failures and 37 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Mechnization	Unmatched	.065789474	0	.065789474	.01848287	3.56
	ATT	.014492754	0	.014492754	.014492754	1.00

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	181	181
Treated	83	69	152
Total	83	250	333

Annex 20 - Results of Mean Bias test and t-test for Nearest Neighbor Matching on Agricultural Mechanization

Variable	Unmatched / Matched	Mean: Treated	Mean: Control	%bias	%reduct |bias|	t-test: t	t-test: p>|t|	V(T)/V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.0855	1.0461	11.9	54.0	1.39	0.166	1.78*
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.2895	2.2237	-164.8	-2460.0	-10.80	0.000	0.36*
Ethnicity	U	1.3289	1.3094	4.2		0.38	0.704	1.03
	M	1.3289	1.7434	-88.7	-2019.5	-7.94	0.000	1.16
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.4934	4.6118	74.0	-308.8	6.29	0.000	1.08
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	39.033	35.559	33.4	-152.5	3.06	0.002	1.19
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0592	2.0461	4.0	64.5	0.36	0.721	3.66*
HHH_Religion	U	3.0526	3.0608	-1.7		-0.16	0.874	1.04
	M	3.0526	3.0329	4.2	-142.4	0.41	0.680	1.78*
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	36.625	30.526	15.1	-35.0	1.40	0.162	1.15
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	5.6513	10.704	-86.2	-952.5	-7.62	0.000	1.15
Land_Size	U	1.3053	1.521	-23.4		-2.12	0.035	0.92
	M	1.3053	1.1743	14.2	39.3	1.56	0.120	3.15*
Land_Frtility	U	1.2763	1.1657	25.8		2.37	0.018	1.64*
	M	1.2763	1.1447	30.7	-19.0	2.73	0.007	1.83*
Land_Use	U	1.0263	1.0221	2.1		0.19	0.851	0.47*
	M	1.0263	1	13.1	-524.1	2.02	0.044	.*
Land_Right	U	2.0526	2.0497	1.0		0.09	0.928	1.48*
	M	2.0526	2.0592	-2.2	-126.2	-0.20	0.839	1.84*
Land_Srce	U	3.0197	3.3315	-14.7		-1.33	0.184	0.91
	M	3.0197	2.0592	45.2	-208.1	4.18	0.000	1.17
Land_Invstmnt	U	4.1776	4.2099	-2.4		-0.22	0.829	0.93
	M	4.1776	4.7632	-43.1	-1712.0	-4.70	0.000	3.07*
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	23.441	24.592	-5.4	90.1	-0.48	0.633	4.55*
Crp_Production	U	.98684	.98895	-1.9		-0.18	0.861	.
	M	.98684	1	-12.0	-524.1	-1.42	0.157	.
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.22368	.01316	70.1	3.5	5.99	0.000	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.14474	.56579	-155.7	-243.3	-8.51	0.000	.
LSAI_Benefit_road	U	.17105	.01105	57.7		5.45	0.000	.
	M	.17105	.02632	52.2	9.5	4.35	0.000	.
LSAI_Benefit_No_bnft	U	.59868	.9779	-104.5		-9.86	0.000	.
	M	.59868	.43421	45.3	56.6	2.90	0.004	.
Loss_ecology	U	.17105	.01657	54.8		5.16	0.000	.
	M	.17105	.03947	46.6	14.8	3.81	0.000	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.05921	.05263	2.6	72.2	0.25	0.804	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.32895	.14474	39.3	-1213.0	3.86	0.000	.
Chemicals	U	.25658	.22099	8.3		0.76	0.449	.
	M	.25658	.14474	26.2	-214.3	2.45	0.015	.
Improvedlivestock	U	.15132	.05525	31.9		2.95	0.003	.
	M	.15132	.09868	17.5	45.2	1.39	0.166	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.58553	.75	-33.5	-493.1	-3.08	0.002	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.23026	.625	-102.9	-304.2	-7.56	0.000	.

* if variance ratio outside [0.73; 1.38] for U and [0.73; 1.38] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.481	220.92	0.000	23.0	12.2	143.5*	19.19*	38
Matched	0.434	179.31	0.000	44.3	33.4	137.4*	12.84*	63

* if B>25%, R outside [0.5; 2]

Annex 21 - Results of Probit Regression and ATT using Nearest Neighbor Matching Algorithm for Technology Transfer (Improved Livestock)

Probit regression — Number of obs = 333
LR chi2(28) = 218.21
Prob > chi2 = 0.0000
Log likelihood = -120.44699 — Pseudo R2 = 0.4753

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.9252276	.34236	-2.70	0.007	-1.596241	-.2542142
Male_no_of_wife	-.1536358	.1753573	-0.88	0.381	-.4973299	.1900583
Ethnicity	-.8234025	.6781236	-1.21	0.225	-2.1525	.5056953
HH_siz	.0696552	.0437667	1.59	0.111	-.0161258	.1554363
HHH_Age	-.010349	.0117037	-0.88	0.377	-.0332878	.0125897
HHH_Marital_Status	.8433965	.3588273	2.35	0.019	.140108	1.546685
HHH_Religion	-.2581907	.2590011	-1.00	0.319	-.7658234	.249442
HHH_Education	-.0024006	.0028643	-0.84	0.402	-.0080144	.0032133
HHH_Occupation	.0773472	.0505004	1.53	0.126	-.0216317	.1763261
Land_Size	-.0552333	.11996	-0.46	0.645	-.2903506	.179884
Land_Frtility	.6798601	.2765042	2.46	0.014	.1379218	1.221798
Land_Use	-.0843699	.4306365	-0.20	0.845	-.9284019	.759662
Land_Right	.7073362	.3451562	2.05	0.040	.0308425	1.38383
Land_Srce	-.0926961	.0564986	-1.64	0.101	-.2034314	.0180392
Land_Invstmnt	-.0300431	.084918	-0.35	0.723	-.1964792	.1363931
Land_Distance_frm_Home	.027886	.0061726	4.52	0.000	.0157878	.0399841
Crp_Production	.6203077	1.050731	0.59	0.555	-1.439087	2.679702
Emplymnt	2.519746	.6506134	3.87	0.000	1.244567	3.794925
LSAI_Benefit_mrkt	-6.69363	268.1395	-0.02	0.980	-532.2375	518.8502
LSAI_Benefit_road	-.0257562	.7677421	-0.03	0.973	-1.530503	1.478991
LSAI_Benefit_No_bnft	-7.853136	268.1397	-0.03	0.977	-533.3974	517.6911
Loss_ecology	1.959041	.5210434	3.76	0.000	.9378144	2.980267
Fert	-1.557718	.5127352	-3.04	0.002	-2.562661	-.5527759
Imprvd_Seed	.443929	.3091553	1.44	0.151	-.1620043	1.049862
Chemicals	.662441	.3314398	2.00	0.046	.0128309	1.312051
Imrovedagripractices	-.4739643	.2550863	-1.86	0.063	-.9739244	.0259957
Imrovedlivestockmgt	1.257081	.4007408	3.14	0.002	.4716436	2.042519
Improvedlandmgt	-.2656621	.2397771	-1.11	0.268	-.7356166	.2042924
_cons	5.387508	268.1462	0.02	0.984	-520.1694	530.9444

Note: 0 failures and 37 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Improvedlivest~k	Unmatched	.151315789	.055248619	.096067171	.032546229	2.95
	ATT	.151315789	.032894737	.118421053	.165299703	0.72

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support On suppor	Total
Untreated	181	181
Treated	152	152
Total	333	333

Annex 22 - Results of Probit Regression and ATT using Kernel Matching Algorithm for Technology Transfer (Improved Livestock)

Probit regression — Number of obs = 333; LR chi2(28) = 218.21; Prob > chi2 = 0.0000; Log likelihood = -120.44699; Pseudo R2 = 0.4753

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.9252276	.34236	-2.70	0.007	-1.596241	-.2542142
Male_no_of_wife	-.1536358	.1753573	-0.88	0.381	-.4973299	.1900583
Ethnicity	-.8234025	.6781236	-1.21	0.225	-2.1525	.5056953
HH_siz	.0696552	.0437667	1.59	0.111	-.0161258	.1554363
HHH_Age	-.010349	.0117037	-0.88	0.377	-.0332878	.0125897
HHH_Marital_Status	.8433965	.3588273	2.35	0.019	.140108	1.546685
HHH_Religion	-.2581907	.2590011	-1.00	0.319	-.7658234	.249442
HHH_Education	-.0024006	.0028643	-0.84	0.402	-.0080144	.0032133
HHH_Occupation	.0773472	.0505004	1.53	0.126	-.0216317	.1763261
Land_Size	-.0552333	.11996	-0.46	0.645	-.2903506	.179884
Land_Frtility	.6798601	.2765042	2.46	0.014	.1379218	1.221798
Land_Use	-.0843699	.4306365	-0.20	0.845	-.9284019	.759662
Land_Right	.7073362	.3451562	2.05	0.040	.0308425	1.38383
Land_Srce	-.0926961	.0564986	-1.64	0.101	-.2034314	.0180392
Land_Invstmnt	-.0300431	.084918	-0.35	0.723	-.1964792	.1363931
Land_Distance_frm_Home	.027886	.0061726	4.52	0.000	.0157878	.0399841
Crp_Production	.6203077	1.050731	0.59	0.555	-1.439087	2.679702
Emplymnt	2.519746	.6506134	3.87	0.000	1.244567	3.794925
LSAI_Benefit_mrkt	-6.69363	268.1395	-0.02	0.980	-532.2375	518.8502
LSAI_Benefit_road	-.0257562	.7677421	-0.03	0.973	-1.530503	1.478991
LSAI_Benefit_No_bnft	-7.853136	268.1397	-0.03	0.977	-533.3974	517.6911
Loss_ecology	1.959041	.5210434	3.76	0.000	.9378144	2.980267
Fert	-1.557718	.5127352	-3.04	0.002	-2.562661	-.5527759
Imprvd_Seed	.443929	.3091553	1.44	0.151	-.1620043	1.049862
Chemicals	.662441	.3314398	2.00	0.046	.0128309	1.312051
Imrovedagripractices	-.4739643	.2550863	-1.86	0.063	-.9739244	.0259957
Imrovedlivestockmgt	1.257081	.4007408	3.14	0.002	.4716436	2.042519
Improvedlandmgt	-.2656621	.2397771	-1.11	0.268	-.7356166	.2042924
_cons	5.387508	268.1462	0.02	0.984	-520.1694	530.9444

Note: 0 failures and 37 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Improvedlivest~k	Unmatched	.151315789	.055248619	.096067171	.032546229	2.95
	ATT	.223529412	.083011034	.140518378	.062641091	2.24

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support		
	Off suppo	On suppor	Total
Untreated	0	181	181
Treated	67	85	152
Total	67	266	333

Annex 23 - Results of Probit Regression and ATT using Caliper Matching Algorithm for Technology Transfer (Improved Livestock)

Probit regression — Number of obs = 333
LR chi2(28) = 218.21
Prob > chi2 = 0.0000
Log likelihood = -120.44699 — Pseudo R2 = 0.4753

Treatment	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.9252276	.34236	-2.70	0.007	-1.596241	-.2542142
Male_no_of_wife	-.1536358	.1753573	-0.88	0.381	-.4973299	.1900583
Ethnicity	-.8234025	.6781236	-1.21	0.225	-2.1525	.5056953
HH_siz	.0696552	.0437667	1.59	0.111	-.0161258	.1554363
HHH_Age	-.010349	.0117037	-0.88	0.377	-.0332878	.0125897
HHH_Marital_Status	.8433965	.3588273	2.35	0.019	.140108	1.546685
HHH_Religion	-.2581907	.2590011	-1.00	0.319	-.7658234	.249442
HHH_Education	-.0024006	.0028643	-0.84	0.402	-.0080144	.0032133
HHH_Occupation	.0773472	.0505004	1.53	0.126	-.0216317	.1763261
Land_Size	-.0552333	.11996	-0.46	0.645	-.2903506	.179884
Land_Frtility	.6798601	.2765042	2.46	0.014	.1379218	1.221798
Land_Use	-.0843699	.4306365	-0.20	0.845	-.9284019	.759662
Land_Right	.7073362	.3451562	2.05	0.040	.0308425	1.38383
Land_Srce	-.0926961	.0564986	-1.64	0.101	-.2034314	.0180392
Land_Invstmnt	-.0300431	.084918	-0.35	0.723	-.1964792	.1363931
Land_Distance_frm_Home	.027886	.0061726	4.52	0.000	.0157878	.0399841
Crp_Production	.6203077	1.050731	0.59	0.555	-1.439087	2.679702
Emplymnt	2.519746	.6506134	3.87	0.000	1.244567	3.794925
LSAI_Benefit_mrkt	-6.69363	268.1395	-0.02	0.980	-532.2375	518.8502
LSAI_Benefit_road	-.0257562	.7677421	-0.03	0.973	-1.530503	1.478991
LSAI_Benefit_No_bnft	-7.853136	268.1397	-0.03	0.977	-533.3974	517.6911
Loss_ecology	1.959041	.5210434	3.76	0.000	.9378144	2.980267
Fert	-1.557718	.5127352	-3.04	0.002	-2.562661	-.5527759
Imprvd_Seed	.443929	.3091553	1.44	0.151	-.1620043	1.049862
Chemicals	.662441	.3314398	2.00	0.046	.0128309	1.312051
Imrovedagripractices	-.4739643	.2550863	-1.86	0.063	-.9739244	.0259957
Imrovedlivestockmgt	1.257081	.4007408	3.14	0.002	.4716436	2.042519
Improvedlandmgt	-.2656621	.2397771	-1.11	0.268	-.7356166	.2042924
_cons	5.387508	268.1462	0.02	0.984	-520.1694	530.9444

Note: 0 failures and 37 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Improvedlivest~k	Unmatched	.151315789	.055248619	.096067171	.032546229	2.95
	ATT	.213333333	.08	.133333333	.06230099	2.14

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	181	181
Treated	77	75	152
Total	77	256	333

Annex 24 - Results of Mean Bias test and t-test for Kernel Matching on Improved Livestock

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.0588	1.0729	-4.2	83.6	-0.37	0.714	0.82
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.3294	1.4694	-24.7	-283.6	-1.33	0.184	0.58*
Ethnicity	U	1.3289	1.3094	4.2		0.38	0.704	1.03
	M	1.4235	1.4747	-10.9	-161.6	-0.67	0.505	0.98
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.3765	5.6889	27.0	-49.4	1.75	0.082	1.35
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	38.847	37.713	10.9	17.6	0.74	0.458	1.15
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0471	2.0684	-6.5	42.4	-0.45	0.653	0.95
HHH_Religion	U	3.0526	3.0608	-1.7		-0.16	0.874	1.04
	M	3.0235	3.0162	1.6	9.7	0.12	0.902	0.64*
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	39.624	39.042	1.4	87.1	0.09	0.926	1.01
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	6.6353	7.4664	-14.2	-73.1	-0.86	0.393	1.03
Land_Size	U	1.3053	1.521	-23.4		-2.12	0.035	0.92
	M	1.2912	1.3078	-1.8	92.3	-0.14	0.892	1.44
Land_Frtility	U	1.2763	1.1657	25.8		2.37	0.018	1.64*
	M	1.3176	1.2068	25.9	-0.2	1.55	0.122	1.61*
Land_Use	U	1.0263	1.0221	2.1		0.19	0.851	0.47*
	M	1.0353	1.0102	12.5	-496.2	0.94	0.347	1.33
Land_Right	U	2.0526	2.0497	1.0		0.09	0.928	1.48*
	M	2.0824	2.0616	7.1	-614.0	0.44	0.663	1.82*
Land_Srce	U	3.0197	3.3315	-14.7		-1.33	0.184	0.91
	M	2.9882	2.6434	16.2	-10.6	1.09	0.279	1.06
Land_Invstmnt	U	4.1776	4.2099	-2.4		-0.22	0.829	0.93
	M	4.3529	4.4524	-7.3	-207.7	-0.51	0.612	0.78
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	19.929	21.254	-6.2	88.6	-0.46	0.643	1.11
Crp_Production	U	.98684	.98895	-1.9		-0.18	0.861	.
	M	.98824	.99651	-7.5	-292.6	-0.62	0.538	.
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.05882	.0247	11.4	84.4	1.11	0.269	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.14118	.21799	-28.4	37.4	-1.30	0.194	.
LSAI_Benefit_road	U	.17105	.01105	57.7		5.45	0.000	.
	M	.04706	.03686	3.7	93.6	0.33	0.742	.
LSAI_Benefit_No_bnft	U	.59868	.9779	-104.5		-9.86	0.000	.
	M	.85882	.78201	21.2	79.7	1.30	0.194	.
Loss_ecology	U	.17105	.01657	54.8		5.16	0.000	.
	M	.05882	.06252	-1.3	97.6	-0.10	0.920	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.08235	.05141	12.0	-30.8	0.80	0.422	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.35294	.24962	22.0	-636.4	1.47	0.144	.
Chemicals	U	.25658	.22099	8.3		0.76	0.449	.
	M	.27059	.18933	19.0	-128.3	1.26	0.210	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.56471	.58164	-3.4	38.9	-0.22	0.825	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.25882	.3215	-16.3	35.8	-0.90	0.371	.
Improvedlandmgt	U	.40789	.34807	12.3		1.12	0.263	.
	M	.37647	.46471	-18.2	-47.5	-1.16	0.246	.

* if variance ratio outside [0.73; 1.38] for U and [0.65; 1.54] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.475	218.21	0.000	22.3	11.8	142.3*	18.99*	38
Matched	0.075	17.72	0.912	12.2	11.2	65.6*	0.80	25

* if B>25%, R outside [0.5; 2]

Annex 25 - Results of Mean Bias test and t-test for Caliper Matching on Improved Livestock

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.0667	1.0933	-8.0	68.9	-0.60	0.550	0.74
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.3333	1.32	2.4	63.5	0.13	0.894	0.94
Ethnicity	U	1.3289	1.3094	4.2		0.38	0.704	1.03
	M	1.44	1.4467	-1.4	65.9	-0.08	0.935	1.00
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.2	6.2733	-2.9	84.1	-0.19	0.846	0.99
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	38.92	38.747	1.7	87.4	0.10	0.917	0.94
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0533	2.0267	8.1	28.1	0.64	0.525	4.00*
HHH_Religion	U	3.0526	3.0608	-1.7		-0.16	0.874	1.04
	M	3.0133	2.9933	4.3	-145.6	0.28	0.777	0.49*
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	40.187	41	-2.0	82.0	-0.12	0.904	1.01
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	6.8667	6.8933	-0.5	94.4	-0.03	0.979	1.05
Land_Size	U	1.3053	1.521	-23.4		-2.12	0.035	0.92
	M	1.31	1.2833	2.9	87.6	0.20	0.840	1.55
Land_Frtility	U	1.2763	1.1657	25.8		2.37	0.018	1.64*
	M	1.32	1.2467	17.1	33.7	0.96	0.338	1.31
Land_Use	U	1.0263	1.0221	2.1		0.19	0.851	0.47*
	M	1.0267	1.02	3.3	-58.1	0.20	0.845	0.44*
Land_Right	U	2.0526	2.0497	1.0		0.09	0.928	1.48*
	M	2.08	2.0933	-4.5	-358.5	-0.23	0.815	1.14
Land_Srce	U	3.0197	3.3315	-14.7		-1.33	0.184	0.91
	M	2.9733	2.5733	18.8	-28.3	1.20	0.233	1.10
Land_Invstmnt	U	4.1776	4.2099	-2.4		-0.22	0.829	0.93
	M	4.3467	4.2867	4.4	-85.7	0.28	0.780	0.77
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	17.987	19.48	-7.0	87.1	-0.51	0.612	1.01
Crp_Production	U	.98684	.98895	-1.9		-0.18	0.861	.
	M	.98667	.98667	0.0	100.0	0.00	1.000	.
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.04	.01333	8.9	87.8	1.01	0.314	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.10667	.15333	-17.3	61.9	-0.85	0.399	.
LSAI_Benefit_road	U	.17105	.01105	57.7		5.45	0.000	.
	M	.05333	.06	-2.4	95.8	-0.18	0.861	.
LSAI_Benefit_No_bnft	U	.59868	.9779	-104.5		-9.86	0.000	.
	M	.89333	.84667	12.9	87.7	0.85	0.399	.
Loss_ecology	U	.17105	.01657	54.8		5.16	0.000	.
	M	.04	.08	-14.2	74.1	-1.03	0.306	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.08	.06	7.8	15.5	0.48	0.634	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.33333	.26667	14.2	-375.2	0.89	0.376	.
Chemicals	U	.25658	.22099	8.3		0.76	0.449	.
	M	.26667	.23333	7.8	6.3	0.47	0.640	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.54667	.47333	14.9	-164.4	0.89	0.372	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.26667	.21333	13.9	45.4	0.76	0.448	.
Improvedlandmgt	U	.40789	.34807	12.3		1.12	0.263	.
	M	.38667	.42667	-8.2	33.1	-0.50	0.621	.

* if variance ratio outside [0.73; 1.38] for U and [0.63; 1.58] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.475	218.21	0.000	22.3	11.8	142.3*	18.99*	38
Matched	0.051	10.69	0.998	7.6	7.4	53.8*	0.98	19

* if B>25%, R outside [0.5; 2]

Annex 26 - Results of Probit Regression and ATT using Nearest Neighbor Matching Algorithm for Infrastructure Development

Probit regression — Number of obs = 333; LR chi2(19) = 191.02; Prob > chi2 = 0.0000; Log likelihood = -134.04253; Pseudo R2 = 0.4161

WithInvest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.6430096	.3033405	-2.12	0.034	-1.237546	-.0484731
Male_no_of_wife	-.1530601	.164795	-0.93	0.353	-.4760524	.1699322
HH_siz	.0513347	.0389633	1.32	0.188	-.0250319	.1277013
HHH_Age	-.010355	.0105017	-0.99	0.324	-.0309379	.0102279
HHH_Marital_Status	.5680581	.3209605	1.77	0.077	-.061013	1.197129
HHH_Education	-.0011543	.0026108	-0.44	0.658	-.0062714	.0039628
HHH_Occupation	.0268005	.0199836	1.34	0.180	-.0123667	.0659676
Land_Distance_frm_Home	.0264533	.0056302	4.70	0.000	.0154182	.0374883
Crp_Production	.629156	1.094651	0.57	0.565	-1.516321	2.774633
Emplymnt	2.385056	.5603947	4.26	0.000	1.286702	3.483409
LSAI_Benefit_mrkt	-5.496696	219.8613	-0.03	0.980	-436.417	425.4236
LSAI_Benefit_No_bnft	-6.926734	219.8611	-0.03	0.975	-437.8465	423.993
Fert	-1.336722	.4671652	-2.86	0.004	-2.252349	-.4210946
Imprvd_Seed	.1572244	.2750764	0.57	0.568	-.3819155	.6963644
Chemicals	.438464	.298818	1.47	0.142	-.1472086	1.024137
Improvedlivestock	.7523923	.3426012	2.20	0.028	.0809062	1.423878
Imrovedagripractices	-.392165	.2245649	-1.75	0.081	-.8323041	.0479741
Imrovedlivestockmgt	.6073549	.352819	1.72	0.085	-.0841576	1.298868
Improvedlandmgt	-.0843473	.2181639	-0.39	0.699	-.5119407	.3432462
_cons	5.05842	219.8638	0.02	0.982	-425.8668	435.9836

Note: 0 failures and 27 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Infrastructure	Unmatched	.364683967	-.33841005	.703094017	.099051738	7.10
	ATT	.364683967	-.33841005	.703094017	.10811969	6.50

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support On suppor	Total
Untreated	181	181
Treated	152	152
Total	333	333

Annex 27 - Summary of _Pscore for Infrastructure Development

Variable	Obs	Mean	Std. Dev.	Min	Max
_pscore	333	.4552964	.3417958	.0097704	1

Annex 28 - Results of PS test for Infrastructure Development using Nearest Neighbor Matching Algorithm

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.0855	1.0789	2.0	92.3	0.21	0.835	1.08
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.2895	2.0263	-130.0	-1919.1	-8.20	0.000	0.32*
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.4934	4.6382	72.9	-303.1	6.63	0.000	1.45*
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	39.033	35.914	30.0	-126.6	2.71	0.007	1.12
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0592	2.0395	6.0	46.8	0.53	0.599	3.15*
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	36.625	29.533	17.6	-57.0	1.64	0.103	1.16
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	5.6513	9.875	-72.0	-779.9	-6.24	0.000	1.05
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	23.441	24.461	-4.8	91.2	-0.41	0.685	3.09*
Crp_Production	U	.98684	.98895	-1.9		-0.18	0.861	.
	M	.98684	1	-12.0	-524.1	-1.42	0.157	.
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.22368	.02632	65.7	9.5	5.43	0.000	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.14474	.47368	-121.6	-168.2	-6.62	0.000	.
LSAI_Benefit_No_bnft	U	.59868	.9779	-104.5		-9.86	0.000	.
	M	.59868	.52632	19.9	80.9	1.27	0.205	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.05921	.05263	2.6	72.2	0.25	0.804	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.32895	.21711	23.9	-697.2	2.20	0.029	.
Chemicals	U	.25658	.22099	8.3		0.76	0.449	.
	M	.25658	.23684	4.6	44.5	0.40	0.691	.
Improvedlivestock	U	.15132	.05525	31.9		2.95	0.003	.
	M	.15132	.15132	0.0	100.0	0.00	1.000	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.58553	.83553	-50.9	-801.4	-4.98	0.000	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.23026	.63816	-106.4	-317.6	-7.85	0.000	.
Improvedlandmgt	U	.40789	.34807	12.3		1.12	0.263	.
	M	.40789	.69079	-58.3	-372.8	-5.15	0.000	.

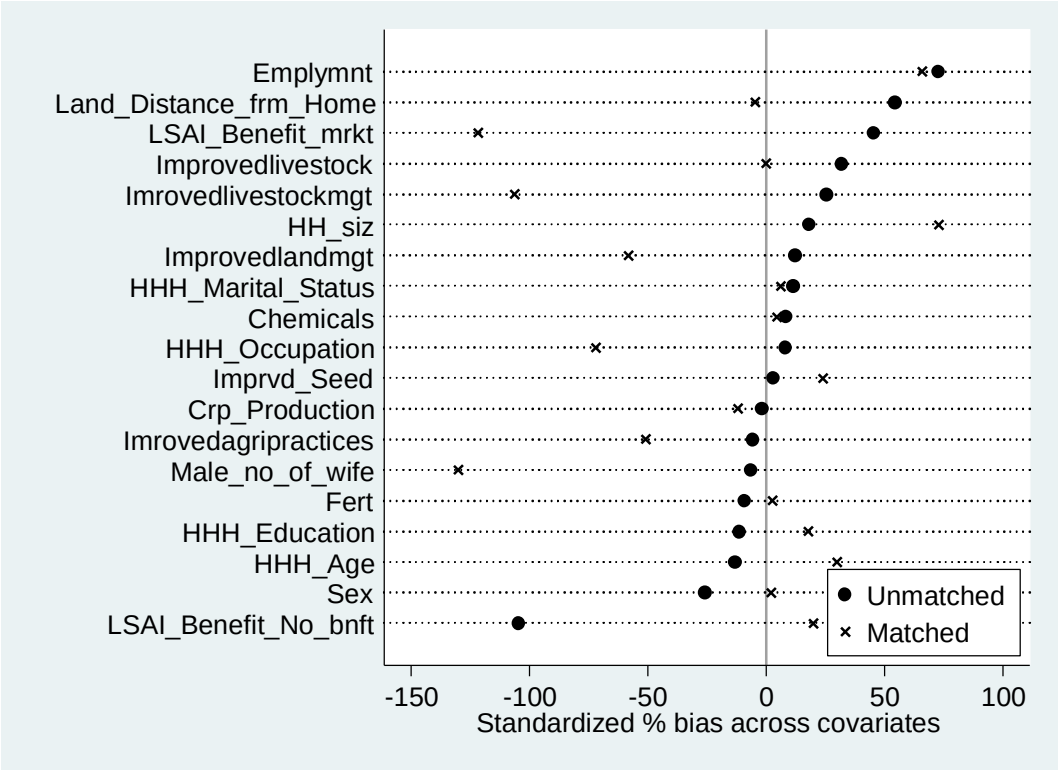
* if variance ratio outside [0.73; 1.38] for U and [0.73; 1.38] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.416	191.02	0.000	24.7	12.3	134.3*	23.06*	38
Matched	0.368	154.02	0.000	42.2	23.9	125.1*	13.01*	50

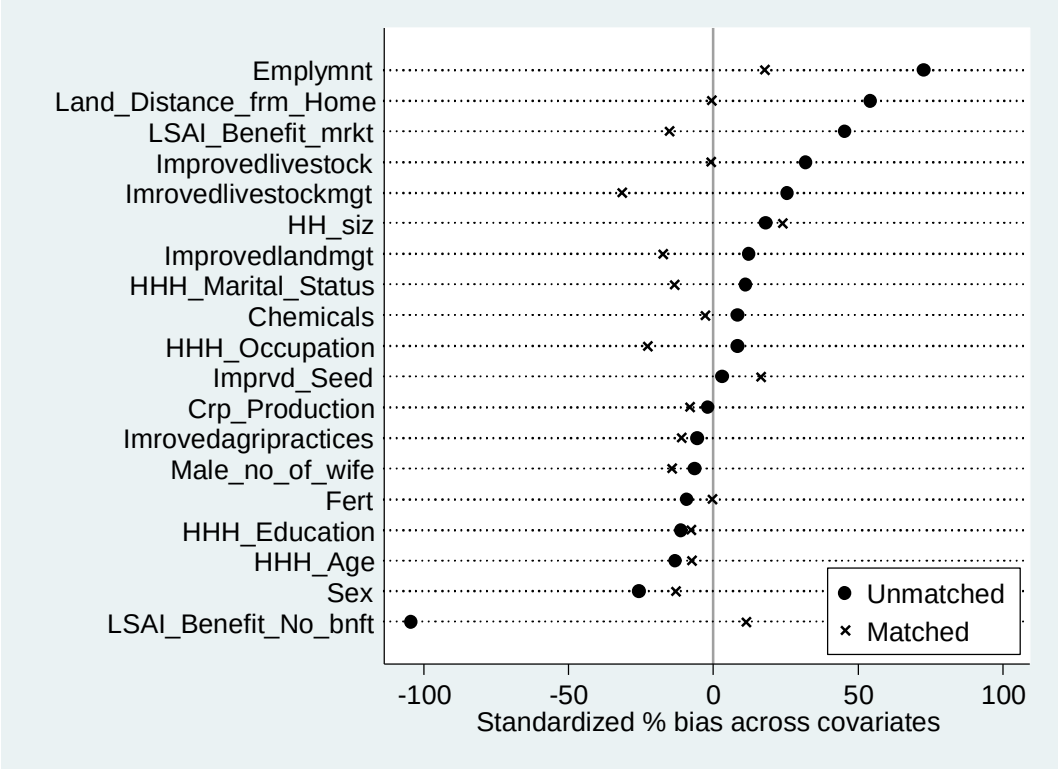
* if B>25%, R outside [0.5; 2]

Annex 29 - RESULTS OF GRAPHS FOR Infrastructure Development

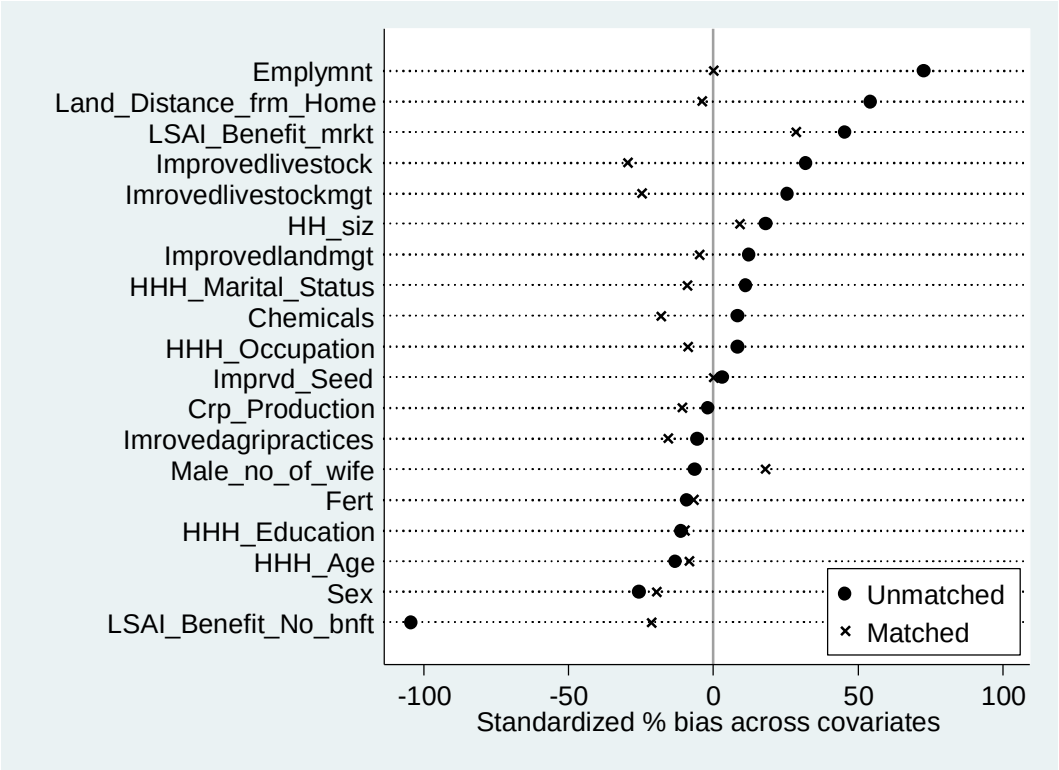
Using Nearest Neighbor Matching Algorithm



Using Kernel Matching Algorithm



Using Caliper Matching Algorithm



Annex 30 - Results of Probit Regression and ATT using Kernel Matching Algorithm for Infrastructure Development

Probit regression — Number of obs = 333; LR chi2(19) = 191.02; Prob > chi2 = 0.0000

Log likelihood = -134.04253 — Pseudo R2 = 0.4161

WithInvest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.6430096	.3033405	-2.12	0.034	-1.237546	-.0484731
Male_no_of_wife	-.1530601	.164795	-0.93	0.353	-.4760524	.1699322
HH_siz	.0513347	.0389633	1.32	0.188	-.0250319	.1277013
HHH_Age	-.010355	.0105017	-0.99	0.324	-.0309379	.0102279
HHH_Marital_Status	.5680581	.3209605	1.77	0.077	-.061013	1.197129
HHH_Education	-.0011543	.0026108	-0.44	0.658	-.0062714	.0039628
HHH_Occupation	.0268005	.0199836	1.34	0.180	-.0123667	.0659676
Land_Distance_frm_Home	.0264533	.0056302	4.70	0.000	.0154182	.0374883
Crp_Production	.629156	1.094651	0.57	0.565	-1.516321	2.774633
Emplymnt	2.385056	.5603947	4.26	0.000	1.286702	3.483409
LSAI_Benefit_mrkt	-5.496696	219.8613	-0.03	0.980	-436.417	425.4236
LSAI_Benefit_No_bnft	-6.926734	219.8611	-0.03	0.975	-437.8465	423.993
Fert	-1.336722	.4671652	-2.86	0.004	-2.252349	-.4210946
Imprvd_Seed	.1572244	.2750764	0.57	0.568	-.3819155	.6963644
Chemicals	.438464	.298818	1.47	0.142	-.1472086	1.024137
Improvedlivestock	.7523923	.3426012	2.20	0.028	.0809062	1.423878
Imrovedagripractices	-.392165	.2245649	-1.75	0.081	-.8323041	.0479741
Imrovedlivestockmgt	.6073549	.352819	1.72	0.085	-.0841576	1.298868
Improvedlandmgt	-.0843473	.2181639	-0.39	0.699	-.5119407	.3432462
_cons	5.05842	219.8638	0.02	0.982	-425.8668	435.9836

Note: 0 failures and 27 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Infrastructure	Unmatched	.364683967	-.33841005	.703094017	.099051738	7.10
	ATT	.125743946	-.33841005	.464153996	.119774537	3.88

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	181	181
Treated	56	96	152
Total	56	277	333

Annex 31 - Results of PS test for Infrastructure Development using Kernel Matching Algorithm

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.0625	1.1055	-12.9	49.8	-1.07	0.285	0.62*
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.3333	1.4152	-14.4	-124.4	-0.84	0.400	0.63*
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.3438	5.7373	23.8	-31.8	1.67	0.097	1.47
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	38.583	39.356	-7.4	43.8	-0.51	0.612	0.89
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0417	2.0861	-13.5	-19.6	-0.97	0.332	0.70
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	37.792	40.907	-7.7	31.0	-0.54	0.591	0.95
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	6.4271	7.7606	-22.7	-177.8	-1.49	0.138	1.05
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	19.688	19.839	-0.7	98.7	-0.06	0.953	1.10
Crp_Production	U	.98684	.98895	-1.9		-0.18	0.861	.
	M	.98958	.99848	-8.1	-321.8	-0.80	0.426	.
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.10417	.05122	17.6	75.7	1.37	0.172	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.13542	.17646	-15.2	66.5	-0.78	0.436	.
LSAI_Benefit_No_bnft	U	.59868	.9779	-104.5		-9.86	0.000	.
	M	.86458	.82354	11.3	89.2	0.78	0.436	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.07292	.07403	-0.4	95.3	-0.03	0.977	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.35417	.27771	16.3	-445.0	1.14	0.257	.
Chemicals	U	.25658	.22099	8.3		0.76	0.449	.
	M	.26042	.27265	-2.9	65.6	-0.19	0.849	.
Improvedlivestock	U	.15132	.05525	31.9		2.95	0.003	.
	M	.21875	.22162	-1.0	97.0	-0.05	0.962	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.59375	.64805	-11.1	-95.8	-0.77	0.441	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.25	.37131	-31.6	-24.2	-1.82	0.070	.
Improvedlandmgt	U	.40789	.34807	12.3		1.12	0.263	.
	M	.40625	.49039	-17.3	-40.6	-1.17	0.243	.

* if variance ratio outside [0.73; 1.38] for U and [0.67; 1.50] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.416	191.02	0.000	24.7	12.3	134.3*	23.06*	38
Matched	0.054	14.39	0.703	12.4	12.9	55.3*	1.35	25

* if B>25%, R outside [0.5; 2]

Annex 32 - Results of Probit Regression and ATT using Caliper Matching Algorithm for Infrastructure Development

Probit regression — Number of obs = 333; LR chi2(19) = 191.02; Prob > chi2 = 0.0000

Log likelihood = -134.04253 — Pseudo R2 = 0.4161

WithInvest	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	-.6430096	.3033405	-2.12	0.034	-1.237546	-.0484731
Male_no_of_wife	-.1530601	.164795	-0.93	0.353	-.4760524	.1699322
HH_siz	.0513347	.0389633	1.32	0.188	-.0250319	.1277013
HHH_Age	-.010355	.0105017	-0.99	0.324	-.0309379	.0102279
HHH_Marital_Status	.5680581	.3209605	1.77	0.077	-.061013	1.197129
HHH_Education	-.0011543	.0026108	-0.44	0.658	-.0062714	.0039628
HHH_Occupation	.0268005	.0199836	1.34	0.180	-.0123667	.0659676
Land_Distance_frm_Home	.0264533	.0056302	4.70	0.000	.0154182	.0374883
Crp_Production	.629156	1.094651	0.57	0.565	-1.516321	2.774633
Emplymnt	2.385056	.5603947	4.26	0.000	1.286702	3.483409
LSAI_Benefit_mrkt	-5.496696	219.8613	-0.03	0.980	-436.417	425.4236
LSAI_Benefit_No_bnft	-6.926734	219.8611	-0.03	0.975	-437.8465	423.993
Fert	-1.336722	.4671652	-2.86	0.004	-2.252349	-.4210946
Imprvd_Seed	.1572244	.2750764	0.57	0.568	-.3819155	.6963644
Chemicals	.438464	.298818	1.47	0.142	-.1472086	1.024137
Improvedlivestock	.7523923	.3426012	2.20	0.028	.0809062	1.423878
Imrovedagripractices	-.392165	.2245649	-1.75	0.081	-.8323041	.0479741
Imrovedlivestockmgt	.6073549	.352819	1.72	0.085	-.0841576	1.298868
Improvedlandmgt	-.0843473	.2181639	-0.39	0.699	-.5119407	.3432462
_cons	5.05842	219.8638	0.02	0.982	-425.8668	435.9836

Note: 0 failures and 27 successes completely determined.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Infrastructure	Unmatched	.364683967	-.33841005	.703094017	.099051738	7.10
	ATT	.142488051	-.33841005	.480898101	.127006701	3.79

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support Off suppo	On suppor	Total
Untreated	0	181	181
Treated	68	84	152
Total	68	265	333

Annex 33 - Results of PS test for Infrastructure Development using Caliper Matching Algorithm

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
Sex	U	1.0855	1.1713	-25.8		-2.31	0.021	0.55*
	M	1.0714	1.1369	-19.7	23.6	-1.39	0.167	0.56*
Male_no_of_wife	U	1.2895	1.326	-6.4		-0.58	0.560	0.87
	M	1.3452	1.244	17.8	-177.3	1.16	0.250	1.38
HH_siz	U	6.4934	6.0331	18.1		1.65	0.100	1.20
	M	6.2976	6.0655	9.1	49.6	0.61	0.541	1.50
HHH_Age	U	39.033	40.409	-13.2		-1.20	0.230	0.97
	M	38.821	39.685	-8.3	37.3	-0.56	0.580	1.00
HHH_Marital_Status	U	2.0592	2.0221	11.3		1.05	0.296	2.94*
	M	2.0476	2.0774	-9.0	19.8	-0.63	0.533	0.98
HHH_Education	U	36.625	41.144	-11.2		-1.02	0.309	0.90
	M	37.75	41.786	-10.0	10.7	-0.65	0.516	0.97
HHH_Occupation	U	5.6513	5.1713	8.2		0.75	0.456	1.08
	M	6.4286	6.9524	-8.9	-9.1	-0.56	0.576	1.14
Land_Distance_frm_Home	U	23.441	11.84	54.3		5.07	0.000	3.85*
	M	18.714	19.583	-4.1	92.5	-0.30	0.762	0.91
Crp_Production	U	.98684	.98895	-1.9		-0.18	0.861	.
	M	.9881	1	-10.9	-464.7	-1.00	0.319	.
Emplymnt	U	.22368	.00552	72.7		6.89	0.000	.
	M	.04762	.04762	0.0	100.0	-0.00	1.000	.
LSAI_Benefit_mrkt	U	.14474	.0221	45.3		4.25	0.000	.
	M	.14286	.06548	28.6	36.9	1.65	0.102	.
LSAI_Benefit_No_bnft	U	.59868	.9779	-104.5		-9.86	0.000	.
	M	.85714	.93452	-21.3	79.6	-1.65	0.102	.
Fert	U	.05921	.08287	-9.2		-0.83	0.407	.
	M	.08333	.10119	-6.9	24.5	-0.40	0.691	.
Imprvd_Seed	U	.32895	.31492	3.0		0.27	0.786	.
	M	.33333	.33333	0.0	100.0	-0.00	1.000	.
Chemicals	U	.25658	.22099	8.3		0.76	0.449	.
	M	.25	.32738	-18.1	-117.5	-1.10	0.271	.
Improvedlivestock	U	.15132	.05525	31.9		2.95	0.003	.
	M	.17857	.26786	-29.6	7.1	-1.39	0.167	.
Imrovedagripractices	U	.58553	.61326	-5.6		-0.51	0.608	.
	M	.57143	.64881	-15.7	-179.0	-1.03	0.307	.
Imrovedlivestockmgt	U	.23026	.1326	25.5		2.34	0.020	.
	M	.2381	.33333	-24.8	2.5	-1.37	0.174	.
Improvedlandmgt	U	.40789	.34807	12.3		1.12	0.263	.
	M	.40476	.42857	-4.9	60.2	-0.31	0.756	.

* if variance ratio outside [0.73; 1.38] for U and [0.65; 1.54] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.416	191.02	0.000	24.7	12.3	134.3*	23.06*	38
Matched	0.043	9.92	0.907	13.0	10.0	49.1*	0.92	13

* if B>25%, R outside [0.5; 2]

TABLE 23 - RESULTS OF DESCRIPTIVE STATISTICS FOR EMPLOYMENT

		Abobo				Itang				Total			
Has any member of your family been employed in the investor's farm?		With Investment		Without investment		With Investment		Without investment		With Investment		Without investment	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	No	112	71%	184	99%	70	100%	84	100%	182	80%	268	100%
	Yes	45	29%	1	1%	-	0%	0	0%	45	20%	1	0%
	Total	157	100%	185	100%	70	100%	84	100%	227	100%	269	100%

	Type of Profession	Abobo				Itang				Total			
		With Investment		Without Investment		With Investment		Without Investment		With Investment		Without Investment	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
If yes, in what kind of employment have your family members been engaged?	Casual/daily laborer	22	49%	1	100%	-	0%	-	0%	22	49%	1	100%
	Guard	20	44%	-	0%	-	0%	-	0%	20	44%	-	0%
	Technical operation (tractor driving, machine operation....)	3	7%	-	0%	-	0%	-	0%	3	7%	-	0%
	Food preparation	-	0%	-	0%	-	0%	-	0%	-	0%	-	0%
	Others (specify)	-	0%	-	0%	-	0%	-	0%	-	0%	-	0%
Total		45		1		0.00		0		45		1	

Table 24 – Results of Descriptive Statistics for Technology Use

Do You Use		Yes		No	
		Count	%	Count	%
Fertilizer for Crop Production?	Investment	14	5%	252	95%
	No Investment	16	7%	213	93%
Improved Seed for Crop Production?	Investment	76	33%	151	67%
	No Investment	68	25%	201	75%
Agrochemicals for Crop Production?	Investment	55	24%	172	76%
	No Investment	47	17%	222	83%
Improved Agricultural Practice for Crop Production?	Investment	127	56%	100	44%
	No Investment	153	57%	116	43%
Agricultural Mechanization for Crop Production?	Investment	13	6%	214	94%
	No Investment	0	0%	269	100%
Irrigation for Crop Production?	Investment	2	1%	225	99%
	No Investment	0	0%	269	100%
Improved Livestock Production?	Investment	46	20%	181	80%
	No Investment	38	14%	231	86%
Improved Land Management Technology?	Investment	83	37%	144	63%
	No Investment	88	33%	181	67%

Do you have		Abobo				Itang				Total			
		Investment		No Invest.		Investment		No Invest.		Investment		No Invest.	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigation skills	No	153	97%	185	100%	69	99%	84	100%	222	98%	269	100%
	Yes	4	3%	0	0%	1	1%	0	0%	5	2%	0	0%
Fertilizer/improved seed application skills	No	149	95%	185	100%	66	94%	84	100%	215	95%	269	100%
	Yes	8	5%	0	0%	4	6%	0	0%	12	5%	0	0%
Pesticides and herbicides skills	No	151	96%	185	100%	60	86%	84	100%	211	93%	269	100%
	Yes	6	4%	0	0%	10	14%	0	0%	16	7%	0	0%
Conservation skills	No	133	85%	185	100%	65	93%	84	100%	198	87%	269	100%
	Yes	24	15%	0	0%	5	7%	0	0%	29	13%	0	0%
Other skills gained (specify)	No	157	100%	185	100%	70	100%	84	100%	227	100%	269	100%
	Yes	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%

Do you get Training on:		Abobo				Itang				Total			
		Investment		No Investment		Investment		No Investment		Investment		No Investment	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigation	No	155	99%	185	100%	68	97%	84	100%	223	98%	269	100%
	Yes	2	1%	-	0%	2	3%	-	0%	4	2%	-	0%
Fertilizer/Improved Seed Use	No	147	94%	185	100%	62	89%	84	100%	209	92%	269	100%
	Yes	10	6%	-	0%	8	11%	-	0%	18	8%	-	0%
Pesticides and herbicides skills	No	150	96%	185	100%	64	91%	84	100%	214	94%	269	100%
	Yes	7	4%	-	0%	6	9%	-	0%	13	6%	-	0%
Environment Conservation	No	134	86%	185	100%	65	93%	84	100%	199	88%	269	100%
	Yes	22	14%	-	0%	5	7%	-	0%	27	12%	-	0%
Other Training	No	157	100%	185	100%	70	100%	84	100%	227	100%	269	100%
	Yes	-	0%	-	0%	-	0%	-	0%	-	0%	-	0%
No Training	No	36	23%	-	0%	10	14%	-	0%	46	20%	-	0%
	Yes	121	77%	185	100%	60	86%	84	100%	181	80%	269	100%

Do you get		Abobo				Itang				Total			
		Investment		No Investment		Investment		No Investment		Investment		No Investment	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Supply of agricultural inputs such as fertilizer, improved seed....	No	131	83%	185	100%	65	93%	84	100%	196	86%	269	100%
	Yes	26	17%	0	0%	5	7%	0	0%	31	14%	0	0%
Supply of water	No	156	99%	185	100%	70	100%	84	100%	226	100%	269	100%
	Yes	1	1%	0	0%	0	0%	0	0%	1	0%	0	0%
Credit services	No	157	100%	185	100%	70	100%	84	100%	227	100%	269	100%
	Yes	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Other support (specify - grain mill)	No	152	97%	185	100%	70	100%	84	100%	222	98%	269	100%
	Yes	5	3%	0	0%	0	0%	0	0%	5	2%	0	0%

If you get support in the form of inputs, what modality did you use?		Abobo				Itang				Total			
		Investment		No Investment		Investment		No Investment		Investment		No Investment	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Credit base	No	26	96%	-	-	2	50%	-	-	28	90%	-	-
	Yes	1	4%	-	-	2	50%	-	-	3	10%	-	-
In Cash	No	26	96%	-	-	1	25%	-	-	27	87%	-	-
	Yes	1	4%	-	-	3	75%	-	-	4	13%	-	-
Exchange for labor	No	23	85%	-	-	4	100%	-	-	27	87%	-	-
	Yes	4	15%	-	-	0	0%	-	-	4	13%	-	-
For Free	No	6	22%	-	-	2	50%	-	-	8	26%	-	-
	Yes	21	78%	-	-	2	50%	-	-	23	74%	-	-

Table 25 - Results of Descriptive Statistics for Infrastructural Development

Have you benefited from		Yes		No	
		Count	%	Count	%
Road Infrastructure due to LSAI?	Investment	68	20%	269	80%
	No Investment	0	0%	159	100%
Health Service Infrastructure due to LSAI?	Investment	5	2%	222	98%
	No Investment	0	0%	269	100%
Schol/Educational Service due to LSAI?	Investment	2	1%	225	99%
	No Investment	0	0%	269	100%
Irrigation Infrastructure due to LSAI?	Investment	0	0%	227	100%
	No Investment	0	0%	269	100%
Potable/Drinking Water Infrastructure due to LSAI?	Investment	4	2%	223	98%
	No Investment	0	0%	269	100%
Purchasing farm products from LSAI?	Investment	69	30%	158	70%
	No Investment	7	3%	262	97%
Selling products to LSAI?	Investment	8	4%	219	96%
	No Investment	0	0%	269	100%

Benefits gained due to LSAL		Abobo				Itang				Total			
		Investment		No Invest.		Investment		No Invest.		Investment		No Invest.	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Improved market for your product	No	135	86%	183	99%	64	91%	80	95%	199	88%	263	98%
	Yes	22	14%	2	1%	6	9%	4	5%	28	12%	6	2%
Improved market roads	No	114	73%	183	99%	65	93%	82	98%	179	79%	265	99%
	Yes	43	27%	2	1%	5	7%	2	2%	48	21%	4	1%
Improved storage for your product	No	151	96%	185	100%	62	89%	83	99%	213	94%	268	100%
	Yes	6	4%	0	0%	8	11%	1	1%	14	6%	1	0%
Improved availability of farm workers	No	145	92%	185	100%	63	90%	83	99%	208	92%	268	100%
	Yes	12	8%	0	0%	7	10%	1	1%	19	8%	1	0%
Other benefits (specify - grain mill)	No	152	97%	185	100%	70	100%	84	100%	222	98%	269	100%
	Yes	5	3%	0	0%	0	0%	0	0%	5	2%	0	0%