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COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

DEPARTMENT OF AGRICULTURAL ECONOMICS

ADOPTION AND IMPACT OF IMPROVED MALT BARLEY VARIETIES ON HOUSEHOLDS INCOME IN BALE ZONE, OROMIA NATIONAL REGIONAL STATE, ETHIOPIA

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DECLARATION

Researchers:- We, the undersigned, solemnly declare that this RESEARCH REPORT entitled "Adoption and Impact of Improved Malt Barley Varieties on households income in Bale Zone, Oromia National Regional State, Ethiopia", funded by and carried out in Madda Walabu University under the ARTTCE Vice President Office and the Research, Publication, Ethics & Extension Directorate. I assert that the statements made and conclusions drawn are the outcome of the research/project work. I further declare that to the best of my knowledge and belief the project report does not contain part of any research work which has been previously conducted, published or submitted for the award of a degree/diploma/certificate in Madda Walabu University or any other University. We are aware that we were held accountable.

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ABBREVIATIONS AND ACRONOMYS

ATT	Average Treatment effect on the Treated
BoARD	Biro of Agriculture Rural Development
CSA	Central Statistical Agency
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
ICARDA	International Center for Agricultural Research in the Dry Areas
EIAR	Ethiopian Institute of Agricultural Research
KII	Key Informant Interview
LDCs	Less Developed Countries
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
MB	Malt Barley
NAFALRC	National Fishery and Aquatic Life Research Center
PSM	Propensity Score Matching
USAD	United States Academic Decathlon

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ABSTRACT

Adoption of improved malt barley varieties are playing vital role in improving household income in Ethiopia. This studied major aim to analyze the adoption of improved malt barley varieties and its impact on the household income in three districts of Bale Zone. The survey consists of 389 sampled respondents out of whom 187 were improved malt barley variety adopters and 202 were non-adopters. In this study, a multi-stage sampling technique employed to select district, Kebeles and respondents. The study used cross-sectional data collected from sample households. The primary data were collected using an interview schedule, key informant interview and focus group discussions and various documents were reviewed to collect secondary data. A logit model and propensity score matching (PSM) models methods were used to analyze factors affecting adoption of improved malt barley varieties and its impacts on household income respectively. The survey result shows that about 51.93% *and 48.07% of sample respondents were found to be non adopter and adopter of malt barley respectively. The logit model results showed that variable significantly and positively affects improved malt barley varieties, means, frequency of contact with extension, farm size, participation in off-farm activities, education level of household, livestock of household and availability of fertilizer on time. The impact results obtained from PSM models indicated that 8464.390 ETB on household income of farmers increase for adopters as compared to non-adopters of improved malt barley varieties and also the average yields of malt barley of adopter households in improved malt barley varieties higher by 20.278 quintals per hectare in given product year when compared with the average yields of non-adopter households. Therefore, Based on the findings of this study it can be concluded that the government and stakeholders should need to focus on improving farm land and livestock productivity through increasing food of livestock, strengthening the of education and frequency of extension services, encouraging participation in off-farm activities, creating the method of easily get fertilizer on time in the area. As a final point, additional support of improved malt barley varieties adoption should be given due attention for its impact on households income generation.*

Keywords: Impact of MB, Improved, Binary Logistic model, PSM, Adoption, Livelihood

1. INTRODUCTION

1.2. Background of the Study

Agriculture is the main sector of Less Developed Countries (LDCs) in general and Sub-Saharan Africa (SSA) in particular. Agriculture is a leading sector of the Ethiopian economy which had a higher contribution to the Gross Domestic Product, foreign exchange earnings, and employment. Agriculture is quite supposed to remain a sector that plays a key role in encouraging the overall economic development of the country (Ermias, 2021).

The economic development of Ethiopia is highly dependent on the performance of its agricultural sector since it is the major economic support of economic growth of the country In Ethiopia, where agriculture is the base of the economy - it accounts for over 34.1% of Gross domestic product, employs over 75% of the population, accounts for 79% of foreign earnings, provides raw material and capital for investment and to market and covers over 90 percent of smallholder agricultural production (Diriba, 2020). The sector is a key for stimulating growth and overcoming poverty (Abewa *et al.,* 2020).

The sound performance of agriculture permits the availability of food crops. This achievement in agriculture does not only signify the adequate acquirement of food crops to attain food security but also heralds a positive aspect of the economy. Regarding this, collective efforts are being geared to securing agricultural outputs of the desired level so that self-reliance in food supply can be achieved and disaster-caused food shortages are contained in the shortest possible time in Ethiopia (CSA, 2020). Cereals are the major staple food crops both in terms of area planted and volume of production obtained. In 2013/14 main crop season, cereals were cultivated on 9.9 million hectares of land producing 22 million tons of food grains. This represented 79.38% and 85.81% of the total area and production of food grains in the country, respectively (CSA 2014).

Barley the first cereal to be domesticated by man, dating back to 7000 BCE, and its cultivation probably originated in the Abyssinia highlands and Southeast Asia in prehistoric times (Workie and Tasew 2023). Barley is one of the major crops widely grown in different countries of the world. After rice, wheat, and maize, it is the fourth most produced crop worldwide (FAO, 2021).

Ethiopia is one of the ten top barley producers in the world and it also ranks fifth in Africa followed by Algeria (FAO, 2020).

In Ethiopia, barley ranked fifth next to teff, maize, wheat, and sorghum in 2020/2021. The two types of barley are food barley for consumption and malt barley for the brewery in the country. Similarly, more than 3.51 million smallholder farmers produced about 20.51 million quintals on 951, 993.15 ha with a productivity of 21.6 qt/ha(CSA, 2021). Ethiopia has a high demand for raw malt barley products due to the older established and new emerging malt and brewery factories (Asokoinsight, 2019).

The malt barley production sub-sector in Ethiopia has recently become a highly emerging one due to the interest shown by multinational beer companies to fulfill their demand for malt by sourcing from domestic production (Bezabeh et al., 2020). However, only about 25% of the total raw malt barley grain demand of breweries in Ethiopia is being covered by the domestic supply (ICARDA, 2019). Malt barley is becoming a major income source to smallholder farmers in the highland areas of Ethiopia, particularly where the agro-ecologies are not more productive to other cereal crops (MoA, 2018). Barley is widely grown by smallholders as a staple food and as a source of cash income.

Ethiopia has great potential for malt barley production. Malt barley grows best at altitudes ranging from 2300 to 3000 meters above sea level. It requires uniform rainfall distribution of 500-800 mm during the crop growing season and well-drained soil. Malt barley is used to produce malt, the key input for brewing beer. About 90% of the total raw material cost for beer production is malt and the material used for malt production in Ethiopia is malt barley (Tadesse, 2012). Malt barley, at the present time, is considered as one of the cash crops produced in the highlands and its demand by malt factory has increased due to its increased capacity of malt barley processing and the expansion of breweries and beer consumption levels in the country (EIAR and NAFALRC, 2020).

The Oromia region is the frist-largest producer in Ethiopia, covering *456,192* ha with a productivity of *2.25* tons per hectare. Bale zone in the Oromia Region is one of the Africa rising project's operational areas, where wheat and barley production are dominant due to its favourable weather, fertile soil, and adequate rainfall. Smallholder farmers in the area have organized themselves as seed multiplication cooperatives and begun to produce malt barley in districts of the zone to increase the income. However, accessing quality improved seed and variety, at the right place and timely at an affordable price remain a challenge for the farmers in the area (Negra *et al., 2020*).

In general, as is well known, Bale is very famous for its malt barley production. Therefore this study was focuses on the impact of malt barley production on farmers' income, as well as the factors that hinder for production of the farmers or reduce their production of farmers' income prohibition, the challenges and opportunity they derive from malt barley production in the selected districts of the zone.

1.2. Statements of the Problem

In Ethiopia Most farmers have very limited access to high-quality of improved varieties, and many released varieties of different crops with higher traits have not still been widely distributed. Specific challenges associated with varieties include the limited capacity and lack of role clarity of the different distributor; the variety distributor focuses on very few crops and varieties, weak seed demand assessment, and a mismatch between supply and demand in the formal system (Dawit et al., 2019).

Malt Barley is one of the country's most important crops for food and human survival; is a once or twice-yearly crop produced in more than 800,000 h. However, despite barley's long history of production and subsistence importance, its productivity has never increased beyond 2.2 t ha − 1, accounting for about one-third of the 6.0 t ha − 1 yield in the experimental plots. Soil fertility decline due to high rates of soil erosion by wind and flooding, scarcity of fertilizers due to' inappropriate fertilizer application, nutrient balance, and limited availability of improved varieties, Ethiopia is considered to be one of the major limiting factors for the low productivity of barley (Habtamu, Bobe, and Enyew, 2014). The very low supply of domestically produced malt barley has resulted in low barley productivity in Ethiopia in general, and malt barley in particular (Rashid et al., 2015). Reason one of the major factors responsible for Ethiopia's low level of production and productivity is the lack of efficiency and quality in farmers' production patterns (Teferra et al., 2018).

Malt Barley Production consisting of improved variety, fertilizer application patterns (urea and dap), and periodic rotation of cropland was offered to the study area to improve to households livelihood. Despite such interventions the adoption of improved malt barley variety is still very low and hence the yield is very low. In other respects, there is also considerable variation among farmers on the income of household depending on their level of adoption of improved malt barley varieties. However, empirical data on the factors influencing the adoption decision of improved malt barley varieties and Impact of improved malt barley varieties on yield of malt barley and household livelihood are completely lacking in the bale Zone. Therefore, this study was analyzing adoption and Impact of improved malt barley varieties on household livelihood in Bale zone and proposes to fill the knowledge gap.

1.3. Objectives of the study

The general objective of the study is to examine adoption and impact of improved malt barley varieties on household livelihood in bale zone

1. To identify factors that affect the farmers' adoption of improved malt barley varieties on household income in study area.
2. To evaluate the impact of improved malt barley varieties on yield of malt barley in study area.
3. To evaluate the impact of improved malt barley varieties on income of household in study area.

1.4. Research Questions

1. What are the factors that affect adoption of improved malt barley varieties?
2. What is the impact of improved malt barley varieties on malt barley yield?
3. What is the impact of improved malt barley production on household income?

1.5. Significance of the Study

The findings of this study assist development activities underway and to be planned in the future. Such information about adoption decisions of improved variety of crop on matters of impact of agricultural production on income of household is very important for researchers, policy makers and extension workers engaged in development and on income of households. Because of they can utilize the results of this study in setting research and extension agenda. Furthermore, information on farmers' characteristics giving a feedback and enable researchers to modify and redirect research activities towards the most important problems. It also useful to farmers in devising ways to increase their production and productivity and enhance income and reduce poverty.

1.6. Scope and Limitations of the Study

This study limit by factors like time, resource, method of data analysis and data availability. Adoption of improved malt barley varieties and impact analysis of improved malt barley on household income undertaken by using different types of data. This study conducted only in three district of Bale zone by selecting six malt barley production potential kebeles from three districts due to time shortage and resource limitation. The study focus only on to the investigation of the factors of improved malt barley varieties adoption decision and its impact on yield of malt barley and household income in Bale zone by using the data collected from the sample farmers and available secondary data. Hence, the results of the study were applicable to the study area and other areas with similar physical and socioeconomic settings.

1.7. Organization of the Thesis

This thesis is organized into five chapters. The first chapter introduces the background, statement of the problem, research question, the objective, as well as the scope and limitation of the study. The theoretical review, empirical review, and relevant literature are reviewed in the second chapter. Chapter three describes the study area and also methodological approach including sampling techniques, methods of data collection and methods used for the analysis of collected data. Chapter four presents the main findings of the study results and discussion of the study. Finally, summary, conclusion and recommendation are presented based on the study area in chapter five.

2. LITERATURE REVIEW

2.1. Theoretical Review

This chapter covers the concepts and theories, empirical and conceptual frame work of adoption of malt barley and impact of malt barley production as well as potential and production situations at area of study.

2.1.1. Definitions and Concepts

Adoption is a mental process through which an individual passes from first knowledge of an innovation to the decision to adopt or reject and to confirmation of this decision (van den Ban and Hawkins, 2015). As indicated by Dasgupta (2019), adoption is not a permanent behavior. An individual may decide to discontinue the use of an innovation for a variety of personal, institutional or social reasons one of which could be the availability of an idea or practices that is better in satisfying his or her needs.

Adoption is the process of beginning to use something new or different within realistic period of time (Ban and Hawkins, 1996). Adoption is the amount of use of a new technology in the long-run equilibrium when the farmer has full information about the technology and its possible uses (Feder*et al*., 1985). Adoption of technology is not in one step method; it takes time for adoption to complete (Runquinst, 1984). On the other hand, adoption is the use or not to use of new technology by a farmer at a given period of time (Rogers, 1985).

Loevinsohn *et al*. (2013) define technology as the means and methods of producing goods and services, including methods of organization as well as physical technique. According to those authors new technology is new to a particular place or group of farmers, or represents a new use of technology that is already in use within a particular place or amongst a group of farmers. Technology is the knowledge/information that permits some tasks to be accomplished more easily, some service to be rendered or the manufacture of a product (Lavison, 2013).

Rogers (1983) described the technology adoption decision process, as the mental process from the first knowledge of an innovation to the decision to adopt or reject. The technology adoption decision process is different from the diffusion process. The first takes place within the mind of an individual while the second occurs among the units in a social system or within a region.

According to this definition there are five stages in the adoption process. Awareness stage (first hear about the innovation), interest stage (seek further information about an innovation), evaluation stage (weigh up the advantages and disadvantages of using it), trial stage (test the innovation on a small scale), and adoption stage (apply the technology on a large scale in preference to old methods). These stages in the adoption process imply a time lag between awareness and adoption. It is usually measured from first knowledge until the decision is made whether to adopt or not. Adoption is not a random behaviour, but is the result of sequence of events passing through these adoption stages (Rogers, 1983).

There is often a significant interval between the time an innovation is developed and available in the market, and the time it is widely used by producers. Adoption and diffusion are the processes governing the utilization of innovations. Studies of adoption behavior emphasize factors that affect if and when a particular individual was beginning using an innovation. Adoption may indicate both the utilizing and level of new technology usage by farmers. Adoption may be described by a discrete choice, whether or not to use technologies, or by a continuous variable that indicates to what extent a separable technology is used (David S and David Z, 2000). Consequently, one measure of the adoption of a high-yield seed variety by a farmer is a discrete variable representing if this variety is being used by a farmer at a certain time; another measure is what percent of the farmer's land is planted with this variety

Differentiation between diffusion and adoption is a social process while adoption is a mental and individual process. Diffusion and adoption are thus closely interrelated even though they are conceptually distinct. It takes time for an innovation to diffuse throughout society. It is unrealistic to expect that all farmers in a community were adopting an innovation immediately after its introduction. There is always a variation among the members of the society in the way they respond to an innovative idea or practice.

2.2. The Theoretical Literature on Agricultural Improved Variety Change

Time changes in agriculture have been observed, as well as the impact of technological change, within the context of the dominant model of agricultural development and technological modernization. Technological change may indicate a partial restructuring of production, while agricultural and social restructuring, in general, and determine, more essentially, the specific character of technology itself. Acceptance of the existing organizational structure and emphasis on technical/production innovations determined by the requirements of the market suggests disregard of critical market failure to ensure sufficient employment and an environmentally and socially viable agricultural economy, misplacement of the factors which have led to the international crisis of the agro-food system, and neglect or abandonment of domestic or local productive practices and know-how, without taking into account specific social, natural and cultural characteristics(Marx k,1997).

2.2.2. Production and Productivity

Production is defined as the organized activity of transforming resources into finished products in the form of goods and services and the objective of production is to satisfy the demand of such transformed resources (Bates and Parkinson, 1983). Production is basically an activity of transformation, which connects factor inputs and outputs (Samuelson and Marks, 2012,) Production consists of various processes to add utility to natural resources for gaining greater satisfaction from them by changing the form and place of natural resources, making available materials at times when they are not normally available and making use of personal skills in the form of services. The process of producing goods in modern economy is very complex. The process depends on basic factors of production in economics. These factors include land, labor, capital and entrepreneurship ability. Land is special term used in economics, because it represents natural resources, fertility of soil, water, air, natural vegetation etc.

Productivity is economic output per unit of input (Atkinson, 2013). The unit of input can be land, labor hours (labor productivity) or all production factors including labor, machines and energy (total factor of productivity). Therefore productivity measures how efficiently production inputs, such as land, labor and capital, are being used in an economy to produce a given level of output. Productivity is considered a key source of economic growth and competitiveness and, as such, is basic statistical information for many international comparisons and country performance assessments.

2.2.3. Barley Production

Barley production and productivity in a country have become an increasing order generally from year to year, while there some variability in area harvested which is measured in a hectare.

Barley production in Ethiopia is the most common and highly productive which shows, in turn, it is highly consumed by the consumers of the country (Samuel, 2016).

Barley is one of the four major feed grains (corn, barley, oats, and wheat) and is widely used as a feed for livestock. The grain may be used as a major source of energy, protein, and fiber for ruminants, and a major source of energy and protein for swine. In Australia, barley and wheat are the grains most commonly used by Australian livestock industries which, when combined, represented around 60% of all cereal grains fed. Oats (20%), sorghum (10%), and triticale (10%) made up the other cereal grains used by the livestock industries. Approximately 40% of the barley fed to feedlot cattle, 34% to dairy cows, 20% to pigs, and 6% to grazing ruminants and Less than 1% used for poultry.

Ethiopia has a larger potential in the world in barley production with a share of 1.2 % of the world's total production. Barley farming is broadly dispersed through the country on more than 1 million hectares of land and by over 4 million barley producers. Presently, it is grown solely for the domestic market and is neither imported nor exported. Barley is a high-opportunity crop, with great room for profitable expansion, particularly when connected with the country's commercial brewing and value-added industries. It is the fifth most important cereal crop in Ethiopia after teff, wheat, corn, and sorghum (USAD, 2014).

Barley is grown as a 'meher' (main season) crop in the higher altitudes of Dega regions. It is grown mainly in Arsi, Bale, Shoa, Welo, Gojam and Gonder. It is also widely cultivated as a 'belg' crop in many areas. The annual cultivated area is estimated at 881,680 hectares and production at 999,610 tons, representing 18.7 per cent of the cultivated area and 18.3 per cent of the total cereal production. Average yield varies between 10 and 13 quintals per hectare. Barley is used as food and raw material for brewing home-made alcoholic drinks. Beverage industries also use some 10,000 tons of barley per annum to prepare malt for breweries (Kuma and Mekonnen, 1994).

Barley is a major staple food crop in the highlands of Ethiopia. The crop is used for preparing various types of traditional foods such as Kita, Kolo, Beso, Enjera, Giat, caccabsa and many others. Although the day to day survival is linked to barley, little focus has been given to improve the productivity of the crop in the dry land area (Berhan, et al, 1996). Barley production has been growing in Ethiopia as both the number of barley farmers and barley yields increase, linked to growth in demand for food and malt barley. It is among the top 5 crops grown in Ethiopia along with teff, wheat, maize and sorghum. Very well suited to growing in temperate climates especially 2,000 meters above sea level, ideal for Ethiopia, 80% of production is in the Oromia and Amhara regions, increasing numbers of farmers, yields and production of barley in Ethiopia as demand for malt and food barley grows (ERA, 2010).

According to CSA, 2011, Barley producers, especially, do not benefit from improved inputs like seed and fertilizer, and productivity is stagnant for a long time due to high soil degradation. In addition, the problem of soil erosion in the highlands contributes to low productivity. As a highland crop, there is little increase in the area planted to barley; the small increases in MY 2011/12 and forecast for MY 2012/13 are due to heightened interest by local breweries and the local malt producer. However, the good rains in the highlands resulted in an increase in production in MY 2011/12.

However, the share of malt barley is small estimated at 7 % of the total annual production. Currently, the cultivation of malt barley is mainly focused in the highlands of Arsi, West Arsi, and Bale administrative zones of the Oromia Regional State. Despite, its limited cultivation, malt barley represents an attractive market opportunity for smallholder farmers in the highlands where cold temperature limits the possibility of successfully growing alternative cash crops. Barley is among the priority crops that have attracted the attention of policymakers in Ethiopia. The government is keen to boost the production of barley through appropriately supporting smallholder farmers and attracting commercial farming. Recently, a lot of effort is being used to increase barley production by establishment barley research and scaling up existing barley technologies (Berhane et al., 2013)

2.2.4. Agro Climatic Conditions for Barley Production

Ethiopia possesses favorable agro-climatic conditions for a range of crops including malt barley, as well as abundant land for agricultural activities. It is home to 18 major agro-ecological zones and 49 agro-ecological sub-zones. The country has the soils and climate suitable for growing over ~150 types of crops, including high value commodities such as coffee, sesame and other oilseeds, cereals, spices, fruits and vegetables. Ethiopia has two main harvest seasons, which are heavily reliant on annual rainfall .The bulk of harvesting is completed from October to

December following the Meher growing season .Just 21% of arable land is currently under cultivation, leaving great potential for growth in the agriculture sector (USAID, 2012).

2.2. 5. Impact of Malt Barley Production

Impact evaluation is an important policy issue nowadays. Impact evaluations have been conducted by different agents with different goals. Different methods can be used to evaluate the impact of the program based on different underlying conditions and availability of data. Among these methods, Difference-in-Difference which is based on before versus after and with and without data, propensity score matching which depends on creating counterfactual or comparison groups based on observable characteristics or propensity score, are some of them. Here in this section, previous studies on impact of malt barley was reviewed briefly.

Impact evaluation is an important policy issue either to improve the program intervention or strengthening the existing activity to be sustainable. But evaluating the impacts of improved technologies is not straightforward because it is a complex and ever-changing environment (Stern *et al*., 2012). Furthermore, there may be a hidden bias that results from unobserved heterogeneity in the participation decision, which can, in turn, influence the outcome of participating in a technological innovation (Smith and Todd, 2005). Methods of impact evaluation like PSM, randomized selection methods, difference-in-difference and instrumental variable estimation method can be used (Khandker *et al*., 2010).

Propensity score matching (PSM**)** has two key underlying assumptions (Baum, 2013). The first one is conditional independence; there exists a set X of observable covariates such that after controlling for these covariates, the potential outcomes are independent of treatment status. The other one is common support, for each value of X, there is a positive probability of being both treated and untreated. It is used when it is possible to create a comparison group from a sample of non-adopters closest to the treated group using observable variables. Both groups are matched on the basis of propensity scores, predicted probabilities of participation given some observed variables. Propensity score matching consist of four phases most commonly: estimating the probability of participation, i.e. the propensity score, for each unit in the sample; selecting a matching algorithm that is used to match beneficiaries with non-beneficiaries in order to construct a comparison group; checking for balance in the characteristics of the treatment and comparison groups; and estimating the program effect and interpreting the results (Caliendo and Kopeinig. 2005).

As shown in Asfaw et al. (2012), analyzing the impact of adoption of technology on farmer's welfare is challenging because of unobserved heterogeneity and possible endogeneity. First, there could be bi-causality between technology adoption and farmers welfare. Technology adoption can result in increase agriculture productivity and better welfare. However, better welfare for the farmers can result in increased adoption of technology.

2.6. Conceptual Framework

There are many factors that can influence the adoption of malt barley by farm households. The findings of different studies conducted on adoption of malt barley in different parts of the world gives an indication on different factors that can influence the adoption of malt barley production of farmers. The factors which affect farmers' adoption of malt barley was categorized into demographic, socio-economic, physical, institutional, personal and knowledge source variables either negatively or positively related to adoption of malt barley among farm households.

Based on literature review and empirical studies, a conceptual framework was formulated by taking into consideration household heads characteristics (demographic), socio-economic, institutional, physical and social capital was affect farmers' adoption of malt barley in the study area. The conceptual framework diagram draws below drawn.

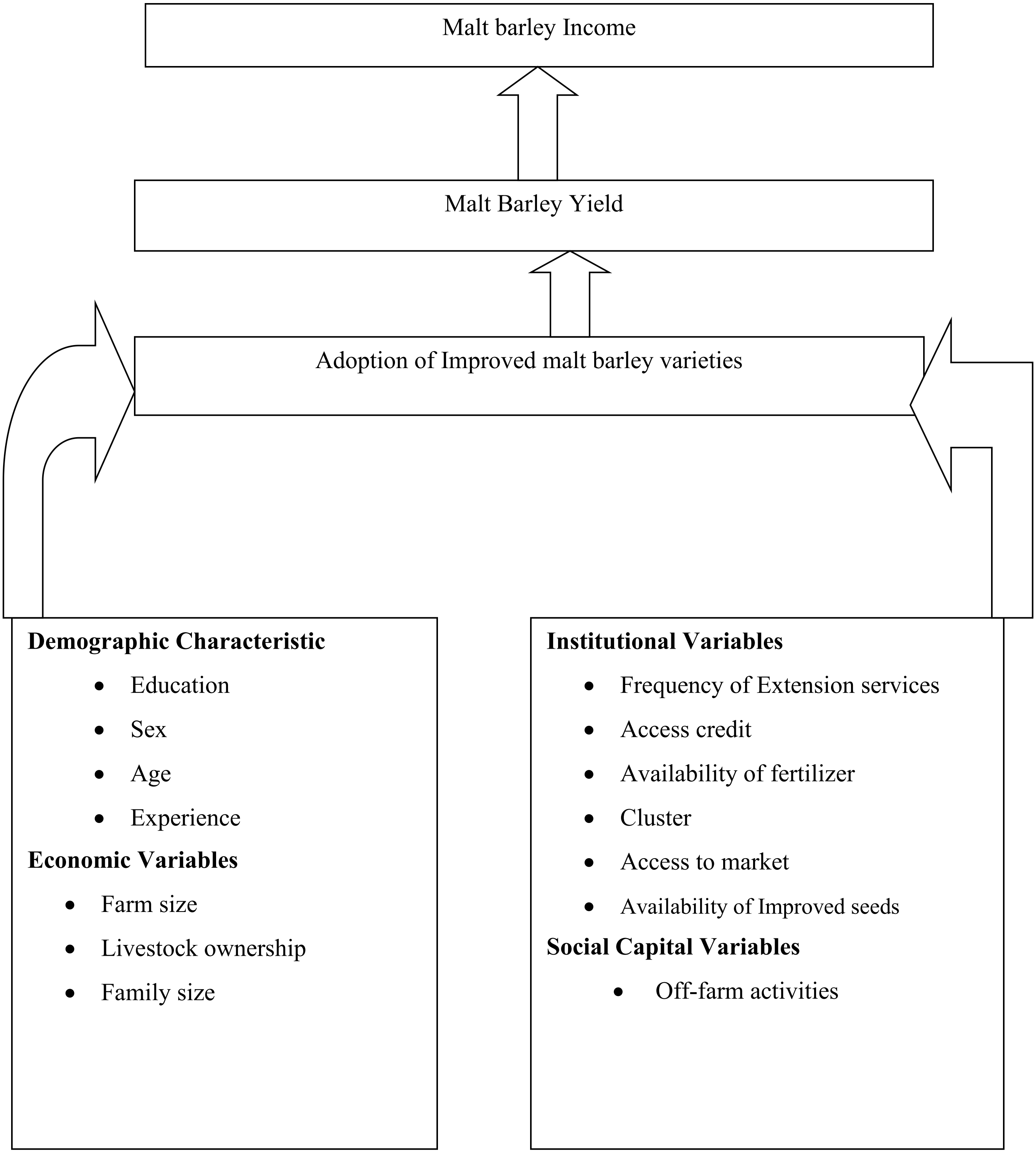

Figure : Conceptual framework of the adoption decision of improved malt barley varieties

Source: Literature review and adjusted by the researchers

3. RESEARCH METHODOLOGY

In this chapter, description of the study area, sources and method of data collection, sampling technique and sample size determination, methods of data analysis, and definition and hypothesis variables presented.

3.1. Description of the Study Area

Bale Zone is a zone in Oromia Region of Ethiopia. Bale is bordered on the south by the Ganale River which separates it from Guji Zone, on the west by the West Arsi Zone, on the north by Arsi Zone, on the northeast by the Shebelle River and East bale which separates it from West Hararghe Zone and East Hararghe Zone, and on the east by the east bale. The economy of the zone is mainly dominated by agriculture and the zone of production is more cereal production. In Bale Zone, cereals covered 87.42% of the grain crop area and 92.32% of the grain crop production. Wheat, barley, maize and Teff made up 32.09%, 19.85%, 12.78% and 12.44% of the grain crop area and 46.03%, 21.49%, 10.99% and 6.95% of the grain production in the zone, in that order.

Agarfa district, is one of the districts in the Bale zone of Oromia regional State of Ethiopia, and located in the northwestern corner of the Bale zone. Among the districts of the Bale region, the district intends to work on this study was conducted at Agarfa district which is located at a distance of about 461 km south east of Addis Ababa and 31 km from Robe the capital of the bale zone. The Latitude between (7 o 06'-7 o 10‘) N and Longitude (39o 12'-39o 20‘) E and the altitude ranges from 1,256 to 3,850 masl. The climate of the district is classified into three agro-ecological zones, Highland (*Dega*), Mid-land (*Woiyna dega*) and low land (*Kola*). The average annual temperature and rainfall of the district is 17.50 ^{0}C and 800 mm respectively, according to get the data from Agricultural Development Office of the District (ARDOoD, 2018).The total population for this woreda is 129,785, of whom 52,136 were men and 49,974 were women; 12,907 or 12.64% of its population were urban dwellers. The district is characterized by mixed farming system where crop and livestock production are the main activities, where crops play the dominant role in terms of contribution to farmers income. The dominant crops grown in the district are potato, sweet potato, wheat, barley, teff, maize, field beans, peas, and chickpeas, onion, garlic, enset, fruits etc. Agriculture is the main stay of the district and hence it provides the largest share of the livelihood for the population (BoARD, 2018).

Among the districts of the Bale region, another district for this study is Dinsho wareda which is located in the western corner of the Bale zone. Dinsho district lies between 6°58′40″ and 7°20′0″ N, and 39°44′0″ and 40°26′40″ E. Physiographical, most of the land area of the district is situated above 2000 m above sea level (masl). The district is classified into three agro-climatic zones: highlands (2300–2600 masl), midlands (1500–2300), and lowlands (1200–1500). Te district has a bimodal rainfall distribution with mean annual rainfall of about 1150 mm. Te maximum and minimum mean annual temperatures of the District are 17.5 and 6 °C, respectively. Wheat and barley are some of the major cereal crops grown in the area. Te major reference soil groups in the district are Pellic Vertisols, Eutric Cambisols, Eutric Nitosols (now Nitisols). The total population for this woreda according to CSA 2007 projection in 2022 the woreda's population is 56, 707 of whom 27,787 were men and 28,920 were women; 91.64% of its population were urban dwellers.

Goba is a woreda in the Oromia Region, Ethiopia and it is Part of the Bale Zone, Goba is bordered on the south by Menna and Harena Buluk, on the west by north Arsi Zone, on the north by the Mena River which separates it from Sinana and Dinsho, and on the southeast by Berbere is one the district was select for area of studying purpose. It lies between 5˚57'30"N to 7˚12'00"N latitude and 39˚35'00"E to 40˚15'00"E longitude. The altitude of the study area ranges from 2400 to 4377 masl. It has a total area of 1,674 km^2. It is found at the distance of 445 km from Addis Ababa the capital city of Ethiopia. Accordingly, the land configuration of the district accounts about 45% plain, 18% mountains, and 37% rugged and gorges. The monthly temperature ranges from minimum 4˚C to a maximum of 25˚C. Goba district experiences two rainy seasons of summer and spring (Bimodal rainfall). The mean annual rainfall vary from 900 mm in lowlands to 1400 mm in highlands (Robe Metrological Station, 2015). These diverse landscapes provide possibilities of producing a variety of crops. Agriculture is the back bone of the economy and provides means of occupation for almost all populations in the district. The district has two major cropping seasons namely summer (Maher) and spring (Belg). Cereals, horse beans, field beans and lentils are important crops grown. Agriculture is dominantly practiced together with animal rearing (Goba District Socio Economic, 2015).

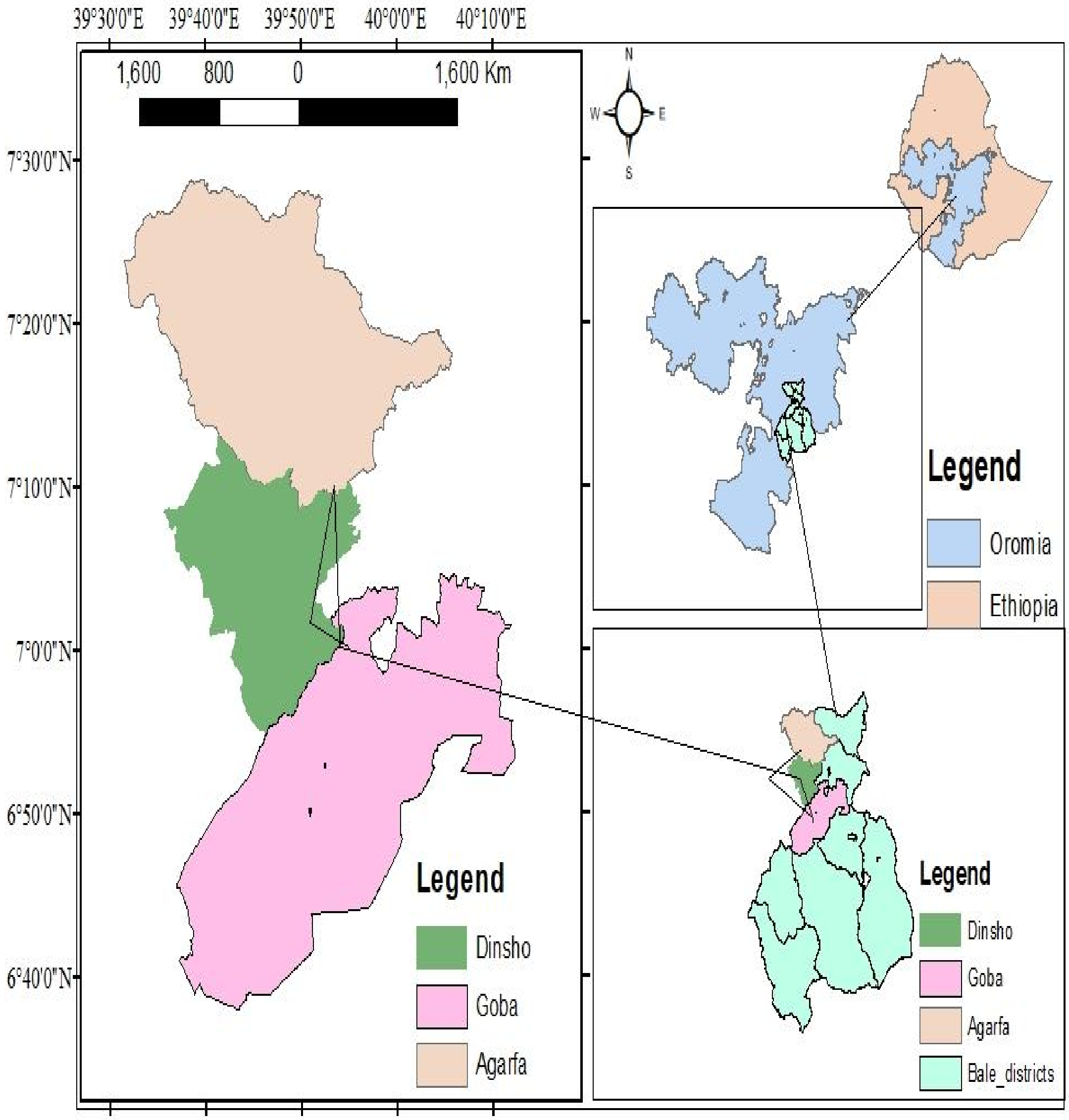

Figure : Location map of Agarfa district, Bale zone of Oromia, Ethiopia

Source: Own design with the help of GIS

3.2. Sampling Techniques and Sample Size Determination

In this study Multi stage sampling used to select representative sample respondents from the total population. Purposive, stratified and systematic random sampling methods were used to select the district, Kebele and samples of respondent's households respectively. At the first stage major improved malt barley variety producing districts selected purposively in which improved malt barley variety production activities enhanced and improved malt barley variety production promoted from the zone (Goba, Agarfa, Dinsho) in consultation with Bale Zone Agricultural Development Department. In second stage based wider exposure to new variety of malt barley proucers, a list of major malt barley producing *kebeles* prepared and taking in to account the resources available, two kebeles were selected purposively from each district based on their malt barley production potentiality and presence of malt barley cooperatives and individual malt barley in the kebeles. On the third stage, by stratifying the households into Adopters and non-adopters, a probability proportional to sample size sampling procedure were employed to select sample households 389 from which adopters and non-adopters randomly selected and used in the analysis, after preparing sample frame of adopters and non-adopters in the selected village administrations.

To determine the representative sample from the study area, the formula for sample size determination adjusting degree of precision to 0.07 due to shortage of resource and time, following Kothari (2004) were used. And the sample size from each kebele determined by proportionality formula. Therefore, sample size determined by formula (1).

$$n=\frac{Z^2(p)(q)(N)}{e^2(N-1)+z^2pq} = \frac{1.96^2(0.51)(0.49)(98{,}879)}{0.05^2(98{,}879-1)+(1.96^2)(0.49)(0.51)} = \mathbf{\underline{389}}$$

Where n - sample size; Z - Standard normal deviation (1.96 for 95% confidence level)
P = 0.51 (The proportion of the population producing malt barley, that is 49%) due to unknown variability; q = 1-P =0.49 (49%); e - Desired degree of precision, (0.05), N total household living in three district of bale zone in this case

Table 1: Distribution of Sample Selected From The Three Woreda

Sampled Woredas	Sampled Kebeles	MB		Total	Sample		Total
		Adopter	Non-adopter	Total	Non-adopter	Adopter	
Goba	Shedam	165	160	325	32	39	71
	Adaba Gefeca	170	164	334	35	30	65
Agarfa	Kasomanso	145	135	280	35	34	69
	Ali	142	132	274	37	32	69
Dinsho	Homa	136	145	281	32	25	57
	Abakera	120	131	251	31	27	58
Total		878	867	1,745	202	187	389

Source: Bale Zone Office of Agriculture and Development Department, 2023

3.3. Research Design

Cross-sectional data was used to collect data from the sample household at specific point in time and based on the results to make generalizations. Descriptive method and econometric analysis was chosen to generally describe the differences experienced was used data obtaining from households on improved malt barley varieties on study area.

3.4. Data Types, Sources and Methods of Data Collection

Both quantitative and qualitative data collected which are of primary and secondary in nature. Producer's survey, key informant interview 40 participants for two day, and focused group discussions 45 and participants for 2 days, used to generate data on socio-economic, institutional and demographic and personal and physical factors that affects malt barley production. Personal observation and informal discussions made so as to elicit information to support the data obtained from the respondents. In addition, secondary data were reviewed from various sources such as documents from district office of agriculture and rural development and empirical findings related to the topic of interest. Structured and semi-structured interview schedules and checklists developed and pre-tested to be used to collect data from producers and key informants. Trained enumerators, who are familiar with the local culture and area, used to conduct the survey.

The primary data collected from randomly selected malt barley producers' farmers in selected areas from Bale Zone using pre-tested and semi-structured questionnaire by both closed and open-ended questions.

3.5. Methods of Data Analysis

The study employing or using both descriptive and econometric data analysis methods. The descriptive analyses apply to discuss the behavior of improved malt barley varieties in the study area and performed using frequencies, means, and maximum and minimum values. Econometric analysis applying to identify variables that influence improved malt barley varieties and to evaluate the effect of improved malt barley variety on household income.

3.6. Binary Logistic Regression Model

The Binary logistic regression function invented in the 19th century for the description of the growth of populations and the course of autocatalytic chemical, or chain reactions (Cramer et al., 2003). Logistic regression incorporated to analyze relationships between a dichotomous dependent variable and explanatory variables. Our focus here on binary logistic regression for two groups. Logistic regression combines the explanatory variables to estimate the probability that a particular event occur that is a subject a member of one of the groups explained by the dichotomous dependent variable. The Probit and Logit models are commonly used models. The Probit probability model is associated with normal probability function and the logit model with logistic probability distribution respectively. The advantage of these models over the linear probability model is that the probabilities are found between zero and one. Both Logit and Probit models may give the same result.

The logistic function is used because it represents a close approximation to the cumulative normal distribution, mathematically easily used model and is easier to work with. Therefore, the Logit model accepted or selected for this study. The model fit employing method of improved malt barley variety as dependent variable, socioeconomic variables as explanatory or independent variables which are influence improved malt barley variety and the outcome variable, malt barley production and it would be important to shows the factors that influence the farmers' adoption decision status. The dependent variable is binary, taking values of 1 (one) if the farmer adopts and zero otherwise. However, the explanatory or independent variables are both continuous and discrete. The justification for using logit is its simplicity of calculation and that its probability lies between zero and one. Moreover, its probability approaches zero at a slower rate as the value of independent variable gets smaller and smaller, and the probability approaches one at a slower and slower rate as the value of the independent variable gets larger and larger (Gujarati, 2003). The function form of model or logit model is specified as follows:

$$p_i = E\left(Y = \frac{1}{X_i}\right) = \beta_0 + \beta_i X_i \qquad (1)$$

Where Y = 1 means the adoption of decision of malt barley, X_i = is a vector of independent variable, β_0 = is a constant and β_i = i=1, 2…m are the coefficient of the independent variables to be estimated.

The probability of malt barley adoption:

$$p_i = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_i X_i)}} \qquad (2)$$

Where: p_i = represent the probability that a household is being adopter xi,

X_i = represents the ith explanatory variable

e = represents the base of natural logarithms (2.718)

β_0 and β_1 are regression parameters to be estimated

$$P_i = \frac{1}{1+e^{-Zi}} = \frac{e^{Zi}}{1+e^{Zi}} \qquad (3)$$

Where, $Z_i = \beta_0 + \sum_{i=1,2,3..}^{m} \beta_i + X_i$ (4)

If P_i the is probability of being adopter MB, then $1 - P_i$ represents the probability of being non-adopter it.

$$1 - P_i = \frac{1}{1 + e^{Zi}} \qquad (5)$$

Therefore, the odds ratio can be written as

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Zi}}{1 + e^{-Zi}} = e^{Zi} \qquad (6)$$

So, $\frac{P_i}{1-P_i}$ is simply the odd ratio in favor of adopting malt barley. It is the ratio of the probability that the farmer would adopt malt barley to the probability that the farmer would not adopt.

Then, if we take the natural logarithm of equation (4) we obtain

$$L = Ln\left[\frac{P_i}{1-P_i}\right] = Z_i = \beta_0 + \sum_{i=1}^{m} \beta_i X_i + U_i$$

3.7. Propensity Score Matching (PSM)

In this study, PSM employ or use in order to capture the impact of improved malt barley variety on malt barley production and household income. The PSM is mainly used in impact determination absence of baseline data. According to Ravallion (2005), impacts estimated with parametric models are more biased and less robust to miss specification of regression functions than those based on matched samples. To determine the effect of adoption of improved malt barley varieties on the productivity and income of the smallholder household's PSM is use. Treated in improved malt barley varieties absence random, matching randomization when compared to parametric models PSM allows the determination of average effects absence of arbitrary assumptions about logistic functional forms, and error distributions. Furthermore, despite that binary logistic models employed or used enough sample, PSM is confined to match one. Propensity score methods allow the researcher to directly address the question of what can be earned from the data and what cannot (David, 2011).

For several underlying conditions, the propensity score matching method used in this particular study. Propensity Score Matching (PSM) is used when it is possible to create a comparison group from a sample of non-participants closest to the treated group using observable variables. Both groups were matched on the basis of propensity scores; predicted probabilities of adoption were giving some observable variables. Propensity score matching consist of four phases most commonly: estimating the probability of adoption, i.e. the propensity score, for each unit in the sample; selecting a matching algorithm that is used to match adoption with non-adoption in order to construct a comparison group; checking for balance in the characteristics of the treatment and comparison groups; and estimating the program effect and interpreting the results (Caliendo and Kopeinig, 2005).

For this study, in analyzing the impact of improved malt barley variety production on household livelihood, propensity score matching used for several reasons. Firstly, there is no baseline data on adoption and non-adoption as it is common in many research works conducted on impact evaluation. Secondly, the adoption in improved malt barley varieties may be self-selected to participate. Furthermore, the available field data based on a cross-sectional survey. The interest of the impact part of this study is to determine the average treatment effect on the treated (ATT) of improved malt barley variety production. But the estimation of this effect is impossible based on the before and after because of absence of baseline data and it needs substituting the counterfactual mean of treated, by the mean outcome of untreated (Caliendo and Kopeinig. 2005).

According to Rosenbaum and Rubin (1983), PSM can be explained as the conditional probability of taking a treatment given pretreatment characteristics of the small farm households. Therefore, Y_i^T *and* Y_i^C are the outcomes or dependent variable treated and control groups respectively. The difference in outcome between treated and control groups can be calculated from the following mathematical equation:

$\Delta Y_i = Y_i^T - Y_i^C$ --- (1)

Y_i^T Outcome of treat, improved Malt barley variety of income in Birr of the i^{th} household, when he/she is control, ΔY_i change in the outcome as a result of treated for the i^{th} household. Let the above equation can be determined in causal effect notational form, by assigning or conveying $D_i = 1$ as treatment variables taking the value 1(one) if the respondents treated and 0 (zero) otherwise. Then the formula for Average treatment effect on treated (ATT) can be seen as follow

$$ATT = E\left(Y_i^T - Y_i^C / D_i = 1\right) = E\left(Y_i^T / D_i = 1\right) - E\left(Y_i^C / D_i = 0\right) ----------$$

$E\left(Y_i^T / D_i{=}1\right)$ = mean outcomes for household, with treated, if he/she be treat $D_i = 1$

$E\left(Y_i^C / D_i{=}0\right)$ = mean outcome for household, with untreated, when he/she control $D_i = 0$

ATT=The Average Effect of Treatment on the Treated for the sample. The Average Effect of Treatment on the Treated (ATT) for the treated and controled sample respondants or households as is given by:

$$ATT = E\left(Y_i^T - Y_i^C / D_i = 1\right) = E\left(Y_i^T / D_i = 1\right) - E\left(Y_i^C / D_i = 0\right) ----------$$

The main evaluation problem in determination of effect is that it is difficult to observe a person's outcome for absence and presence treatment of treated at the same time. The post-intervention outcome $E\left(Y_i^T / D_i = 1\right)$ is can be to observe, however, the counterfactual outcome of the i^{th} household when she/he does not a treated the treatment is not observable in the data.

According to Rosenbaum and Rubin (1983), there are two basic assumptions to determine importantance of outcome variable: Improved malt barley variety on household income and production effect by using PSM model.

3.8. Description of Variables and Hypothesis

3.1.1. Dependent Variable

The dependent variable for the logit model is adopting improved malt barley variety. Dependent variable is a dummy variable (given a value of 1 (one) if the household adopt and 0 (zero) otherwise). The outcome variables are improved malt barley income and yield of malt barley for the PSM model household malt barley income is continuous variable, calculated by dividing total amount of household income to total household family size (i.e per capita household income), and measured by birr (ETB) and malt barley yield is continuous variable and it is calculated as total production of malt barley at the household level, measured by quintals.

3.8.2. Explanatory Variables

The explanatory variables of importance in this study are those variables, which are a consideration to have an influence on adoption of improved malt barley varieties on malt malt barley household income. This included socioeconomic variables and demographic variables, household personal, household socio-capital variables and institution variables. These explanatory variables are listed as follows:

Sex of the household head (SEX): It is dummy variable with the values of either 1 if the household head is male and 0 for female. Male headed households often have better control to the households resources and decisions concerning to adoption of improved agricultural technologies. The sex of the household head positive and significantly related to urea, improved variety, manure, and crop rotation, (Ermias 2021). Sex of the household head is hypothesized to positively affect the adoption of malt barley by favor of male.

Education level of the household head (EDUCL): It represents the level of formal schooling completed or attended by the household head at the time of the survey. It is often assumed that highly educated household heads are better able to process information and search for appropriate technologies to alleviate their production constraints. Hence, educational level of the household head has a positive effect on the status and speed of technology adoption (Sisay, 2016). Education level expected to have positive effect on the decision of farmers to adopt malt barley.

Family size (famsz): family size implies that the number of family members in a household which is measured in number.It interred to in the model as continuous variable. The existence of large family size positively affects on household improved malt barley varieties. It is a continuous variable measured in the number of adult equivalent.

Farm size (FARSIZ): This refers to the total area of farm (own, shared or rented in) land the household managed during a production year. It is a continuous variable measured in hectares. Farm size is an indicator of social status and wealth and impact within a community. Some of the literatures argue that farm size affect technology adoption positively for that those large farmers have the required resource to adopt available technologies.

Availability of fertilizer on time (AVILFER): In this study, the availability of fertilizer affects the adoption of wheat row planting technology. Unavailability of fertilizer on time forces farmers to drop totally the use of wheat row planting and the inverse is true for availability of fertilizer on time. Availability of fertilizer is a dummy variable which takes a value 1, if fertilizers are available on time, 0 otherwise. Fertilizer availability on time determines adoption decision of new wheat varieties. Availability of fertilizer on time affects positively the decision to adopt improved malt barley varieties.

Participation in off-farm activities (OFFARM): This is a measure of whether the household member participated in off/non–farming activities and generated an income in ETB. It is a dummy variable that takes a value 1 if the household participates in off/non-farm activity and 0, otherwise. Participation in off/non-farm activities promotes the capacity to invest in new agricultural technologies. The study by Regasa (2019) indicated that participation in off/non-farm income activities has a positive influence on the adoption improved wheat variety. It is hypothesized to positively affect improved malt barley variety.

Access to market (ACCMKT): Access to market hypothesized to be positively related to the probability of adoption of innovation. If the households located near to market tend to buy improved agricultural inputs and they can have easy access to sell their product in the market. Therefore, the variable treated as a dummy variable in that if the household has an access to market has coded as 1and 0, otherwise. As market distance increases adoption and probability of adoption expected to decrease (Rahimeto, 2017).

Farmer's age (AGE) – Farmer's age and adoption of technology are associated. As the farmer's age increases, it expected that farmer become conservative. Therefore, it is hypothesized that farmer's age and adoption are expected to relate negatively. As farmer age increases probability of adoption is expected to decrease (Dereje, 2016).

Farming experiences (FEXP): It is a continuous variable and measured in number of years as a respondent started farming on his own. Experience of the farmers is likely to have a range of influences on adoption. Farmers with higher experience appear to have often full information and better knowledge and were able to evaluate the advantage of the improved seed technology. Abera (2013) indicated farming experience of the household positively influenced adoption and intensity of adoption of improved wheat varieties. Hence it hypothesized to affect adoption of malt barley positively.

Livestock ownership (Tlu): In agricultural based economies like Ethiopia livestock is the most important source of income and crop cultivation. It is treated as a continuous variable and measured in tropical livestock unit conversion factors (TLU). Adunea (2017) stated that having more units of livestock affects new agricultural technology adoption positively. It is hypothesized to positively affect wheat row planting technology.

Cluster (Clstr): is new method introduced by government for increasing production by cooperating farmers. This variable is dummy variable taking value of 1 if the respondents have cluster and, or 0 if the respondent does not have cluster. It is hypothesized to be positively related to the adoption of improved malt barley varieties.

Access to Credit: It is a dummy variable that takes 1 if the farmer obtained credit and, 0 otherwise. The accessibility of credit from appropriate sources helps farmers to increase their adoption of improved crop variety. Hence, credit is hypothesized to influence the adoption of improved malt barley varieties positively.

Availability of Seed Used (SEED): this indicates the availability of improved malt barley varieties used for production. For Available improved seeds 1 was used and 0 for not availabilities varieties of seeds. The availability of improved seeds encourages farmers to allocate more land as it is very productive as compared to shortage of seeds. The use of improved seeds hence also improves volume of supply. It was expected that it has either positive or negative effect on production decision and volume of supply.

Table 2: Summary of Variable Definition and Its Unit of Measurement

Variable	Type	Value	Expected sign
Dependent variable			
Adoption decision	Dummy	1, adopter 0 non adopter	
Malt Barley Income and Yield of Malt barley	Continuous		
Explanatory variable			
Age of household	Continuous	Years	-/+
Sex of household	Dummy	Male (1), (0) otherwise	+/-
Household of education	Continuous	Formal school years	+
Availability of fertilizer on time	Dummy	Available (1), otherwise (0)	+/-
Access to credit	Dummy	Utilized (1), otherwise (0)	+
Farmer experience	Continuous	Years	+
Contact to extension agent	Dummy	(1) if yes, otherwise (0)	+
Access to market	Dummy	(1) if yes, otherwise (0)	+
Availability of Improved seeds	Dummy	If available improved seed, 0 otherwise	+
Cluster	Dummy	(1) If bought crop insurance, (0) otherwise	+
Livestock ownership	Continuous	Numbers	+
Farm size	Continuous	Hectares	+
Acceess to credit	Dummy	1 if yes, 0 otherwise	+

4. RESULTS AND DISCUSSION

This chapter presents the findings and discussion of the descriptive statistics and model outputs. The main findings of the study are presented in to two sections. First section contains analysis related with the description of variables in terms of descriptive and inferential statistics. Second section displays and deals with econometric results from the Propensity Score Matching PSM and Logit Model.

4.1. Descriptive and Inferential Statics Results

4.1.1. Sample Household Characteristics for Continuous Variables

Among the total sample households, 187 (48.07%) were the Adopter of Malt Barley and the remaining 202 (51.93%) were Non-Adopter. There were various demographic, socio-economic and institutional variables which affects the adoption of Malty Barley in the study area. The mean comparison between adopters and non-adopters showed that there is a statistically significant difference between the two groups in terms of some variables. Results showed that adopters are having large land size, have many TLU, higher education level, more contact with extension agents and get more fertilizer than non-adopters in the study area. The discussion of each of the continuous variable is given below.

Education level of household head (Educl): The mean year of schooling for the sampled households 4.30 in terms of years of schooling, whereas the adopters were to be 4.55 with a standard deviation of 1.84 and 4.06 years with a standard deviation of 1.79 for non-adopters. Results indicate that there are significant differences between the two groups in terms of education level at 1% significant level. Education is very important for farmers to understand and interpret the information coming from any source. Farmers' education is also essential for the active work of extension personnel because if the farmer has better education level he/she can have the ability to understand and interpret the information transferred to them easily.

Frequency of contact extension agents (Fqcextag): The results indicated that the mean annual of extension contacts with the farmers were 1.66 with a standard deviation of 0.44 for adopters, and 1.54 with a standard deviation of 0.33 for non-adopters and 2.69 with a standard deviation of 2.16 for the whole sample respondents (Table 4). This indicates that adopters had relatively a better frequency of extension contact than non-adopters. The mean difference between the two groups (adopters and non-adopters) statistically significant at 1% significance level; showing that there are strong discrepancies between adoption groups based on the frequency of extension contacts with extension agents.

Availability of active family labour (Actflab): The mean of availability of active family labor in sample households in terms of man equivalent (ME) found to be 3.64 with standard deviation of 0.83. The mean of availability of active family labour for non-adopters 3.62 with standard deviation of 0.89 while it 3.67 with standard deviation of 0.77 for adopters (Table 3). Therefore, the availability of active family labor shows that, there is statistically significant mean difference between adopters and non-adopters at 1% significance level.

Farm size (landsz): Land size is important variable for agricultural production and adoption of malt barley for the households. In this study, the mean Farm size of sample respondents found to be 1.62 hectares with a standard deviation of 0.76 hectares. (Table 3). The mean farm sizes for adopter group 1.81 hectares with a standard deviation of 0.88 while that non-adopters group is 1.44 with a standard deviation of 0.57 hectares. The t-test analysis result shows that there are significant differences between the two groups at 1% level of significance. This implies that, households with large farm size holding had adopted malt barley than those with small farm size households.

Tropical Lives stock (TLU): In this study, the mean TLU of sample respondents found to be 5.18 with a standard deviation of 1.63. (Table 3). The mean TLU for adopter group 4.98 hectares with a standard deviation of 1.69 while that non-adopters group is 5.36 with a standard deviation of 1.56. The t-test analysis result shows that there are significant differences between the two groups at 1% level of significance. This implies that, households with many TLU holding had adopted malt barley than those with few TLU households.

Off-farm income: From total of 389 sampled household heads 44.99% of them were participate in off-farm activities and 55.01% of the household head are not participate in any of off-farm actives available in the area. Whereas From Malty Barley Adopter 60.96% of them are off-farm activity participant and 49.50% of them were off-farm activity non-Adopter. The chi-square test result indicated that there significant relationship between Malty Barley adopter and off-farm participation at 1% level of significance

Table : Summary of Descriptive Statics and Inferential statics for Continues Variables

Variables	Participate (N=187)	Non-Participate (N=202)	Total(N= 389)	t-value
	Mean (Std. Dev.)	Mean (Std. dev.)	Mean (Std. dev.)	
Edu	4.55(1.84)	4.06(1.79)	4.30 (1.83)	2.64***
Age	42.93 (11.69)	43.09(10.74)	43.01 (11.19)	0.14
Landsize	1.81 (0.88)	1.44 (0.57)	1.62 (0.76)	-4.83***
TLU	4.98 (1.69)	5.36 (1.56)	5.18 (1.63)	2.27***
Extcontact	1.66 (0.44)	1.54 (0.33)	1.60 (0.39)	-3.03***
Dismkt	6.63 (5.27)	7.03 (4.87)	6.84 (5.07)	0.78
Fertilizer	0.48 (0.0.16)	0.52 (0.19)	0.50 (0.18)	1.99**
Seed	0.80 (0.28)	0.80 (0.27)	0.80 (0.27)	-0.01
Fams	3.67 (0.0.77)	5.36 (1.56)	3.36 (0.83)	-0.58
Exper	19.26(7.33)	19.91(7.71)	19.6(7.53)	0.85

*** And ** Significance at 1% and 5% level respectively

Source: Own computation based on survey data, 2024

4.1.2. Household Characteristics for Dummy Variables

The proportion comparison between adopters and non-adopters showed that there is a statistically significant difference in terms of Off-farm income categorical variables.

Table : Sample household Characteristics for Dummy Variables

Variable	Category	Adopt (N=187)		Non-Adopt(N=202)		Total (N =389)			
		N	%	N	%	N	%	χ 2 value	P value
Sex	Male	157	83.96%	30	14.85 %	60	15.42%	0.10	0.74
	Female	30	16.04%	172	85.15%	329	84.58%		
Cluster	Yes	88	57.52%	101	50%	119	51.16%	0.22	0.63
	No	65	42.48%	101	50%	190	48.84%		
Offarm	Yes	73	39.04%	102	49.50%	175	44.99%	5.15	0.02***
	No	114	60.96%	100	50.50%	214	55.01%		
Credit	Yes	74	39.57%	89	44.06%	163	41.90%	0.80	0.37
	No	113	60.43%	113	55.94%	226	58.10%		

Source: Computed from survey data, 2024

Note: ***, at 1% level and NS=Not Significant

4.2. Results of the Econometric Model

4.2.1. Factors affecting Malty Barley adoption of Farmers

Table 5: Logit model estimates of factors affecting the adoption Malt barley

Variables	Coefficients (B)	S.E	Significance Level	Marginal effects (dy/dx)
Constant	-1.604	1.182	0.000	-
Sex	-0.234	0.320	0.465	-0.058
Age	0.015	0.017	0.379	0.004
Edulev	0.198	0.065	0.002***	0.050
Exper	-0.016	0.026	0.525	-0.004
Farmsz	0.675	0.155	0.000***	0.168
Fert	1.397	0.638	0.029**	0.348
Famlysz	0.067	0.137	0.622	0.016
TLU	0.114	0.068	0.095*	0.029
Offarm	0.654	0.233	0.005***	0.161
Fqcextagt	0.803	0.286	0.005***	0.200
Cluster	-0.048	0.228	0.833	-0.012
Distmkt	-0.032	0.023	0.165	-0.008
Seed	-0.206	0.404	0.609	-0.051
Credit	-0.232	0.228	0.308	-0.058

Number of obs. = 389	Correctly predicted = 85.30%
LR chi2 (16) = 58.10	Non-adopters predication =90.80%
Prob > chi2 = *0.000****	Adopters predication = 89.74%
Log likelihood = -240.2972	Pseudo R2 = 0.107

Source: Econometric model output, 2024.

Note: ***, ** and * represents Significant at less than 1%, 5% and 10% probability level respectively.

The logistic model applied to all sample farmers (both adopters and non-adopters) to find the factors affecting the adoption of malt barley. Before going on to see the relation of variables by using the logit model, it found important to look into the problem of multi-collinearity or linear association among the hypothesized independent variables. Variance inflation factors (VIF) used to check the multi-collinearity problem with all variables. It concluded that there were no multi-collinearity and association problems between all variables, as the particular coefficients were very low (VIF less than 5 for all variables) (Appendix Table II).

Lastly the ten continuous and the four dummy variables were entered into the logistic regression analysis. The various goodness of-fit measures were employed to check and validate that the model fits the data well. The chi-square goodness-of-fit test statistics of the model show that the model fits the data with significance at the 1 % level. This shows that the independent variables were relevant in explaining the farmers' adoption of malt barley. The model predication result also shows that about 89.74% of the adopters and 90.80% of non-adopters were correctly predicted by the model. Generally, the correct prediction of all sample (count-R^2) is 90.30% of the overall sample cases. Thus, the model prediction good for both adopters and non-adopters of malt barley producers.

The logistic regression results shows, the presence of relationship between the dichotomous dependent with the explanatory variables for the continuous and dummy variables for the study. The factors considered are related to demographic, socio-economic, institutional and psychological factor related to the adoption of malt barley. Among the 14 variables used in the model, five variables were significant with respect to adoption of malt barley with less than 1%, 5% and 10% the probability levels. These variables include education level, frequency of contact with extension agent in the year, off-farm activity, farm size, fertilizer whereas the rest nine explanatory variables were found to have no significant influence on the adoption of malt barley. The influence of the significant explanatory variables on adoption of malt barley in the study area is interpret and discussed below:

Frequencyof contact extension agents (Fqcext): Frequency of contacts with extension agents is important for creating farmers technically skillful and confidential on running agricultural production in a sustainable way. Frequency of contact with extension agents as measured in frequency of extension agents contact with farmers per year during the agricultural production season were positively and significantly affected the adoption of malt barley at 1% significance level, indicating that farmers who had commonly contacted with extension agents during the agricultural cropping season allocated more of their farm size for malt barley and are technically more competent on the production of malt barley on farm plots than those who had less frequency of contacts with extension agents. The result of marginal effect indicates as increase the frequency of contacts with extension agents by one day, the probability of adopting malt barley increases by 20% holding other factors constant. Thus, farmers' who more contacts with extension agents are believed to be exposed to different, new and update information that help them to quickly adoption of malt barley. Lema and Degafa (2019) study conducted on Impact of improved agricultural technologies adoption on farm household income in east shewa zone, Ethiopia improved this result.

Education level of household head (Educl): Education level of the household head is one of the important indicators of human capital. Moreover, education enhances farmers' to make independent decision and to act on the basis of the decision and increase the households ability to acquire, analyze, interpret and use information relevant to the adoption of enhanced agricultural production. It is positively and significantly influenced the adoption of malt barley at 1% probability level. The result of marginal effect indicates as education level of household head increases by one year, the probability of adopting malt barley increases by 5% holding other factors constant. Because educated household head can understand agricultural guidelines easily, have better access to information and higher tendency to adopt better agricultural productions than uneducated household heads. Regasa *et al*, (2023) studied on impact of high yielding wheat varieties adoption on farm income improved this result.

Participation in off-farm activities (Offarm): Participation in off/non-farm income activities found to have positive and significant influence on the adoption of malt barley. Other things held constant, the result of marginal effect 0.16 reveals that the predicted probability of using malt barley increases by 16% for the farmer's participated in off/non-farm activities as compared to those who do not participated. This implies that the more a farmer participates and earns from off -farm activities, the higher the likelihood of taking a continued use decision, of adopting malt barley. This could be linked to the possibility of using money from off/non-farm activities for purchasing of inputs and hiring labor necessary to continue producing malt barley.

Livestock ownership (TLU): The logit model result indicates that, livestock ownership had positive and significant effect on household adoption in improved malt barley varieties at 10% significant level. This indicates that households who had large number of livestock in the tropical livestock unit were more adopt in improved malt barley varieties than household who had small livestock number. The implication of the result was that, Farmers who had a large number of livestock might consider their asset base as a mechanism of ensuring any risk associated with malt barley. The result of marginal effect indicates as the number of livestock increases by one unit, the probability of adopting malt barley increases by 2.9% holding other factors constant. This result similar to the result reported by Gemechu *et al*. (2018) livestock endowment had positive and significant effect on household to participate in honey and vegetable CF respectively.

Farm Land Size: This variable found to be positively related with the adopting in Malty Barley. This implies that household that has more cultivated land size leads to increase in probability of adopting Malty Barley. The interpretation of the marginal effect also implies that an increase in total land size one ha leads to increase adoption of Malty Barley by a factor of 16.8%.

Fertilizer: This variable found to be positively and significantly affect the adoption of malt Barley. The result of marginal effect of logit showed that being the member of get fertilizer on time increases the probability of adopting Malty Barley by a factor of 34.8%. Ermias, (2021) using multivariate model to study adoption of agricultural technology packages in barley based farming system concluded that farmers, who have access to fertilizer, are more likely to adopt agricultural technology packages in barley based farming system.

4.3. Impact of Malt Barley on yield and Income of Household

4.3.1. Estimation of propensity scores

Logistic regression model used to estimate propensity scores of Adopter and non-Adopter of Barley. The low Pseudo R^2 value shows that the explanatory variables are not highly influenced Malty Barley adopters. On other hand, there no systematic difference in the distribution of covariates between Adopter and non-Adopter of Malty Barley in the study area. Therefore, after matching there should be no systematic differences in the distribution of covariates between both groups. Hence, pseudo- R^2 should be fairly low to meet balancing test (Caliendo and Kopeinig, 2005).

Once a propensity score has been calculated for each covariate, one should set common support region. It is the area which contains the minimum and maximum propensity scores of Adopter and non-Adopter respectively. Propensity score is probability, since it lies between 0 and 1. The propensity scores estimate where vary between 0.113 and 0.900 with a mean of 0.550 for Adopter and between 0.054 and 0.788 with a mean of 0.0.411 for non-Adopter of Malty Barley. Thus, the common support region would lie between 0.113 and 0.788. Because of this restriction, 24 Adopter and 3 of non-adopter sampled farmers were dropped from the analysis in estimating the average treatment effect of Malty Barley on annual income. Note that no inferences can be made for these treated and control individuals.

Table 6: Distribution of estimation propensity score

Variable	Obs.	Mean	Std. Dev.	Min	Max
All households	389	0.480	0.190	0.054	0.900
Adopter	187	0.55	0.182	0.113	0.900
Non-Adopter	202	0.411	0.169	0.054	0.788

Source: Own computation based on survey data, 2024

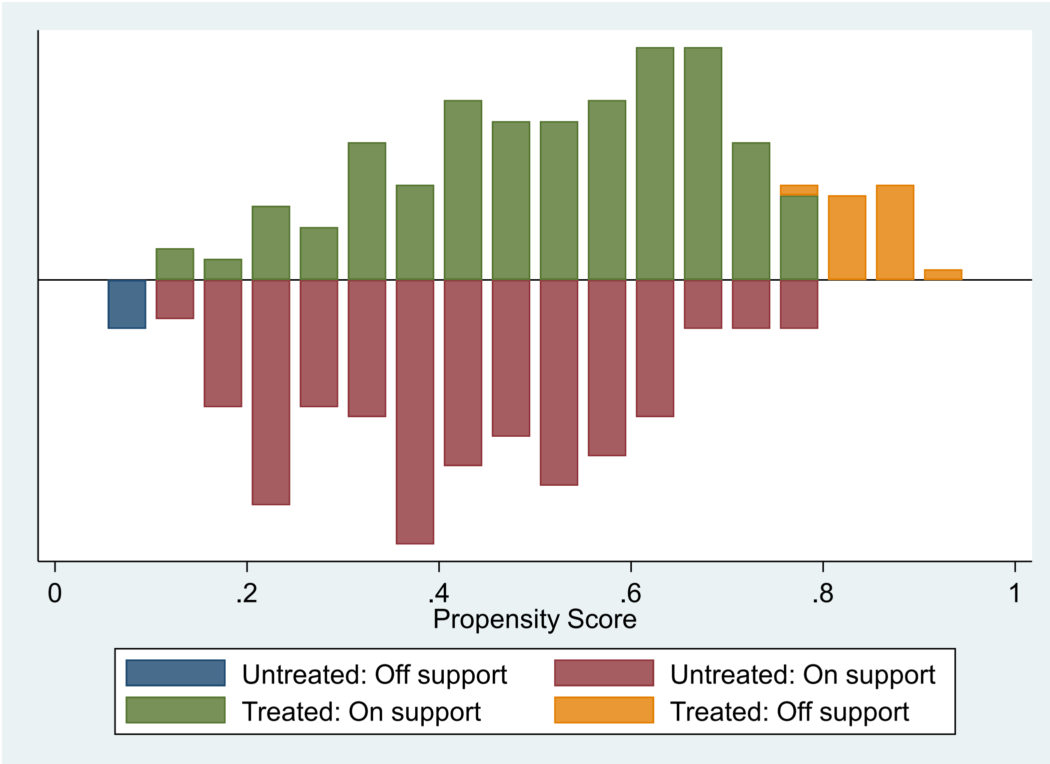

Figure 3: Graph of Propensity Score on Matching Indicators

Source: Own computation results survey data (2024)

4.3.2. Choice of the matching algorithm

Once the estimation of propensity score and common support region were set, the next step in propensity score analysis is choice of the best matching algorithm with a large matching sample size, a large number of insignificant variables after matching, small pseudo-R^2 after matching and small mean standardize bias as compare with another algorithm which is known as the balancing test (Dehejia and Wahba, 2002).Based on the above-mentioned performance criteria, the matching estimators with Caliper (0.01), which has low pseudo-R^2 with best balancing test and small mean standard bias selected as the appropriate matching estimators for household income (Table 7)

Table 7: Choice of appropriate matching algorithm for household inccome

Matching estimators		Performance of matching estimators			
		Insignificant variables after matching	Pseudo-R^2	Std. mean bias	Matched sample size
Nearest neighbor matching	Neighbor(1)	13	0.026	8.3	364
	Neighbor(2)	14	0.019	6.4	364
	Neighbor(3)	14	0.021	7.2	364
	Neighbor(4)	14	0.018	6.3	364
	Neighbor(5)	14	0.014	5.2	364
Caliper matching	**Caliper(0.01)**	**14**	**0.008**	**4.3**	**359**
	Caliper (0.1)	13	0.027	8.0	321
	Caliper (0.25)	13	0.042	9.6	367
	Caliper (0.5)	14	0.042	9.6	367
Radius matching	Radius (0.01)	14	0.016	6.1	355
	Radius(0.1)	14	0.010	4.4	364
	Radius(0.25)	14	0.330	6.4	364
	Radius (0.5)	12	0.071	12.8	364
Kernel matching	Bandwidth(0.01)	14	0.016	6.2	355
	Bandwidth(0.1)	14	0.010	4.8	364
	Bandwidth(0.25)	14	0.018	4.7	364
	bandwidth(0.5)	13	0.052	9.7	364

*Number of explanatory variable with no statistically significant mean difference between the matched groups of household

Source: Own computation result based on survey data (2024)

Relatively, this estimator (Caliper (0.01)) resulted in lowest pseudo R2 (0.008) value, well balanced covariates, and large number of matched sample size that were 202 treated and 161 untreated with a total of 389 sample households by discarding only 26 unmatched (off support) households. Moreover, in what follows estimation results and discussion are the direct outcomes of the Caliper matching algorithm based on propensity score.

The result of Radius matching algorithm shows small mean standardize bias (4.4) in lowest pseudo R2 (0.009) value, well balanced covariates, and large number of matched sample size that were 210 treated and 158 untreated with a total of 389 sample households by discarding only 21 unmatched (off support) households. Moreover, in what follows estimation results and discussion are the direct outcomes of the radius matching algorithm based on propensity score.

Table 8: Choice of different match algorithm selection criteria for household yield

Matching estimators		Performance of matching estimators			
		Insignificant variables after matching	Pseudo-R^2	Std. mean bias	Matched sample size
Nearest neighbor matching	Neighbor(1)	13	0.021	8.3	364
	Neighbor(2)	14	0.017	6.4	364
	Neighbor(3)	12	0.021	7.2	364
	Neighbor(4)	14	0.019	6.3	364
	Neighbor(5)	13	0.015	5.2	364
Caliper matching	Caliper(0.01)	13	0.036	4.3	359
	Caliper (0.1)	14	0.027	8.0	321
	Caliper (0.25)	14	0.032	9.6	367
	Caliper (0.5)	12	0.041	9.6	367
Radius matching	Radius (0.01)	14	0.016	6.4	355
	Radius(0.1)	**14**	**0.009**	**4.4**	**364**
	Radius(0.25)	14	0.330	7.4	355
	Radius (0.5)	13	0.071	11.8	367
Kernel matching	Bandwidth(0.01)	14	0.018	6.2	355
	Bandwidth(0.1)	12	0.017	4.8	364
	Bandwidth(0.25)	14	0.021	4.7	355
	bandwidth(0.5)	13	0.037	9.7	364

*Number of explanatory variable with no statistically significant mean difference between the matched groups of household

4.3.3. Testing the Balance of Propensity Score and Covariates

After choosing the appropriate matching algorithm, the next step in propensity score matching is checking the balancing test for covariates before and after matching to ensure similar distribution of covariates among adopters and non-adopters of improved malt barley varieties.

Hence, the main aim of propensity score estimation is not to obtain a precise prediction of selection into treatment, but rather to balance the distributions of relevant variables in treated and control groups. This balancing test is used to get the treatment effect by applying the selected matching algorithm (in our case, caliper matching (0.01). The balancing quality of the estimations are guided by taking different criteria into account such as, reduction in mean standardized bias between matched and unmatched households, equality of means using t-test and insignificant of chi^2 -test for joint significance for the variables used.

Table 9: Propensity score and covariate balancing

Variable	Unmatched Matched	Mean			%reduct	t-test		V(T)/
		Treated	Control	%bias	Bias	T	p>t	V(C)
_pscore	Unmatched	0.555	0.415	80.7		7.97	0.000	1.26*
	Matched	0.475	0.472	2.0	97.5	0.18	0.854	1.02
Age	Unmatched	42.93	43.09	-1.5		-0.14	0.886	1.19
	Matched	43.29	43.48	-1.7	-18.2	-0.13	0.895	1.37
Edu	Unmatched	4.55	4.06	26.8		2.64	0.009	1.06
	Matched	4.17	4.28	-6.2	76.7	-0.48	0.631	0.98
Fams	Unmatched	3.67	3.62	6.0		0.59	0.556	0.75*
	Matched	3.71	3.68	3.0	49.6	0.25	0.803	0.81
TLU	Unmatched	4.98	5.363	-23.1		-2.28	0.023	1.19
	Matched	5.085	5.235	-9.2	89.6	3.03	0.003	1.79*
Extcontact	Unmatched	1.665	1.544	30		0.26	0.799	1.82*
	Matched	1.596	1.584	3.2	85.2	0.28	0.783	1.65*
Exper	Unmatched	9.263	9.912	-4.6		-0.85	0.396	0.90
	Matched	9.978	20.163	-2.4	56.5	-0.18	0.856	1.00
Fert	Unmatched	0.488	0.526	-10.6		-2.00	0.046	0.70*
	Matched	0.491	0.498	-20.4	80.4	-0.32	0.753	0.57*
Seed	Unmatched	0.809	0.809	0.2		0.02	0.984	1.09
	Matched	0.800	0.814	-5.1	-2431.7	-0.39	0.698	1.16
Landsize	Unmatched	1.812	1.449	48.7		4.84	0.000	2.32*
	Matched	1.531	1.552	-2.8	94.2	-0.23	0.820	2.35*
Sex	Unmatched	0.840	0.851	-3.3		-0.32	0.746	.
	Matched	0.848	0.857	-2.3	29.50	-0.18	0.856	.
Cluster	Unmatched	0.524	0.5	4.8		0.47	0.636	.
	Matched	0.487	0.470	3.4	30.2	0.26	0.796	.
Offarm	Unmatched	0.390	0.509	-20.4		-2.00	0.046	0.70*
	Matched	0.420	0.428	-4.0	80.4	-0.32	0.753	0.57*
Credit	Unmatched	0.395	0.440	-9.1		-0.89	0.371	.
	Matched	0.428	0.386	8.5	6.4	0.66	0.512	.
Dismkt	Unmatched	6.632	7.036	-8.0		-0.79	0.023	-
	Matched	6.693	7.142	-8.8	-11.0	-0.67	0.896	-

Source: Own computation results survey data (2024)

Table 9 displays results of balancing test of the covariate by comparing the before and after matching algorithm significant differences. Before matching, there were some variables which were significantly different for the two groups of respondents. However, after matching some of these significant covariates were conditioned to be insignificant which indicates that the balance that made in terms of the covariates between treatments and untreated. The low pseudo-R2 and the insignificant likelihood ratio tests support the hypothesis that both groups have the same distribution in covariates after matching (Table 9). The result clearly shows that the matching technique is capable to balance the characteristics in the treated and control comparison groups. It used to evaluate the effect of the adoption of improved malt barley varieties among groups of households having similar observed characteristics that compare observed outcome for treatments with those of a comparison group sharing a common support.

Table 10: Tests for the joint significance.

Sample	Pseudo R^2	LR chi2	prob>chi2
Unmatched	0.108	58.32	0.000
Matched	0.008	2.70	1.000

Source: Own computation results survey data (2024)

4.3.4. Estimator of Treatment effect on the treated

Algorithm of PSM can be selected based on its own criteria: like, balancing test, low Pseudo R-square, large matched sample size and insignificant LR chi-square, the algorithm which are selected from four matching algorithm: nearest neighbor matching, radius matching, caliper matching, and kernel matching. Accordingly, a caliper (0.01) found to be the best estimator of the data of household malt barley yields and income from malt barley. As depicted in the table, relatively, this estimator resulted in the least pseudo-R-square (0.008), a large number of matched sample size and balancing test after matching the percent of bias is below 5% and also its LR chi-square is insignificant.

Table 11. Estimate of average treatment effects for household income and yield of household.

	Sample	Treated	Controls	Difference	S.E	T-stat
Household income	Unmatched	28418.3155	19989.2327	8429.08283	609.893433	13.82
	Matched	28272.6891	19808.2983	8464.39076	794.030548	10.66***
Malt barley yield of household	Unmatched	66.0390375	40.7742574	25.26478	4.78381556	5.28
	Matched	61.987395	41.7092437	20.2781513	5.56155344	3.65***

As showed the Average Treatment effect on the Treated (ATT) computed based on the four alternative matching methods (Table 11). Outcome variables are yield is measured in quintal and household income are measured in ETB respectively. The impact of improved malt barley varieties on the based on a sample of matched treated and control groups, the estimated average treatment effect (ATT) significant effect on the product of participant farmers with significant t-statistic (10.66) at 1% significance level (0.000). The average yields of malt barley of adopter households in improved malt barley varieties higher by 20.27 quintals per hectare in given product year when compared with the average yields of non-adopter households. The caliper (0.01) matching method result revealed that the malt barley production net income of the farmers who were adopter of improved malt barley varieties much greater with 8464.39 ETB than non-adopters in given product year (2015/2016).

In the table 11, it is clear that the average treatment effect on the treated (ATT) of malt barley production average income with t-value 10.66, Malt barley yield of household with t-value 3.65, indicating the effective level of significance. So it is concluded in this analysis that the improved malt barley varieties have positive yields and income effect on the farm households of the study area. For that reason, the adoption of improved malt barley varieties has a positive impact on the life of the adopters indicating positive benefit result; improve food security or reduction of poverty level on the side of the adopters than non adopters of improved malt barley in the study area. Overall, the results are in agreement with the findings of other researchers on the impacts of high yielding wheat adoption by Efrem (2018), Regasa *et al* (2019), Fikrab (2022), estimation with this best choice estimator.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary and Conclusion

The malt barley production sub-sector in Ethiopia has recently become a highly emerging one due to the interest shown by multinational beer companies to fulfill their demand for malt by sourcing from domestic production. Malt barley is becoming a major income source to smallholder farmers in the highland areas of Ethiopia, particularly where the agro-ecologies are not more productive to other cereal crops.

In this study, we assessed the adoption and impact of improved malt barley varieties on households' income. Both descriptive and econometrics methods were employed for data analysis. A propensity score matching approach used to compare adopter households with non-adopters in terms of key measure of household income and yield of malt barley. The matching techniques employed were the nearest neighborhoods matching, radius matching, caliper matching, and kernel matching. Among the algorithms used caliper matching (0.01) and radius matching algorithm (0.1) for income and yield found to be the best estimator of data based on balancing test, pseudo R_2 and matching sample size.

Logit model results showed that education level households, farm size, off-farm activity, availability of fertilizer, frequency of extension contact, tropical livestock were found to be important variables to affect farmers' adoption of improved malt barley varieties. And PSM result shows of improved malt barley varieties significantly and positively impact on households' income and yield.

Consequently, it can be concluded that the overall the results are remarkably robust and the analysis supports the robustness of the matching estimates. The implication of the findings is straightforward; even if the adoption of improved malt barley varieties is quite low in three study district of bale zone; those households who could adopt the improved malt barley varieties could improve their income and yield. Therefore, it is used to scaling up malt barley for the adopters to other farmers can be considered as one the option to enhance household income and yield of malt barley in the study area while solving or improving that variables affects malt barley is another option.

5.2. RECOMMENDATIONS

Based on the results of this research, the following core points are presented as recommendations in order to improve the adoption and income gained from malt barley. Improved malt barley production involves the use of different agricultural input, which require knowledge, and skill of use and management.

Education found to have a strong relation with the adoption of improved malt barley varieties as it enhances malt barley yield and household income. Therefore, due emphasis has to be given towards strengthening rural farmers education at different levels for small farm households using farmers training centers.

Frequency of contacts with extension agent positively influenced the adoption of improved malt barley varieties. The districts agricultural office should strengthened the present extension service facility as to improve farmers' number of contact with extension agents through increasing the number of extension workers and improving educational performance of the extension agents is important to improve farmers' adoption of improved malt barley varieties. Enhance the capacity of extension workers to provide training on improved cultivation practices, pest management, and post-harvest handling of malt barley. Because Education and Frequency of Extension Contact is positive and significant

Off-farm activities positively and significantly influence the adoption of improved malt barley varieties. This additional income from participation in off-farm activities increased financial capacity of farmers to purchase farm inputs, hiring labor and also have a confidence. As a result, good attention is needed for the development of income generating activities.

Farm size significant and had a positive relationship with the adoption of improved malt barley varieties at a 1% level of significance. Meaning, farmers with bigger farm sizes had a higher probability to adopt improved malt barley varieties compared with those who had smaller farm sizes. So government and any concern body improve the method of the farmers increase their production on their small amount of land by introducing different method and technologies.

Fertilizer availability significant and had a positive relationship with the adoption of improved malt barley varieties. The results of logit model indicate that those households who have access fertilizer are more likely to adopt improved malt barley varieties than those who have no access fertilizer. Hence, accessibility of fertilizer from appropriate sources helps farmers to produce more improved malt barley varieties. Develop efficient input supply to ensure that farmers have timely access to quality seeds and agricultural inputs.

Other recommendation we can, it is strong and very important that other researchers should work on it because there are many things that we cannot touched on and explained because of lack of time and budget.

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7. APPENDIX TABLES

Table 1: Conversion factor of Tropical Livestock Unit (TLU)

Livestock Category	TLU	Livestock Category	TLU
Camel	1.25	Donkey (young)	0.35
Ox	1.00	Horse	1.10
Cow	1.00	Sheep (adult)	0.13
Bull	0.34	Sheep (young)	0.06
Heifer	0.75	Goat (adult)	0.13
Calf	0.25	Goat (young)	0.06
Donkey (adult)	0.7	Poultry	0.013

Source: Storck, *et al*., 1991

Table 2: Result of variance inflation factor for continuous explanatory variables

Variable	VIF	1/VIF
Frequext	1.46	0.686064
Farmsz	1.36	0.733904
Age	1.30	0.770079
Famsz	1.27	0.784401
Avilfer	1.18	0.850928
Educl	1.18	0.849366
Tlu	1.20	0.836240
Cluster	1.10	0.905514
Sex	1.12	0.894124
credit	1.08	0.925983
Offarm	1.06	0.941182
Seed	1.12	0.891423
Mean VIF	1.20	

Source: Computed from own survey, 2019

Table 3: Conversion factor used to compute man equivalent (Labour Force)

Age group	Male	Female
< 10	0.00	0.000
10-13	0.20	0.200
14-16	0.50	0.40
17-50	1.00	0.80

>50	0.70	0.50

Source: Strock*et al*. (1991)

QUESTIONNAIRES

TITLE: Adoption and Impact of Improved Malt Barley Varieties on Households Livelihood in Bale Zone, Oromia National Regional State, Ethiopia

Madda Walabu University

College Of Agriculture and Natural Resources

Department of Agricultural Economics

Questionnaire

Questionnaire numbers………………….... Interviewer's…………………….

Date of interviews ……………………….... signature………………………...

Instructions to Enumerators

1. Make a brief introduction to the respondent before starting the interview (greet them, tell your name, get her/his name, and make clear the purpose and objective of the study that you are undertaking).

2. Please ask the question clearly and patiently until the respondent understands.

3. During the process put the answers of each respondent both in the space provided and encircle the choice or tick mark as requiring

1: General information

1.1 Kebele…………………………………………………………….

1.2 Village……………………………………………………………

1.3 Name of household head………………………………………….

1.4 Age of household head (in year)………………

1.5 Sex of household head……………………. Male=1 Female=0

1.6 Education level of household head (in year school), 1 for illiterates (0), 2 for primary (1-5), 3 for secondary (6-8) and 4 for tertiary (above grade 9).

II: Demography characteristics of household head

2: About family information

2.1. How many family members live in your home? In number……………………….

2.2. Are all they participating in household farm activity? 1= Yes, 0=No.

2.3. If No Question number 2.2, how many are they participating in household farm activity? ....

2.4. Do you face labor shortage to adopt improved malt barley varieties? 1=Yes, 0=No

2.5 If yes question number 2.4, how do you solve labor shortage problem

a) By hiring b) Asking for cooperation c) All d) Others (Specify)………………..

3: About improved malt barley varieties

3.1 Did you have ever information about improved malt barley varieties the past time?

1=Yes 0=No

3.2 If Yes question number 3.1, where did you get that information?

a) Extension agents b) Friends and families d) From Ethiopia sofflett malt

d) Others (please specify)………………

3.3 Did you adopt improved malt barley varieties in the year 2015/16 E.C? 1= Yes, 0=No

3.4 If "YES" question number 3.3, what are impacts on malt barley production?

a) Increased household income

b) Reduce fertilizer consumption

c) Minimized seeding rates d) all e) other specify…………………………………..

3.5 If yes # 3.3, what the area under improved malt barley varieties?.................................Ha

3.6 What total the area under malt barley production? .... Ha

3.7 If “NO “Number question number 3.3, why did not adopt improved malt barley varieties?

a. It requires labor time

ii. It takes more land

iii. It is low productive than others

iv. Other specify……………………………………………………………

3.8. Which variety is more productive in malt barley?

____

____

____

____

3.9. How many you produced from each improved varieties?____

____

____

____

4: QUESTIONS CONCERNING SOCIO-ECONOMIC FACTORS

4. LAND HOLDING

4.1. Do you have own land on which you cultivate your crops /grazing? 1) Yes 2) No

3.2. If yes, Question number 3.1 1) Size of total land holding -- (hectare)

1) Area under cultivation----------------- (hectare). 3) Area under fallow 2) Rent in 4) Rent out

5. LIVESTOCK HOLDING

4.1. Do you own livestock? 1. Yes 2. No

4.2. If yes, question number 4.1. Indicate the number of livestock owned currently and income earned.

NO	Types of livestock	Total number of owned	Did you sale your livestock and product?		Total income(birr)
			Sold livestock and amount in 2021	Sold livestock product in 2021	
1	Ox				
2	Cow				
3	Sheep				
4	Goat				
5	Donkey				
6	Horse				
7	Mare				
8	Heifer				
9	Calf				
10	Bull				
11	Chickens				
12	Others				
	product and by product of livestock				
13	Egg(No)				
14	Milk(Liter)				
15	Butter(kg)				
16	Hide and skin(no)				
17	Other				
	Total				

5. SOURCES OF OFF/NON-FARM INCOME OF HOUSEHOLDS

5.1. Have you involved in off/non-farm activities in last 12 months? 1. Yes 2. No 5.2.

If yes, what is the type of off/non-farm activity you involved in and the income earned?

1) --- (income -----------

2) ---(income -----------

3) --- (income -----------

4) --- (income------------

5) --- (income------------

6. CROP ENTERPRISES ON THE FARM

6.1. Types of crops, production purposes and area

No	Types of crops	Amount of production by kg/quintal	**Area**	Purpose of production	Sale in quintal in 2021	Price per quint al	Consu med value in Birr
1	Wheat						
2	Barley						
3	Malt barley						
4	Bean						
5	Pea						

6	Teff						
7	Maize						
8	Sorghum						
Others							

7. IPMROVED MALT BARLEY SEED AND PRODUCTION

7.1. Which malt barley variety do you prefer? 1) Improved 2) Local

7.2. What are your reasons for preferring it? 1) High yield 4) Weed competition 2) Resistance to disease 5) Taste in injera 3) Resistance to lodging 6) Taste in bread 7) Other (specify)-------------- --------------------------------------

7.3. Have you planted improved varieties of malt barley for last two years? 1) Yes 2) No

7.4. Did you get the improved malt barley variety that you wanted in 2015/16? 1. Yes 2. No

7.5. If No question number 7.4. why? 1) Seed not available 3) Seed too expensive 2) Lack of knowledge about improved varieties 4) Poor quality 5) Other (specify) ------------------------------

7.6. If yes, question number 7.4, which improved varieties in 2015/16?

1) --

2) --

3) --

4) Other specify ---

7.7. What the source of your seed? 1) Co-operatives 4) Market 2) Research Centre 5) Neighbor 3) Own 6) NGOS 7) Others, specify --

7.8. If you buy seed, where you did buy? 1) NGO 3) Market 2) Other farmers 4) Neighbors 5) others specify---

7.9. If you use your own seed, why? 1) -- -------------- 2) -- 3) ---------- ---

7.10. What are your constraints in using improved malt barley seed?

1) Not available 5) Lack of cash 2) High price of seed 4) Weather not good

3) Lack of credit to buy seed 6) Lack of knowledge 7) Others (specify), ------------------------

7.11. In Q#7.2. your preference is improved verities, why you adopt improved malt barley variety is better than local variety in?

1) Yield capacity 4) Resistance to diseases/weeds 2) Drought resistance 5) Lodging resistance 3) Maturity period 6) others (specify) -----------------------------

7.12. What the productivity of malt barley per hectare without improved seed?

1) In 2014--------------------- Qt/ha 2) In 2015 --------------------- Qt/ha 3) In 2016 ----------------

7.13. What the productivity of malt barley per hectare with improved seed 2016? ----------- Qt/ha

8. FREQUENCY OF EXTENSION VISITS

8.1. Have you contacted extension agents on agricultural activities in the last one year?

1) Yes 2) No

8.2. If your answer is yes for Q# 8.1, how often you were visited in the last year (2015)? ----------

8.3. Who provides you the extension service? 1) Development agents (DAs). 3) Researchers 2) NGOs 4) Others---

8.4. Types of extension messages given by the agents? 1) Fertilizer use 4) Manure use 2) Insecticide use 5) Land use practices 3) Improved seed use 6) Use of credit 86 7) Other (specify) --

8.5. Are you a new extension package framer? 1) Yes 2) No 8.6. Have you ever attended a farmer-training course? 1) Yes 2) No

9. INFORMATION ON CREDIT USE

9.1. Have you ever got credit to purchase malt barleyproduction inputs? 1. Yes 2. No

9.2. If yes, for #Q9.1 1) When --------------------------------- (year). 2) Rate of interest -------------------------- 3) Amount --------------------------------- 4) Source-----------------------------------

9.3. Did you use credit to buy improved malt barley seed in the past 12 months?1. Yes 2. No

9.4. If yes, for #Q9.3 what the amount of credit? -------------------- (birr)

9.5. If yes, for #Q9.3 what the duration of the loan? ----------------- (birr)

10. DISTANCE FROM THE NEAREST MARKET

10.1 What is the distance from your home to the nearest market center (in minutes) ____________?

10.2. Have you got market information? 1) Yes 2) No

10.3. If yes, #Q 12.2 where to get the basic source of market information? 1) Radio 3) Development agents 2) Traders 4) Friends/relative/neighbor 5) Other (specify) ---

11. MEMBERSHIP TO CO-OPERATIVES

11.1. Are you a member of co-operatives? 1) Yes 0) No

11.2. If yes, for #Q12.1 which one? 1) Service cooperative 3) Women group 2) Peasant association 4) Others (specify) --------------------------------------

11.2 If yes, for #Q12.1 what service do you get from the co-operatives you belong to? 1) Loans/credit 3) Labor 2) Farm inputs (fertilizer, chemicals, and improved seeds) 4) Others (specify) ---------------------------------------

12. USE OF FERTILIZER

12.1. Did you use fertilizer, this year? 1) Yes 2) No

12.2. If yes, for #Q134.1

No	Type	Quantity in Kg	**Total**
1	**Urea**		
2	**DAP**		
Others			

4) Other (specify) ---

12.3. If no, for #Q13.1 why? 1) Not heard of fertilizer/never tried before 4) Unavailable 2) Fertilizer doesn"t increase yield 3) Too expensive 5) Late delivery 6) Other (specify) -------------------------

12.4. What constraints do you face on fertilizer use on malt barley? 1) Not available 4) High price of fertilizer 2) Lack of knowledge usefulness of fertilizer 5) Soil fertility adequate 3) Lack of credit 6) Others (specify) ------------------------------

12.5. Did you use herbicide in this year? 1. Yes 2. No

12.6. If do not use herbicide, why? 1) Not heard of Herbicide 3) Unavailable 2) Too expensive 4) Others (specify) -------------------------------

13. AVAILABLE NEIGHBOR ADOPTER

13.1 Do you have neighbor farmers who grow improved malt barley varieties in 2020/21 production year? 1) Yes 0. No

13.2. Do you communicate information with your neighbor about improved malt barley production? 1) Yes 0)

14: Different expenditure of household

1. Household expenditure for the agricultural input to produce malt barley yield year 2015E.C

Type of inputs	Quantity in quintal	Cost in Birr
Malt barley seed		
Fertilizers		
Pesticide		
Others		

2. Expenditure of household on food and Nonfood in year 2015 E.C.

Type of food	From their own agriculture products		From market		Total expenditure	
Sorghum	Quantity	Price in birr	Quantity	Price in birr	Quantity	Price in birr
Wheat						
Teff						
Maize						
Beans						
Barley						
Vegetables						
Oilseeds Fruits						
animals products						
Nonfood expense						
Oil, meat						
Drinks						
Others						