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**COLLEGE OF DEVELOPMENT STUDIES
CENTRE FOR FOOD SECURITY STUDIES**

**POTATO PRODUCTION AND POST-HARVEST TECHNOLOGIES
ADOPTION BY SMALLHOLDERS AND ITS IMPLICATION TO
FOOD SECURITY IN QUARIT WOREDA, ETHIOPIA**

BY

ANIMAW YEHENAW

AUGUST, 2019

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MASTERS OF SCIENCE IN FOOD SECURITY AND DEVELOPMENT

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ADDIS ABABA, ETHIOPIA

DECLARATION

This thesis is my original work and has not been presented for MA/MSc degree in any other University and that all the sources and materials used for the thesis have been properly acknowledged.

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge as an advisor.

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Final approval and acceptance of this thesis is depending up on the candidate’s submission of the final copy of the thesis, incorporating all the comments by Examining Board, to the Council of Graduate Studies through the Center Academic Committee of the Center.

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ACRONYMS

ARD:	Agricultural and rural development
CBP:	Center of potato breeding
Cm:	Centimeter
CSA:	Central Statistical Agency
DAP:	Di Ammonium Phosphate
Das:	Development Agents
DCs:	Developing Country
DLS:	Diffused Light Storage
FAO:	Food and Agricultural Organization
Ha:	Hectare
HHs:	Households
Kg:	Kilogram
N:	Nitrogen
P:	Phosphorus
Qt/ha:	Quintal per hectare
SNNPR:	South Nation Nationalities of People Regional State
T/ha:	Ton per hectare
\$:	Dollar
%:	Percent

ABSTRACT

Potato (SolanumtuberosumL.) family Solanaceae is one of the most important tuberous food crops in the world that is ranked fourth in volume of production after rice, wheat and maize. Whereas; among root and tuber crops ranked first which are followed by cassava, sweet potato and yam. Potato plays an important role in improving household income and nutrition and there by contributes to food security in Ethiopia. Despite this, the current production and productivity of potato in the national and regional as well as in that particular study area has been below its potential. This is due to low level of use of improved potato production packages are among the causes for low productivity and low level of use of post harvest technology with storage technology packages for potato was a priority problem in the study area. In this context, this study analyzed the factors influencing adoption of potato production and post harvest technology packages by smallholder in Quarit woreda, Amhara reginal state, Ethiopia in 2018/19. The study uses cross-sectional study design with purposive sampling (Woreda and Keble) and systematic randem sampling (targated household head) has been applied. The analysis was based on a household survey conducted on 276 randomly selected potato growing households. The analyses of the factors affecting adoption is measured in an index computed with censored regression analysis (Tobit model) has been used for identifying the deteremenat factors for the adoption of potato production and post harvest technology packages in the study area with the recomended components of the technology packages. Education, family size and farm size, extension service distance to market and distance to main road of the households were found to significantly affect the adoption of potato technology package. This study also addressed and identifying its determinants on adoption of postharvest technology and in the study area. In line with this sex family size, distance to the nearest market, postharvest handling practices allocated for potato determine postharvest technology packages affect negatively. Generally Potato production, post harvest and both of technologies adoption has also a significant effect on food security of the household in the districts. Intervention of government from adoption of production technology and adoption of post harvest technology until the end consumers with preparing storage mechanism must. Furthermore, both storage facility and mechanisms must be improved in order to reduce post-harvest loss in the study area. Policy makers, planners and development practitioners are required to give due attention to these determinants in order to support smallholder in production and post harvest handling practice improvements for potato.

Key words: *Technology packages, Technology adoption, production technologies, postharvest technology, Adoption index and Food security.*

1 INTRODUCTION

1.1 Background

Potato (*Solanumtuberosum L.*) family *Solanaceae* is one of the most important tuberous food crops in the world that is ranked fourth in volume of production after rice, wheat and maize. Whereas; among root and tuber crops ranked first which are followed by cassava, sweet potato and yam (FAO, 2010). Potato has economically important and significant roles for consumption that provides a source of low cost energy to human being and rich source of starch, vitamins and minerals. It also used for several industrial purposes such as production of starch and alcohol (Deepali et al., 2016). Production of potato is over the past two decades has expanded from 267 to 375 million tons globally. Potato is a popular source of affordable food for growing populations and produces more food per unit area than other major food crop. It generates more employment in the farm economy than other crops are serves as a source of cash income for low-income farm households (USAID, 2013). Potato has been considered as a strategic crop by the Ethiopian government aiming at enhancing food security and economic benefits, and it is mainly produced in Oromia, Amhara, and SNNPR regions, which constitute 46%, 34%, and 19% of the national potato production, respectively (CSA, 2012).

The adoption of recommended technology and practices of potato production by the farmers could easily raise food production and net income of the users (Amin, 2009). Yet low productivity remains a major challenge the average national farm level yields. This implies that technological advances generated through research have not widely translated to increased efficiency and improved resource productivity. In Ethiopia, at the country level in the year 2013/14, about 1,437,697 private peasant holders participated in potato production, on the total area of 66,745.61 hectare (having 31.80% distribution) covered by potato, and 7,849,934 quintals of potato was produced, yielding 117.61Qt/ha in Meher Season(CSA, 2013/14). Even though smallholder farmers in the country grow potato with national productivity of potato are ranging between 8-10 tons per hectare, which is very low compared to Asian, and other countries in the world. As a highland country located in the tropics and has very favorable conditions for the production of high quality potato (FAO, 2008). Amhara regional state produces potato about 71325.18 ha land mainly grown on small farms (CSA, 2003).

Ethiopia has a much higher potential to increase agricultural production of the crop through use of improved seeds and undertaking technological innovation that facilitate the management and reduce postharvest losses (Vita and IPF, 2014). However, potato is widely regarded as a secondary non-cereal crop in part because it has never reached the potential that it has in supporting food security due to estimated that about 296,577.59 ha is now planted and 36,576,382.69 qt production annually (CSA, 2016). Postharvest loss (20–25%) is also another major problem in the potato production (BoFED, 2007). Potatoes were mostly found in the Regional State (51%) that smallholder farms are based on low input that leads to low output production systems and the use of improved seeds and planting material of high yielding varieties and other inputs such as fertilizer and plant protection materials is not common in the smallholder farmers. According to Holeta Research Center (2011) that the recommended packages of improved potato production technology are: (land preparation 3-4 times until it is fine seed bed, seed rate are 20q/ha, fertilizer rates are 60 kg UREA and 60 kg of DAP, chemical application 2 times sprayed 50-55, 70-75, spacing 30x75cm-30cm between plant -75cm between row, seed size must be medium, planting method is row, weeding/hoeing and hilling frequency 2hand weeding at 35-40 and 60-70 days, seed storage diffused light store(DLS)).

Usually farmers follow different levels of production technologies depending upon their infrastructural facilities and socioeconomic conditions which ultimately resulted in variability in yields of potato (Elias *et al.*, 1992). Postharvest system encompasses the delivery of a crop from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and maximum return for all involved (Grolleaud, 2002). But there is a huge gap between recommended and adopted practices of potato production technology postharvest practices for potato in the district. Currently the study areas have no concrete data which technology adoption and level of intensity is essential for the small holder farmers in order to solve poor potato production system at the household. So this study is crucial to analyze the adoption intensity of production technology and post-harvest technology that ensuring food security and provide intervention of appropriate technology adoption strategies for policy makers for future in the district and to increase food efficiency(availability) of the smallholder farmers.

1.2 Statement of the problem

In Ethiopia, potato has been produced with in a small plot of land which can be significantly contribute to food security improvement by increasing food availability at the household level and cash income of smallholder farmers that support economic status of the household in the given community. But adoption of potato production technology packages (improved varieties, Row planting, DAP, UREA, land preparation and herbicide) as well as low adoption of post-harvest technology packages' (Seed storage (DLS), Transportation, Sorting Grading and Packing) by smallholder farmers are poor which leads to poor production and productivities of potato due to this various integrated agronomic, input supply and extension system of the country.

Currently in the country according to CSA 2017/18 at the national level potato were cultivated by 2,076,262.00 private peasant holders with area coverage of 24107144ha and average potato productivities 136.73 Qt/ha with total production of 32,961,177.74 Qt. Particularly in Amhara regional states potato were cultivated by 331,790.00 private peasant holders with area coverage of 30914.48 ha and average potato productivities 78.91 Qt/ha with total production of 2,439,440.82 Qt. Quaritworeda found in the Amhara Regional State which is one of the major Potato producer area in the region which total production area covers 2908 ha of land and each smallholder farmers cultivated on average more than 0.5 ha which produced less than 4.8 tons per hectare due to poor adoption of production and post harvest technology packages in the district(Quarit ARD, 2010). In the study area it has also been revealed that the constraints that affect potato production in the district are high cost of inputs (seeds, chemicals and fertilizer); low technical support by extension, poorest and diseases control, expensive input price and no organized marketing channels for improved technologies supply. Also farmers preserve potato in a hole that they dig which leads to waste due to poor postharvest handling techniques. They also store potato using smoking area to extend shelf life of potato. Both of them are traditional way of storing potato and leads to food loss in specific study area.

Also the adoption of recommended cultivation practices by farmers is conditioned by many factors that interact with each other. In such situation, it is essential to know which adoption technology influenced potato grower in area. Lack of improved varieties, Lack improper use of fertilizers and chemicals, Poor cultivation system, lack adoption of post harvest practice and storage system. So by identifying the intensity of adoption of both technologies by the farmers and improving the sector contributes to increase productivity of potato and generat incomes as well as promote food self-sufficiency of the smallholders in the district. Therefore, this research was studied the adoption technology in related to potato production and post-harvest technology, which had been significant effect on ensuring food security in the study area.

1.3 Objectives of the study

1.3.1 General objective

- To analyze factors determining adoption intensity of major potato production and post-harvest technologies by smallholders in Quarit woreda, Amhara region Ethiopia, 2019.

1.3.2 Specific objective to:

- ✓ Analyze factors determining adoption of major production technologies in the study area.
- ✓ Analyze factors determining adoption of major post-harvest technologies in the study area.
- ✓ Analyze the effects of technology adoption on food security status of study area.

1.4 Research questions

Based on the specific objectives, the research attempts to answer the following question:

- ✓ What are the factors determining adoption of major potato production and post-harvest technologies with in the *Woreda*?
- ✓ What are the effects of technology adoption on food security status of smallholder farmers?

1.5 Scope and limitation of the study

The study was assessed the adoption of potato production technology of smallholders only in Quarit woreda, Ethiopia. The limitation of the study was considered only potato and due to the absence of the other crops, which has been a significant role to food security in smallholders at household.

1.6 Significance of the study

This research has several important contributions. It is very important to help enhance the adoption of potato production and post-harvest technologies of smallholder farmers in Quarit woerda, Ethiopia to ensure food security. Of the study tried to link potato production with post-harvest practices that comprehensively assessed suboptimal use of technologies that contribute to reduction of losses in production, harvest and postharvest systems.

1.7 Organization of the thesis

Organization of the thesis is such that chapter one includes introduction, statement of the problem, objectives (general and specific), research questions, scope and limitation and significant of the study. In chapter two focused on literature review of the study. Chapter three includes research method and materials (description of the study area, research design, sampling methods, tools and techniques of data collection and techniques of data analysis). Chapter four includes result and discussion based on descriptive statistics and censored regression analysis (Tobit model). Chapter five has been included conclusion and recommendation of the study. Finally thises has been contend list of references and appendix at the end of the thesis.

2 REVIEW OF RELATED LITERATURE

2.1 Theoretical literature review

Adoption and diffusion are two interrelated concepts depicting the decision to use or not to use and the spread of a given technology among economic units over a period. Adoption is conceptualized as a multi-stage decision process involving information acquisition and learning by doing by growers who vary in their risk preferences and their perceptions of riskiness of an innovation (Feder *et al.*, 1985). Technology refers to the means and methods of producing goods and services, including methods of organization as well as physical technique. According to these 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. Adoption refers to a mental process an individual passes from first hearing about an innovation to final utilization of it. Adoption is assessed in two categories: rate of adoption and intensity of adoption. The former is the relative speed with which farmers adopt an innovation, has as one of its pillars as the element of 'time'. On the other hand, intensity of adoption refers to the level of use of a given technology in any time.

For instance, the study by Doss (2003) showed that adoption of improved seed by farmers as adopters if they were using seeds that had been recycled for several generations from hybrid ancestors. Therefore, in defining agricultural technology adoption by the farmers, the first thing to consider is whether adoption is a discrete state with binary response variables or not (Doss, 2003). That means definition depends on the fact that the farmer is an adopter of the technologies or non-adopter taking values zero and one or the response is continuous variable (Challa, 2013). The appropriateness of each approach depends on the particular context (Doss, 2003). Many researchers use a simple dichotomous variable approach in the farmers' decisions of new technology adoption. This approach is necessary but not sufficient because the dichotomous response reflects the status of awareness of improved technology rather than the actual adoption.

2.2 Empirical literature review

2.2.1 Determinants of technology adoption

Farmer's decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology and the array of conditions and circumstances. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting. An understanding of the factors influencing this choice is essential both for economists studying the determinants of growth and for the generators and disseminators of such technologies. Economic analysis of technology adoption has sought to explain adoption behavior in relation to personal characteristics and endowments, imperfect information, risk, uncertainty, institutional constraints, input availability and infrastructure.

In recent times literature has included social networks and learning in the categories of factors determining adoption of technology (Uaiene et al., 2009). Socioeconomic factors refer to personal context of the primary decision maker of the farm. Once some technologies demand high level of information and knowledge, the skills and abilities of farmers clearly influence their decision to adopt technologies (Mcbride, 1998). Demographic factors includes gender, age, education, family size, influence in decision making, experience in agriculture, ability to obtain and process information, networking, financing and credit sources of producers in the region. Agro ecological factors: are known as the biophysical factor of the farm influences both the exploitation of natural resources and the operational factors to explain the adoption (Brindal, 2012). Although this factor was insignificant in some cases, its impact on the adoption has been generally consistent (Isgin et al., 2008). Institutional factors are indicators that influence the behavioral change of the farmer. The main determinants: distance to fertilizer distributor, region, use futures contracts, development pressure and distance to the main market. Most adoption studies have attempted to measure human capital through the farmer's education, age, gender, and household size (Mullins, 2010).

Available information about the new technology influences adoption. It reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time. This simply implies that farmers may perceive the technology and subjectively evaluate it differently than scientists (Uaiene et al., 2009). Access to information may also result to dis-adoption of the technology. Information is the key to the diffusion of innovations (Rogers, 2003). Access to credit has been reported to stimulate technology adoption. It is believed that access to credit promotes the adoption of risky technologies through relaxation of the liquidity constraint as well as through the boosting of household's-risk bearing ability. This is because with an option of borrowing, a household can do away with risk reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments (Simtowe, 2006). In certain cases, necessitate designing credit packages that are tailored to meet the needs of specific target groups (Muzari et al., 2012). Input price is the determinant of the adoption of a new technology is the net gain to the farmer from adoption, inclusive of all costs of using the new technology (Foster, 1995).

Farmer's perception is refers to a subjective assessment of attributes and personal innovation. Among the perceived attributes suggested by Rogers (2003), perceived relative advantage is used to evaluate the perception of relative benefits of adopting new technologies and the gain that it brings to overcome other technologies. Among other advantages, profitability is a major concern when considering increase in any capital intensity of agricultural technology. This factor has a positive impact on the adoption of technologies, especially when the cost of acquiring them is being subsidized (Khanna, 2001). The main determinants found were profitability with increased use of technology, perceived importance of adopt variable rate application of inputs and behavioral profile of producer.

2.3 Constraints of technology adoption of potato production by small holder farmers

Sufficient land availability is available a wider spacing is preferred and planting distances is a much-debated subject that farmers did not give attention to spacing that plays significant role for all activities. Absence of proper spacing creates difficulties for production that indicated in difference in spacing associated with difference in size and expansion nature of varieties used. Land shortage is cross-cutting constraint for some household specifically associated land shortage to the large amount of land required to meet the recommended rotation (≥ 3 -years) of potatoes and high population density areas of the country (Josephson et al., 2014). It is one of the constraints that hinder the full implementation of the extension packages for the crop in Ethiopia (CSA,2011a). Improved varieties is the use of improved varieties was predominantly governed by the households' wealth, adoption and education levels that consistent with other research from Ethiopia that has shown that education level and access to extension service significantly influence the adoption of improved potato production technology.

Fertilizer management is Potato has already considered as specialty crop in Ethiopia due to its role in improving food security of the nations. Poor nutrient management practices and lack of high yielding varieties, productivity of potato is still limited to be 11.5 tons per hectare (t/ha) (CSA, 2015) in Ethiopia; which is very much less than globally potato yield potential (100 t/ha) (Grewal et al., 1992). Research results indicated that 108/69 and 81/69 kg/ha N/P₂O₅ were economically feasible and optimum rate for potato production in south Gondar and Gojamareas, respectively (Tesfaye et al., 2008). For optimum potato tuber yield in nitosols and light verticals of the highland areas of north Shewa, 110 kg/ha nitrogen and 70.5kg/ha P₂O₅ kg/ha were recommended (Semagn, 2008). Berga et al. (1994) recommended 165/90 N/P₂O₅ as feasible rate for the central Shewa, and this recommendation is still in use as blanket recommendation throughout the country. However, its low productivity in the areas is attributed to the present practices of its production without appropriate nutrient management practices and lack of high yielding varietal options (Mitiku et al., 2015).

Nitrogen and phosphorus are among the essential macronutrients identified as the most yield-limiting factors in crop production that Nitrogen is required for good vegetative and reproductive development. Component of protein and nucleic acids are reduced when N is inadequate, growth is reduced. Nitrogen serves as an intermediary in the utilization of P, K and other elements in plants (Weil, 2000). Phosphorus also has many vital functions in photosynthesis, utilization of both sugar and starches and in energy transfer processes; so that young plants absorb P very rapidly, to provide rapid and extensive growth of roots (Asumadu et al.,2012). Many poor households identified inadequate access to inorganic fertilizers a constraint, citing high prices and cash shortages. Moreover, some farmers in the country cannot purchase available fertilizers, due to the large pack size (IFDC, 2012). Tesfaye (2008) reported that regardless of type of varieties, yield declined as planting date was delayed. Therefore, May 1–June 1 were recommended planting dates around Adet for potato cultivars and similar agro-ecologies that are late blight disease susceptible and moderately tolerant/resistant. Similarly, early June was recommended for Emdiber (Gurage zone), Holetta (Central Shewa), and other similar agro-ecological areas (Berga et al., 1994).

2.4 Potato production opportunities, challenges and strategies

Opportunities of potato production provide excellent opportunities in raising the income of the farmers as it has capacity to yield 5-10 times more than cereals, pulses or oilseeds. The high profitability of potato as a cash crop has made it an economically viable enterprise for the small and marginal farmers and has contributed to increasing equity among farmers. Potato provides higher unit return and offers great scope for value addition. Potato has high employment generation potential during crop raising, post-harvest handling, and processing and value addition. Potato requires an input of 250 man-days for cultivation of the crop in one hectare area. The cultivation of potato in 1.4 million hectare area generates rural employment to the level of 350 million man-days annually. Potato is grown in multiple cropping systems in rotation with other vegetable or cereal crops. Potato responds well to input and gives high returns. The residual potash and phosphorus of the crop are generally adequate and half for good growth of succeeding cereal crops reduce the nitrogen requirement. Thus, it contributes towards improved management of natural resources and optimization of fertilizer use, which are essential for sustainable agricultural production.

Challenges of potato production include diseases, the lack of improved varieties, poor crop management practices, use of inferior quality seed tubers of unknown origin, inappropriate storage structure, poor seed system, poor research-extension linkage, are among the key factors contributing to low productivities of yield. Potato marketing system also has many challenge due to lack of improved storage facility, Lack of seed potato, poor road and transport facilities, lack of market information, high market price instability, lack of capital, lack of marketing facilities and lack of integration among chain actors. Lack of post-harvest technology for sustainable use of potato products for a long period and bring to market before perishable the product. It is also another most important technology factors that leads to many products are lost and farmers have a low financial and technical capacity to construct improved storage to store and sell their product when prices improve. Strategies of potato production has been improved either by increase in production or reduction in loss for sustainable food supply in the given community. Potato production practice and Postharvest handling Practices include harvesting, pre-cooling, cleaning, sorting, grading, packaging, transportation and storage must be improved. So above all is crucial in potato production and post-harvest technology to ensure food security of small household in a region like Ethiopia.

2.5 Conceptual framework

The conceptual framework indicates in Figure 1 that adoption of potato production and post harvest technologies is influenced by several interrelated components within the decision environment in which farmers operate. For instance, Feder et al. (1985) identified lack of credit, limited access to information, inadequate farm size and inappropriate transportation infrastructure as key constraints to rapid adoption of innovations in less developed countries. Socio economic conditions of farmers are the most cited factors influencing technology adoption. The variables most commonly included in this category are age, education, household size, landholding size, and other factors that indicate the wealth status of farmers. Farmers with bigger land holding size are assumed to have the ability to purchase improved technologies and the capacity to bear risk if the technology fails (Feder et al., 1985).

Technology adoption is influenced by socio- economic, institutional, information, farmers perception and agro- ecological factors which has been determined with age, gender, educational level, family size, off farm income, asset owned, farming experience, access to credit facilities, extension service, availability of training and perception of input price. More technology adoption in the case of production that productivity will be increased and as well as the adoption of post-harvest technology increased then reduced food loss. So, in both cases the figure shows that increases in food availability leads to food security at the household levels of each smallholder farmers. Potato producers are the major actors who perform most of the value chain functions right from farm inputs preparation on their farms or procurement of the inputs from other sources to post harvest handling technology.

So, the major adoption technology functions that potato producers perform both potato production and post harvest technology packages (practices) for increase and ensuring their food security in a sustainable maner. Figure 1 shows that potato production and post-harvest technologies adoption by smallholders has its significant role to ensure sustainable food security at the household level. In production technology that practiced in small holder farmers includes Improved variety, Land preparation, planting methods, Fertilizer (UREA and DAP) and Chemicals (pesticides and herbicides) on the other hands in potato post-harvest technology includes: harvesting, pre-cooling, grading, sorting, cleaning and disinfecting, packing, transporting and storage system are affect one of the food security dimensions known as food availability that small holder farmers are being food in secured. Conceptual framework of adoption of potato production and postharvest technologies has been presented as follows;

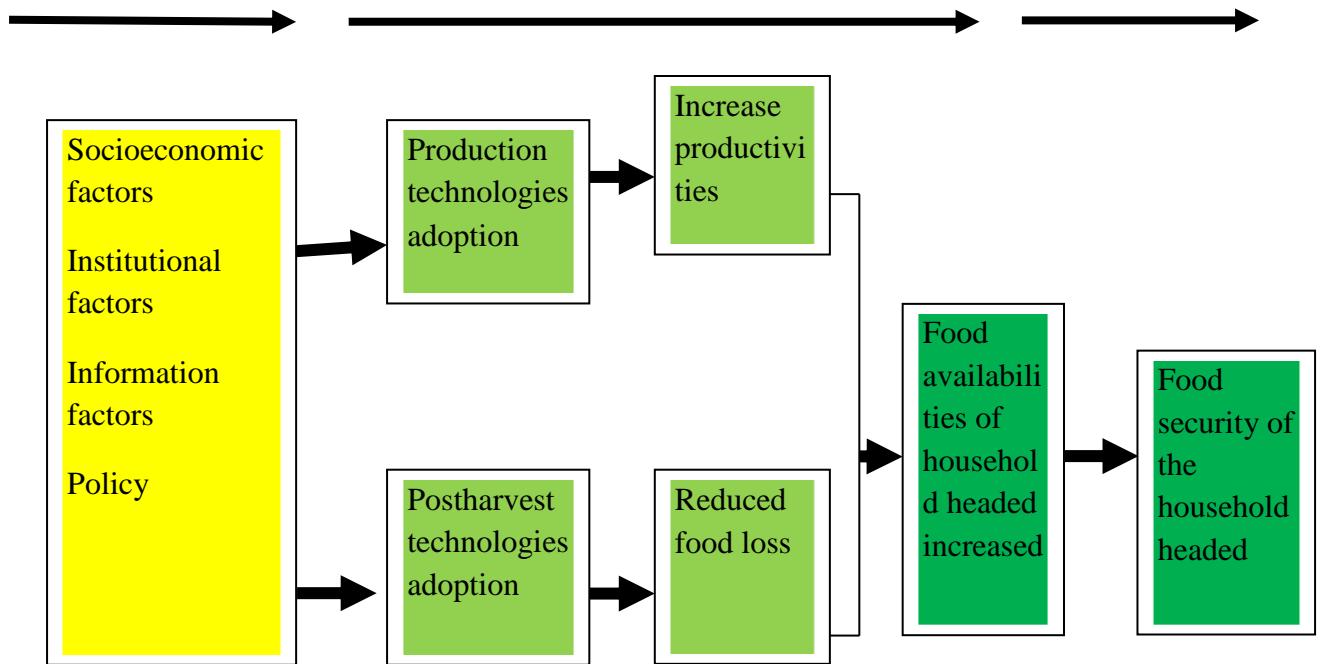


Figure 1. Conceptual framework of adoption potato production and postharvest technology
 Modified from Integrated model of adoption of precision agricultural technology by farmers:
 technology acceptance Model 3, Venkatesh and Bala (2008).

3 RESEARCH METHODOLOGY

3.1 Description of the study area

The study was carried out in *Quarit woreda* that one of the woredas in the Amhara Region of Ethiopia which lies between $10^{\circ}30'00''$ to $11^{\circ}07'00''$ N latitude and $37^{\circ}22'30''$ to $37^{\circ}28'00''$ E longitude with total of 30 *kebeles*. It covers a total area of about 61,360 ha, out of this 6835ha is cultivated by potato. The altitude of the highest point in this woreda and in the West Gojjam Zone is Mount *Amedamit*, a part of the *Choqa* Mountains, with an elevation of 3619 meters above sea level. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 114,771, an increase of 16.49% over the 1994 census. Of this, about 56,767 were men and 58,004 were women; and 4,750 or about 4.14% are urban inhabitants. A total of 25,402 households were counted in this woreda, resulting in an average of 4.52 persons per household, and 24,927 housing units (CSA, 2007). Rainfall amounting about 1900 mm and Temperature ranged from $17.5-25.5^{\circ}\text{C}$ on average and according to *Quarit* office of agricultural and rural development(OoARD) soil type of *Quarit woreda* has 20% clay, 35% vertisols and 45% brown in the study area.

Quarit is bordered on the southwest by *Jabi Tehnan*, on the west by *Sekela*, on the north by *Yilmana Densa*, on the east by the *Misraq Gojjam Zone*, and on the southeast by *Dega Damot*. The major town in *Quarit* is *Gebeze Mariam*. The study area has been low land that can be considered as flat land with gentle undulations comprises very small proportion, while the lions share is high land with a more broken topography dominated by steep slopes, ravines and high mountains. The woreda is a typical rural set up with about 90% of population making their living from agriculture and allied activities. The total cultivable land in the woreda is around 27,984 hectares. This implies that only around 45.6% of the total area of the Woreda is suitable to farming activities. The total population in the woreda was estimated as 166,848 persons almost showing same proportion of males and females at all age groups but with a slight difference in urban areas. About 97.3% of the total population is residing in rural areas and the balance lives in urban areas.

The age composition revealed that the proportion of young age population (below 15 years of age) constitutes 47.5%. Whereas the proportion of old age (64 +) population constitutes about 2.4%. More than 97 % of the dependent age population (both young age and old age) lives in rural areas and the balance resides in urban areas. *Quart Woreda* is broadly divided into two livelihood zones, namely: Central highland barley and potato producing (CBP) and South west maize, finger millet and teff producing (SWM) livelihood zones. The CBP is a mountainous and hilly area with four seasonal calendar (*Bega, Kiremet, Tibi and Meher*) while the extensive zone of SWM comprises three seasonal calendar (*Kiremt, Meher, and Bega*). About 53 % of the woreda population is settled in CBP livelihood zone and the remaining 47% of the population lives in the SWM livelihood zone.

The typical productive asset holdings and the amount of land cultivated varies across these livelihood zones and among households categorized into different wealth strata. This in turn significantly influenced the per capita income (PCI) pattern among the two livelihood zones (ARD office *Quarit*). The study was carried out after getting permission and after obtaining the ethical approval letter from the institutional review board (IRB) of Addis Ababa university center of food security studies MSC program in food security and Development studies to the Agricultural Office of *Quarit woreda*. The woreda also gave a letter to the respective study kebeles. Accordingly, the participants were volunteer and gave consent to participate. Confidentiality of the participants consent form was prepared before conducting the data collection. The participants were promised to keep confidentiality regarding their details. Interview was carried out only with full consent of the person being interviewed. Each respondent was assured that the information provided by her/his will kept confidential and used only for the purpose of this research. The study will be conduct from November 2018 to May 2019

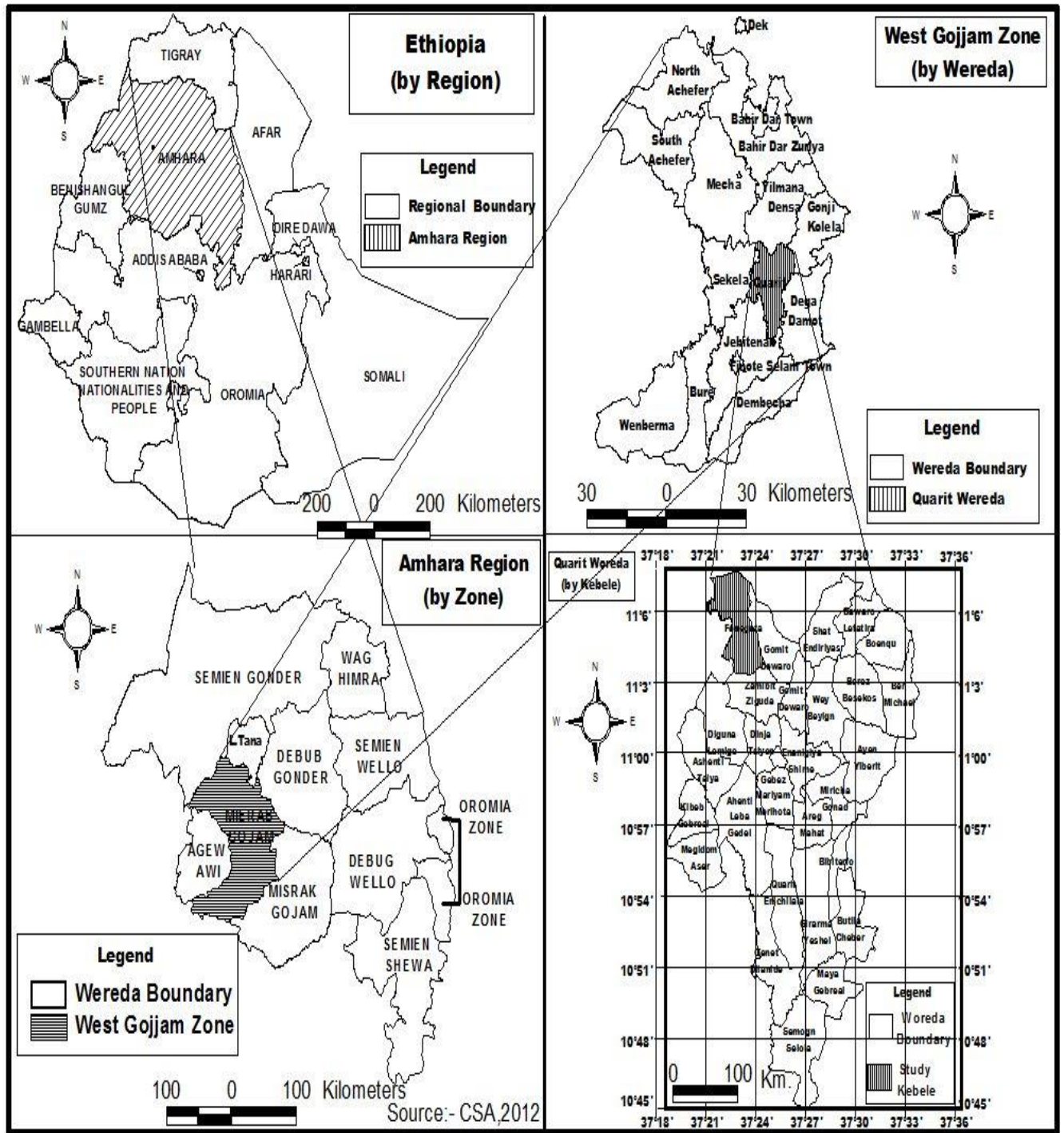


Figure 2. Geographical map of the study area

Source: CSA, (2012)

3.2 Research design and methodology

The study was used cross-sectional study design with both qualitative and quantitative approaches. A cross-sectional study a type of observational or descriptive study the research has been employed. Based on the specific characteristics determined analysis have been done to answer the research questions.

3.3 Sampling techniques

The study was conducted in the woreda particularly in *Fenegeta Keble* which is 16 km far from the head quarter that potato is grown intensively and the kebele was selected by purposive sampling technique. A census was conducted to obtain the list of smallholder farmers in the *Keble*, supported by the existing secondary data purposefully. Head of households were selected by systematic random sampling technique from fresh list of the farmers which was organized by development agents. Every 3rd point of the list was used as targeted farmers to collect the required data from that specific study population until reached 276 of the sample size. For the purpose of this research purposeful and systematic random sampling techniques was applied to select the samples to be considered from the study area.

Sample size determinations: There are a total of 885 smallholder household heads in *Fengeta kebele* which produce potato. The sample population consists of randomly chosen smallholder potato producer and the sample size was calculated based on Yamane (1967) at 95% confidence level. Since working with a finite population and if the population size is known and when the original sample collected is more than 5% of the population size, the corrected sample size is determined by using the Yamane formula for determining the sample size. As well as it gives the opportunities that the researcher has to make a decision to collect even smaller number in order of ease of handling, costing but he has to ensure that the sample is representative.

So a population proportion formula is used to estimate the sample size needed for this study. The sample size determined by using this formula,

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

Whereas: n the sample size, N the population size, and e is the level of precision.

$$\text{Sample size} = \frac{885}{1 + 885 (0.05)^2} = 276$$

Since all the required sample has been got in their homes and farm site i didn't use non respondents of 5%

3.4 Tools and techniques of data collection

Tools

For this researches the following tools such as questionnaires (structured & semi-structured), Interview guidelines and as well as field survey/observation/ of small holder farmers was applied.

Techniques

Source of data include primary (through questioner from each house hold and filed observation) & secondary sources (gathering from recorded document from *Quarit* agricultural office); Data collection approaches are qualitative & quantitative by the sampling methods of Purposive (*woreda and Kebeles*) and systematic random sampling for targeting household head. Questionnaires: Structured questionnaire was developed for the purpose of data collection which was designed to obtain information on adoption of potato production and post-harvest technologies in smallholder farmers and its implication to food security. It was translated into and administered in Amharic for easy communication with respondents. The researcher maintained data quality with enumerators daily through regular observation and reviewing of the completed questionnaire. For the qualitative method the researcher used the pre-designed checklist to probe the desired answers from the smallholder farmers. The data were collected directly by the researcher.

3.5 Study variables

Variables for the factors determining the adoption of major technologies are:

Dependent variables:

- ✓ Adoption of Potato production technology packages, Adoption of Postharvest technology packages and food security status of smallholder farmers.

Independent variables are:

- ✓ Age, gender, educational level, and family size, farm experience, farm size, extension service, availability for socio demographic characteristics.
- ✓ *Improved varieties, Row plant, DAP, Urea*, land preparation and herbicide are for Production technologies adoption index.
- ✓ Seed storage (DLS), Transportation, Sorting Grading and Packing are Post-harvest technologies index.
- ✓ Both production and post-harvest technology adoption index separately as well as together to saw the implication for food security status of the households.

3.6 Techniques of data analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) for new windows 25.0 software package and stata14.1. Descriptive statistics including mean, standard deviation, minimum, maximum, frequencies and percentage were used. In addition, descriptive tools such as tables were used to present results. In order to see the association between technologies' adoption and food security status, descriptive tests such as chi-square, t-test and f-test are used. The quantity of the bundle of food is determined in such a way that the bundle meets the predetermined level of minimum caloric requirement (2200 kilocalorie). So the recommended level of calorie per adult equivalent (2200kcal/day/person for Ethiopia) is used as a cut-off point for food insecure and food secure households. (FDRENPC, 2017)

In the econometric model estimation of the intensity of adoption using a dependent variable which bears a zero value for a portion of the observations and certain proportion of continuous nature requires a censored regression model (Tobit model). Censored regression models (including the standard Tobit model) are usually estimated by the Maximum Likelihood (ML) method. The log likelihood function is specified with an assumption that the error term ε follows a normal distribution with mean 0 and variance 2. The Tobit coefficients can be interpreted as coefficients of a linear regression model. In line with this, determinants of adoption of potato technology package were investigated by using Tobit model. Such censored regression is preferred because it uses data at the limit as well as those above the limit to estimate regression. The dependent variable in the model is an index value ranging from 0 to 1. A value of 0= indicates non adopter; index value 1=low adopters, 2=medium adopters and 3=which implies high adopters of the technology component and the values between 0 and 1 indicate the level of the adoption within Tobit model values. Tobit model can be derived by defining a new random variable y^* that is a function of a vector of variables (Maddala, 1997).

The equation for the model is constructed as: $y^* = X_i\beta_i + \varepsilon_i$ ----- (1)

Where y^* is unobserved for values less than 0 and greater than 1 (called a latent variable). It represents an index for potato technology package adoption, X_i represents a vector of explanatory variables, β_i is a vector of unknown parameters, and ε_i is the error term. By representing y_i (selected technology adoption index) as the observed dependent variable, the Tobit model can be specified as:

Production technology adoption index:

$$Adop.index = \frac{Imp.var. + Row\ planting + DAP + Urea + land\ preparation + Herbicide}{6} \dots \dots \dots (2)$$

The dependent variable for potato production technology adoption package was an index computed from the use and intensity of technologies related to improved variety, row planting, Di-Ammonium Phosphate (DAP) Urea and herbicides in potato production. It is a weighted index, censored between 0 and 1, which is computed based on these six technology components. $y_i = \{0$ if $y_i^* = 0$; $1=y^*$ if $0 < y_i^* \leq 0.170$, $2= y^*$ if $0.171 \leq y_i^* \leq 0.670$, $3= y^*$ if $0.671 \leq y_i^* \leq 1\}$; 0=non adopters, 1 low adopters, 2 medium adopters and 3 which implies high adopters.

Postharvest technology adoption index:

$$Adop.index = \frac{\text{Seed storage (DLS)} + \text{Transportation} + \text{Sorting} + \text{Grading} + \text{Packing}}{5} \dots \dots \dots (3)$$

The dependent variable for potato post harvest technology adoption package was an index computed from the use and intensity of technologies related to Seed storage (DLS), Transportation, Sorting, Grading, Packing in potato post harvest technologies. It is a weighted index, censored between 0 and 1, which is computed based on these five technology components.

$y_i = \{0 \text{ if } y_i^* = 0; 1=y^* \text{ if } 0 < y_i^* \leq 0.20, 2= y^* \text{ if } 0.21 \leq y_i^* \leq 0.60, 3= y^* \text{ if } 0.61 \leq y_i^* \leq 1\}$; 0=non adopters, 1=low adopters, 2=medium adopters and 3=which implies high adopters.

Both technologies adopted adoption index:

$$Adop.index = \frac{Imp.var. + Row\ plant + DAP + Urea + \text{land preparation} + \text{herbicide} + \text{Seed storage (DLS)} + \text{Transportation} + \text{Sorting} + \text{Grading} + \text{Packing}}{11} \dots \dots \dots (4)$$

The dependent variable for both potato production and post harvest technology adoption package was an index computed from the use and intensity of technologies related to *Imp.var.*, *Row plant*, *DAP*, *Urea*, land preparation, herbicide, and Seed storage (DLS), Transportation, Sorting, Grading, Packing in both adoptions of potato technologies. It is a weighted index, censored between 0 and 1, which is computed based on these eleven technology components.

$y_i = \{0 \text{ if } y_i^* = 0; 1=y^* \text{ if } 0 < y_i^* \leq 0.330, 2= y^* \text{ if } 0.331 \leq y_i^* \leq 0.670, 3= y^* \text{ if } 0.671 \leq y_i^* \leq 1\}$; 0=non adopters, 1=low adopters, 2=medium adopters and 3=which implies high adopters.

In potato production technology adoption index has been use intensity is the proportion of potato farm covered by improved variety(Sabew, Ater abeba); DAP use intensity is the ratio of the actual rate of DAP applied on a potato field to the recommended rate of DAP (i.e. 195 kg per ha); Urea use intensity is the ratio of actual rate of Urea applied on a potato field to the recommended rate of Urea (i.e. 165kg per ha); use herbicides(2 times sprayed 50-55& 70-75 days), and row planting is whether the farmers have used nearly or exactly the recommended spacing between rows and plants.

In the case of post-harvest technology adoption also includes: Seed storage (DLS), transportation, Sorting, Grading and Packing. Theoretical justifications and prior literature has been showthat a number of explanatory variables have been hypothesized to influence the adoption of potato technology package. Accordingly, attempts were made to include relevant variables that are expected to influence the decision of adoption of potato technology package by smallholder farmers. Household Food Balance Model (HFBM): is employed to compute the net quantity of per capita food. The net available food per household, as reported from household recall, is converted into dietary energy equivalent using EHNRI/FAO (1998)'s Food Composition Table for Use in case of Ethiopia. Then, the medically recommended level of calorie per adult equivalent (2200kcal/day/person for Ethiopia) is used as a cut-off point for food insecure and food secure households or individuals.

$$TG = TGP + TGB + TGQ + TGG + TGPHL + TGRS + TGS + TGGO + MP + DP \dots\dots\dots(5)$$

Where; total grain(TG)=TG(produced)+TG(bought)+TG (Quantity of food aid obtained)+TG(obtained through gift)+TG(Post harvest losses)+TG(Quantity of grain reserved for seed)+TG(Amount of grain sold)+ TG(Grain given to others within a year)+ MP(Meat, meat based products and poultry)+DP(Dairy and dairy based products). This is a simple equation originally adapted by Degefa (1996) from FAO Regional Food Balance Model and thenceforth used by different researchers in Ethiopia. The potential explanatory variables hypothesized and included in the Tobit model are those indicated as follows.

Table 1 Summary of the independent variables hypothesized adoption of technology package

Variables	Type of Variable	Description of the variable	Expected sign
Sex of the household head	Dummy	1 if the household head is male, 0 otherwise.	+/-
Age	Continuous	Age of household head (in years)	+
Marital status	Dummy	Marital status of the household head has been(single,married,divorced and wudowed	+/-
Education	Dummy	The educational status of the head of household, 1 if literate, 0 otherwise	+
Family size	Discrete	Number of individuals in a household	+/-
Distance from all- weather roads	Continuous	The distance of home from all-weather road, measured in Kilometers.	-
Distance to market	Continuous	The distance of home from market, measured in Kilometers	-
Extension contact	Categorical	Frequencies of extension contact which takes a value 0, 1, 2, 3, 4 and 5 if no contact, every day, every week and every month, respectively	+/-
Total land size	Continuous	Total land size owned and cultivated by households, measured in ha	+

4 RESULTS AND DISCUSSION

4.1 Descriptive analysis of socio demographic of the study area

This sub-section discusses the association of various variables with adoption and intensity of adoption of potato technologies by using descriptive and inferential statistics.

Table 2 Demographic characteristics with adoption of potato production technologies

Demographic variables		Non adopters %	Low adopters %	Medium adopters %	High adopters %	Test-Statistics
Sex	F	10.8	12.7	21.6	22.7	.225
	M	77.3	78.4	87.3	89.2	
Age-grouped	20-30	5.4	5.5	6.8	10.0	.348
	31-40	15.5	24.3	27.3	35.1	
	41-50	45.9	45.9	46.4	47.3	
	51-65	13.5	20.0	23.0	28.2	
	Mean	43.92	45.33	45.81	46.50	.787
Marital- status	Married	78.2	81.1	87.3	89.2	.611
	Divorced	8.1	9.1	13.5	18.2	
	Widowed	2.7	3.6	3.6	5.4	
Education level of HH head	illiterate	89.2	91.8	94.5	94.6	.532
	Grade1-8	4.1	5.5	8.1	8.2	
	Grade 9-12	0.0	0.0	1.4	2.7	
Average Family size (4.85)	13.4	19.9	26.8	39.9	.034	
Average Total farm size(1.33ha)	21.2	23.1	26.9	44.2	1.208	
Average Potato farm size(0.40ha)	11.5	17.3	26.9	28.8	1.414	
Average Distance to market(10.66km)	17.3	21.2	25.0	36.5	1.069	
Average DA contact days/year(2.98)	13.4	19.9	26.8	39.9	2.677	

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

Table 3 Demographic characteristics with adoption of potato post-harvest technologies

Demographic variables		Non adopters	Low adopters	Medium adopters	High adopters	Test-Statistics
		%	%	%	%	
Sex	F	17.0	19.1	18.1	20.5	.962
	M	79.5	80.9	81.9	83.0	
Age-grouped	20-30	3.4	8.5	8.5	12.8	.360
	31-40	21.6	23.4	23.4	23.4	
	41-50	39.4	42.6	51.1	53.4	
	51-65	12.8	21.6	25.5	28.7	
	Mean	43.55	45.68	46.30	46.33	
Marital status	Married	80.7	80.9	83.0	84.0	.896
	Divorced	11.7	13.6	14.9	17.0	
	Widowed	2.1	2.1	4.3	5.7	
Education level of HH head	illiterate	90.4	91.5	93.6	95.5	.725
	Grade1-8	4.5	6.4	6.4	8.5	
	Grade 9-12	0.0	0.0	1.1	2.1	
Average Family size (4.85)		17.0%	17.0%	31.9%	34.1%	1.207
Average Total farm size(1.33ha)		18.2	22.7	34.2	39.5	.219
Average Potato farm size(0.40ha)		10.5	15.8	27.3	31.8	.402
Average Distance to market(10.66km)		12.1	15.4	35.2	37.4	.911
Average DA contact days/year(2.98)		14.0%	16.0%	31.9%	38.1%	.966

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

4.1.1 Gender of the household headed

The survey result revealed that in the case of potato production technologies gender distribution of the sample households are as shown in table-2 the gender profile with the adoption of potato production technologies 10.8% and 77.3% non-adopter female and male respectively, 12.7% and 78.4% low adopter female and male respectively, 21.6% and 87.3% medium adopters female and male respectively and the 22.7% and 89.2% high adopters female and male respectively. In the case of potato post-harvest technologies gender distribution of the sample households are as shown in table-3 the gender profile with the adoption of potato postharvest technologies 17.0% and 79.5% non-adopter female and male respectively, 19.1 % and 80.9 % low adopter female and male respectively, 18.1% and 81.9% medium adopters female and male respectively and 20.5% and 83.0% high adopters female and male respectively.

4.1.2 Age of the household headed

The survey result revealed that about as shown in table-2 the respondents' age mean indicate the adoption of potato production technologies 43.92 non adopter, 45.33 low adopter, 45.81 medium adopter and 46.5 high adopter. On the other hand for adoption of postharvest technologies the age mean indicate in table-3 that 43.55, 45.68, 46.30 and 46.33 are non-adopters, low-adopters, medium adopters and high adopters respectively. This indicates the survey result revealed that more of the respondents were found in the age category of 31-65 years, the average age of the total sample household head is found to be 45.74 with standard deviation of 8.971 ranging from 20 to 65 years. Age is also assumed a determinant of adoption of new technology. Older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Dewi, 2013). On different age has been found to have a negative relationship with adoption of technology that relationship is explained by (Barrera, 2005). Farmers grow older; there is an increase in risk aversion and a decreased interest in long-term investment in the farm.

4.1.3 Marital status of the household headed

The survey result revealed that in the case of potato production technologies marital status of the household headed of the samples are as shown in table-2 for non-adopters are with the adoption status of potato production technologies has been (78.2% married, 8.1% divorced and 2.7% widowed), low -adopters are with the adoption status of potato production technologies has been (81.1% married, 9.1% divorced and 3.6% widowed), medium -adopters are with the adoption status of potato production technologies has been (87.3% married, 13.5% divorced and 3.6% widowed) and high-adopters are with the adoption status of potato production technologies has been (89.2% married, 18.2% divorced and 5.4% widowed). In the case of potato postharvest technologies marital status of the household headed of the samples are as shown in table-3 for non-adopters are with the adoption status of potato postharvest technologies has been (80.7% married, 11.7% divorced and 2.1% widowed), low -adopters are with the adoption status of potato postharvest technologies has been (80.9% married, 13.6% divorced and 2.1% widowed), medium -adopters are with the adoption status of potato postharvest technologies has been (83.0% married, 14.9% divorced and 4.3% widowed) and high-adopters are with the adoption status of potato postharvest technologies has been (84.0% married, 17.0% divorced and 5.7% widowed). So in general the adoptions of both technologies are show slightly increment but from the respondent marital status which are shows from the result that more adopter householder has been married.

4.1.4 Educational status of the household headed

The survey result revealed that in the case of potato production technologies that educational status of the household headed of the samples are as shown in table-2 for non-adopters are with the adoption status of potato production technologies has been (89.2% illiterate, 4.1% grade 1-8 completed and 0% grade 9-12 has been completed), low -adopters are with the adoption status of potato production technologies has been (91.8% illiterate, 5.5% grade 1-8 completed and 0% grade 9-12 has been completed), medium -adopters are with the adoption status of potato production technologies has been (94.5% illiterate, 8.1% grade 1-8 completed and 1.4% grade 9-12 has been completed) and high-adopters are with the adoption status of potato production technologies has been (94.6% illiterate, 8.2% grade 1-8 completed and 2.7% grade 9-12 has been completed).

In the case of potato postharvest technologies educational status of the household headed of the samples are as shown in table-3 for non-adopters are with the adoption status of potato postharvest technologies has been (90.4% illiterate, 4.5% grade 1-8 completed and 0% grade 9-12 has been completed), low -adopters are with the adoption status of potato postharvest technologies has been (91.5% illiterate, 6.4% grade 1-8 completed and 0% grade 9-12 has been completed), medium -adopters are with the adoption status of potato postharvest technologies has been (93.6% illiterate, 6.4% grade 1-8 completed and 1.1% grade 9-12 has been completed) and high-adopters are with the adoption status of potato postharvest technologies has been (95.5% illiterate, 8.5% grade 1-8 completed and 2.1% grade 9-12 has been completed). So in general the adoption of both technologies is show slightly increment but from the respondent educational status which are shows from the result that more adopter householder has been illiterate. Education level of a farmer increases his ability to obtain process and use information relevant to adoption of a new technology (Akinwalere, 2011).

This is because higher education influences farmers' decision, hence making them more open, rational and able to analyze the benefits of the new technology. This eases the introduction of a new innovation which ultimately affects the adoption process (Okunlola, 2013). On the other hand, some authors have reported insignificant or negative effect of education on the rate of technology adoption (Faham, 2009). Access to information through training and formal education is expected to enhance farmers' innovation capacity by creating effective demand for the adaptation and adoption of sustainable agricultural practices, including potato production and postharvest technologies. Low level of education and high illiteracy rate is typical in developing countries like Ethiopia.

4.1.5 Family size of the household headed

The average family size of the sampled respondent household headed was 4.85 persons with standard deviation 1.007 during survey year, which is equivalent to the national rural household size of 4.9 persons (CSA, 2012). The minimum and maximum household sizes varied between 3 and 7 persons, respectively. The survey result revealed that in the case of potato production technologies that average family size of the household headed of the samples are as shown in table-2 that 13.4%, 19.9%, 26.8% and 39.9% non-adopters, low –adopters, medium -adopters and high-adopters respectively.

In the case of potato postharvest technologies average family size of the household headed of the samples shows in table-3 that 17.0%,17.0% 31.9% and 34.1% non-adopters, low –adopters, medium -adopters and high-adopters respectively. So in general the adoption of both technology are show slightly increment but from the respondent high number of family size has more adopter than low family member of the households. Household size is simply used as a measure of labor availability. It determines adoption process in that, a larger household have the capacity to relax the labor constraints required during introduction of new technology (Mignouna et al., 2011).

4.1.6 Farm size of the household headed

In the study areas, sampled households have only 0.4 ha, serving appropriately average 4.85 members). The average total farm size and potato farm size is 0.33 ha and 0.4 ha respectively of the sampled farmers is 4.85 persons with standard deviation 1.007 during survey year, which is equivalent to the national rural household size of 4.9 persons (CSA, 2012). The survey result revealed that in the case of potato production technologies that average farm size of 0.33 ha of the household headed that the samples are as shown in table-2 that 21.2 %, 23.1%, 26.9% and 44.2% non-adopters, low –adopters, medium -adopters and high-adopters respectively. In the case of potato postharvest technologies average farm size of the household headed of the samples shows in table-3 that 18.2%, 22.7%, 34.2% and 39.5% are non-adopters, low –adopters, medium -adopters and high-adopters respectively.

The survey result revealed that also in the case of potato production technologies that average potato farm size of the household headed of the samples are as shown in table-2 that 11.5%, 17.3%, 26.9% and 28.8% non-adopters, low –adopters, medium -adopters and high-adopters respectively. In the case of potato postharvest technologies potato farm size of the household headed of the samples are shown in table-3 that 10.5%, 15.8% 27.3% and 31.8% non-adopters, low –adopters, medium -adopters and high-adopters respectively. The farm size refers to the total amount of land available to a farmer perform its agricultural production (Brindal, 2012). Farm size plays a critical role in adoption process of a new technology that some technologies are termed as scale-dependent because of the great importance of farm size in their adoption. Many studies have reported a positive relation between farm size and adoption of agricultural technology.

Farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to try new technology unlike those with less farm size (Uaiene et al., 2009). Since total farm size has an effect on overall adoption, considering the crop acreage with the new technology may be a superior measure to predict the rate and extent of adoption of technology (Lowenberg-DeBoer, 2000). Therefore, with regard to farm size, technology adoption may best be explained by measuring the proportion of total land area suitable to the new technology.

4.1.7 Average distance to market of the household headed

The average distance to market of the respondent the survey result revealed that in the case of potato production technologies that average distance to market of the respondent of the household headed of the samples are shown in table-2 that 17.3%, 21.2%, 25.0% and 36.5 % non-adopters, low –adopters, medium -adopters and high-adopters respectively. In the case of potato postharvest technologies average distance to market of the respondent of the household headed of the samples are shown in table-3 that 12.1%, 15.4%, 35.2% and 37.4 % non-adopters, low –adopters, medium -adopters and high-adopters respectively.

4.1.8 Development agent contact days per year of the household headed

The average development agent (DA) contact days per year of the respondent the survey result revealed that in the case of potato production technologies that average distance to market of the respondent of the household headed of the samples are as shown in table-2 that 13.4%, 19.9%, 26.8% and 39.9 % non-adopters, low –adopters, medium -adopters and high-adopters respectively. In the case of potato postharvest technologies average development agent (DA) contact days per year of the respondent of the household headed of the samples are shown in table-3 that 14.0%, 16.0%, 31.9% and 38.1 % non-adopters, low –adopters, medium -adopters and high-adopters respectively. Extension services of technology adoption among farmers are higher when extension services are made available. Through extension services, farmers get to know the benefits of new technology through extension agents. This helps to reduce transaction cost incurred when passing the information on the new technology to a large heterogeneous population of farmers. Extension agents usually target specific farmers (farmers with whom a particular farmer interacts) exerting a direct or indirect influence overall population of farmers in their respective areas (Genius et al., 2013).

Table 4 Adoption of potato production technology

Production Technology packages	Non adopters %	Low adopters %	Medium adopters %	High adopters %	Test-Statistics
Improved variety(Sabew, Ater abeba)	0.0	0.0	33.6	100	13.6***
Row planting	0.0	33.6	48.6	100	20.2***
Fertilizer rate DAP(195 kg per ha) and UREA(165kg per ha)	0.0	51.4	67.3	100	20.5***
Spacing 30*70 cm(30cm between plant and 70 cm between row)	0.0	0.0	32.7	75.7	11.72***
land preparation(3-4)	0.0	0.0	82.7	100	20.2***
Herbicide (2 times sprayed 50-55& 70-75 days)	0.0	0.0	17.3	74.3	10.03***

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

The respondent survey result in table-4 revealed that based on potato production technology adoption in that particular study area has been indicated the adoption intensity of production technology packages are for improved variety which are practically done to the recommended amount and type are as follows 0%, 0%, 33.6% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For Row planting which are practically done to the recommended amount and type are as follows 0%, 33.6%, 48.6% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For Fertilizer rate DAP(195 kg per ha) and UREA(165kg per ha) which are practically done to the recommended amount and type are as follows 0%, 51.4%, 67.3% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For Spacing 30*70 cm(30cm between plant and 70 cm between row) which are practically done to the recommended amount and type are as follows 0%, 0%, 32.7% and 75.7% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For land preparation(3-4) which are practically done to the recommended amount and type are as follows 0%, 0%, 82.7% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively.

For Herbicide (2 times sprayed 50-55& 70-75 days) which are practically done to the recommended amount and type are as follows 0%, 0%, 17.3% and 74.3% are non-adopters, low –adopters, medium -adopters and high-adopters respectively

Table 5 Adoption of potato postharvest technology

Post-harvest Technology packages	Non adopters %	Low adopters %	Medium adopters %	High adopters %	Test-Statistics
Seed storage (DLS)	0.0	0.0	21.6	100.0	13.8***
Transportation with handling sacks	0.0	48.9	52.3	75.5	16.82***
Sorting	0.0	51.1	100.0	100.0	28.44***
Grading	0.0	0.0	73.9	100.0	19.33***
Packing	0.0	0.0	0.0	74.5	9.66***

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

The respondent survey result in table-5 revealed that based on potato post-harvest technology adoption in that particular study area has been showed the adoption intensity of postharvest technology packages are for DLS (Diffused light storage) which are practically done to the recommended amount and type are as follows 0%, 0%, 21.6% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For transportation with handling sacks which are practically done to the recommended amount and type are as follows 0%, 48.9%, 52.3% and 75.5% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For sorting which are practically done to the recommended amount and type are as follows 0%, 51.1%, 100% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For grading which are practically done to the recommended amount and type are as follows 0%, 0%, 73.9% and 100% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. For packing which are practically done to the recommended amount and type are as follows 0%, 0%, 21.6% and 74.5% are non-adopters, low –adopters, medium -adopters and high-adopters respectively.

Table 6 Food security status of the households headed

Technology adoption	Food security status of the households headed(2200 kcal-cutoff point)	Non adopters %	Low adopters %	Medium adopters %	High adopters %	Test-Statistics
Adoption of potato production technology	Food secured \geq 2200Kcal/day	16.8	20.2	26.9	36.1	.005**
Adoption of Potato postharvest technology	Food secured \geq 2200Kcal/day	15.1	16.0	33.6	35.3	.002**
Both Technology adoption	Food secured \geq 2200Kcal/day	39.2	48.6	50.0	54.5	.001***

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

The results table-6 shows from the respondent survey result revealed that based on potato production technology adoption index and cutoff point of food secured of 2200 kcal/day indicate that food security status of the household headed in that particular study area has been showed 16.8%, 20.2%, 26.9% and 36.1% are non-adopters, low –adopters, medium -adopters and high-adopters respectively. On the other hand based on survey result of potato postharvest technology adoption index and cutoff point of food secured of 2200 kcal/day of the respondent household headed in that particular study area has been showed 15.1%, 16.0%, 33.6% and 35.3 % non-adopters, low –adopters, medium -adopters and high-adopters respectively. Those household headed which has been adopted both technology has better food secured status than those respondents which has been adopted two technology separately. The respondent survey result revealed that based on both technology adoption (potato production technology adoption index and potato postharvest technology adoption index) with cutoff point of food secured of 2200 kcal/day indicate that food security status of the household headed in that particular study area has been showed 39.2%, 48.6%, 50.0% and 54.5% are non-adopters, low –adopters, medium -adopters and high-adopters respectively.

4.2 Tobit regression analysis for adoption of potato technology package

Table 7 Parameter estimates of the Tobit model for adoption of potato production technologies

Parameter estimates of the Tobit model for adoption of potato production technologies		
Variables	Coefficient	Standard error (Robust)
Sex of household head	.1254	.10
Age of household head (years)	-.0228**	.01
Marital status of the household head	.0630*	.08
Education of household head (dummy)	-.0408**	.04
Family size (number)	-.001***	.01
Farmsize total (ha)	-.0235**	.03
Improved varites	-.4005	.06
Row planting	.9102	.02
Fertilizer rate	.9621	.02
Spacing30by70cm	.3447	.04
Landpreparation3upto4times	.9530	.02
Herbicied2times	.6734	.06
Number of days counsulted per year	-.0128**	.006
Distance to all weather roads (km)	-.0185**	.01
Distance to market (km)	.0047***	.006
Constant	.0451**	.27
LR Chi2 (31)	31.49***	
Number of observation (N)	276	

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

4.3 Determinants for adoption of potato production technology package

The Tobit model results demonstrated a good fit at 5% level of significance. Moreover, the overall variance inflation factors (VIF) of all the independent variables in the model is less than 10, indicating that multi collinearity was not a severe problem. According to the model results, from the censored regression analysis model (Tobit model) result revealed in table -7 that age of household head, education of household head, farmsize, number of days counsulted per year and distance to all weather roads were found significantly determining adoption of potato production technology packages at 0.05 with constant value have been p- value 0.05. The result depicts that farmers who used more frequent DAs contact were found to be better adopters of potato technology package as compared to those who are not contact DAs. The result was having access to extinction service results in increase of adoption of potato technology package. Family size and distance to market significantly affect the adoption of potato production technology at 0.01 with constant value have been p- value 0.05. However marital status is significantly affect at 0.1 but sex has no significant effect on adoption of potato production technology.

Farm size was hypothesized to positively influence adoption of potato technology package. However, the current result is against this expectation. The result shows that farm size was negatively affecting adoption of potato technology package. This could happen as the production of potato, unlike other crops, requires more intensive production managements that fit into smaller farms. This intensive management could in turn result into a relatively higher productivity that further intensifies adoption of the package. A similar finding was reported by Yigezu et al., 2015 on adoption of potato technology component. Also similar results were reported by Kumilachew et al.,2013 the possible reason, among others, could be due to the fact that having higher income reduces financial constraints for purchasing inputs required for potato production. Crop technology adoption studies also revealed similar results (Tura et al., 2010; Musa 2015).

Table 8 Parameter estimates of the Tobit model for adoption of potato post-harvest technologies

Parameter estimates of the Tobit model for adoption of potato post-harvest technologies		
Variables	Coefficient	Standard error (Robust)
Sex of household head	-0.049 **	0.09
Age of household head (years)	-0.011 **	0.02
Marital status of the household head	-0.044**	0.08
Education of household head (dummy)	-0.066 *	0.05
Family size (number)	-0.010***	0.02
Farmsize total (ha)	-0.010 ***	0.05
Seed storage with in difused light storage (DLS)	0.523	0.05
Transportationwithsacks	0.641	0.03
Sorting	1.216	0.05
Grading	0.511	0.05
Packing	0.369	0.36
Number of days counsulted per year	0.004 ***	0.01
Distance to all weather roads (km)	-0.000***	0.01
Distance to market (km)	0.003***	0.01
Constant	0.0158***	0.30
LR Chi2 (56)	56.58***	
Number of observation (N)	276	

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

4.4 Determinants for adoption of potato post harvest technology package

The Tobit model results demonstrated a good fit at 5% level of significance. Moreover, the overall variance inflation factors (VIF) of all the independent variables in the model is less than 10, indicating that multi collinearity was not a severe problem. According to the model results, from the censored regression analysis model (Tobit model) result revealed in table -8 that sex of household head, age of household head and marital status were found significantly determining adoption of potato post-harvest technology packages at 0.05 with constant value have been p- value 0.01. Farmsize, family size, number of days counsulted per year and distance to all weather roads and distance to market has been significantly determining adoption of potato post-harvest technology packages at 0.01 with constant value have been p- value 0.01. However education of household head is significantly affect at 0.1 on adoption of potato post-harvest technology.

Table 9 Parameter estimates of the Tobit model for adoption of both technology packages

Variables	Coefficient	Standard error (Robust)
Sex of household head	0.152	0.10
Age of household head (years)	-0.022**	0.02
Marital status of the household head	0.090*	0.08
Education of household head (dummy)	-0.069*	0.06
Family size (number)	0.015**	0.03
Farmsize total (ha)	0.004**	0.05
Improved vairites	0.224	0.08
Row planting	0.434	0.07
Fertilizer rate	0.383	0.06
Spacing30by70cm	0.243	0.04
Landpreparation3upto4times	0.152	0.04
Herbiced2times	0.123	0.05
Seed storage with in difused light storage (DLS)	0.282	0.06
Transportationwithsacks	0.251	0.03
Sorting	0.314	0.05
Grading	0.317	0.06
Packing	0.199	0.05
Number of days counsulted per year	-0.004***	0.01
Distance to all weather roads (km)	-0.004***	0.01
Distance to market (km)	0.002***	0.01
Constant	0.061*	0.3
LR Chi2 (59.48)	59.48***	
Number of observation (N)	276	

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

From the above censored regression analysis model (Tobit model) result revealed in table -9 that age of household head, farmsize and family size are significantly affect both the adoption of potato production and post harvest technologies technology at 0.05 with constant value have been p- value 0.1. Numbers of days counsulted per year, distance to all weather roads and distance to market significantly affect both the adoption of potato production and post harvest technologies technology at 0.01 with constant value have been p- value 0.1. Education of household head and marital status are significantly affected at 0.1 on both the adoption of potato production and post harvest technologies technology. But sex of household head has no significant effect on both adoption of potato production and post harvest technologies.

Table 10 Parameter estimates of the Tobit model to food secutity status of the household head

Parameter estimates of the Tobit model to food secutity status of the household head		
Variables	Coefficient	Standard error (Robust)
Adoption production index cata	-0.073 *	0.08
Post-harvest adoption index cat	-0.008***	0.07
Both technology adoption index catagories	0.010***	0.14
Constant	0.050**	0.14
LR Chi2 (29.1)	29***	
Number of observation (N)	276	

Note: ***, **, & * implies statistical significance at 1%, 5%, and 10% levels, respectively. Source: Own calculation based on field survey (2018/19).

From the above censored regression analysis model (Tobit model) result revealed in table -10 that post-harvest adoption index and both technology adoption index is significantly affect food secutity status of the household head at 0.05 with constant value have been p- value 0.01. Adoption production index significantly affect food secutity status of the household head at 0.1 with constant value have been p- value 0.01.

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study analyzed the factors that affect adoption of potato technology package using descriptive statistics, chi-square test and censored regression analysis. The study was based on data collected from 276 potato growing farmers from Quarit districts. The econometric model result revealed that in districts: In the case of potato production technology adoption intensity that age of household head, education of household head, farmsize, number of days consulted per year and distance to all weather roads significantly affect the adoption of potato production technology at 0.05. Family size and distance to market significantly affect the adoption of potato production technology at 0.01. However marital status is significantly affect at 0.1 but sex has no significant effect on adoption of potato production technology. In the case of potato post harvest technology adoption intensity that sex of household head, age of household head and marital status are significantly affect the adoption of potato production technology at 0.05. Farmsize, family size, number of days consulted per year and distance to all weather roads and distance to market significantly affect the adoption of potato post harvest technology at 0.01. However education of household head is significantly affect at 0.1 on adoption of potato post harvest technology.

The econometric model result revealed that in districts also in the case of both the adoption of potato production and post harvest technologies technology adoption intensity that age of household head, farmsize and family size are significantly affect both the adoption of potato production and post harvest technologies technology at 0.05. Numbers of days consulted per year, distance to all weather roads and distance to market significantly affect both the adoption of potato production and post harvest technologies technology at 0.01. Education of household head and marital status are significantly affected at 0.1 on both the adoption of potato production and post harvest technologies technology. But sex of household head has no significant effect on both adoption of potato production and post harvest technologies. In the case of food security status of the household head in table -10 that post-harvest adoption index and both technology adoption index is significantly affect food security status of the household head at 0.05. Adoption production index significantly affect food security status of the household head at 0.1.

This study revealed that farmers in the district practice potato production technologies have adopted but due to poor practices and low knowledge and skill with related to recommended production technologies with recommended levels that potato production are characterized by low productivities in the district. On the other hand post-harvest technologies were also practiced traditionally and have impacte on food security status in the area. In general, the study finding shows that low levels of adoption of potato production technologies and adoption of postharvest technologies were practiced due to lack availabilities of technologies with poor awareness, knowledge and skill gaps of the farmers, etc. This leads to poor productivities and high loss of potato in the study area that significantly affecting food security status of the households. So development agent of the region, zone, woreda as well as the keble currently assiniend in the study area should be has been intensively work on the issue food security in the district related to the main crop of potato and other different related crops (ereales and pulses) which has asignificant role on improving food security status of the smallholder farmers in the district.

5.2 Recommendation

Use of potato production and post harvest technology packages are still lagging behind the recommendations for potato production system in the study areas. This implies that there is a possibility for enhancing potato productivity by encouraging use of these technology packages to their recommended levels. Potato production technologies in particular require consideration of location specific factors, attempts in technology dissemination should take in to account these realities. To facilitate the adoption of modern potato production technology packages and postharvest technology packages with storage facilities among farmers in the study area, the following recommendations are proposed;

- Extension agents should actively disseminate information on improved potato production and postharvest technology packages as well as storage techniques to farmers in the study area through use of mass media (e.g. radio/tv) and farmers groups.
- To solve the problem of inadequate capital, farmers should pool their funds through joint contribution. Such funds can be used to purchase the costly postharvest and storage facilities.
- Available sources of potato production and postharvest technology packages as well as storage techniques should be communicated to farmers by the zonal extension service.
- Use of some modern potato production and postharvest technology packages as well as storage techniques require specialized skills and technical know-how which farmer's lack.
- Farmers and extension staff should continuously be trained on the use of these improved potato production and postharvest technology packages as well as methods.

In general, potentially effective improved potato production and postharvest technology packages as well as storage techniques for potato have been identified. In future, the focus on food security status related to nutritional security status of smallholder in related diferent crops as well food safty in the study area will be an interested issue to solv the critical problem in district

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C) Tobit Adoptionproductionindexcata Sex Age Agegroup Marstatus Edustatus Familsze Farmsizetot Farmsizecultland Improvedvarity Rowplanting Fertilizerrate Spacing30by70cm Landpreparation3upto4times Herbiced2times Spacingbetwenplant Spescingbeteweenrow Totapotprodu Totpotpostharvloss Numbdayscounsultedperyr Distanceofmainroad Timetakendistancetomarket.

Tobit regression Number of obs = 272

F(21, 251) = 934.01

Prob > F = 0.0000

Log pseudolikelihood = 31.844661 Pseudo R2 = 1.0760

Adoptionproductionindexc~a	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
Sex	.1081309	.1025735	1.05	0.293	-.0938835	.3101453
Age	.0045493	.0040873	1.11	0.267	-.0035006	.0125991
Agegroup	-.0667079	.0409971	-1.63	0.105	-.1474501	.0140343
Marstatus	.0507392	.0829333	0.61	0.541	-.1125947	.2140731
Edustatus	-.042889	.0386641	-1.11	0.268	-.1190364	.0332583
Familsze	-.0140856	.0138666	-1.02	0.311	-.0413953	.013224
Farmsizetot	-.0258645	.0330444	-0.78	0.435	-.0909441	.0392151
Farmsizecultland	-.0014685	.0353532	-0.04	0.967	-.0710952	.0681583
Improvedvarity	-.3980198	.0680718	-5.85	0.000	-.5320845	-.263955
Rowplanting	.911589	.0243412	37.45	0.000	.86365	.959528
Fertilizerrate	.959983	.0242249	39.63	0.000	.9122729	1.007693
Spacing30by70cm	.3405235	.046066	7.39	0.000	.2497984	.4312486
Landpreparation3upto4times	.9554986	.0257446	37.11	0.000	.9047956	1.006202
Herbiced2times	.6730758	.0654959	10.28	0.000	.5440842	.8020674
Spacingbetwenplant	-.0383236	.0321501	-1.19	0.234	-.101642	.0249947
Spescingbeteweenrow	.0112212	.0110509	1.02	0.311	-.0105432	.0329855
Totapotprodu	-.0013641	.0005236	-2.61	0.010	-.0023953	-.0003329
Totpotpostharvloss	.0052784	.0092156	0.57	0.567	-.0128714	.0234281
Numbdayscounsultedperyr	-.0125968	.0063129	-2.00	0.047	-.0250297	-.0001638
Distanceofmainroad	-.0191487	.0107331	-1.78	0.076	-.0402871	.0019898
Timetakendistancetomarket	.0053074	.0068953	0.77	0.442	-.0082726	.0188874
_cons	.0596111	.2682015	0.22	0.824	-.468601	.5878232

0 left-censored observations; 198 uncensored observations & 74 right-censored observations at Adoptionpr~a >= 3

POST HARVEST ANALYSIS RESULT

A) Tobit Postharvestadoptioncat Sex Agegroup Marstatus Edustatus Familsze Farmsizetot Farmsizecultland Improvedvarity Totpotpostharvloss Ac tivelabor Illiterate Numbdayscounsultedperyr Distanceofmainroad Timetakendistancetomarket SeedstoragewithDLS Transportationwithsacks So rting Grading Packing Adoptionproductionindexcata,

Tobit regression Number of obs = 272; F(20, 252) = 226.78 & Prob > F = 0.0000

Log pseudolikelihood = -56.585796 Pseudo R2 = 0.8689

Postharvestadoptioncat	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
Sex	-0.049	0.099	-0.494	0.622	-0.243	0.146
Agegroup	-0.011	0.024	-0.460	0.646	-0.058	0.036
Marstatus	-0.044	0.080	-0.546	0.586	-0.202	0.114
Edustatus	-0.066	0.055	-1.207	0.229	-0.175	0.042
Familsze	-0.010	0.022	-0.446	0.656	-0.053	0.033
Farmsizetot	-0.010	0.050	-0.196	0.845	-0.107	0.088
Farmsizecultland	0.005	0.052	0.104	0.917	-0.097	0.108
Improvedvarity	0.003	0.053	0.049	0.961	-0.101	0.106
Totpotpostharvloss	0.004	0.013	0.337	0.736	-0.021	0.030
Activelabor	0.007	0.020	0.367	0.714	-0.033	0.048
Illiterate	-0.002	0.026	-0.076	0.939	-0.054	0.050
Numbdayscounsultedperyr	0.004	0.012	0.378	0.706	-0.019	0.028
Distanceofmainroad	-0.000	0.017	-0.015	0.988	-0.033	0.032
Timetakendistancetomarket	0.003	0.011	0.284	0.777	-0.018	0.025
SeedstoragewithDLS	0.523	0.057	9.125	0.000	0.410	0.636
Transportationwithsacks	0.641	0.039	16.479	0.000	0.565	0.718
Sorting	1.216	0.055	22.074	0.000	1.108	1.325
Grading	0.511	0.055	9.245	0.000	0.402	0.620
Packing	0.369	0.047	7.814	0.000	0.276	0.462
Adoptionproductionindexcata	0.005	0.024	0.197	0.844	-0.042	0.052
_cons	0.0158	0.307	0.515	0.607	-0.447	0.763

47 left-censored observations at Postharves~t <= 0; 225 uncensored observations & 0 right-censored observations

Sorting	0.314	0.056	5.616	0.000	0.204	0.425
Grading	0.317	0.063	4.998	0.000	0.192	0.441
Packing	0.199	0.054	3.681	0.000	0.092	0.305
_cons	0.061	0.309	0.199	0.843	-0.548	0.671

10 left-censored observations at Bothtechno~s <= 0; 262 uncensored observations & 0 right-censored observations

FOOD SECURITY ANALYSIS RESULT

A) Tobit Foodsecuritystatuscat Adoptionproductionindexcata Postharvestadotioⁿcat Bothtechnologyadotioⁿcatagories
Tobit regression Number of obs = 276

F(3, 273) = 0.42

Prob > F = 0.7392

Log pseudolikelihood = -276.93273 Pseudo R2 = 0.0022

Foodsecuritystatuscat	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
Adoptionproductionindexcata	-0.098	0.113	-0.869	0.386	-0.319	0.124
Postharvestadotio ⁿ cat	-0.012	0.105	-0.113	0.910	-0.219	0.195
Bothtechnologyadotio ⁿ catagories	0.136	0.196	0.694	0.488	-0.249	0.521
_cons	-0.109	0.202	-0.541	0.589	-0.507	0.289

157 left-censored observations at Foodsecuri~t <= 0; 119 uncensored observation & 0 right-censored observations

B) Tobit Foodsecuritystatuscat Adoptionproductionindexcata Postharvestadotioⁿcat Bothtechnologyadotioⁿcatagories,
Tobit regression Number of obs = 276

F(3, 273) = 0.41

Prob > F = 0.7461

Log pseudolikelihood = -29.199613 Pseudo R2 = 0.0021

Foodsecuritystatuscat	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
Adoptionproductionindexcata	-0.073	0.084	-0.874	0.383	-0.238	0.092
Postharvestadotio ⁿ cat	-0.008	0.076	-0.103	0.918	-0.157	0.141
Bothtechnologyadotio ⁿ catagories	0.0101	0.144	0.701	0.484	-0.182	0.384
_cons	0.050	0.148	4.133	0.000	0.321	0.905

0 left-censored observations; 157 uncensored observations & 119 right-censored observations at Foodsecuri~t >= 1

APPENDICES II- ENGLISH VERSION QUESTIONNAIRE

Questionnaire and Interviews

Addis Ababa University

College of development studies center for food security studies

The aim of this research is potato production and post-harvest technology adoption by smallholder and its implication to food security in Quarit *Woreda*, Ethiopia. The information you provide used only for academic purpose. So, please put a thick mark for the appropriate answers and write on the specified blank space for the following item of the questionnaires.

“I would like to thank you in advance for sharing your time with me!”

Part 1. Identification:

- 1.1. Questionnaire no: _____
- 1.2. Date of interview (DD/MM/YYYY): _____
- 1.3. Zone: _____
- 1.4. District: _____
- 1.5. Peasant Association (Kebele) _____

Part2.General background of small holder farmers

1. Sex: 1. Male /ወንድ/ 2. Female/ሴት/
2. Age
3. Marital status: 1. single 2. Married C. divorced D. widowed
4. Educational level : Enter grades of school completed): 1 Not reading and writing 2. Reading and writing 3. ከ1-8 Grade 4) ከ 9-12 Grade 5. Above

5 Education level of the partner of the household head; 1= not read and Write 2= informal education(Then enter grades completed): ----- 1 Not reading and writing 2. Reading and writing 3. ከ1-8 ክፍል 4. ከ 9-12 ክፍል 5. ስርተፍኬት 6. ዲፕሎማ

6. Demographic Characteristics/

6.1. Number of family members by sex and age Composition

	Name of family member	Age	Sex of the members	Education: Grade level of schooling): ----- 1. h1-8 Grade 2. h 9-12 Grade 3. Certificate 4. Diploma	involvement in potato production/ marketing
1.					
2.					
3.					
4.					
5.					
6.					
7.					

6.2 Farming experiences of household head, since s/ he started farming potato [in year]: _____

6.3. How many of your family members do permanently work on farm activities: _____

7. Farming experience _____

7.1	Experience of household in potato farming	-----in years
7.2	Experience of household in improved potato technologies	
	7.2.1. Improved variety	-----in years
	7.2.2 .Fertilizer use	-----in years
	7.2.3. Fow planting	-----in years
	7.2.4. Use of herbicide& pesticide	-----in years
	7.2.5. Pre harvest Managements	-----in years
	7.2.6. post-harvest Management	_____in years

8. Landholding status (ha) :

8.1. Total landholding: _____

8.2. Total cultivable land: _____

8.3. Land allocated for improved potato production in 2009/2010E.C.

9. Allocation of your farm land by crops:

Crops/forage	Area This year	Area last year	Area before last year	Current year Average production value /in Birr
9.1 Maize				
9.2 Teff				
9.3 Potato				
9.4 Sorghum				
9.5 Wheat				
9.6 Barley				
9.7 Eucalyptus				

10. What are the main uses of potato for you in 2009/2010 E.C?

1) for consumption 2) For sale 3).Source of livestock feed 4).For other purpose (Please Specify)_____ (Multiple answer possible)

Part -3

Cultural practices for potato

11. What are the current farming culture that you implement while cultivating potato

Practice used by farmers	Potato
11.1 Frequency of land preparation. 1.2 Times 2.3 Times 3.4 Times 4. 5 Times	
11.2 Planting time: 1. March1-10 2. March 11-15 3. March 16-20	
11.3 Seed rate per hectare (4 eqa bery = 1ha): 1. 5 Kesha/1 eqa bery/ 5ኪሻ 2.10 Kesha be ande eqa bery 3.15 kesha beand eqa bery 4. 20 kesha beand eqa bery 5. Others	
11.4 Fertilizer rate per hectare: (4 eqa bery/ = 1ha/) 11.4.1.DAP : 1) 1Quntal/1 eqa 2). 1.5Quntal/1 eqa 3. 2 Quntal/1 eqa 4. 2.5 Quntal/1 eqa/2.5 11.4.2.UREA 1. 1Quntal/1 eqa 2. 1.5Quntal/1 eqa 3) 2 Quntal/1 eqa 4) 2.5 Quntal/1 eqa	
11.5 Planting method (1.Row planting 2. Broadcast)	
11.6. Weeding frequency: 1).2 times 2.3 times 3. 4 times 4.5 times	
11.7 Harvesting time: 1) May 15-20 2) May 21-30 3) June 1-10 4) Others	

12. List the major problems in potato production?

1) Lack of seed 2) Lack of fertilizer 3) .Disease 4) Lack of rainfall (drought) 5) Lack of market 6) Others (specify) _____ (Multiple answer possible)

Livestock production

13. Do you practice rearing livestock? A) Yes B) No

13.1. If yes, fill the table bellow?

Class of livestock	Number			Amount sold last year (2009 E.C)		Unit potato		Total potato
	Local	Improved	Total	Local	Improved	Local	Improved	
13.1.1 Cows								
13.1.2 Oxen								
13.1.3 Heifers								
13.1.4 Bulls								
13.1.5 Calves								
13.1.6 Sheep								
13.1.7 Goats								
13.1.8 Donkeys								
13.1.9 Horses								
13.1.10 Mules								
13.1.11 Poultry								

Part 4

Adoption status of potato production practices

14. Are you aware about potato production technologies? 1)Yes 2)No

14.1 List the technologies you know of _____;
 _____;
 _____;

14.2 If yes what is the length of time since you first heard about improved potato technologies?
 -----Years (in E.C.)

15. On improved potato technologies

SN	Potato Technology	Since when you started using the technology (specify the year)	From whom/where did you first heard about the improved potato varieties 1.) Development agent 2).Research Center 3).Neighbor farmers 4).Farmers organizations 5). Radio 6)Others (specify)	If you did not use why? 1.Not aware 2.Unavailability of technology 3.Cost of technology 4. Not relevant 5. Other specify
15.1	Variety			
15.2	Fertilizer			
15.3	Herbicide or pesticide			
15.4	Preharvest technologies(specify)			
15.5	Postharvest technologies(specify)			
15.6	Storage System			
15.7	Seed Sprouting			

16. How much land did you allocated for improved potato technologies in the last three years?

No	potato technology	2008 E.C		2009 E.C		20010 E.C	
		Total Potato Area (ha)	Total area used with technology	Total Potato Area (ha)	Total area used with technology	Total Potato Area (ha)	Total area used with technology
16.1	Improved varieties						
16.2	DAP						
16.3	Urea						
16.4	-----times Weeding frequency						
16.5	Herbicides and insecticides						
16.6	Row planting						

Part 5

[17. Why are you using improved potato varieties (multiple answer is possible)?

- 1) Improving yield performance
- 2.) Reducing cost of production
- 3).Offsetting environmental effect
- 4.) Increasing income
- 5.) Improving soil fertility
- 6).food security
- 7.) Other (please specify) _____

18. Do you face any challenge in adoption process of farm inputs (-fertilizer and improved seed)?

- 1) Yes 2) No

18.1. If your answer is Yes for above what are the major challenges that affect the use of these farm inputs (multiply answer is possible)?

- 1) Lack of improved seed 2) Lack of fertilizer 3) .Disease 4). Lack of information about these technology 5) Others (specify)._____

24. How much size of girth in diameter by cm/kg

- A. Big-----Cm/Kg
- B. Medium-----Cm/Kg
- C. Small-----Cm/Kg
- D. very small-----Cm/Kg

25. How much space you use in your potato farmlands for ?

- 1) between plants?
- 2) between rows.....?

26. Did you apply urea on potato crop? 1. Yes 2. No

26.1 if your answer is yes when did you apply urea fertilizer in your farm?

- 1) Immediately 2) After 1 week 3. After 2 week 4) After 3 week 5) After 4 week 6. After 5 week
- 7. After 6 week 8. After 7 week

26.1.1 How much qt/ha did you apply/ምን ያህል ኩ/ል በሄ/ር.....?

27 . Did you apply DAP on potato crop? 1. Yes 2. No

if your answer is yes when did you apply DAP fertilizer in your farm/አዎ ከሆነ መልሱ: መቼ ነው ዳፕ ማዳበሪያ የምታረግ?

- 1) Immediately 2) After 1 week 3. After 2 week 4) After 3 week 5) After 4 week 6. After 5 week
- 7. After 6 week 8. After 7 week

27.1.1 How much qt/ha did you apply.....?

28. How many times did you apply in rounds-----? 1.1st round2. 2nd round..... 3. 3rd round.....4).4th round..... 5).5th round.....

29. Which types of weed is common?

- 1).....,2).....3).....:

30. Common pottao Insect pestes?

- 1).....,2).....3).....:

31. Common potato Disease ?

- 1).....,2).....3).....:

32. Which types of chemical apply in your potato farm lands?

Type of chemicals	Name	How much liters did you buy	How much lit did you apply	How many times	When did you apply 1.Early in morning(2-4 hr) 2.Mid day (6-8 Hr) 3.After noon (9-12) 4. Night/ After 12 Hr	Results after application
32.1. Herbicides						
32.2 Pest control						
32.3Diseasecontrol						

33. How many qt/ha you produced after all this expenditureQt/ha ?
1. 50 Qt/ha 2. 51-100 Qt/ha 3. 101-150 Qt/ha 4) 151-200 Qt/ha 5) 201-250 Qt/ha 6) 251-300 Qt/ha

Part 6

Extension Service

34. Did you consulted by DAs in the last cropping season (2009/10 E.C) on potato related activities?

1. Yes 2.) No

34.1 If your answer is yes, for the question Q#34, how many days did DA contacted you in 2009/10 cropping season for purpose of potato production and mgt? _____

34.2 If yes for Q#34 how did the DA helped you?

1).Practical assistance at farm 2).Demonstration 3.) Training at FTC 4)other (please specify)

35. Have you ever attended any demonstration or field days arranged by DAs or research center on potato? 1) Yes 2) No

36. Have you ever participated in training on potato production? 1) Yes 2) No

37. Was political membership making difference in technology accessibility: 1)Yes 2) No

38. Have you been enforced to participate in membership to help access the technologies? 1)Yes 2) No

39. Was Kebele leadership participation making difference in accessing potato technologies? 1) Yes 2) No

40. Have you participated in kebele leadership: A. Yes/አዎ B. No/አይደለም

Market service and potato

41. Do you have market for potato? 1) Yes 2) No

42. Did you sell your potato crop during the 2009/10 E.C year of cropping Season?

1)Yes 2).No

42.1 In 2009/10: /በ 2009/10

Total production of potato was about: ___ Qt;

Total sold amount in was about: _____ Qt

Total sales value was about: _____ Birr

42.2. If yes, where do you sell your crop?

1) at farm gate 2) village market 3) District market 4) Others (specify) _____

43. At what season do you usually sell potato product? 1) Right at harvest 2) Latter after harvest

3) Any time I face problem 4) Other (specify): _____

44. Distance to the nearest market center (in hrs of walk: ____; and in km: _____

45. Distance to the all-weather road (in hr.) _____

Uses of crop produced /የምትጠቀሙት እና የምታመርቱት ሰብል

46. What are the major crops you cultivate in your farm for 2009/10 cropping season?

Please fill the requested information here below:

Crop	Area of land	Amount produced in Qt	Amount used for			
			Seed	Food	Sale	Average Potato per Qt/
46.1 Maize						
46.2 Sorghum						
46.3 Wheat						
46.4 Potato						
46.5 Barely						
46.6 Chickpea						
46.7 Field pea						
46.8 Fababean						
46.9 Guaya						

47. What marketing problems did you face in the last years?

Part 7

Participation on off/non-farm income

48. Did you participate in non-farm activities last year? 1.) Yes 2).No

Type of non-farm activity	Who in your family involve in	Average annual income

49. Cash income from livestock production

Type of product	Unit	Quantity produced/	Quantity sold(Q)	Unit potato(P)	Total (P*Q)
49.1 Milk					
49.2 Eggs					
49.3 Butter					
49.4 Cheese					
49.5 Others(specify)					
49.6 Total					

Labor availability

50) Did you experience labor shortage in crop farm operation? 1) Yes 2) No

50.1 If yes, for which farming operation? 1) Land preparation 2) Planting 3) Weeding (manual) 4) Herbicide and/or pesticide application 5) Harvesting 6) Threshing 7) Storage

51. How did you solve the shortage? A.) Hiring labor/ቀን ሰራተኛ/ B.) Debo/ደቦ/ C.) Others/ሌላ (Specify/ይገለጥ) _____

52. Did you hire labor for potato production (ploughing of the land, planting, weeding, and harvesting) for the last cropping season? 1) Yes 2) No

Credit availability and use/የብድር አቅርቦት እና ጠቀሜታ

53. Do you have access to credit for you farming operation? 1) Yes 2) No

53.1 If yes, from where and how much did you obtain in last cropping season (2009/10) E.C?

Source of credit	Amount or value/መጠን/	Interest rate/ወለድ/
53.1.1 Microfinance		
53.1.2 Cooperative/union		
53.1.3 Bank (specify)		
53.1.4 Traders		
53.1.5 Iqub/Iddir		
NGOs(specify)		

53.2 If yes for Q #53.1 for what purpose did use credit you got?

1). To pay school fee 2) To pay tax 3). To buy agricultural inputs 4). To cover house hold expenditure 5) to buy food 6)To buy livestock 7) Others (specify) _____

53.3 If no, what are your sources of finance for farming operation?

1) Crop sales 2) Livestock sales 3) Off-farm activities 4) Others (specify) _____

54. How far is from your home to credit office (in Km) _____

55. Do you have any problems in getting credit? 1). Yes 2). No

55.1 If yes, what is the nature of your credit problems?

1) Bank loans not available 2) Do not have required collateral 3) Loans from informal sources not available 4) Repayment terms are unfavorable 5) Interest rates are too high 6) Others (specify)

Perception of farmers on potato technology attributes

56. Characteristics of improved potato varieties as compared to local variety

No	Characteristic	Inferior	The same	Superior
56.1	Yield	1	2	3
56.2	Drought resistance	1	2	3
56.3	Earl maturity	1	2	3
56.4	Shattering	1	2	3
56.5	Marketability	1	2	3
56.6	Disease resistance	1	2	3
56.7	Logging	1	2	3

57. Cooperative or crop collection center

57.1	Is there any farmers' cooperative in your area? 1)Yes 2)No	
57.2	If yes, Are you a member of farmers' cooperative 1) Yes 2) No	
	57.2.1 If yes, what benefit you obtained from engaging in cooperative. 1) Market access for crop product 2) Less cost for crop technologies 3)Access to crop technologies (variety, fertilizer 4) Credit	

Part 8

Questionnaires regarding post-harvest technology

58.How did you harvest your potato after matured and ready to harvest?

1) Manually 2) plowing by oxen 3)Machinery (mechanically)

59) Did you separate and grading potato based on size, shape with its physically damaged and infected potato from the whole products before transported to the storage place? 1) Yes 2)No

60. Did you use post-harvest technology? 1) Yes 2)No

61. If yes, currently what type of storage system that you practiced and used

1) On the floor in dark place 2) On the floor in open light place 3) On the bead 4) others (please specify)

62) Did you pack the product with air circulated packing materials before transported to the storage room?

1)Yes 2) No

63) Did you store potato by using diffused light storage system? 1) Yes 2)No

63.1 If the answer is no for the above question, why?

1) lack of awareness 2) Lack of technologies 3) Carelessness 4) Others (specify)

Part 9

Questionnaires regarding Food security status by HFBM/ስለ ምግብ ዋስትና ቦተመለከተ የተዘጋጀ መጠይቅ

Food security use standard Questionnaire

64. How much months you face shortage of food: 1) This year: ____; 2)Last year: ____: 3) Before last year: ____

65. Are you member of PSNP : 1) Yes; 2) No

65.1 If yes, since when?_____

66. How much you at household level spend on non-food, such as alcohol , Khat, etc :

66.1. per month on average: Birr: ____

66.2 Per year on average: Birr_____

67 How long does your farm production last supporting the family? ____Months

68. How do you cope with food insecurity situation (during the food deficit moths)

1) support from off/non-farm income? 2). Depend on relatives 3). PSNP 4)Children support 5) NGO aid 6) others specify

69. Has there been any shift in your food security status now compared to that on past 1). Yes I am food secured 2)I used to be food secure in past but not now? 3) No change

70. if household food security situation improved now than in past, what do you think is the reason? (your assumption)? 1). I adopted improved varieties of crop including potato 2). I now bought oxen 3).Use of fertilizer 4) Other reasons (specify)

71. If you become food insecure now than before do you think that adoption of new varieties of potato has improved your food security status? 1) Yes 2.) No

72. Do you meet all year round food requirement of your household members from your own farm production 1) Yes 2) No repeated

73. If you are not food self-sufficient for how many months does your production covers your food requirement at home? (Indicate in number of months) repeated)

74. Household Food Balance Model

SN	Total grain	1) Potato	2) Maize	3)Barley	4)Soybean	5)Chickpea	6)Wheat	7)Teff	8)Aster	9)Guaya	10) Sorghum	Others/ dairy products or poultry
74.1	TG= produced											
74.2	TG= grain bought											
74.3	TG= Quantity of food aid obtained											
74.4	TG=grain obtained through gift											
74.5	TG= Post harvest losses											
74.6	TG= Quantity of grain reserved for seed											
74.7	TG =Amount of grain sold											
74.8	TG =Grain given to others within a year											
74.9	MP=Meat, meat based products and poultry											
74.10	DP= Dairy and dairy based products											

75. Rank the source of income for your household, as a family in order of importance, per year, the latest year?

S.N	Income source	Amount Birr per year on average	Rank
75.1	Crops total		
75.2	Potato		
75.3	Animal total		
75.4	Trade		
75.5	Forest		
75.6	Other business (specify)		
75.7	Remittance		
75.8	Wage/salary		

APPENDICES III – AMHARIC VERSION QUESTIONNAIRE

አዲስ አበባዩኒቨርሲቲ የሀገር ልማት ጥናት ኮሌጅ የምግብ ዋስትና ጥናት ማዕከል

የዚህ ጥናት ዋና አላማ ቋሪት ወረዳ የፈንግጣ ቀበሌ ገበሬ ማህበር ውስጥ የድንች አመራረት እና ምርት አያያዝ ቴክኖሎጂ አቀባበል እና ትግበራ በአርሶ አደሩ የኑሮ መሻሻል እና ለምግብዋስትና መረጋገጥ ላይ ያለውን አስተዋፆ ለማወቅ የሚያስችል የዳሰሳ ጥናት መጠይቅ ነው። ስለምታደርጉት መልካም ትብብርና እውነተኛ መረጃ አመሰግናለሁ።

ክፍል-1. የመለያ መርጃ:

- 1.1. ጥያቄ ቁጥር: _____
- 1.2. የተጠየቀበት (ቀን/ወር/ዓ.ም): _____
- 1.3. ዞን: _____
- 1.4. ወረዳ: _____
- 1.5. ቀበሌ: _____

ክፍል-2. የአርሶ አደሩ/የግለሰቡ/ ስነህዝብና ማህበራዊ ጉዳዮች አጠቃላይ መረጃ

- 1. ጾታ: 1. ወንድ 2. ሴት
- 2. እድሜ:
- 3. የጋብቻ ሁኔታ: 1. ያላገባ/ች 2. ያገባ/ች 3. የፈታ 4. የሞተችበት/የሞተባት
- 4. የትምህርት ደረጃ: 1. ማንበብና መጻፍ የማይችሉ 2. ማንበብና መጻፍ የሚችሉ 3. ከ1-8 ክፍል
- 4 ከ 9-12 ክፍል 5. ከዛባላይ
- 5 የአባወ-ራ/አማው-ራ የትምህርት ደረጃ: 1. ማንበብና መጻፍ የማይችሉ 2. ማንበብ እና መጻፍ የሚችሉ/(ያጠናቀቁት ክፍል): 3. ከ1-8 ክፍል 4. ከ 9-12 ክፍል 5. ሰርተፍኬት
- 6. ዲፕሎማ
- 6. የስነህዝብ ሁኔታዎች መረጃ
- 6.1. የቤተሰብ አባላት ሁኔታ በጾታ እና በእድሜ ያለው ስብስብ

	የቤተሰብ አባላት ስም ዝርዝር	እድሜ	የአባላት ጾታ	ትምህርት: /ያጠናቀቁት ክፍል) 1. ከ1-8 ክፍል 2. ከ 9-12 ክፍል 3. ሰርተፍኬት 4. ዲፕሎማ	በድንች ምርት እና ሽያጭ ላይ ያላቸው ተሳትፎ
1.					
2.					
3.					
4.					
5.					
6.					
7.					

- 6.2 የአባወ-ራው/ የማው-ራው የድንች ምርትን ማምርት የጀመሩበት ዓ.ም?.....
- 6.3. ምን ያህሉ የቤተሰብዎ አባላት በቋሚነት በእርሻ ስራ ላይ የተሰማሩት?.....

7. በእርሻ ስራ ላይ ያለው የአመራረት ልምድ _____

7.1	የአባወራው/ የማውራዋ የድንች ምርትን አመራረት ልምድ	-----ዓ.ም
7.2	የአባወራው/ የማውራዋ የድንች ምርት የአመራረት ቴክኖሎጂዎች ልምድ በዝርዝር	
	7.2.1. ምርጥ ዘር	-----ዓ.ም
	7.2.2. ማዳበሪያ መጠቀም	-----ዓ.ም
	7.2.3. በመስመር መዘራት	-----ዓ.ም
	7.2.4. ፀረ-አረም እና ፀረ- ተባይ መጠቀም	-----ዓ.ም
	7.2.5. ከመሰብሰብ በፊት ያለው እንክብካቤ	-----ዓ.ም
	7.2.6. ከተሰበሰበ በኋላ ያለው እንክብካቤ	_____ ዓ.ም

8. የመሬት የይዘታ መጠን በሄ/ር:

8.1. አጠቃላይ የመሬት የይዘታ መጠን በሄ/ር: _____

8.2. አጠቃላይ የሚታረስ መሬት መጠን በሄ/ር: _____

8.3. አጠቃላይ ለድንች ምረት በምርጥ ተሞክሮ አመራረት ለመስራት የተመደበ የመሬት መጠን በሄ/ር በ 2009/2010 ዓ.ም _____

9. የአረስዎ መሬት ለያንዳንዱ ሰብል የተመደበው የመሬቱ መጠን በሄ/ር

ሰብል/ፎሬጅ/	በዚህ አመት	ባለፈው አመት	ከባለፈው አመት በፊት/	የአሁኑ አመት ያለው አማካኝ ውጤት በብር
9.1. ቦቆሎ				
9.2. ጤፍ				
9.3. ድንች				
9.4. ማሽላ				
9.5. ገበስ				
9.6. ስንዴ				
9.7. ብሀርዛፍ				

10. በዋናነት ድንችን በ 2009/2010 ዓ.ም ለምን ጥቅም ዋለ?

1.) ለምግብነት 2) ለሽያጭ 3) ለከብትመኖ 4) ለሌላ (ይገለጽ) _____
(ሁለት እና ከዛ በላይ መልስ ይቻላል)

ክፍል -3ባህላዊ የድንች አመራረት ተግባራት/

11.በአሁን ወቅት በእርሻ ማሳዎት ላይ የሚተገበሩት ተግባራት በዋናነት ድንችን ሲያመራቱ ምንድን ናቸው።

በአረሶ አደሩ የሚተገበሩ ተግባራት	ድንች
11.1. ምን ያህል ጊዜ ነው መሬቱን የምታረሰው/የምታለሰልሰው/. 1. 2ጊዜ 2. 3ጊዜ 3. 4ጊዜ 4. 5ጊዜ	
11.2.መቼ ነው የምትዘራው፡ 1.መጋቢት 1-10 2. መጋቢት 11-15 3. መጋቢት 16-20	
11.3የዘር መጠን በሄ/ር(4 ዕቃበሬ =1ሄ/ር): 1. 5ኬሻ/1ዕቃበሬ 2. 10 ኬሻበአንድዕቃበሬ 3. 15ኬሻበአንድዕቃበሬ 4. 20ኬሻ በአንድ ዕቃ በሬ 5. ሌላ	
11.4 የማዳበሪያ መጠን በሄ/ር(4 ዕቃበሬ = 1ሄ/ር) 11.4.1.ጻፕ : 1. 1 ኩንታል/1 ዕቃበሬ 2. 1.5 ኩንታል/1ዕቃበሬ 3. 2ኩንታል/1 ዕቃበሬ 4. 2.5ኩንታል/1ዕቃበሬ	
11.4.2. ዩሪያ 1. 1 ኩንታል/1 ዕቃበሬ 2. 1.5 ኩንታል/1ዕቃበሬ 3. 2ኩንታል/1 ዕቃበሬ 4. 2.5ኩንታል/1ዕቃበሬ	
11.5 የአዘራርዘዬ (1. በመስመር 2. በብተና)	
11.6. ምንያህ ልገዳዎች አሉ? 1.2ጊዜ 2.3 ጊዜ 3. 4ጊዜ 4.5 ጊዜ	
11.7 ምርት የመሰብሰቢያ ጊዜ: 1.ግንቦት 15-20 2. ግንቦት 21-30 3. ሰኔ 1-10 4. ሌላ	

12. በድንች አመራረት ላይ ያሉ ዋና ዋና ችግሮችን የትኞቹ ናቸው

- 1) ዘር አለመኖር 2) ማዳበሪያ አለመኖር 3) .በሽታ 4.)ዘናብ አለመኖር/ድርቅ 5)ገቢያ አለመኖር

6)ሌላ (ይገለጽ) _____ (ሁለት እና ከላይ መልስ ይቻላል)

Livestock production

13. እንስሳት ታርባለህ? 1) አዎ 2) አይደለም

13.1.አዎ ከሆነ ከታች ያለውን ሳጥን ይሙሉ?

የእንስሳት አይነት /ዘርዘር	ብዛት			በ2009 ዓ.ም በአጠቃላይ የተሸጠ		ድንች በነጠላ		አጠቃላይ ድንች
	አካባቢያዊ	ምርጥ ዘር	አጠቃላይ	አካባቢያዊ	ምርጥ ዘር	አካባቢያዊ	ምርጥ ዘር	
13.1.1. ላም								
13.1.2 በሬ								
13.1.3 ጊደር								
13.1.4ወይፈን								
13.1.5 ጥጃ								
13.1.6 በግ								
13.1.7 ፍየል								
13.1.8 አህያ								
13.1.9 ፈረስ								
13.1.10 በቅሎ								
13.1.11 ዶሮ								

ክፍል-4

የድንች የአመራረት ቴክኖሎጂን የአቀባበል እና የትግበራ ሁኔታ

14. ስለ ድንች ምርተ አመራረት ቴክኖሎጂ ታውቃለህ? 1) አዎ 2) አይደለም

14.1 የምታውቃቸውን ቴክኖሎጂዎች ንዘርዘራቸው: _____ ;

_____ ; _____ ;

14.2 አዎ ካልክ ስለ ድንች አመራረት ቴክኖሎጂው ከሰማህ ምን ያህል ጊዜ ሁኖህል..... ዓመት(ዓ.ም)?

15. በድንች ላይ የሚተገበር አዳዲስ ቴክኖሎጂ

ተ.ቁ	የድንች-ቴክኖሎጂዎች	መቼ ዓ.ም ነው ቴክኖሎጂውን የጀመርከው	ከማነ/ከየት ነው ለመጀመሪያ ጊዜ ስለ ድንች ምርጥ ዘር የሰማህዎ 1.) ከግብርና ባልሙያ 2.) ከምርምር ተቋም 3.) ከጎንጎህ ካለው አርሶ አድር 4.) ከገበሬዎች ዩኒየን 5.) ሬዲዮ 6. ከሌላ(ይጠቀስ)	ካልተጠቀምክ፣ ለምን A. አታውቅም 2. ቴክኖሎጂ አለመኖር ነው 3. የቴክኖሎጂው መግዣ 4. አይጠቅምም 5. ሌላ፣ ይጠቀስ
15.1	ምርጥ ዘር			
15.2	ማዳበሪያ			
15.3	ፀረ-አርም እና ፀረ-ተባይ			
15.4	ከመሰብሰብ በፊት የምንጠቀመውን ቴክኖሎጂ/ይጠቀስ			
15.5	ከተሰበሰበ በኋላ የምንጠቀመውን ቴክኖሎጂ/ይጠቀስ			
15.6	የማከማቻ ዘዴ			
15.7	የዘር ማጎንቆያ/			

16. ላለፉት 3 ተከታታይ አመታት ምን ያህል መሬት ለአዳዲስ የድንች ምረት እና ምርታማነት ለሚያሳድጉ ቴክኖሎጂዎች ለመተግበር መድበሀል?

ተ.ቁ	የድንች ቴክኖሎጂዎች	2008 /ዓ.ም		2009 /ዓ.ም		2010 /ዓ.ም	
		አጠቃላይ ለድንች የተመደበ የመሬት ስፋት(ሄ/ር	አጠቃላይ ለድንች ከተመደበ በየመሬት ስፋት(ሄ/ር ውስጥ በአዳዲስ ቴክኖሎጂዎች የተሰራ ስፋት (ሄ/ር)	አጠቃላይ ለድንች የተመደበ የመሬት ስፋት(ሄ/ር	አጠቃላይ ለድንች ከተመደበ የመሬት ስፋት(ሄ/ር ውስጥ በአዳዲስ ቴክኖሎጂዎች የተሰራ ስፋት (ሄ/ር)	አጠቃላይ ለድንች የተመደበ የመሬት ስፋት(ሄ/ር	አጠቃላይ ለድንች ከተመደበ የመሬት ስፋት(ሄ/ር ውስጥ በአዳዲስ ቴክኖሎጂዎች የተሰራ ስፋት (ሄ/ር)
16.1	ምርጥ ዘር						
16.2	ደገ						
16.3	ዩርያ						
16.4	...ጊዜአረምማ ረም/						
16.5	ፀረ-አርም እና ፀረ-ተባይ						
16.6	በመስመር መዝራት/						

ክፍል-5

17. ለምንድን ነው አዳዲስ የድንች ምርጥ ዘርን የምትጠቀም

- 1.) ምርት እና ምርታማነትን ለመጨመር/
- 2.) የማምረቻ ወጪን ለመቀነስ
- 3.) የአካባቢውን የአየር ንብረት ለውጥን ለመቋቋም
- 4.) ገቢን ለመጨመር
- 5.) የአፈር ለምነትን ለመጨመር
- 6.) የምግብ ዋስትናን ለማርጋገጥ
- 7.) ሌላ (ይጠቀስ) _____

18. ቴክኖሎጂን በምትቀበልበት ወቅት የሚያጋጥሙህ ችግሮች አሉ በዋናነት የእርሻ ግባቶች እንደ ማዳበሪያ እና ምርጥ ዘር?

- 1.) አዎ
- 2.) አይደለም

18.1. አዎ ካልአገኙ ዋና ዋና ችግሮች እነማን ናቸው (ከሁለት በላይ መልስ ይቻላል)

- 1.) ምርጥ ዘር አለመኖር
- 2.) ማዳበሪያ አለመኖር
- 3.) .በሽታ
- 4.) መረጃ አለመኖር
5. ሌላ (ይጠቀስ). _____

24. የድንቺ መጠን በጊርዝ/በዲያሜትር ወይም በኪ/ግ ምን ያህል ይሆናል

1. ትልቁ-----ሳ/ሜ/ኪ/ግ
2. መካከልኛው-----ሳ/ሜ/ኪ/ግ
3. ትንሹ-----ሳ/ሜ/ኪ/ግ
4. በጣምትንሹ-----ሳ/ሜ/ኪ/ግ

25. በድንቺ ማሳሰቢያ ውስጥ ምን ያህል ቦታት ተዋለህ ማለትም?

- 1) በድንቺ እና በድንቺ መካከል
- 2) በፈር እና በፈር መካከል-----?

26. ድንቺ ስታመርት የሪያ ማዳበሪያ ትጠቀማለህ? 1. አዎ 2. አልጠቀምም

26.1 አዎ ከሆነ መልሱ መቼ ነው የሪያ ማዳበሪያ የምታረግ?

1. ወዲያው እንደ ተዘራ 2. ከሳምንት በኋላ 3. ከ 2 ሳምንት በኋላ 4. ከ 3 ሳምንት በኋላ
5. ከ 4 ሳምንት በኋላ
6. ከ 5 ሳምንት በኋላ 7. ከ 6 ሳምንት በኋላ 8. ከ 7 ሳምንት በኋላ

26.1.1 ምን ያህል ኩ/ል በሄ/ር.....?

27 ድንቺ ስታመርት ዳፕ ትጠቀማለህ? 1. አዎ 2. አልጠቀምም

27.1 አዎ ከሆነ መልሱ መቼ ነው ዳፕ ማዳበሪያ የምታረግ?

1. ወዲያው እንደ ተዘራ 2. ከሳምንት በኋላ 3. ከ 2 ሳምንት በኋላ 4. ከ 3 ሳምንት በኋላ 5. ከ 4 ሳምንት በኋላ
6. ከ 5 ሳምንት በኋላ 7. ከ 6 ሳምንት በኋላ 8. ከ 7 ሳምንት በኋላ

27.1.1 ምን ያህል ኩ/ል በሄ/ር.....?

28. በስንት ጊዜ ዙር? 1. 1ኛዙር 2. 2ኛዙር 3. 3ኛዙር 4. 4ኛዙር
5. 5ኛዙር

29. ምን አይነት አረም ናቸው በእርስዎ ማሳ ላይ ሁሌም የሚበቅሉት:

- 1).....,2).....,3).....

30. በእርስዎ ማሳ ላይ የሚያውቁት የድንቺ ተባዮች ካሉ ?

- 1).....,2).....,3).....

31. በእርስዎ ማሳ ላይ የሚያውቁት የድንቺ በሽታዎች ካሉ ?

- 1).....,2).....,3).....

32. እርስዎ ምን አይነት ኪሚካል በድንቺ ማሳ ላይ እረጩ?

የኪሚካል አይነት	ስም	ምን ያህል ሊትር የገዙት መጠን	ምን ያህል ሊትር ሄ/ር እረጩ	ለምን ያህል ጊዜ	ምን ስነ-ምግባር እረጩት 1. ጥዋት (2-4 ስድስት) 2. ቀን (6-8 ስድስት) 3. ምሽት-ላይ (9-12) 4. ማታከ12 ስድስት በኋላ	የተመለከቱት ለውጥ
32.1. ፀረ-አረም ;						
32.2. ፀረ-ተባይ						
32.3. በሽታ-መከላከያ						

45.ሁሉንም ቦታ የሚያገናኘው የመንገድ ርቀት በስዓት-----

የምትጠቀሙት እና የምታመርቱት ሰብል

46.እርስዎ በዋናነት በእርሻ ማሳዎ ላይ በ 2009/10 ዓ.ም የምርት ዘመን የአመራቶአቸው ሰብሎች የትኞቹን ነው?

እባክዎት የሚቀጥለውን ሳጥን ይሙሉ

ሰብል	የመሬት ስፋት	የተመረተ ምርት በኩንታል	ጥቅም ላይ የዋለ			
			ለዘር	ለምግብ	ለሽያጭ	የድንች አማካኝ በኩንታል
46.1 ቦቆሎ						
46.2 ማሽላ						
46.3 ገብስ						
46.4 ድንች						
46.5. ስንዴ						
46.6 ሽምብራ						
46.7 አተር						
46.8 ባቄላ						
46.9 ንያ						

47. ባለፈው ዓመት ምን አይነት የገብያ ችግር አጋጥሞህ/ሽ ነበር?

ክፍል -7

ከእርሻ ስራ ውጪ ገቢ ለማግኘት የሚሰሩት ተግባራት

48. ባለፈው ዓመት ከእርሻ ስራ ውጪ ተሳትፈው ያውቃሉ? 1.) አዎ

2).አይደለም/

ከእርሻ ስራ ውጪ ያሉ እንቅስቃሴዎች	ካሉዎት ቤተሰብ ውስጥ ማን ነው የሚሳተፍ	አማካኝ አመታዊ ገቢ

49. ከእንስሳት እርባታ የሚገኝ ቀጥተኛ ገቢ

የምርት አይነት	መለኪያ	የተመረተ ውመጠን	የተሸጠው መጠን(Q)	የድንች መጠን(P)	አጠቃላይ የድንች ምርት ሽያጫ(P*Q)
49.1 ወተት					
49.2 እንቁላል					
49.3 ቅቤ					
49.4 አይብ					
49.5 ሌላ (ይገለጽ)					
49.6 አጠቃላይ					

የቀንሰራተኛ መገኘት/መኖር

50. በእርሻ ስራ ወቅት የቀን ሰራተኛ እጥረት አጋጥሞት ያቃል? 1.) አዎ 2.) አይደለም

50.1 አዎ ከሆነ መልሱ፣ ለየትኛው የእርሻ ስራ ? 1.) መሬት ዝግጁነት 2.) የተከላ 3.)/አረም(በሰው) 4.) ፀረ-አርም እና ፀረ-ተባይ የማድረጊያ ጊዜ 5.) የስብሰባ ጊዜ 6.) ውቁያ 7.) ማከማቻ

51. የሰራተኛን እጥረት በምን ነው የሚፈቱት? 1) ቀን ሰራተኛ 2) ደቦ 3) ሌላ (ይገለጥ)

52. ላለፉት የምርት ዘመን ማለትም (ለእርሻ ለማረስ፣ ለተከላ፣ ለአረም እና ለስብሰባ) የቀን ሰራተኛ ለድንች ማምርት ይዘው ያውቃሉ?

1.) አዎ 2.) አይደለም

የብድር አቅርቦት እና ጠቀሜታ

53. የብድር አቅርቦት ለእርሻ ስራዎች አግኝተው ያውቃሉ? 1.) አዎ 2.) አይደለም

53.1 አዎ ከሆነ መልሱ፣ ባለፈው የምርት ዘመን 2009/10 ከየት እና ምን ያህል ነው ያገኘኸው?

የብድር ምንጭ	መጠን	ወለድ
53.1.1 ጥቃቅን እና አነስተኛ		
53.1.2 የህብረት ስራ ማህበር/		
53.1.3 ባንክ (ይጠቀስ)		
53.1.4 ነጋዴዎች		
53.1.5 እቁብ ወይም እድር		
53.1.6 መንግስታዊ ያልሆነ ድርጅት (ይጠቀስ)		

53.2 ለጥያቄ ቁጥር 53.1.1 አዎ ከሆነ መልሱ፣ ብድር ለምን ጉዳይ ነው ያገኘኸው?

1.) ለትምህርት ቤት ክፍያ 2.) ለግብር ክፍያ 3.) ለግብርና ግባት መግዣ 4.) ለቤት ወጪ 5.) ለምግብ መግዣ

6. ለእንስሳት መግዣ 7. ሌላ (ይጠቀስ) _____

53.3 አይደለም ከሆነ፣ ለእርሻ ስራዎ የሚያደርጉትን የገንዘብ ምንጭ ከየት ነው?

1) ከሰብል ሽያጭ 2) ከእንስሳት ሽያጫ 3) ከእረሻ ስራ ውጪ ከሆኑ ስራዎች/እንቅስቃሴዎች 4) ሌላ (ይጠቀስ) _____

54. ቤትህ ምን ያህል ከብድር እና ቁጠባ ተቋም ይርቃል? በኪ/ሜ _____

55. ብድር ለማግኘት የሚያጋጥምህ ችግር አለ ወይ? 1.) አዎ 2.) አይደለም

55.1 አዎ ከሆነ መልሱ ምን አይነት የብድር ችግር ሲያጋጠጥምህ ይችላል?

1.) የባንክ ብድር አለመኖር 2.) ጥምረት አለመኖር 3.) ባህላዊ የብድር አገልግሎት አለመኖር 4.) የብድር መመለሻው ጊዜ ምቹ አለመሆን 5.) የወለድ መጠኑ ከፍተኛ መሆን 6.) ሌላ (ይገለጽ) _____

አርሶአደሩ በድንች አመራረት ቴክኖሎጂ ላይ ያለው ግንዛቤ፡

56. የድንች አዳዲስ ዘር ባህሪያት ከአካባቢያዊ ዝርያ ጋር ሲነጣጠር

ተ.ቁ	ባህሪያት	Inferior/ያንሳል/	The same/ተመሳሳይነው/	Superior/ይበልጣል/
56.1	ምርት	1	2	3
56.2	ድርቅን መቋቋም	1	2	3
56.3	ቶሎ መድርስ	1	2	3
56.4	ችግሮችን በቋቋም	1	2	3
56.5	በገብያ ተፈላጊነት	1	2	3
56.6	በሽታ መቋቋም	1	2	3
56.7	በውሀ መዋጥን በመቋቋም	1	2	3

57. የህብረት ስራ ማህበር/የሰብልመሰብሰቢያ ማእከል

57.1	በእናንተ አካባቢ የገበሬዎች ህብረት-ስራ ማህበር አለ ወይ? 1. አወ 2. አይደለም	
57.2	አዎ ከሆነ መልሱ-እርስዎ የዩኒየኑ አባል ነዎት ወይ? 1) አወ 2) አይደለም	
	57.2.1 አዎ ከሆነ መልሱ- እርስዎ ከዩኒየኑ አባል ከሆኑ በኋላ ምን ጥቅም አገኙበት? 1. ለተመረተው ምረት የገብያ ትስስር 2. ለሰብል ማምርቻ ቴክኖሎጂዎች አነስተኛ ክፍያን 3. አዳዲስ የሰብል ቴክኖሎጂዎችን ማግኘትን (ዘር, ማዳበሪያ) 4. ብድር	

ክፍል-8

ስለ ድህረ- ምህርት አዳዲስ ቴክኖሎጂዎች መጠይቆች

58. የደረሰን የድንች ምርትን ለመሰብሰብ ምን ነው የምትጠቀም?

1. በሰው-ቁፋሮ 2. በበራማረስ 3. በማሽን/ በመሰብሰቢያ ትራክተር

59. የተበላሸውን እና የተወጋጋውን ድንች ወደ ማከማቻ ከመውሰድዎ በፊት በመጠንና በቅርጽ ለይተው ያውቃሉ?

1. አዎ 2. አይደለም

60. ምርትዎን ከሰበሰቡ በኋላ ምርትዎ አንዳይበላሽ አዳዲስ ቴክኖሎጂዎችን ይጠቀማሉ?

1. አዎ 2. አይደለም

61. አዎ ከሆነ መልሱ አሁን ምን አይነት የማስቀመጫ ዘዴዎች እርስዎ ይተገብራሉ/ይጠቀማሉ?

1. መሬት ላይ ሆኖ ጨለማ ቦታ 2. መሬት ላይ ሆኖ ብርሀን ያለበት ቦታ. 3. አልጋ/ቆጥ/ላይ 4. ሌላ (ይገለጥ)

62) ምርትዎን አየር በሚያስገባ እና በሚያስተላልፍ ኬሻ ነው የሚያስቀምጡት ወደ ማከማቻ ከመውሰድዎ በፊት?

1. አዎ 2. አይደለም

63) ብርሃን አስተላላፊ ከእንጨት የተሰራ አልጋ መሰል የዘር ማጎንቆያ እና ማጠራቀሚያ ተጠቅመው ያውቃሉ?

1.አዎ

2.አይደለም

63.1 ለጥያቄ ቁጥር 60 መልስዎ አይደለም ከሆነ ለምን?

- 1. ግንዛቤ አለመኖር
- 2. ቴክኖሎጂ አለመኖር
- 3. ግድየለሽነት
- 4.ሌላ (ይገለፅ)

ክፍል-9

ስለምግብ ዋስትና በተመለከተ የተዘጋጀ መጠይቅ በ HFBM

64. ለምን ያህል ወራቶች ለምግብ እጥረት ተጋልጠው ነበር:1/በዚህአመት: ____; 2/ባለፈውአመት: ____;3/ከባለፈውአመትበፊት: ____

65. አንተ የምግብዋስትና ተጠቃሚዎች አባል ነህ ወይ: 1. አዎ 2. አይደለም

65.1 አዎ ከሆነ መልሱ፣ ከመቼ ጀምሮ?_____

66. እርስዎ ለቤተሰብዎ ምግብ ነክ ባልሆኑ ነገሮች እንደ አልኮል፣ እና ሌሎች ነገሮች ምን ያህል ያወጣሉ?

66.1. በወር አማካኝ: ብር: _____

66.2 በአመት አማካኝ: ብር_____

67. ለምን ያህል ጊዜ ነው የእርስዎ የግብርና/የእርሻ ስራ ውጤት ቤተሰብዎን ያገዙበት? _____በወራት

68. የምግብ እጥረት በሚያጋጠጥምዎ ወቅት እንዴት ነው/በምንአይነት ዘዴ ነው/ችግሩን የሚያልፉት/የሚቋቋሙት/(በዋናነት የምግብ እጥረት በሚያጋጥምዎ ወራቶች

1) ከእርሻ ስራ ውጪ ከሚገኙ ገቢዎች? 2)ዘመድ ላይ በመጠጋት 3). በምግብዋስትና እና በስራ-ፈጠራ ማእቀፍ ውስጥ በመታቀፍ

4) በህጻናት አድን ድርጅት በመታቀፍ 5. መንገስታዊ ባልሆኑ ድርጅቶች እርዳታ 6.ሌላ (የገለጽ)

69. አሁን የእርስዎ በምግብ እራስን የመቻል አቅም ሁኔታዎች ከባለፈው ጋር ሲነጣጠር ለውጥ አለ ወይ?

1). አዎ እኔ የምግብ ዋስትናየን አረጋግጫለሁ እራሴን ችያለሁ 2) ላለፉት ጊዜያት በምግብ እራስን ለመቻል ተጠቅሜዋለሁ

3. ለውጥ የለም

70.በእርስዎ ቤተሰብ ውስጥ በምግብ እራስን በመቻል ሁኔታ ከባለፈው አሁን ከተሻሻለ፣ምክንያቱ ምን ይሆናል ብለው ያስባሉ? (በእርስዎ ግምት/ግንዛቤ)?

1)የተሻሻሉ የሰብል ዝርያዎችን ድንችን ምጫምሮ ቴክኖሎጂዎችን ለመተግበር በመቀበል 2). አሁን በሬ በመግዛቴ/ስለገዛሁ/

3). ማዳበሪያ ስለተጠቀምኩ 4. ሌላ ምክንያት ካለ(ይገለጽ)

71. ከባለፈው አሁን የእርስዎ ቤተሰብ በምግብ እራሱን ካልቻለ፣ እርስዎ አዳዲስ የድንች ዝርያዎችን በመቀበል የምግብዋስትናን ለማረጋገጥ / በምግብ እራስን የመቻል ሁኔታዎች/ ይሻሻላሉ ብለው ያስባሉ?

1.) አዎ 2.) አይደለም

72. የእርስዎ የቤተሰብ አባላት አመት እስከ አመት የምግብ ፍላጎታቸውን ከእርስዎ የእርሻ ማሳ የምርት ውጤቶች አሟላለሁ ብለው ያስባሉ 1.)አዎ 2.) አይደለምም፣አይደገምም?

73. እርስዎ ምግብ አራስዎን ካልቻሉ፣የእርስዎ ምርት ለምን ያህል ወራት ነው ለቤተሰብዎ መሸፈን የሚችለው (ወራቶችን በቁጥር አስቀምጡ)

74. የቤተሰብ የምግብ ዋስትናን መረጋገጡን የምናውቅበት ሞዴል/ዘዴ/

ተ.ቁ	አጠቃላይ ምርት (TG)	1)ድንች	2)ቦቆሎ	3)ስነዴ	4)ባቁላ	5)ሽምብራ	6)ገብስ	7)ጤፍ	8)አተር	9)ጓዶ	10)ማሽላ	11)ሌላ/የእንስሳት ተዋጾ ወይም ደሮ እርባታ
74.1	አጠቃላይ ምርት የተመረተ											
74.2	አጠቃላይ ምርት የተገዛ											
74.3	ከምግብ እረዳታ ሰጪ ድርጅቶች የተገኘ በመጠን											
74.4	አጠቃላይ ምርት በስጦታ የተገኘ											
74.5	ከተሰበሰበ በኋላ አጠቃላይ ምርት የተበላሸ እና የተጣሏ											
74.6	አጠቃላይ ምርት ለዘር የተቀመጠ											
74.7	አጠቃላይ ምርት የተሸጠ											
74.8	አጠቃላይ ምርት ለሌላ የተሰጠ											
74.9	አጠቃላይ ስጋ፣ ከስጋ ውጤቶች እና ደሮ እርባታ											
74.10	አጠቃላይ ከእንስሳት እና የእንስሳት ውጤቶች											

75. ለቤተሰብዎ የገቢ ምንጭ ከሚሆኑት ምርቶች ፣ ስራዎች እና እንቅስቃሴዎች ውስጥ በቅርብ ባለው አመታዊ ገቢ ላይ እና ለቤተሰቡ ያላቸው ጥቅም ተመርኩዘን በቅደም ተከተል እና በደረጃ ሲቀመጡ?

ተ.ቁ	የገቢ ምንጭ	አጠቃላይ የብር መጠን በአማካኝ በአመት	ደረጃ
75.1	አጠቃላይ ሰብል		
75.2	ድንች		
75.3	አጠቃላይ የእንስሳት ምርት		
75.4	ንግድ		
75.5	ደንልማት		
75.6	ሌላ ቢዝነስ/ (ይገለጽ)		
75.7	ውርስ		
75.8	ደግሞ		