Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.6, No.17, 2015

Does Adoption of Quncho Tef Increases Farmers' Crops Income? Evidence from Small Holder Farmers in Wayu Tuqa District, Oromia Regional State, Ethiopia

Debelo Duressa Awesa (MSc)
Wayu Tuka District Agricultural Growth Program Monitoring and Evaluation Expert, Oromia, Ethiopia

Abstract
The purpose of this paper is to analyze the impact of adoption of Quncho tef on crops income in the case of Wayu Tuqa District. The primary sources of data were obtained from sample farmers and the secondary data from different sources were used. The methodology of this study was case study due to the research was conducted to study social group in the community. Both Probability and purposive sampling technique were employed to conduct the study, stratified random sampling procedure was employed for the selection of sample kebele and random sampling was used to select 355 sample households from which 125 were adopters. For data analysis, descriptive statistics and logit model were used to state the influence of variables and also propensity score matching was employed for analysis of the income impact of the adoption decision of Quncho tef. Result shows that distance from household residence to market center was found to affect negatively and significantly, age of the households of the sample survey, family labor in-terms of man equivalent and participation of farmers in agricultural trainings were found to affect adoption negatively and significantly while farmers owning the oxen was found to be negatively significant. Also education level of the respondents, livestock holding in-terms of tropical livestock unit, farmer's ability of meeting the family food consumption, frequency of extension contact and crops net income of the households were found to affect adoption of Quncho tef positively and significantly. The Propensity score matching result revealed that the crops net income of the farmers who were adopter of Quncho tef was much greater than non adopters with about 11,790.59 Ethiopian Birr.
Keywords: Technology, Wayu Tuqa, propensity score matching, Impact.

1. Introduction

Technology adoption is often used broadly to encompass physical/biological structures or objects as well as management practices. Most often, researchers are interested in the adoption of specific technology components (e.g. fertilizer) or integrated technological packages (e.g. high yielding crop variety with fertilizer). However, it may be more important to study the character or functions and impacts of these technologies (Frank and Brent 2000).

Although adoption of improved technologies by smallholders might contribute to improvements in household food security and supplement incomes, given their limited assets, they cannot be expected to make major contributions to reducing rural poverty; especially in the short term (Siegel and Alwang 2005). Since the role of the agricultural sector of its contribution to the Ethiopian economy is very immense, the success and failure of the Ethiopian economy is highly correlated to the performance of this sector. This means that it is still the single largest sector of its contribution to GDP, employment, source of foreign exchange, and its impact on the overall performance of the economy is also significant (Admassu, Workneh and Sisay 2015).

Many scholars stated as tef is the most widely adapted crop, but, the research conducted on the crop was shallow. For instance according to one scholar, even though tef is the most widely adapted crop compared to any other cereal or pulse crop and can be grown under wider agro-ecologies (temperature and soil condition) in the country, the research conducted on this crop is shallow and more focus given to agronomic part of the crop (Setotaw 2013). However, the productivity of indigenous tef became low which leads to use improved variety. Indeed, Quncho tef which is new variety and high yielding crop was introduced for farmers before five years (MoA. 2014). But, to the best of my knowledge there was no systematic research conducted on the adoption decision and income impact of the crop, i.e. this indicates that the research conducted regarding this crop is on genetic improvement and agronomic part, which needs to conducted on its economic part.

Wayu Tuqa District has three Agro Ecological Zone (AEZs), which are Dega, Woina dega and Kolla. According to the source of data from Wayu Tuqa District agricultural office, the major cereal crops grown in the area include; Maize, Tef, Sorghum, Wheat, Millet and Barley in descending order. Although, the District has potential and suitable area for quncho tef, farmers' participation was minimal and the research study conducted in the area for poor participation was unavailable in the study areas (WAO 2014). Thus, this study tries to calculate the crops income impact of adoption of Quncho tef.

Statement of the Problem

Most of developing economies are characterized by heavy dependence on agricultural sector, traditional type of farm practices, higher labor to capital ratio, low adoption rate of technology and farm inputs, poor infrastructure

facilities including roads, transport, marketing, etc and low farm productivity (Alemitu 2011, Susan 2011, Berhane 2009).

According to Setotaw (2013), to increase the production and productivity of agricultural output, the use of improved agricultural inputs are very important out of which high yielding variety crop with fertilizer is the most important. A number of improved tef varieties were developed and disseminated to farmers along with optimum management practices but no systematic studies have been made to investigate the rate and intensity of adoption by smallholder farmers (Setotaw 2013).

Quncho tef is one of the new crop varieties which are rapidly expanding to the most tef growing areas of the country with the genetic capacity of the crop's production more than 30qt per ha, which is three times more than the local tef but faces the adoption bottle neck. The most prevalent challenge to adoption of Quncho variety of tef is the sowing method (row planting, transplanting) and its management /the serious sequence of agronomic practices/. For instance, to give more yields, the recommended sowing methods are drilling with three hand fingers and/or transplanting after seedling preparation on seedbed (ATA. 2012).

Even though this variety was released in the years 2005, under the collaboration of effort of Ministry of Agriculture (MOA), Agricultural Growth Program (AGP) and Agricultural Transformation Agency (ATA) in all agro-ecologies of the country in, the dissemination and adoption of the crop is not as much the effort and to the required level and also its impact on crops income was not considered (MoA. 2014). Thus, the objective this study is to examine the impact of Quncho tef adoption on crop income level of farmers.

2. Literature Review

2.1. Definition

Impact analysis refers to the analysis of the distributional impact (change) of adoption of new technology on the well-being or welfare or income of the beneficiary (World Bank 2003). Adoption of new technology aims at impacts or changes that are intermediate to livelihood outcomes and that relate more to the income of the user to the policies and structure in the sustainable livelihood framework (Asres 2003). And also, David Madison noted that using different varieties of the same crop and livestock holdings were considered as the most important variables in adoption activities in many African countries (Todaro and Smith 2012).

The good importance of tef is, it can also be stored for many years without quality deterioration and being seriously damaged by common storage insect pests if a holder expects upward price movement. Farmers have an interest to increase total production of tef. One way of increasing production is through the use of improved technologies and eventually improving productivity per unit area (Mesfin, et al. 2004). This means the economic importance of the crop is very high as compared to other cereals and pulse crops.

Tef (Eragrostis tef) is indigenous to Ethiopia in its origin. It is a grain crop solely produced in this country for human consumption purpose. Tef grows in most of the agro ecology zones of Ethiopia ranging from lowland to highland areas. The grain is an important crop used to make the Ethiopian staple food, Injera. This food is consumed at least once a day in better off households. It is nutritionally rich with high levels of iron and calcium, as well as highest amount of protein among cereals consumed in Ethiopia. It ranks low on the glycemic index, is gluten free and is high in fiber. The straw serves as a feed for livestock. Also the straw is important row material for the purpose of house construction. Marketwise, urban dweller has very high demand to consume tef. These demand made its price level higher than other cereals. As a result, tef price is reasonably stable (MAFAP 2013).

According to Greene (2003) Marginal effect is the effect on conditional mean of the dependent variables of changes in the regressor. PSM is defined as the conditional probability of assignment to a particular treatment according to Marcelo Coca-Perraillon (2006). The advantage of PSM: at the time of its introduction by using a linear combination of covariates for a single score, it balances treatment and control groups on a large number of covariates without losing a large number of observations & its advantage is only accounts for observed (observable) covariates.

2.2. The Origin of Tef

Like the relationship of rice to Asia, or maize to Latin America, tef is not only a fundamental ingredient in Ethiopian diets, but also an integral part of the national culture. Without the attention of worldwide focus, tef remains what is often called an "orphan crop"; one that has received significantly less international research on breeding, agronomy, mechanization, and processing (ATA 2012, Piccinin 2002). Tef is the most widely adapted crop compared to any other cereal or pulse crop in the country and can be grown under wider agro-ecologies (Gezahegn, Mekonnen and Samia 2006). This is to mean that even though it is the country born crop, no much attention was given for many years and made farmers fade up for the cultural crop production.

In other words, Tef, which serves as the main ingredient of Injera, a staple food for the majority of Ethiopians, is in great demand and is known by the scientific community as Eragrostis tef. It is most commonly grown in the Ethiopian highlands and midlands. The Quncho variety, which was developed over five years ago

by EIAR, is proved for its high productivity and quality and can grow in moisture-stress prone areas. Farmer can produce up to more than 30 quintals per hectare using this Quncho variety while the old tef variety yields only up to nine quintals on average. Tef is considered to have an excellent amino acid composition, high lysine levels and high contents of several minerals, particularly iron and others (MOA 2014).

Generally, quncho tef is the crop of Ethiopian obtained in Debre Zeit Agricultural Research center. There are about thirty two improved varieties of tef released by agricultural research institutions. Some of them are Magna, Enatit, Ambotoke, Tseday, Gibe, Dukem, Genet, Zikuala, Gerado, Koye, Kaytena, Gola, Ajora, Zobile, Yilmana, Mechare, Gemechis, Kenna, Etsub, Guduru, Amarach, Dima, Gimbichu, Lakech, Simada, Bosat, Degatef, Quncho and other four varieties are in production. From those varieties, quncho tef (Dz-Cr-387) is high yielding and can be done in almost all of agro-ecologies. Seed rate for one hectare is very low (3-5kg/ha) (MoA 2005).

Quncho was developed from an intra-specific hybridization between two improve pure line selection varieties (DZ-01-974 Dukem and DZ-01-196 Magna). The variety DZ-01-974(Dukem) is high yielding, but because of the seed color (pale white) its preference by farmers was limited. On the other hand the variety DZ-01-196 (Magna) has been popular for its very white seed color, but its productivity has been relatively low. So, Quncho was developed by crossing the high yielder and color full varieties (Kebebew, et al. 2011). The crop is high yielder and the seeding rate is low means it is more economical than other varieties of the crop and local type.

2.3. Current Situation of Tef

Tef currently account for up to a quarter of total cereal production in Ethiopia. The grain is gluten free and has a high concentration of different nutrients, very high calcium content, and significant levels of the minerals phosphorus, magnesium, aluminum, iron, copper, zinc, boron, barium, and thiamin. Tef is also high in protein. It is considered to have an excellent amino acid composition, including all essential amino acids for humans, and is said to have lysine levels higher than wheat or barley (Piccinin 2002). Further, Tef is high in carbohydrates and fiber. Ethiopia possesses the ideal agro-climatic conditions for the production of tef and it has all the genetic varieties of the plant that can be used to produce healthier, drought and disease resistant crop. Knowledge about tef itself is abundant in Ethiopia with farmers here having thousands of years of experience raising the plant (EARI 2014). In addition to local tef, quncho tef is now becoming popular for farmers through the help and collaboration of AGP and ATA under the umbrella of MOA.

The country also has the world's largest domestic market for the crop, increasing the incentive and sustainability of the crop to Ethiopian farmers. This is all certainly a lasting competitive advantage. The Ethiopian government which has accorded attention to the crop for purely domestic food security reasons must now expand its horizons and bearing the country to take advantage of emerging global opportunities. The country will need to invest heavily in research into the plant with the aim to improve its yield and to disseminate this knowledge and new technology to farmers. Where possible it should also incentivize major increases in tef production using market forces. Given rising food and commodity prices, the Government of Ethiopia currently has restrictions on the export of tef. While this is the right measure in the short run and appropriate to stabilize the crop's price for millions of Ethiopians, the only lasting solution is to provide price incentives to farmers to produce much more tef. The Ethiopia Commodity Exchange (ECX) can play a crucial role in this endeavor by making the market for tef much more predictable and transparent (EARI 2014). To produce much more tef for consumption and marketing, using the new productive variety is important.

On the top of that, Ethiopians in the Diaspora are already doing a marvelous job on promoting tef overseas greatly by promoting itself as a source for organic and healthy foods. This can create capacity to produce and supply to global markets (EARI 2014). Therefore, the crop is increasingly becoming known in all parts of the world and this can create market opportunity for export sector.

2.4. The Ethiopian Situation Policy towards Quncho Tef

The principal economic policy presently implemented by the Ethiopian governments is the Agricultural Development-Led Industrialization (ADLI). The implication is rapid agricultural growth to produce sufficient food for the citizens, exports and releases surplus of raw materials and labor to foster agro-industrialization. Hence the Five-year Development Plan of the Ethiopian government has put special emphasis on the development of the agricultural sector. It primarily attempts to transform traditional low productivity agriculture into high productivity agriculture, and to provide enough income for the people; and secondly to raise the level of raw materials for industrial sector. The strategy ADLI revolve around the productive improvement of small scale agriculture and industrialization that makes extensive use of the country's natural resource base by means of adoption of labour intensive (Tekete 1996).

The performance of a given economy of a country is largely determined by the policies and strategies followed by the government. Policies either encourage or discourage economic growth and hence the

development endeavors of a country. Sound and effective government policies serve as a tool of development while poorly conceived and non-flexible government policies stuck development, which eventually lead to the poor performance of the whole economy and then to poverty (Abebe 2000).

According to the strategy, the development of smallholder agriculture is envisaged to proceed in three stages. Stage one includes the involvement of agricultural practices including animal husbandry and the utilization of improved seeds. Stage two consists of the development of agricultural infrastructures, such as small-scale irrigation, and the introduction of modern inputs including fertilizers and agro-chemicals. Stage three relates to increasing farm size that would take place along with the shifting of population from agriculture to non-agricultural activities (Tsegaye 2003). Until the fall of the Derge regime in 1991, the Ethiopian government's economic policies gave less emphasis to agriculture especially to the peasant sector, which largely contributed to the lack of success in the development of agriculture, being the bottlenecks for improved productivity of subsistence small-scale farmers who made up the majority of the agricultural production system (Fresenbet 2005).

Generally, the strategy gives emphasis to the development of the agricultural sector in order to fulfill domestic food requirement, so as to attain national food security, expand commodities for export and be used as bounce enter for development of local industries through capital formation, supply of industrial inputs as well as expansion of markets for domestically produced goods and services as a result of increased income of small holders (Fresenbet 2005). In addition to the strategy, one of the major programs in the rural development in general and the Ethiopian agriculture in particular is the extension package that supported the promotion of modern agricultural technologies and intensifies agricultural growth. This shows that Agriculture is remained to be the mainstay of Ethiopian economy despite the dismal performance of the sector.

Through the diffusion of improved agricultural technologies, the Ethiopian government policy attempts to create simultaneous progress in both economic growth (efficiency) and equitable distribution of the benefit (equity) by households from the use of the transferred technologies. For this purpose, in 1995 a new extension approach referred "Participatory Development Training and Extension System (PADETES)" was formulated. It mainly comprises the delivery of improved seed, fertilizer, and pesticide on a credit (at a Bank official interest rate) with a 25% down-payment. The number of extension participants increases every year at a multiple of 10. Therefore the Government then has ambitiously launched massive technology diffusion process in all parts of the country, with ambitiously expecting the PADETES promote uniform adoption of a technology by all farmers thereby enabling the nation to simultaneously achieve at both growth and equitable distribution of income. Today, the PADETES is in implementation through FTC based extension (Beyene 2001). The main objective here is that farmers demonstrate with participation and obtain the required knowledge to internalize for own.

Intentionally, the current Ethiopian economic development strategy, ADLI, brings the growth of agriculture at its heart to lead the development of the other sectors as well (Atkilt and Paul 2010). Since input is the important startup of the production, the government initiated a 100 percent credit guarantee scheme on fertilizer purchases in 1994, allowing farmers to purchase fertilizer at below-market interest rates. However, the program has been gradually scaled down and farmers are being encouraged to buy on cash or credit provided through cooperatives and micro finances. The extent of interest rate subsidies is expected to be very small (FAO 2013).

According to (Assefa, Chanyalew and Tadele 2013), in order to meet the food requirement of the several increasing population of Ethiopia, the current level of tef production should be increased. At this juncture, it may be in order to quote what his Excellency late Prime Minister Meles Zenawi has once said: "…unless a miracle happens, tef will die down to be the staple food for many Ethiopians". This saying was created sense of urgency for agricultural researchers to get this Quncho tef variety and it aims the production of crops to enhance food security of the populations of which tef, the one dominant food crops in our country Ethiopia, is the main concern. By the same scenario adoption of new agricultural technologies that encourages the productivity of any agricultural output is very decisive. From those agricultural technologies; quncho tef is one that has high productivity and production that needs to conduct the study on the production bottle necks.

2.5. Empirical Study

Numerous studies have related household and institutional characteristics to adoption behavior and impact with different findings. The following are some of the results of previous studies. In order to increase adoption of suitable varieties it is important to know the factors that influence the choice of variety and adoption.

Using Tobit model and partial budgeting method (Getahun 2003), conducted a research on an Assessment of Factors Affecting Adoption of Improved Wheat Technology and its Impact: The case of Hula District, Ethiopia. He revealed that adopters obtained net benefit of 2673.90 birr/ha and the non-adopters obtained 2139.85 birr/ha. The adopters have gained additional net benefit of 534.05 birr/ha with the additional variable cost of 146.50 birr/ ha. The profitability of the new wheat technologies increases the rate of adoption of

improved wheat technologies. The impacts of these technologies also demonstrated that the use of improved wheat varieties were more profitable than the use of traditional practices. Hence, adopters have benefited substantially from the use of improved varieties.

Mesfin (2005) conducted a research on analysis of factors influencing adoption of triticale and its impact: The Case of Farta District by using logit model and stated findings shows that in his findings he rushed as Triticale is one of the potential technologies is used in the study area. He revealed that famers' perception on the yield superiority of triticale has positively and significantly affected adoption of triticale. The empirical results of his study indicate that variables found to be significant included; perception of yield superiority of triticale which was found to be significant at 1%, off / non-farm income and distance from household residence to market center, which were found to be significant at 5% probability level. Moreover, leased-in land, distance from household residence to all weather road, livestock holding, and Investment cost are found to be significant at 10% probability level. The result revealed that the probability of adopting triticale decreases by 0.800 as the distance from all weather road increases by one kilometer, other things kept constant. Similarly, the probability of adopting triticale increases by a factor of 1.0 as the farmers' income from off/non/farm source increase by one unit and the probability of adopting triticale increases by the factor of 1.685 for each increase in TLU.

González, et al. (2009) evaluates the direct impact of PATCA on technology adopter's productivity and value of production. Using a propensity score matching technique, they found that the technologies financed through PATCA effectively improved the productivity of rice producers and breeders. However, they did not find any significant impact on other producers. These heterogeneous impacts could be due to the different level of effectiveness of the promoted technologies in the short run, where land leveling and pasture conservation could be the fastest in showing significant effects.

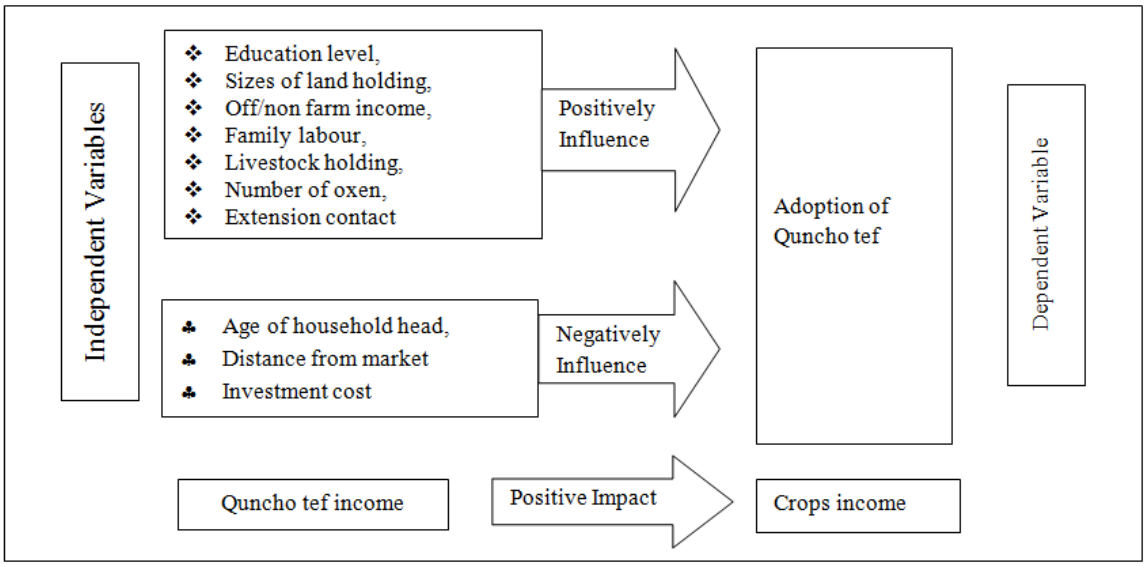
Solomon, et al. (2011) analyzed in their paper the adoption determinants and estimates the causal effect of adopting improved chickpea technologies on smallholder farmers' integration into output market in rural Ethiopia. Results confirmed that the level of adoption of improved chickpea varieties was strongly related to a range of household wealth indicator variables. Those households with more family labor force, livestock and land were considerably more likely to allocate extra land for the improved chickpea varieties. Ownership of these assets seems to ease the access of households to improved seed, some of which may be due to its potential effect on accessing credit. Livestock ownership may also help farmers spread some of the risks they face. Also for the causal effect purpose, PSM used with the four matching algorithm. The standard errors of the impact estimates are calculated by bootstrap using 100 replications for each estimate. The estimated results based on the four matching algorithms showed that our ATT estimate is robust. The overall average gain in the percentage of total chickpea production sold ranges from 0.16 to 0.20. The estimated gain was statistically significant at 99 percent confidence level for all the matching methods.

Akter and Fu (2012) examined the impact of a mobile phone technology enhanced services on agricultural extension services delivery system in India. An impact analysis is carried out based on randomized survey data taking into account of potential systematic selection bias through double difference techniques and reflexive comparisons. Findings from the research show that the amount and quality of the services and the speed of services delivery have been improved significantly as a result of the intervention. The estimated effect of Information and Communication Technology on the quality of services is positive and statistically significant at 1 percent level. The results are consistent and robust across different models and specifications. The magnitude of the estimated coefficient of the Information and Communication Technology variable is 0.42 in the Tobit model, suggesting that the quality of services is 0.42 units higher due to the use of mobile phone technology. Given the mean Quality Index of the treatment group before intervention at 0.57, this suggests an increase of 74 percent in overall quality after the introduction of Knowledge Help Extension Technology Initiative (Program in India) intervention.

2.6 Conceptual Framework of the Study

The conceptual framework of the study is developed on the existing literature. that is the education level, sizes of land holding, off/non farm income, family labour, livestock holding, number of oxen, extension contact and net income of the households influences adoption of quncho tef positively, while age of household heads, distance from market and investment cost influence negatively. Similarly, the crops income of adopters is greater than non adopters which shows positive impact of the adoption of Quncho tef on farmers' crop income (See Fig.1)

Figure 2: Conceptual framework of the study



Source: Own completion based on literature

3. Research Methodology

3.1. Description of the Study Area

The study was conducted in Wayu Tuqa District which is found in East Wollega Zone Oromiya Regional state, Ethiopia. It is one of seventeen District of East Wollega zone, Oromiya, Ethiopia. The land size of the Wayu Tuqa is 45,895 ha and it is located 320 km from the capital city Addis Ababa toward the west of the country and 10 km away from Nekemte, which is the East Wollega zonal town. The District is bounded by Guto Gida and Sibu Sire Districts in the north, by Guto Gida and Leqa Dulacha Districts in the west and East by Sibu Sire District, and Wama Hagalo in the south and Nunu Qumba District in the east.

The District is classified in to three agro Climatic zones: Dega covers about 37.66 percent, Woina Dega 49.23 percent and Kolla 13.11 percent, with min 12 ^{0}C and max 32 ^{0}C temperatures. The altitude range of the District is 750 masl to 3180 masl, and the Rainfall of the area is min 1400mm & max 2400mm respectively.

The population size of the Wayu Tuqa District is 78,871. The male and female populations of the District are 40350 (51.16%) and 38,521 (48.84%) respectively. The household size of the Wayu Tuqa District rural PAs is estimated 11,947. The male and female headed households of the District is estimated to be 10577 (88.53%) and 1370 (11.47%), respectively. Agriculture (mainly rain fed and characterized by low productivity) is the economic base of the Wayu Tuqa District. Major crops such as cereals, pulse and oil crops are cultivated annually in their descending order of area coverage (CSA 2007).

According to the District office of livestock, the total population of the livestock is, Cattle 86,453 Goat 9,848, Sheep 29,981, Mule 1,031, Horse 7,450, Donkey 5,784, and Hens 54,133. The role of livestock in the study area is for drought power, income for family life and additionally, their dung used as organic fertilizer (WLAO 2014).

3.2. Research Design

The purpose of this research was to analyze the impact adoption of quncho tef on crops income in the case of Wayu Tuqa District. In order to assess this specific objective, the study tries to answer the following research questions: does adoption of Quncho tef improve crop income level of farmers?

The main methodology of this study was case study due to the research was conducted to study social group in the community of the Wayu Tuqa District. Thus, it is about the quality of theoretical analysis that is allowed by intensive investigation into one or a few cases, and how well theory can be generated and tested, using both inductive and deductive reasoning. Both quantitative and qualitative methods are appropriate for case study designs, and multiple methods of data collection are often applied. In this study both primary and secondary data were used. Primary data was from sampled households and secondary data were from District Office of Agriculture, District livestock agency office, Central Statistics Agency and others. The data was collected from sample households in sample Peasant Association (one from Dega, three from weinadega and one from Kola) of the District by using structured questioner with interview, and analysis was undertaken by the researcher using STATA software.

3.3. Sampling Procedures and sampling size

Both Probability and non-probability sampling technique were employed to conduct the study. The study District was selected purposively. Based on the traditional agro-climatic zones, stratified random sampling procedure was employed for the selection of sample kebele (PA's) from the District. In the first stage, by considering the Peasant Associations where quncho tef is currently under production, ten quncho tef growing peasant associations was stratified, in this regard the main aim was in order to remove heterogeneity in production system, types of crops grown, amount of rainfall, temperature etc. Also after stratifying the District in to three, the sample Peasant Associations was selected by using random sampling procedure.

Accordingly, after stratifying the Peasant Associations in to three agro ecological zones, 5 Peasant Associations were selected randomly using proportional allocation for the study. The five Peasant Associations were Dalo Komto from Daga AEZ, Wara Babo Migna, Megna Kura and Gute from Woina Dega AEZ, and Bonaya Molo from Kolla AEZ. The farmers in each Peasant Associations were stratified into adopter and non-adopter categories giving the relative homogeneity of the sample respondents of their adoption status of quncho tef and their experience of growing the tef. Hence, in this study, considering those farmers cultivated quncho tef for one and more years as adopters and those not cultivating quncho tef currently as non-adopters. Since the numbers of farmers in each sample peasant association are different, specific numbers of respondents were selected with probability proportionate to size (PPS) random sampling technique to ensure representativeness of the population.

Following (Watson 2001) the sample size of the population that was interviewed was selected using the following formula

$$n=\left(\frac{\boldsymbol{p}[\boldsymbol{1}-\boldsymbol{p}]}{\frac{\boldsymbol{A2}}{\boldsymbol{Z2}}+\frac{\boldsymbol{p}[\boldsymbol{1}-\boldsymbol{p}]}{\frac{N}{R}}}\right)$$

Where**,** n = sample size required, N = size of total population, P = estimated variance in population, A = is the desired level of precision, Z= confidence level for the test, R = estimated Response rate. Based on the (Watson 2001) formula the required sample size would be:

$$n=\left(\frac{0.5[1-0.5]}{\frac{(0.05)2}{(1.96)2}+\frac{0.5[1-0.5]}{\frac{6274}{0.95}}}\right) \quad = \underline{362} \text{ farmers}$$

So, the total sample population is divided in to two, adopters and non adaptors based on the proportion of the users and non users. Here, the total population of the District, N is 6274, estimated variance in population, as a decimal, P, would be (0.5 the presumption is 50-50), desired level of precision, A which is expressed as decimal is (0.05 thinking that the precision would be 5 %), confidence level for the test, Z, is estimated at 1.96 (95 % confidence), estimated Response rate, R, is assumed that 95 percent of the respondents would respond. Here, since the researcher couldn't obtain the research conducted in the study area before, the level of precision was used as a rule of thumb as 0.5.

3.5. Method of Data Collection

Data collection activity was conducted from September 2014 to January 2015**.** Primary data was collected from sample respondents through a structured closed and open ended questionnaire, which was designed to generate data on some social, institutional and economic variables that were supposed to be important for the study. Five enumerators (one in each Peasant Association) who speak local language (Afan Oromo) were assigned from the study area and familiar with the questions, were trained on methods of data collection and interviewing techniques.

Field trips were conducted before the actual survey to observe the overall features of the selected Peasant Association and to pretest the questionnaire. For pretesting purpose, five farm households outside the sample farmers were interviewed, at the rate of one farmer by each enumerator. After pre-testing, a second meeting was conducted with the enumerators to discuss on their field experiences, clarity of questions, language, unexpected responses and additional response options for questions. After incorporating corrections, the final version of the questionnaire was prepared. As data collection started by enumerators, continuous supervision was made by the researcher to correct possible errors on the spot.

3.6. Method of Data Analysis & Econometric Model: Propensity Score Approaches

Matching has become an increasingly popular method of causal inference in many fields including statistics, medicine, economics, political science, sociology and even law. There is, however, no consensus on how exactly matching ought to be done and how to measure the success of the matching procedure. A wide variety of matching procedures have been proposed, and Matching implements many of them. When using matching methods to estimate causal effects, a central problem is deciding how best to perform the matching (Sekhon

2011).

Propensity score methods allow the researcher to directly address the question of what can be earned from the data and what cannot (David 2011). Hence, some analytical tool commonly used in impact analysis was matching, treatment regression model, switching regression model and partial budgeting (gross margin) analysis (Blundell and Costadias 2000). As indicated in the review of literature part, Propensity score methods allow the researcher to directly address the question of what can be earned from the data and what cannot (David 2011).

Another issue is that PSM requires large samples, with substantial overlap between treatment and control groups. Any hidden bias due to latent variables may remain after matching because the procedure only controls for observed variables. Most of the time, PSM is used in logistic regression models for dummy variables to figure out the outcome/change of using or not (Rubin 2006). Thus, Propensity score methods allow the researcher to directly address the question of what can be earned from adopters and the loss of being non-adopters. Hence, some analytical tool commonly used in impact analysis would be matching, Based on literature, to analyze the impact of adoption of quncho tef on farmers' income, propensity score matching was employed.

According to (Grilli and Rampichini 2011) the necessary steps when implementing propensity score matching are: Propensity Score estimation, Choose matching algorithm, Check overlap/common support, Matching quality (effect estimation), and Sensitivity analysis.

Propensity score matching estimators are widely used in evaluation research to estimate average treatment effects. Our derivations take into account that the propensity score is itself estimated in a first step, prior to matching. We prove that first step estimation of the propensity score affects the large sample distribution of propensity score matching estimators and derive adjustments to the large sample variances of propensity score matching estimators of the Average Treatment Effect (ATE) and the average treatment effect on the treated (ATT). The adjustment for the ATE estimator is negative (or zero in some special cases), implying that matching on the estimated propensity score is more efficient than matching on the true propensity score in large samples. However, for the ATT estimator the sign of the adjustment term depends on the data generating process, and ignoring the estimation error in the propensity score may lead to confidence intervals that are either too large or too small and ATT is calculated using propensity score matching method (Abadie and Imbens 2012).

According to Becker and Ichino (2002), matching has become a popular method to estimate average treatment effects. In this method since the main aim is to calculate the impact of Quncho tef adoption on income, the outcome variable which is net income is used in this analysis. Before estimating the impact of Quncho tef adoption, specifying the propensity scores for treatment variable using logit or probit model is required (Becker and Ichino 2002). Hence the logit model is applied in this case to predict the probability of adoption of Quncho tef. For this purpose the household characteristics variables such as age, sex, labor, and education level and the outcome variable net income were used to analyze the adoption decision and impact.

According to (Marcelo, Adheris and Burlington 2006), the first step to perform PSM consists of estimating the propensity score for a particular individual. The propensity score, in most applications it is estimated using a logistic regression in which the dependent variable is a dummy variable indicating treatment participation. In principle, however, other estimation techniques can be used; such a random effect models, models that include instrumental variables, or discriminate analysis. The independent variables are all the observable factors that are considered to be related to the treatment inclusion and outcome. The most commonly used matching methods, such as nearest available neighbor, calipers and radius with- without replacement and Stratification.

According to Yang, Stephen and William (2008), it is unavoidable that good matching generates an incomplete match and that a "maximum" match cannot avoid an inexact match; therefore a trade-off between incomplete matching and inexact matching needs to be determined. In practice, severe bias due to incomplete matching is of less concern than inexact matching. The selection of a proper matching algorithm is an important procedure affecting estimation of treatment effect. Careful comparison among at least two matching algorithms is critical according to both tests prior to matching and tests after matching (Yang, Stephen and William 2008).

Form the methods of matching, according to (Gashaw, Getnet and Gian 2014), the kernel matching method is used to allow matching of treatment (adopter) with the whole sample of non treatment (non-adopters), since the technique uses the whole sample of the comparison with common support to construct a weighted average match for each adopted. That is, the entire sample of non-adopters in the comparison group is used to construct a weighted average match to each member in the adopter group. Thus, kernel method of matching was used to analyze the income impact of the adoption of Quncho tef.

According to (Verónica, et al. 2009), the correct evaluation of the impact of the technologies will require identifying the ATT defined as the difference in the outcome variables between the treated farmers and their counterfactual (i'e the outcome of beneficiaries if they had not been adopter). In this context, if Y represents the outcome variable and if D is a dummy variable that takes the value of 1 if the individual was adopter and 0 otherwise, the "average treatment effect on the treated" will be given by:

$$ATT = E[Y(1)|D=1] - E[Y(0)|D=1] \quad \ldots\ldots (6)$$

However, given that the counterfactual (E[Y (0) |D=1]) is not observed, a proper substitute has to be chosen to estimate ATT. Using the mean outcome of non-beneficiaries -which is more likely observed in most of the cases- do not solve the problem given that there is a possibility that the variables that determine the treatment decision also affect the outcome variables. In this case, the outcome of treated and non-treated individuals might differ leading to selection bias. To clarify this idea the mean outcome of untreated individuals has to be added to (6) from which the following expression can be easily derived:

ATT ={ E[Y (1) |D=1] - E[Y (0) |D=1]}- {E[Y (0) |D=1] - E[Y (0) |D=0]}…….…… (7)

Here E[Y (0)|D=1] - E[Y (0)|D=0] represents the selection bias which will be equal to zero if the program was given randomly; that means, in the case where treated and control groups did not differ before the program was implemented. Therefore, it is necessary to call upon identifying assumptions to evaluate the impact of the quncho tef adoption. The primary assumptions underlying matching estimators are the conditional independence assumption (CIA) and common support assumption (Wooldridge 2002, Ravallion 2008).

The CIA states that the decision to participate is random conditional on observed covariates *X,* that means self selective (Wooldridge 2002, Ravallion 2008).

$Y_o \perp T_1|X$ …….…… (8)

This assumption equation rules out adoption on the basis of unobservable gains from adoption. The CIA requires that the set of *X*'s should contain all the variables that jointly influence the welfare indicators with non-adoption as well as the selection into adoption.

Common support assumptions shows that for matching to be feasible, there must be individuals in the comparison group with the same value of covariates as the participants of interest (Wooldridge 2002, Ravallion 2008). It requires an overlap in the distribution of the covariates between adopter and non-adopter comparison groups. This assumption is expressed as:

P(X) = Pr (T=1|X) < 1 ……...…..…….. (9)

This equation ensures existence of non-adopters analogue for each adopter and it restrict matching within the common support region.

According to (Admassu, Workneh and Sisay 2015), standardized tests of mean difference and testing for the joint equality of covariate means between groups using the Hotelling test or F-test is required. Thus, the following equation shows the formula used to calculate standardized tests of mean difference.

$$\mathbf{B}\ \text{before matching}(x) = \frac{\bar{X}T-\bar{X}c}{\sqrt{\frac{VT(x)-Vc(x)}{2}}} \text{ x } 100,\ \mathbf{B}\ \text{after matching}(x) = \frac{\bar{X}Tm-\bar{X}cm}{\sqrt{\frac{VT(x)-Vc(x)}{2}}} \text{ x } 100 \quad \text{.....} (10)$$

Where for each covariate, $\bar{X}T$ and $\bar{X}c$ are the sample means for the adopter and comparison groups, $\bar{X}Tm$ and $\bar{X}cm$ are the sample mean for the matched treatment and comparison groups, and VT(x) and Vc(x) are the corresponding sample variance.

4. Results and Discussion

4.1 Descriptive Data Analysis

The required data was collected from five Peasant Associations (Dalo Komto, Wara Babo Migna, Migna Kura, Gute and Boneya Molo) of Wayu Tuqa from 355 households (Table.1) and seven sample populations were not responding meaning 7 missed value. Thus, the initial sample size was 127 from the adopters and 235 from the non-adopter farmers thereby making total sample size of 362. Finally, completed data for the study were collected from 125 adopters and 230 non-adopter farmers thereby making total sample size of 355. These were 35.21 and 64.79 percents of the total sample of adopters and non-adopters, respectively. The mean and standard deviation of adopters was 0.91 and 0.28 respectively, while it was 0.84 and 0.36 for non-adopters respectively.

Table 1: Collected sample size

Agro-climatic zone	Sample Peasant Associations	Number of total Households	sample size of adopters	sample size of non adopters	Total sample size
Dega	Dalo Komto	1521	28	43	71
Woina	Wara Babo Migna	1092	20	50	70
Dega	Megna Kura	900	21	24	45
	Gute	1106	17	52	69
Kolla	Bonaya Molo	1655	39	61	100
Total		6274	125 (35.21)	230 (64.79%)	355

Source: own computation based on data of September 2014 to January 2015

In general the descriptive statistics of variables such as age of households, family labour, non/off-farm activity, education level, farm land size, number of livestock in-terms of TLU, oxen holding, market access, extension contact, crops net income and investment cost of households were summarized as the table 4 below.

Table 2: Summery of descriptive statistics

	Mean Values			t-test	
Variables	Adopters	Non-adopters	Total	t	p>|t|
Age of households	38.26	38.29	38.28	-2.59	0.010*
Family labor	3.70	2.09	2.66	1.84	0.066*
Non/off- farm activity	514.56	1235.46	981.62	-0.93	0.354
Education	7.92	3.35	4.96	2.54	0.011*
Farm Land size	2.10	1.79	1.89	0.77	0.441
Livestock (TLU)	4.83	3.66	3.55	2.99	0.003**
Oxen holding	1.94	1.5	1.64	-4.63	0.008**
Market Access (Km)	4.58	14.04	10.70	-2.63	0.009**
Extension contact	3.3	1.33	2.02	2.5	0.012*
Crops Net Income	48590.1	24780.6	33164.2	3.10	0.002**
Investment cost	4483.89	3251.05	3685.17	-0.34	0.731

*, ** shows the significance level at 5% and 10% respectively
Source: own computation based on data of September 2014 to January 2015

Age of the household head of sample respondents ranged from 25 to 65 years with mean of 38.28 years and standard deviation of 7.00. Likewise, the mean and standard deviation the age of adopters was 38.26 and 6.95 respectively, while it was 38.29 and 7.05 for non-adopters respectively.

The man equivalent (ME) of the economically active family labor of total sample households was calculated for the sample respondents with the mean of the 2.66 and standard deviation of 0.99. The mean and standard deviation of the labor of adopters was 3.70 and 0.93 respectively, while it was 2.09 and 0.40 for non-adopters respectively. The size of labour force in the household is a priori to contribute for variation on adoption decision of Quncho tef as expected.

About 27.04 percent of the total respondent household's family members were involved in off farm activities. Of the total respondents, 6.76 percent of the family members who participated in off farm activities were adopters and 20.28 percent were from the non-adopters. The mean income from off/nonfarm for non-adopters were 1235.45 birr and 514.56 birr for adopters. This shows that difference in adoption was not observed due to family members' engagement in off-farm activities.

The mean and standard deviation of the education level of adopters was 7.92 and 2.28 respectively, while it was 3.35 and 3.22 for non-adopters respectively which could explain the variation with regard to adoption decision of Quncho tef. The study indicated that farmers who had higher education level show willingness to take new ideas and to try the technology by allocating some of the scarce resources.

The land size of sample households vary from 0.5 to 4.0 hectare with an average holding of 1.89 hectares with standard deviation of 0.88. The average size of land for adopters was 2.10, while that of non-adopters was 1.79. The result showed that the farm size of the household was the required resource for adoption of new technology.

Farm animals have an important role in rural economy. They are source of draught power, food, such as, milk and meat, cash, animal dung for organic fertilizer and fuel and means of transport. Farm animals in the study area also serve as a measure of wealth in rural area. The types of livestock found in the study area were cattle, sheep, goat, poultry and Horses, Mule and donkey. To help the standardization of the analysis, the livestock number was converted to tropical livestock unit (TLU) conversion factors used. The average livestock holding of respondents was 3.55 TLU with a standard deviation of 2.74. Also, the mean and standard deviation of the livestock holding of adopters was 4.83 and 2.75 respectively, while it was 3.66 and 2.65 for non-adopters respectively.

This study indicated that there was a significant difference in livestock holding between adopters and non-adopters at a 5 percent significance level. This shows that adopters have higher livestock holding than the non-adopters. It could also indicate that adopters have better access to financial source through sell of livestock which could be used to purchase farm inputs, such as seed and fertilizer, and livestock used for minimizing risk.

Oxen are source of draught power in Ethiopian field of farming agriculture. The average oxen holding of the sample respondents were 1.64 with a standard deviation of 1.18. From the total sample respondents 46.48 percent of them faced shortage of oxen. To overcome the problem of lack of oxen 18.87 percent, 14.09 percent, and the rest 13.52 percent of the total respondents used Hiring, borrowing, and exchange arrangement of oxen. This shows that only about 53.52 percent of the total respondents had no lack of oxen. Thus, result revealed that without owning of oxen farmers can adopt new technologies by using Hiring, borrowing, and exchange arrangement of oxen.

The survey result indicated that the average distance of respondents' home from the nearest market place was 10.70 km. The average distance from market for adopters was 4.58 km with standard deviation of 2.86,

while it was 14.04 with standard deviation of 4.40. The result also revealed that mean difference of distance to market was significant at 1 percent level of significance. This shows that farmers nearest to market were better adopter than the farmers far from market.

Frequency of Extension contact has an important role in rural economy. The mean frequency of extension contact of respondents was 2.02 with a standard deviation of 1.46. Also, the mean and standard deviation of the frequency of extension contact of adopters was 3.3 and 0.83 respectively, while it was 1.33 and 1.25 for non-adopters respectively. This study indicated that there was a significant difference in the frequency of extension contact between adopters and non-adopters at a 10 percent significance level. This shows that adopters have higher frequency of extension contact with DAs than the non-adopters. It could also indicate that adopters have better access to information source which could be used to implement new agricultural technologies.

It is obvious that net income is an important as in any economy. The mean crop net income of respondents was 33164.23 with a standard deviation of 13908.42. Also, the mean and standard deviation of the crops net income of adopters was 48590.1 and 12170.97 respectively, while it was 24780.6 and 4282.88 for non-adopters respectively.

This study indicated that there was a significant difference in crops net income between adopters and non-adopters at a 5 percent significance level. This shows that adopters have higher crops net income in birr than the non-adopters.

4.2. Regression Results: The Impact of Quncho tef Adoption on Income.

This study was based on the farmers interview and this section attempts to address the impact of quncho tef adoption on farmers' income in Wayu Tuqa District.

4.3.1 Propensity score matching result

In the country as a whole and particularly in the study area asking questions relevant to yield of crops, and income earned is sensitive. Farmers were unwilling to respond truly when requested to comment on yield and income aspects. They mostly underestimate the yield and income earned because of the fear that higher taxes might be levied on them due to high yield and income, cultural beliefs that may reduce the outcome if kwon by others is another concern. Hence, yield and income data obtained by interviewing farmers are subject to underestimation. But, it was believed that both adopters and non-adopters give underestimated yield and income data. Hence it follows that the problem created by underestimation may not create bias in the analysis of impact of Quncho tef adoption, as data from both categories are liable to underestimation of yield and income. Here, the crops net income includes the yield obtained from crop produced (the produced quintals were converted to Birr by the price of farm gate price of the survey time) minus price of farm investment cost.

PSM was employed to identify the impact of the adoption on crops income; Even though there are a number of methods to match the sample adopter with non adopter, the methods used in this analysis are the kernel matching and the nearest neighbourhood with psmatch2 command. Both matching methods with one command are supposed to lead to the same conclusion although the specific results may not be necessarily the same. This means, if the adoption impact on any indicatory is robust, finding from most matching algorithms must lead to the same conclusion. Thus, such use of different matching algorithms is used as effective method of checking the robustness of the adoption impact.

Table 3: Estimation of Propensity score: dependent Variable adoption of Quncho tef

Variables	Logit Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Education	1.497017	.5904795	2.54	0.011*	.3396986	2.654336
Age of HH	-.4494574	.173654	-2.59	0.010*	-.7898129	-.1091018
Farm land	.9722194	1.262822	0.77	0.441	-1.502866	3.447305
Sex of HH	4.176921	2.762171	1.51	1.130	-1.236834	9.590677
Market distance	-.7026707	.2671239	-2.63	0.009**	-1.226224	-.1791175
Productive Labour	2.013284	1.096195	1.84	0.066*	-.1352198	4.161787
Livestock holding	1.275337	.4269533	2.99	0.003**	.4385242	2.11215
No oxen holding	-4.355365	1.653019	-2.63	0.008**	-7.595222	-1.115507
Extension contact	1.47079	.5580784	2.64	0.008**	.376976	2.564603
Agri. trainings	3.808499	2.271659	1.68	0.094*	-.6438716	8.260869
Family food meet	3.566943	1.544124	2.31	0.021*	.5405154	6.59337
Investment cost	-.0001422	.0004135	-0.34	0.731	-.0009525	.0006682
Crops net income	.0002903	.0000935	3.10	0.002**	.000107	.0004736
Constant	-15.42841	5.105481	-3.02	0.003	-25.43497	-2.421849
				Number of obs =		355
				Prob > chi2 =		0.0000***
Log pseudolikelihood = -112.91840				Pseudo R2 =		0. 3979

,* Shows significance level at 5% and 10% respectively ** shows adequacy of the model
Source: own computation based on data of September 2014 to January 2015

Educational level of the household head measured in terms of years of schooling, owning of farm land, sex of households, productive labour of households in terms man equivalent, number of livestock in terms of TLU, number of development agents' contact with the household per cropping year, ability of family food requirements meeting, as well as crops net income of the households were positively associated with adoption of Quncho tef. In the contrary, such covariates as age of the household head, distance from nearest market centers, number of oxen holdings and investment costs were negatively associated with the adoption of Quncho tef.

The predicted propensity scores range from 0.0013193 to 0.9999999 with mean value of 0.8908125 for the adopter farmers with standard deviation of 0.2277041, while it ranges from 0.000000831 to 0.8972222 with mean value of 0.059341 for those non-adopter farmers with standard deviation of 0.1354519. Accordingly, the common support region was satisfied in the range of 0.001319 to 0.8107097 with 67 losses of observations (5 from those adopters and 62 from those non-adopters farmers).

4.3.2 Crops Net Income impact of the quncho tef adoption

The neighbourhood result showed the positive result with nearest different magnitudes (Table 4), i'e from the table, it is clear that the average treatment effect on the treated (ATT) of net crops income is 12,019.61 Ethiopian Birr with t-value 2.60, and 11,790.59 Ethiopian Birr with t-value 2.57 indicating the effective level of significance for Neighborhood and Kernel matching methods respectively.

Table 4: Propensity score, kernel matching and Neighborhood result

Algorithms	Adopters(N)	Non-adopters(N)	ATT	std. Err	t- value
Kernel matching	120	168	11790.59	4589.64	2.57
Neighborhood Matching	120	168	12019.61	4623.61	2.60

Source: Own computation Result based on data of September 2014 to January 2015

The kernel matching method result revealed that the crops net income of the farmers who were adopter of Quncho tef was much greater with 11,790.59 Ethiopian Birr than non adopters, which is similar result with (Getahun 2003), which states the crops net income of agricultural technology adopters is greater than non adopters. So it is concluded in this analysis that the agricultural technology adoption has positive income effect on the farm households of the study area. From the table, it is clear that the average treatment effect on the treated (ATT) of crops net income is 11,790.59 Ethiopian Birr with t-value 2.57, indicating the effective level of significance. So it is concluded in this analysis that the quncho tef adoption has positive income effect on the farm households of the study area.

Both calculation methods indicated that adoption of quncho tef creates positive average crops net income differences between adopters and matched non-adopters of the crop. Hence adoption of quncho tef has positive crops net income effect on the life of the adopters indicating positive welfare effect or reduction of poverty level on the side of the adopters. This leads to the conclusion that quncho tef adoption has positive welfare effect on the life of the adopters. This result is consistent with the findings of (Getahun 2003), who

identified a strong and positive effect of adoption on farm household's wellbeing.

4.3.3 Sensitivity test for ATT

Sensitivity analysis is a strong identifying assumption and must be justified. Thus, checking the sensitivity of the estimated results with respect to deviations from this identifying assumption becomes an increasingly important topic in the applied evaluation literature. According to (Grilli and Rampichini 2011) sensitivity analysis is the final diagnostic that must be performed to check the sensitivity of the estimated treatment effect to small changes in the specification of the propensity score. Based on this concept the sensitivity analysis of this research conducted as shown by table 7 below.

As one can clearly see from the table, the significance level is unaffected even if the gamma values are relaxed in any desirable level even up to 50 percent. This shows that ATT is not sensitive to external change. Hence there are no external variables which affect the result above calculated for ATT above.

Table 5: Sensitivity test of external effect on ATT

Gamma	sig^+	sig^-	t-hat $^+$	t-hat $^+$	CI^+	CI^-
1	0	0	15806	15806	13915	17706
1.05	0	0	15525	16012.5	13697	17931.5
1.1	0	0	15289.5	16250	13460	18177
1.15	0	0	15057.5	16485.5	13316.5	18381.5
1.2	0	0	14854	15726.5	13125	18574.5
1.25	0	0	14641	16900	13007.5	18763
1.3	0	0	14430	17077.5	12812.5	18973.5
1.35	0	0	14282.5	17271	12650	19211
1.4	0	0	14112.5	17513.5	12533.5	19400.5
1.4 5	0	0	13941.5	17658.5	12374	19586.5
1.5	0	0	13828	17826.5	12262.5	19720
1.5 5	0	0	13665.5	17966	12131.5	19886.5
1.6	1.1e -16	0	13493.5	18133	11790.59	20066.5
1.65	2.2e -16	0	13390	18307	11840	20316
1.7	5.6e -16	0	13287.5	18406	11745	20429.5
1.75	1.4e -15	0	13169.5	18501.5	11610	20586
1.8	1.4e -15	0	13169.5	18501.5	11610	20586
1.85	7.9e -15	0	13000	18765	11377.5	20902.5
1.9	1.7e -14	0	12861	18928.5	11289	21055
1.95	3.7e -14	0	12783.5	19034.5	11177.5	21185.5
2	7.5e -14	0	12657	19203	11086.5	21277.5

* Gamma - log odds of differential assignment due to unobserved factors
Sig^+ - upper bound significance level
Sig^- lower bound significance level
t-hat $^+$ - upper bound Hodgest-Lehmann point estimate
t-hat $^+$ - lower bound Hodgest-Lehmann point estimate
CI^+ - upper bound confidence interval (a=.95)
CI^- - lower bound confidence interval (a=.95)

Source: Own Survey Data based on data of September 2014 to January 2015

5. Summery and Conclusion

The need for applying modern agricultural technologies in Ethiopian agriculture is not doubtful. The agricultural sector of the country is well known for its being traditional and use of backward technologies. The destiny of the sector of increasing its contribution to the overall growth of the economy and securing food self sufficiency depends on the development and adoption of appropriate technologies. Hence, the adoption of Quncho tef can contribute a lot for productivity enhancement of the sector.

This paper, using the sample household data, tried to identify the major impacts of the adoption's crops income impact of the farmers. The analysis was undertaken using both the descriptive and regression analysis. The descriptive analysis reveals that households with larger family labor were better adopter and gain more income. It was also observed that there is no significant difference between adopters and non-adopters based on their land holding because the adoption of quncho tef needs few land than other due to its labor consuming and also difference in adoption was not observed due to family members' engagement in off-farm activities.

Further, farmers having high frequency of extension service are found to be better adopters of Quncho tef. But, there was no difference observed between adopter and non-adopters in adoption decision due to the amount of off/non-farm of income. Distance of the farmer's residence from the nearest market influence adoption

of Quncho tef negatively and significantly show that distance of farmers' residence from the nearest market area associated with adoption decision of Quncho tef negatively and significantly. This implies that distance to the nearest market in different localities had similar influence on the adoption of technology.

Age of the households influence adoption of Quncho tef negatively and significantly, implies that as the age of farmers increase up the ability of the farmer to adopt new technology will decline. Similarly, family labour influence adoption of Quncho tef positively and significantly implies that as the labour of farmers increase up the ability of the farmer to adopt new technology will increase. In the same way, the households' education level and participation in different Agricultural trainings influence adoption of Quncho tef positively and significantly show that as the education level and participation on agricultural trainings of farmers' increase, the ability of the farmer to adopt Quncho tef will increase

The crops net income by Ethiopian Birr and number of households' livestock holding interims of tropical livestock unit influence adoption of Quncho tef positively and significantly. This shows that the relationship was that as the number of livestock of farmers increase, the ability of the farmer to adopt new technology will increase. Also crops net income the farmers influence adoption of Quncho tef positively and significantly. The relationship was that as the crops net income of farmers increase, the ability of the farmer to adopt new technology will increase.

However, which is contrary to previous researches, number of oxen own influence adoption of Quncho tef negatively and significantly. This relationship was that as the oxen holding of farmers increase up the ability of the farmer to adopt new technology will decrease this is may be due to farmers who have oxen think to cultivate all of their lands widely in traditional way than using intensive technologies.

In general, it is clear that the crops net income of adopter farmer is 11,790.59 Ethiopian Birr with t-value 2.57, indicating the effective level of significance. So it is concluded in this analysis that the quncho tef adoption has positive income effect on the farm households of the study area which is about 11,790.59 Ethiopian Birr than non-adopter farmers.

ACKNOWLEDGEMENT

First of all, thanks to the almighty God for providing me the opportunity and smoothening of all aspects regarding the overall activities of the research work. I am indebted to and gratefully acknowledge to my major advisors Mekonnen Bersisa (PHD Candidate) and co-advisor Gutu Gutema (MSc) for their genuine and constructive ideas and who were shown the right track for the successful and timely accomplishment of the study which would have been very difficult without their contribution. Also, I am very much indebted to express my great and appreciation to my true friends Mr. Fikadu Goshu (MBA, MSc) for his unreserved support and encouragement.

REFERENCE

Abadie, Alberto, and Guido Imbens. "Matching on the Estimated Propensity Score." 2012.

Abebe, H/Gebrie. "Development Strategies and the Ethiopian Peasantry: Supply Response and Rural Differentiation." PhD Dissertation, Hague, Netherland, 2000.

Admassu, Tesso, Negatu Workneh, and Asefa Sisay. "Does Farmer Field School Training Improve Technical Efficiency? Evidence from Smallholder Maize Farmers in Oromia, Ethiopia." *Journal of Economics and Sustainable Development*, 2015.

Akter, Shaheen, and Xiaolan Fu. "Impact of Mobile Telephone on the Quality and Speed of Agricultural Extension Services Delivery: Evidence from the Rural e-services Project in India." *Triennial Conference.* Bangladesh, 2012. 18-24.

Alemitu, Mulugeta. "Factors Affecting Adoption of Improved Haricot Bean Varieties and Associeted Agronomic Practice in Dale Woreda, SNNPRS." MSc Thesis at Hawassa University, Hawassa, 2011.

Asres, Kebede. "Impact of incentive system on soil and water conservation activities in Ambasel Area, South Wollo, Ethiopia." An M.Sc. Thesis Presented to the School of Graduate Studies of Alemaya University, 2003.

Assefa, Kebebew, Solomon Chanyalew, and Zarihun Tadele. "Achievements and prospects of Tef improvements." Switzerland: Stampfli, 2013.

ATA. "Transforming Agriculture in Et hiopia." Addis Ababa, 2012.

ATA. "Annual Report." 2012.

Atkilt, Admasu, and Issac Paul. "Assesment on The Mechanisms and Challenges of Small Scale Agricultural Credit From Commercial Banks in Ethiopia:The Case of Aa'a Liben Woreda Ethiopia." *Journal of Sustainable Development in Africa*, 2010.

Becker, Sascha, and Andrea Ichino. "Estimation of average treatment effects based on propensity scores." *Stata Journal*, 2002: 358–377.

Berhane, Hailu. "The Impact of Agricultural Policies on Smallholder Innovation Capacities." MSc Thesis, 2009.

Beyene, Tadesse. "Differential Adoption of Technologies and its Implications for Policy choice between Equity and Growth." *International Conference on African Development Archives.* Western Michigan University, 2001. 40.

Blundell, Rosetto, and Mattew Costadias. "Evaluation methods for non-experimental data." 2000.

CSA. "Population and housing sensus ." 2007.

David, Pasta. "Using Propensity Scores to Adjust for Group Differences." San Francisco, 2011.

EARI. *The Rise of Tef on the World Market. Why Ethiopia's Next Gift to the World is a Likely Boom for Business.* F F.eb, 2014. www.ethiopiainvestor.com (accessed Feb 15, 2014).

FAO. "Analysis of Incentives and disincetives for Tef in Eyhiopia." 2013.

Frank, Place, and Swallow Brent. *Assesing the Relationships Between Property Right and Technology Adoptipn in Smallholder Agriculture: A Review of Issues and Empirical Methods.* Washington, D.C.: International Food Policy Research Institute, 2000.

Fresenbet, Zeleke. "Assesment of Comparative advantageof Horse Bean and Lentle in Bosona Wosona Woreda, North Shewa , Ethiopia." M.Sc. Thesis, Alemaya University, 2005.

Gashaw, Tadesse, Kindie Getnet, and Nicola Gian. "Impact of AgriculturalL Cooperatives on Smallholdres' Technical Efficiency: mperical Evidence From Ethiopia." *Annals of Public and Cooperative Economics*, 2014: 30.

Getahun, Degu. "An Assessment of Factors Affecting Adoption of Improved Wheat Technology and its Impact: The case of Hula Woreda, Ethiopia." MSc Thesis, 2003.

Gezahegn, Ayele, Bekele Mekonnen, and Zekeria Samia. "Productivity and Efficiency of Agricultural Extension Package in Ethiopia." Addis Ababa, Ethiopia, 2006.

González, Verónica, Pablo Ibarrarán, Alessandro Maffioli, and Sandra Rozo. "The Impact of Technology Adoption on Agricultural Productivity: The Case of the Dominican Republic." Working paper, Washington, D.C., 2009.

Grilli, Leonardo, and Carla Rampichini. "Propensity scores for the estimation of average treatment effects in observational studies." 2011.

Kebebew, Assefa, Aliye Sherif, Belay Getachew, Metaferia Gizaw, and Tefera Hailu. "Quncho: the first popular tef variety in Ethiopia." *International Journale of Agricultural Sustainability*, 2011: 25-34.

MAFAP. "Analysis of Incentives and Disincentives for Tef in Ethiopia." 2013.

Marcelo, Coca-Perraillon, Inc. Adheris, and MA Burlington. "Matching with Propensity Scores to Reduce Bias in Observational Studies." *NESUG*, 2006.

Mesfin, Astatkie. "Analysis of Factors Influencing Adoption of Triticale and its impact." MSc Thesis, Alamaya Unversity, 2005.

Mesfin, Haile, Agajie Tesfaye, Aregu Lemlem, and Mulat Eyob. "Market access versus productivity: the case of Tef." *Paper prepared for the Ethiopian Economic Association, Conference on Ethiopian Economy,.* Addis Ababa, 2004.

MoA. "Implimantation of improved tef." Addis Ababa, 2005.

MOA. *Quncho, a Tef variety developed by Ethiopian Institute of Agricultural Research.* 2 15, 2014. www.waltainfo.com/…07:kuncho-teff (accessed Feb. 15, 2014).

MoA. "Implimantation of improved tef: Ministry of Agriculture." 2014.

Piccinin, Doris. "More about Ethiopian Food: Tef." 2002.

Ravallion, Martin. "“Evaluating Anti-poverty Programs.” In Handbook of Development Economics, vol. 4, ed.T. Paul Schultz and John Strauss." Amsterdam: North-Holland, 2008.

Rubin, Donald. "Propensity Score Matching in Observational Studies." 2006.

Sekhon, Jasjeet. "Multivariate and Propensity Score Matching Software with Automated Balance Optimization:The Matching Package for R." *Journal of Statistical Software*, 2011.

Setotaw, Ferede. "Technological change & Economic viability in tef production." *achievements and prospects of tef improvement.* switzerland: stampfli AG, 2013. 255-273.

Siegel, Paul, and Jeffrey Alwang. "Poverty Reducing Potential of Smallholder Agriculture in Zambia:Opportunities and Constraints." *Africa Region Working Paper Series No. 85*, July 2005.

Solomon, Asfaw, Shiferaw Bekele, Simtowe Franklin, and Messia Hagos. "Agricultural technology adoption, seed access constraints and commercialization in Ethiopia." *Journal of Development and Agricultural Economics* 3, no. 39 (September 2011): 436-447.

Susan, Chiona,. "Technical and Allocative Efficiency of Smallholder maize farmers." MSc Thesis, 2011.

Tekete, Forsido. *Ethiopia's Agricultural Development Strategy: Achieving Greater Impact from Research Investment in Africa.* Mexico: Sasakawa Africa Association, 1996.

Todaro, Michael, and Stephen Smith. *Economic Development. 11th Edition.* New York, San Francisco: Cataloging, 2012.

Tsegaye, Tasesse. *The Impact of the Participatory Demonstration and Training Extension System on*

Productivity and Income of the Farmers in Potential Areas of the Amhara National Regional State, Ethiopia: The Case of Yilmana Densa Woreda. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University, 2003.

Verónica, González, Ibarrarán Pablo, Maffioli Alessandro, and Rozo Sandra. "The Impact of Technology Adoption on Agricultural Productivity: The Case of the Dominican Republic." Washington, D.C., 2009.

WAO. "2nd Quarter report." unpublished document, 2014.

Watson, Jeff. *How to Determine a Sample Size: Tipsheet #60, University Park.* Penn State Cooperative Extension, 2001.

WLAO. "2nd Quarter Report." unpublished report, 2014.

Wooldridge, Je¤rey. *Econometric Analysis of Cross Section and Panel Data.* Cambridg: The MIT Press, 2002.

World Bank. *A users' guide to poverty and social impact analysis.* Washington, D.C. USA.: Poverty Reduction Group and Social Development, 2003.

Yang, Guiping, Stemkowski Stephen, and Saunders William. "A Review of Propensity Score Application in Healthcare Outcome and Epidemiology." 2008.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar