

Determinants and Impacts of Modern Agricultural Technology Adoption in West Wollega: The Case of Gulliso District

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Abstract

This study analyzed factors affecting modern agricultural technology adoption by farmers and the impact of technology adoption decision on the welfare of households in the study area. The data used for the study were obtained from 145 randomly selected sample households in the study area. Binary logit model was employed to analyze the determinants of farmers' decisions to adopt modern technologies. Moreover, the average effect of adoption on household incomes and expenditure were estimated by using propensity score matching method. The result of the logistic regression showed that household heads' education level, farm size, credit accessibility, perception of farmers about cost of the inputs and off-farm income positively and significantly affected the farm households' adoption decision; while family size affected their decision negatively and significantly. The result of the propensity score matching estimation showed that the average income and consumption expenditure of adopters are greater than that of non-adopters. Based on these findings it is recommended that the zonal and the woreda leaders extension agents farm and education experts, policy makers and other development oriented organizations have to plan in such a way that the farm households in the study area will obtain sufficient education, credit accessibilities and also have to train farmers to make them understand the benefits obtained from adopting the new technologies. These bodies have also to arrange policy issues that improve farm labour participation of household members and also to arrange the ways in which farmers obtain means of income outside farming activities.

Keywords: Agriculture, Farm household, Technology Adoption Logit, Propensity Score Match

1. INTRODUCTION

There has been much discussion on the need to increase productivity and sustainability in agriculture globally in the medium to long terms, but much less information is available on specific means to achieve this aim. Increasing agricultural productivity is critical to meet expected rising demand and, as such, it is instructive to examine recent performance in cases of modern agricultural technologies (FAO, 2011). It is no longer possible to meet the needs of increasing numbers of world population and to achieve food security objectives by expanding areas under cultivation since the fertile land is not increasing over time. But this problem can only be solved more by increasing agricultural productivity of farm households. However, achieving agricultural productivity growth will not be possible without developing and disseminating yield-increasing technologies and application of these technologies by farm households.

Agricultural research and technological improvements are therefore crucial to increase agricultural productivity and thereby reduce poverty and meet demands for food without irreversible degradation of the natural resource base. Agricultural research and technological improvements are also crucial in reducing poverty (Solomon (2010); Solomon *et al.*, 2011). Barriers to technology adoption, initial asset endowments, and constraints to market access may all inhibit the ability of the poorest to participate in the gains from agricultural productivity growth. This agricultural productivity growth can also be driven by improved farm technologies, including improved seeds, fertilizer, and water control (Johnston & Kilby, 1975).

Despite rapid yield growth in agricultural production all over the world, the realized yields are still well below their genetic potential. Deviations from potential yields appear to vary remarkably among countries and regions even after adjusting for different soil, moisture and temperature environments. Other conditioning factors, such as different farm sizes and management capacities, access to markets, and legislative/institutional factors, play heavily in determining yield performance (FAO, 2011). The role of agriculture in economic development of Ethiopia has been well recognized for years. It accounts for roughly 43 % of GDP, and 90 % of exports and 85% to employment. Cereals dominate Ethiopian agriculture, accounting for about 70 per cent of agricultural GDP (MoARD, 2010). Agriculture is also the source of food and cash for those who are engaged in the sector and others. Most agricultural households earn the food they consume and the cash they need to cover other expenses only from farming activities so that improvement of agricultural productivity is very important to them (CSA, 2011). An increase in agricultural productivity is a prevailing motive for farmers and a driving force in Ethiopia's agricultural policy. Increasing productivity in smallholder agriculture is Government's top priority, recognizing the importance of the smallholder sub-sector, the high prevalence of rural poverty and the large

productivity gap (MoARD, 2010). Agriculture in Ethiopia is subsistence-oriented, that is, households in the agricultural sector mostly produce on the basis of their demand on household level. In order to achieve the objectives of food security and nutrition for all and to reduce poverty through improving incomes of rural households, there is a need to progressively transform the agricultural sector away from subsistence oriented production towards an integrated economy. This transformation process can be fueled by agricultural productivity growth through the help of modern agricultural technologies (CSA, 2011).

In Gulliso woreda, most of the people are rural dwellers farm households. All of the problems which affect agricultural productivity of the country also equally affect the woreda. The farmers started the use of modern agricultural technology to overcome the problem of low production before ten years. All of the government efforts to using eradicate poverty and to ensure the food security by the people of the country are being practiced in Gulliso Woreda, in Wellega Zone. Government body administering the woreda is making its best performance to implement these policy issues. DA (Development Agents) s and other necessary farm experts are utilizing their best expertise knowledge to help the poor farm households to gain better output from their farm activities.

Considerable resources are being utilized by the Ethiopian government to realize agricultural productivity and alter the state of agriculture in the country. Human and material resources are rallied towards this end. Development agents, extension packages, and agricultural inputs are some of the resources that are made available to farmers to change their style of farming and augment productivity (CSA, 2011). Despite of all these efforts of the government, in Ethiopia, the crop yield of small farm households is very low. On CSA (2012) it was reported that the productivity of teff, barley, wheat, maize and sorghum are 12.81 qt/ha, 16.72 qt/ha, 20.29 qt/ha, 29.54 qt/ha and 20.54 qt/ha respectively. This low productivity is because of low utilization of improved technologies and traditionally accustomed ways of production. As CSA (2011) report indicated, from total area cultivated 13,359,438Ha in Ethiopia during 2010/2011 cropping season, the total area covered by improved seeds in 2010/11 (2003 E.C) is 745, 924Ha which is only 5.5%. This is very low when compared to some African countries like that of (Tanzania which is 27 %) (Liberio, 2012). Different development projects are being designed and implemented by the scarce resource of the country to improve the farm production and productivity at the woreda at desirable level. Improved seeds and chemical fertilizers are being distributed among the adopters of the modern technology. However, the households receive very low amount from their farm lands because of the dominant traditional way of farming. Information received from the Gulliso Woreda Agricultural and Rural Development Office (GWARDO) in 2012 also shows that , the total number of farm households of the woreda is 11,935 and of this only 1,074(=0.09%)(at least applied fertilizer) are adopted the modern agricultural technologies. This shows that the level of technology adoption is very low leading the population to gain low production from their farming activities since the percentage of adopters is less than ten.

As data obtained from Gulliso woreda Agricultural and Rural Development Office in 2004/2005 E.C cropping year 11,171 hectare of land is cultivated of which only 931.25 Hectares which is 9.1% is cultivated by applying modern technologies. Though the difference 69 quintal per hectare is because the application of modern technologies (improved seed and fertilizer), 91.7% of cultivated land is not applied with those technologies. More than a decade is passed since the introduction of these technologies to the woreda but still very small proportion of farm land is applied with this precious technologies. What is the reason? Is it because the difference in output wholly transformed to cost of production without generating any positive outcome? To answer the above key questions, studies are required to be conducted in the area but to my knowledge, no such adoption studies were conducted in West Wollega zone in general and Gulliso district in particular to identify the determinants of agricultural technology adoption and the impact of the adoption on the livelihood of adopters and to address the problem of very low adoption of the modern agricultural technologies for productivity and there by welfare improvements. To this end, this study was conducted on the study area to fill the gap by identifying those constraints of adoption decision and the impacts of the adoption on the lively hood of the adaptors.

The main objective of this study is to analyze the determinants and welfare impacts of modern agricultural technology adoption by smallholder farmers in the study area. The specific objectives are to identify the determinants of agricultural technology adoption by farm households, examine the impacts of modern agricultural technology decision on welfare of the adopter households.

2. Materials and Methods

The data set used in this study consists of household sample survey data collected in rural area of Gulliso Woreda in West Wollega zone. Gulliso woreda is selected purposively by the researcher because the researcher believed to obtain quality adoption data. This is because the information from the GWARDO collected in year 2012 by the researcher, shows that the farm households of the woreda started using the modern technology very early and there is big difference between the life of adopters and non-adopters observed even though no adoption analysis is performed on the woreda. The researcher is also familiar with the woreda as he was born there and

was the education worker there nearly 10 years there. The 145 households were selected from the 6 Kebeles of the 26 Kebeles of farm households by random sampling procedure. The six Kebeles were selected for sampling unit in this study, nearly equal number of households were selected from each kebele without considering the ratio of the number of total farm household of each Kebele because the sampling is considered on the woreda basis. The reason for selecting the six kebeles is that it is very difficult to consider all kebeles the researcher faced time and finance limitations. Selection of the six kebeles is possible because the total distributions of the farm households of the woreda are socioeconomically, culturally and institutionally similar. The administration, technology diffusion procedures and plans of development by the woreda leaders are almost the same for all the 26 kebeles and so any household from any Kebele of the woreda can be representative of the woreda. The woreda farm households were categorized in to two categories:

A sample of adopters and non-adopters, nearly 50% of the sample size (72), were selected randomly from the adopters of the technology and 50% of the sample size (73), were selected randomly from the non-adopters of the technology. This is done because as number of adopters, 1074 compared to non adopters, 10861 is very small and insignificant number of adopters may be included if the selection takes place randomly from the total farm households. So the procedure of categorizing is important since significant sample of adopters and non-adopters are required to analyze adoption decision and effect of adoption on the adopters.

Depending on the information from Gulliso woreda (District) the sample size is found to be 145 households. The sample size is calculated as the following and the total number of farm households is 11,935. The formula for sample size determination for finite population is given by Kothari (2004) in such treatment and non-treatment analysis. Given the precision, confidence level, population proportions p and q where q=1-p

$$n = \frac{z^2 pqN}{e^2 (N - 1) + z^2 pq}$$

Where, n stands for estimated sample size, e is the allowable error; N number of population under the study; z is confidence level. Accordingly, for this study, N=11,935 the total number of population under the study in the district. e=4.5%=0.045 the maximum allowable error p=0.09 the proportion of adopters of the agricultural technology in the district, q=1-0.09=0.91 the proportion of non adopters Taking confidence level of 95.5% or probability of 0.955), Then the sample size of farm households is found to be 145 applying the above formula.

Questionnaires depending on the variables of the analysis were prepared according to the number of sample farm households to be surveyed. Then at the study area, six data collectors were chosen depending on their expertise knowledge from extension workers. They are all models of the woreda because of their high performance in the woreda. The data collectors were trained according to the questionnaires for the successes of the objective of the study for two days. The trained Data collectors went to each sample household farmland (home) and collected the necessary data by interviewing the farm households by translating the questionnaires prepared in English language to the respondents' native language. They were collected the data for 8 days. The researcher supervised the data collectors during the collecting activities guiding in some cases for best outcomes the researcher required. After the necessary data were collected, the researcher collected the response papers by careful checking up of the responses recorded specially missing data, by the data collectors.

The dependent variable to identify the determinants of adoption of the modern agricultural technology in this study is the response of the farm household whether to adopt new agricultural production technology or not if yes (for adoption) =1 and if not (not adopting) =0, thus binary response variable.

The logit, probit and Tobit models are used to identify such modern agricultural Technology adoption decision of the households. Both logit and probit models are equally applied for binary response dependent variables and they also provide almost equal results. But the logit model requires far fewer assumptions than the probit model mentioned above (Hosmer & Lemeshow, 1989). The logistic distribution (logit) is also more preferable than the others in the analysis of dichotomous outcome variable like this adoption decision, in that it is extremely flexible and easily used model from mathematical point of view and results in a meaningful interpretation, which also resolves the problem of heteroscedasticity. Logit model is chosen over probit model in this paper primarily because of its mathematical convenience and simplicity and its resolution of problem of heteroscedasticity (Greene, 2008). The Model is formulated as follows.

$$Z_i = \beta_0 + \sum_{i=1}^n \beta_i X_i, \dots \dots \dots (1)$$

Where is a constant and Zi is equal to one (1) when a choice is made to adopt and zero (0) otherwise; this means: The equation represents a binary choice model involving the estimation of the probability of adoption of a given technology (Z) as a function of independent variables (X). Mathematically, this is represented as:

$$\text{Prob}(Z = 1) = F(\beta' X_i) \dots \dots \dots (2)$$

$$\text{Prob}(Z = 0) = F(1 - \beta' X_i) \dots \dots \dots (3)$$

Where, Z_i is the observed response for the i th observation of the response variable, Z . This means that $Z_i = 1$ for an adopter (i.e. farmers who adopt modern agricultural production technologies) and $Z_i = 0$ for a non-adopter (i.e. farmers who do not adopt modern agricultural production technologies). X_i is a set of independent variables such as farm size, family size, education of household head, among others, associated with the i^{th} individual, which determine the probability of adoption, (P). The function, may take the form of a normal, logistic or probability function. The logit model uses a logistic cumulative distributive function to estimate, P given z by,

$$P(Y=1/X) = \frac{e^z}{1 + e^z} \dots \dots \dots (4)$$

$$P(Y=0/X) = 1 - \frac{e^z}{1 + e^z} \dots \dots \dots (5)$$

$$Z = \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k = \sum_{i=1}^k \beta_i X_i \dots \dots \dots (6)$$

Where, k represented number of independent variables to be analyzed in the study. Since the model is non-linear, the parameters are not necessarily the marginal effects of the various independent variables. The maximum likelihood method was used to estimate the parameters. The empirical model for the logit model estimation is specified as follows:

$$Z_i = \ln\left(\frac{P}{1-P}\right) = \alpha + \beta_i X_i + \delta_i \dots \dots \dots (7)$$

Where the above formula is called log of odds ratio and X_i is the combined effects of X explanatory variables that promote or prevent farmers' decision to adopt modern agricultural production technologies. In

other words the model $\ln\left(\frac{p}{1-p}\right)$ in the formula represents log-odds in favor of farm households' decision to adopt modern agricultural production technologies or not to adopt. It is the logarithm of the ratio of probability

of adopting the technologies (p) to probability of not adopting them ($1-p$). The ratio $\left(\frac{p}{1-p}\right)$, shows the odds

ratio of probability of adopting the technology to not adopting it. That means it is the ratio of probability of adopting the technology (p) to not adopting the technologies ($1-p$) in the observational studies. The independent (explanatory) variables which are expected to determine the adoption decision of the farm households in this study are categorized into three. They are: The socio-cultural factors: such as age, education, family size, gender of farm household head which were hypothesized to influence agricultural technology adoption significantly. Economic factors: such as farm size, farm income, non-farm income, cost of modern production inputs, distance to market center, and the institutional factors: such as access to credit, extension visits, and tenure X_1, \dots, X_i , are factors that promote or prevent farm households' from adopting modern agricultural technologies. They are explanatory variables in the equation above described as follows:

- i. Age of the household head: The age of the farmer specially related to farm experience is expected to affect the decision of adopting modern agricultural technology positively. It is measured by number of years of the farm household head and hence continuous variable (Adesina & Baidu, 1995).
- ii. Gender: Mostly cultural factors matter when it is seen from gender point of view. Most agricultural input decisions in Ethiopia are influenced by decision of the male household heads. Hence it is expected to affect the adoption decision of farm households. It is a dummy variable taking 1 for male and 0 for female (male=1 and female= 0, for this study) (FAO, 2011).
- iii. Education level of the house hold: It is well expected that farmers with more education are aware of more information, and be more efficient in evaluating and interpreting information about innovations than those with less education. Thus it is hypothesized that producers with more education are more likely to be adopters than farmers with less education. It is measured by number of years of schooling of the head of the households and hence a continuous variable (Abay and Assefa, 2004; Salasya *et al.* 2007, Alene & Manyong, 2007).

- iv. Family size: It is a continuous variable which indicate the number of person living in the house of the farmers. It is expected that as the size of the house hold increase the adoption of new technology increase provided that number of pendent family members in a household is less. This indicates the family with large number is more involved in adopting the new technology during their farm production effort (Liberio 2012, Idrisa 2012).
- v. Off-farm income: Off-farm income represents the amount of income the farmers earn in the year on other than on-farm activity. It is the amount of income (in Birr) generated from activities other than crop and livestock production. These include petty trading, charcoal selling, firewood selling and others. It is expected that the availability of off-farm income is positively related with adoption decision since households engaged in off-farm activities are better endowed with additional income to purchase initial seeds or other essential agricultural inputs Beshir *et al* (2012).
- vi. Asset owned: It is continuous variable which is expected to affect the decision of the farm households positively. This is because as the asset becomes larger the household gets more money and materials and equipments to practice the new technology of production.
- vii. Farming experiences: Is measured in the number of years since a respondent started farming on his own. Experience of the farmers is likely to have a range of influences on adoption. Experience expected to improve farmers' involvement in seed production. Farmers with higher experience appear to have often full information and better knowledge and were able to evaluate the advantage of the technology. Hence it was hypothesized to affect adoption positively (Chilot *et al.*, 1996).
- viii. Access to credit facilities: It is a dummy variable, which takes a value of 1 if the farm household had access to credit and 0 otherwise. Adoption of new technology with complementary inputs require considerable amount of capital for purchase of modern agricultural inputs such as fertilizers and improved seeds, especially when farm land to be covered is. Farmers who have access to formal credit are more probable to adopt improved technology than those who have no access to formal credit (Million & Getahun, 2001; Beshir *et al*, 2012, Saleem *et al.*, 2011, Akudugu *et al*. 2012).
- ix. Extension service: Extension service will help the farm households to understand the importance of the modern technology and enhance the accuracy of implementation of the technology packages. More frequent DA visits, using different extension teaching methods like attending demonstrations and field day can help the farmers to adopt a new technology. If the farmers get better extension services, they are expected to adopt seed production technologies than others. In this study this variable was treated as a dummy variable. That is if the farmers gets extension service it is coded as 1 and 0, otherwise (Akudugu *et al*, 2012, Kaliba *et al.*, 2000; Maiangwa *et al.*, 2007).
- x. Availability of training: Farmers may obtain information from different source and may learn also from DA through extension programs. However unless they can obtain required skill through training they may face some difficulties to understand and apply improved agricultural technology. So those farmers who got training on improved agricultural technology are more willing than those who didn't get training. It is dummy variable measured as 1 if farmers get specific training on the technology (in this case improved seed of the main crops included in the study and fertilizer usage) and 0 otherwise.
- xi. Perception of input prices: Profitability of modern technology depends on the costs incurred on it. The more it increases farmers hesitate to utilize the technology significantly. Hence it is expected that cost of inputs affects the farmer's negatively and to adopt the technology. The attitudes of the farm households towards the cost of inputs are difficult to identify. This because farm households in general are at lower education level which makes it hard to calculate profit and output in a production processes. Most farmers think that the output is the return to their farming activities, while this is not true in economic theories. In this study, their attitudes whether cost of inputs is fair at market price or not was analyzed and related to their adoption decision. The response was one if they respond as fair and zero otherwise (Akudugu, 2012).
- xii. Availability of quantity of input supplied (improved seed and fertilizers): The response for amount required. Yes= 1, if quantity supplied is as required by the household, and zero otherwise.
- xiii. Time of input supplied (improved seed and fertilizers): This is the time on which the farm household needs the input. It takes the value 1 if the farm household gets the input required on time and zero otherwise.
- xiv. Distance from the market center:-It is a continuous variable measured in kilometer. It refers to the distance from farmer's farmland to market centre. As farmers' farm lands get closer to the main road or market centre, they can have access to transportation facilities and better support from concerned bodies to their seed multiplication which might increase the use of technology. Therefore, in this study, it is hypothesized that this variable is negatively related to participation in technology adoption of farm households (Idrisa *et al*, 2012).
- xv. Availability of transportation Facilities: Whether the distance small or big, the existence of transportation facilities in a required amount is very decisive to farmers for adoption of technologies. It is expected that existence of these facilities is positively related to adoption decision.

- xvi. Farm size: it affects the technology adoption positively as the farmer with larger farm size tries to use the technology in abundant amount for efficiency issues. It is continuous variable measured in hectares (Akudugu *et al.*, 2012; Salasya *et al.*, 2007; Saleem *et al.*, 2011). The model used to examine relationship between adoption and determinants of adoption involved a mixed set of qualitative and quantitative analyses (e.g. binary response model and continuous dependent models). Qualitative models such as binary response models or censored models have been used extensively in adoption studies although they have been criticized for their inability to account for partial adoption (Feder *et al.*, 1985). The two most frequently used applications in explaining the socio-economic phenomena, especially for analyzing the relationship between dependent discrete variables (adoption) and explanatory variables (factors affecting the adoption decision) are, the qualitative choice models including the linear probability models: the probit model and the Logit (Polson *et al.*, 1992).

The ATT is calculated using propensity score matching method. According to Becker & Caliendo (2007), matching has become a popular method to estimate average treatment effects. The method is based on the conditional independence assumption, which states that the researcher should observe all variables simultaneously influencing the participation decision and outcome variables which are incomes and consumption expenditures in this analysis. Income or consumption expenditures are traditionally used to measure effect of agricultural technology adoption (MoFED, 2012). Prior to estimating the impact of technology adoption, specifying the propensity scores for treatment variable using logit model is required (Mendola, 2007). Hence the logit model is applied in this case to predict the probability of adoption of the improved seeds and chemical fertilizers. For this purpose all of the household characteristics used to analyze the adoption decision above such as age, sex and education level were also included in as treatment variables in the prediction of propensity scores on which the adopters and non-adopters were matched. To identify the impact of the technology adoption on the sample households, in the study, outcome variables which are farm income & consumption expenditures of the farm households surveyed were analyzed using the propensity Score match of the adopters and non-adopters of the technology. Propensity score matching has the advantage of reducing the dimensionality of matching to a single dimension. This is the best possible procedure to follow since the households in both adopters and non adopters" samples might have similar or closer propensity scores even though they might be dissimilar on the basis of each covariate (Rubin and Rosenbaum, 1983). Based on the fact above, once matching process is taken place, a comparable sample of control (non-adopters) is created which is similar to the adopters except the decision of adopting the technology. So the outcome variables average income and average consumption expenditures of these two new samples of adopters and non-adopters were compared using the nearest neighborhood matching method of ATT estimation without any significant biases.

The procedure of calculating ATT based on propensity score match method is consistent with the Mendola (2007) who conducted a study on the potential impact of agricultural technology adoption on poverty alleviation strategies and found a positive effect of agricultural technology adoption on farm household wellbeing suggesting that there is a large scope for enhancing the role of agricultural technology in contributing to poverty alleviation. According to Mendola (2007), propensity score matching(PSM) procedure balances distributions of observed covariate between adopters of technology and non-adopters based on similarity of their predicted probabilities of adopting the technology (matching their propensity scores). In this study, the impact of adoption of modern agricultural technology by farm households in Gulliso district is analyzed through causal effect of average income and average expenditure differential between adopters and non adopters using propensity score match. The poverty reduction effect is not calculated in this analysis but it assumed that based on ATT for income and consumption expenditures, it was inferred that the positive result of these two outcome variables are implication of poverty reduction. In this study any farm household using some of the modern technology on his/her farmland is considered as an adopter of the technology, irrespective of the proportion of the modern technology covered by his/her farm land. This is possible because the impact is calculated by average treatment effect (ATE) or ATT average treatment effect for the treated. Let D denotes a dummy variable such that $D = 1$ if the individual in the group adopt improved technology and $D = 0$ otherwise. Similarly let Y_1 and Y_0 denote potential observed average incomes and average consumption expenditures for adopter and, non-adopter units respectively. Y_1 = Average farm incomes of the period when the data were collected from the households. Y_0 = Average farm income of the non-adopters of the technology in 2004-2005 E.C. measured in Birr at the market price of the time when the data is to be collected from the households. The sample of non-adopters is comparable to the sample of the adopters as it is adjusted by propensity scores. Then ATT, which is in this case $Y = Y_1 - Y_0$ is the impact of the technology on the individual in the treated group, usually called treatment effect (the effect of adopting the modern agricultural technology). As it is clearly observed, $Y = DY_1 + (1-D) Y_0$, rather than Y_1 and Y_0 for the same individual, we are unable to compute the treatment effect for every unit. The primary treatment effect of interest that can be estimated is therefore the Average impact of Treatment on the Treated (ATT). The value of welfare Y_1 , when the household is an adopter ($D = 1$) and Y_0 the same variable when it does not adopt improved agricultural technology ($D = 0$). Then the observed welfare above is

$$Y = DY_1 + (1 - D) Y_0 \dots\dots\dots (8)$$

When ($D = 1$) Y_1 is observed; when ($D = 0$) Y_0 is observed. The average effect of treatment on the treated (adopters) (ATT) is defined as

$$ATT = E(Y_1 - Y_0 | D = 1) = E(Y_1 | D = 1) - E(Y_0 | D = 1) \dots\dots\dots (9)$$

Only outcome variable of adopters is observed and the $E(Y_1 | D = 1)$; however, we cannot observe the outcome of those adopters had they not adopted $E(Y_0 | D = 1)$. Therefore, matching estimation assumes counterfactual analysis by matching treatment (Adoption) and control (Non adoption) as if they are similar groups. The primary assumption underlying matching estimators is the conditional independence assumption (CIA). The CIA states that the decision to participate is random conditional on observed covariates X (Wooldridge, 2002) (that means self selective). This assumption implies that the counterfactual welfare indicators in the treated group are the same as the observed welfare growth indicators for the non-treated group:

$$E(Y_0 | X, D = 1) = E(Y_0 | X, D = 0) = E(Y_0 / X) \dots\dots\dots (10)$$

This assumption 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 no-treatment as well as the selection into treatment. Under the CIA, ATT can be computed as follows:

$$ATT = E(Y_1 - Y_0 | X, D = 1) = E(Y_1 | X, D = 1) - E(Y_0 | X, D = 1) \dots (11)$$

Where Y_1 is the treated outcome (farm income or consumption expenditure of the adopters in this case), Y_0 is the untreated outcome (that of non-adopters), and D indicates the treatment status and is equal to 1 if the individual receives treatment and 0 otherwise. ATT calculated above is the difference between two terms with the first term being the welfare indicator (in this case income and expenditures) for the treated group (adopters of the technology) which is observable and the second term being the welfare indicator for the treated group had it not been treated, representing a counterfactual situation which is unobservable and needs to be treated, the control group. Despite the fact that propensity score matching tries to compare the difference between the outcome variables of adopters and non-adopters with similar inherent characteristics, it cannot correct unobservable bias because propensity score matching only controls for observed variables (to the extent that they are perfectly measured

$$\alpha(x) = E(Y_1 - Y_0 / X) = E(Y_1 / D=1 / X) - E(Y_0 / D=0 / X) \dots\dots\dots(11)$$

$$\text{Where average logical effect is } \alpha = E \alpha(X) \dots\dots\dots(12)$$

This is the propensity score, which allows us to identify similar households, treatment group and comparable control group which are comparable on their propensity scores. This is crucial to our context, since farm household's choice on whether or not adopt a new technology has to be taken into account when evaluating its causal effect on the household's wellbeing. But this is corrected by matching their propensities. The explanatory variables for p-score estimation in this study are considered as the variables which affect the adoption decision of the farm households considered in the logistic regression above. The same variables used in logit analysis of adoption decision. That means the same variables used as the determinants of adoption decision are also applied here provided that the propensity score of adopters and non adopters are similar given the variables. The outcome variables used in this study are: Farm income: It is expected that the income of the adopters will significantly improved as effect of their decision. Consumption expenditures: It is also expected to increase with adoption because as income increases consumption increases. Economic theories of modern times support this.

3. Results and Discussion

This part of the paper discusses the major findings of the study. It begins with analysis of the descriptive result on the main variables used in the regression analysis followed by discussion of results obtained from estimation methods used under each objective of the study.

Table 1 Table showing mean standard deviations and mean difference of adopters and non-adopters were calculated (N=145, Adopters=72, Non-adopters=73).

Variables	Total sample		Adopters		Non-adopters		Mean difference	t-value
	Mean	Std.D	Mean	Std.Dev.	Mean	Std. Dev.		
Age of HH head(in years)	43.78	8.39	42.3	8.434	45.2	8.14	-2.927**	2.13
Gender of HH head(1=male 0=female)	0.91	0.29	0.92	0.278	0.90	0.3	0.01	0.26
Education level of HH head(years of schooling)	5.63	3.47	7	3.162	4.27	3.22	2.726***	5.10
Family Size of the sample HH(number of members)	4.32	1.47	3.93	1.214	4.7	1.6	-0.77***	3.25
Distance to market center(in Km)	13.16	8.52	12	8.209	14.3	8.73	-2.307	1.64
Credit accessibility OfthHH(1=accessible,0=not)	0.46	0.50	0.63	0.487	0.3	0.46	0.324***	4.10
Farm size(number members)	1.01	0.37	1.14	0.342	0.88	0.36	0.258***	4.41
Seedsupply time(yes=1,no=0)	0.58	0.50	0.72	0.451	0.44	0.5	0.284***	3.59
Extension service(yes=1,no=0)	0.72	0.45	0.75	0.436	0.68	0.47	0.065	0.87
perception of the to cost of inputs(fair=1, not=0)	0.36	0.48	0.63	0.487	0.1	0.3	0.529***	7.91
Sufficiency of input supply(yes=1,no=0)	0.70	0.46	0.81	0.398	0.6	0.49	0.203***	2.72
Farming experience(years of farming)	26.26	8.61	25.51	8.455	27	8.77	-1.486	1.00
Availability of training (yes=1,no=0)	0.89	0.30	0.93	0.255	0.86	0.35	0.068	1.33
Income from off farm labour participation	0.72	0.45	0.94	0.230	0.49	0.5	0.451***	6.92
Dependency ratio ^β transportation facilities(yes=1,no=0)	0.91	0.20	0.89	0.230	0.94	0.16	-0.05	1.5
Fear of farming risk(yes=1,no=0)	0.86	0.35	0.92	0.278	0.79	0.41	0.122**	2.11
Hired labour(yes=1,no=0)	0.18	0.38	0.18	0.387	0.18	0.39	0.179	0.04
	0.88	0.32	0.90	0.298	0.86	0.35	0.04	0.74

Source: Calculated from the collected Data, 2013

^β shows ratio of dependent members to total family number.***,**,* shows 1%, 5%, 10% respectively

The Table 1 above shows means and standard derivations of the observation variables (covariate) of adopters and non-adopters. From the table, it is inferred that the mean age of agricultural technology adopters in the study area is about 42 years while that of non-adopters is nearly 45 years. This shows that adopters are younger than non-adopters with significant mean difference of nearly 3 years on average. Moreover the mean difference of the ages of adopters and non adopters is 2.927 and significant at 5% level. This on the other hand indicates that increasing age of the farmers in the study area increases their resistance to adoption of modern agricultural technologies. But the average age of all the sample households is nearly 44 years which is the indication of the fact that most of the farm household heads are in the adulthood age. The mean education level of the adopters is grade 7 while the mean education level of the non-adopters is less than grade 5, with their mean difference nearly 2.7 which is also significant. This shows that the adopters are more educated farm household heads than the non- adopters. On the other hand this result shows the positive effect of education of farmers on the adoption of modern agricultural technology. However, the mean of all samples in nearly grade 6 indicated most of the farmers obtained the primary education. Family size of adopters and the non-adopters are almost 4 & 5 respectively on average. These results show significant mean difference of 0.77 and the size of household members of the non-adopters is bigger than that of the adopters nearly by one person. Of the total sample households, 63% of the adopters responded to have credit accessibility while only 30% of the non-adopters had responded having this opportunity. Their mean difference is 0.324 which also is significant. This clearly shows

that 32.4% more adopters have chance of getting credit services than the non-adopters.

The mean (average) farm size of the adopters of the technology is 1.14 hectare while that of non-adopters are only 0.88 Ha. They also have significant mean difference of 0.258 hectare. When seen from the farmers' attitude towards cost of inputs (fertilizers & improved seed), 62.5% of the adopters replied the cost of inputs as fair while only 9.6% of non-adopters thought the cost as fair market price with significant mean difference of 0.529. This shows that about 52.9% more adopters of the technology think the cost of inputs as fair in their market prices. Most probably this attitude made the non-adopters to reject adoption of the new technologies. From the total sample households 81% of the adopters responded to have enough amounts of the inputs while 60% non adopters responded the same with significant mean difference of 0.203. This means that the 20.3% more adopters have more opportunity of getting the required amount of improved seeds and fertilizers than non-adopters. This calls for more consideration of those who lack sufficient amount of these inputs during their distribution. Off-farm income: From the whole sample households 94% of the adopters have off-farm income from participation on off-farm labour and other sources of incomes while only 49% of non-adopters of the technologies have the this opportunity with significant mean difference of 0.451. This indicated that 45.1% more adopters have sources of income from other than non-farm incomes than that of the sample of non-adopters. This reveals that having non-farm income has positive influence on the adoption decision of farm households. However, 72% of the whole sample households have incomes different from farm incomes.

Incomes: Table 2 below shows that the average farm income of the adopters of the technologies is 20992.63ETB while that of non-adopters of the technologies is 11985ETB with significant mean difference of 9007.75. Most of this difference in income is the result of adoption of the agricultural technologies which is identified in the econometric analysis part using propensity score match method. However the mean income of the overall sample households is 16457 with standard deviation of 9669.

The mean expenditure of the adopters is 16520.94ETB while that of non-adopters is nearly 11012ETB with significant mean difference of 5509 indicating that the adopters have more consumption expenditure than that of non-adopters. Moreover the whole sample has mean expenditure of 13747 with standard deviation of 7474.

Table 2 Table showing the mean difference of incomes, expenditures and asset of the sample households

Variable	Total sample		Adopters		Non-Adopters		Mean Diff	t-value
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev		
Incomes	16457	9669	20992.63	5.15	11985	6452.069	9007.75***	6.32
Expenditures	13747	7474	16520.94	7562.	11012	6329.957	5509.30***	4.76
Asset	45176	22501.	48656.74	21104	41743	23439	6913.955	1.87

Source: survey data

Results of Econometric Analysis

Since cross-sectional data is prone to problems of multicollinearity, it is necessary to test it for this problem before presenting the econometric result. To eliminate the multicollinearity problem, VIF (variance inflation factors) and tolerance level 1/VIF was calculated for all the variables under observation. Table 3 below, shows the variables, whose VIF do not have significant effect on creating multicollinearity problem. This is identified depending on the rule of thumb method since their values are less than 10. Hence the effects of these variables were analyzed using logit model and propensity score match method on adoption decision and their impacts on income and expenditure of the farm households as the result of their adoption decision in Gulliso woreda. Out of all the independent (explanatory), the variables age, farm experience, use of hired labour, availability of training and extension services were excluded from the logit analysis of the adoption decision and the propensity score match of the impact analysis. This is because with those variables with their very high VIF (variance inflation Factor), if included, the very high multicollinearity problem will be created. Table 4, below shows the result of logistic regression on the adoption decision of the farm households of the study Woreda for which the VIF level was feasible (5.46) on average.

The model is adequate since LR $\chi^2 = 111.6$ and Prob $> \chi^2 = 0.000$. So based on this information the following analysis was made.

Odds ratio = $P / (1-P)$

Table 3 showing logistic regression results and their probabilities

Adoption	Coef.	Odds-ratio	Marginal effects (dy/dx)	Std. Err.
Gender(sex) of household head	0.15	1.16	0.037	0.895
Education of household head	0.28***	1.33***	0.07***	0.099
Family size of the sample household	-0.45**	0.64**	-0.113**	0.225
Distance to market center	-0.006	0.99	-0.001	0.060
Credit accessibility of the sample household	2.02***	7.5***	0.47***	0.600
Farm size of the sample household	2.35***	10.5***	0.586***	0.894
Time of input supply	0.153	1.16	0.0379	0.620
Availability of extension service perception towards Cost of inputs	-1.05	1.61	-0.259	0.760
Sufficiency of improved seed	2.35***	0.35***	0.5223***	0.670
Participation in off-farm labour	0.48	10.6	0.1186	1.020
Fear of climatic risk in farming	2.93***	18.6***	0.5767***	0.830
Availability of Transport facilities	0.09	0.42	0.0225	1.097
Asset ownership of the sample household	-0.89	1.1	-0.21	0.850
Constant	0.00001	1.00	3E-06	1.040
LR $\chi^2=111.6$	6.24028			2.700
Prob > $\chi^2 = 0.000$				

Source Survey Data, 2013

Log likelihood = -50.720972, Pseudo R²=0.4953 Key ***, **& * in the above table show 1%, 5%, 10% significant level respectively.

According to the result of the logistic regression on the table 3 above, the variables education, credit a accessibility, the attitudes of farmers towards fairness of Cost of inputs and having off-farm income & farm size affected farm households decision positively and significantly at 1% significant level while Family size negatively influenced the decision of household at 5% significant level in adoption of modern agricultural technologies (improved seed and fertilizers in this study).

Education level of household head is found to be very significant determinant factor at 1% significant level in the study area as expected. This means that as the education level of the respondents increased, their adoption decision also increased significantly. This indicates that the more the household heads are educated the more they decide to enter into the modern farming practices .That means Education has strong influence on the households' decision and leads towards modern way of agricultural activity. This result is Similar to that of Abay and Asefa (2004), Salasya *et al*(2007), Beshir *et al*(2012) and Alene & Manyong (2007) who found positive and significant influence of education on the adoption decision of farm households. The table also shows that the marginal effect of household's head education level is 0.07. This shows that with an increase of one schooling year the probability of being an adopter of the agricultural technologies increases by 0.07 keeping other variables constant at their means. Credit accessibility of the households is found positive and significant factor at 1% significant level on the adoption decision of households of the study worda as hypothesized. This means that the more these farm households were accessible to Credit facilities the more they were motivated towards adoption of modern agricultural technologies. This is because as farm households get sufficient credit, they are able to purchase the improved seed and fertilizers on the time it is required, and on the desired amount. The result also shows that the marginal effect for credit accessibility is 0.47. This means that the probability of being an adopter of the technologies with access to credit is greater than the being adopter without access to credit availabilities by 0.47 keeping other variables constant at their means. A number of researchers such as Million & Getahun (2001), Beshir *et al* (2012) found out the same influence of credit facilities on adoption decision. For example Beshir *et al* (2012) found that having access to credit had the positive and significant effect at less than 5% significant level on probability of adopting inorganic fertilizer due to access to finance for these technologies.

The other positive and significant factor that determined the farm households' decision of modern agricultural technology adoption at 1% significance level in the study area is the household heads' attitudes towards the fairness of the cost of inputs; that is the more the farmers think that cost of inputs (improved seed and fertilizers in this study) as fair, the more they adopted the technology. The marginal effect of the perception towards cost is 0.52. This indicates that the probability of being an adopter of the modern agricultural technologies of the one who perceives the cost of inputs as fair market price is greater than the probability of the one who perceives the cost as unfair by 0.52 keeping other variables at their means. The other factor which affected the farmers' decision positively and strongly at 1% significant level is having off form income. This

result indicates that a household, who has income outside farming activities, is more probable to become adopter of the modern agricultural technologies than the one with no such opportunities. In the table, we also see that the marginal effect of having off-farm income from off-farm labour participation is 0.58. This indicates that the probability of being an adopter of the modern agricultural technologies of the one who has off-farm income is greater than the probability of the one who does not have off-farm income by 0.58, keeping other variables at their means. This means that having incomes other than farming activities has strong positive role on the decision of households in accepting the new agricultural technologies. Moreover the above result also conforms to the hypothesis in the pre- assumption which was regarded off farm income as creating positive pressure on farmers to practice the new agricultural technology and also in conformation with the analysis of Beshir *et al* (2012). The farm size influenced the adoption decision of the farm households positively and significantly at 1% significant level. This indicates that the more farmers have larger farm sizes, the more they become adopters of the modern technology. The positive coefficient of the regression result indicates this fact. This means that households with larger farm size are more adopters of the technology. The marginal effect of farm size is also 0.58 showing that increase of farm by one hectare increases the probability of Adopters than the non-adopters by 0.58 keeping other variables at their means. This result is consistent with the result of Akudugu *et al* (2012), Idrisa *et al* (2012), Salasya *et al* (2007), Salam *et al* (2011) & Sharma *et al* (2011) who obtained positive and Significant result on farm size.

The family size has a negative influence on the technology adoption of the households of the study woreda at 5% significant level ($p < 0.05$). This means that as number of members of households become more and more, their adoption decision becomes less and less. This is because more of the household members are dependent on the household head's income. Hence house hold with such large number of members outlays its income more on consumption expenditure rather than investing in the new technology. Moreover it is found that the marginal effect for family size is -0.113. This indicates that increase of one household member decreases the household's decision to adopt the technology at 11.3% marginally. This result is in contradiction with the results found by Liberio (2012) and Idrisa *et al* (2012) who found the positive influence of large family size on the adoption of modern agricultural technologies. The result of the studies conducted by those researchers had become positive and significant relationship b/n household size and adoption decision. This might be attributed to the differences in better quality management and provision of large labour required for the technology adoption in those researches. The negative effect in this study however might indicate the lack of better management of the house hold to use the opportunity that could be obtained from large household members in generating labour. The marginal effect of family size is -0.113. This indicates that with an addition of one household member, the probability being adopter of technology decreases by 0.113 keeping other variables at their means.

Estimating the impact of agricultural technology adoption decision

Table 3 below shows the ATT estimation based on their propensity scores using nearest neighbor and radius matching methods.

As it was clearly identified on the table, the difference between the average (mean) incomes of adopters and the matched non adopters of the technology are 11009. That is the average incomes of the adopters greater than average incomes of matched non-adopters by 11009ETB. For this study it can be inferred that any difference between the average incomes and average consumption expenditures of both matched groups are the outcome of their decision to adopt the modern agricultural technologies. This is based on the fact that the two groups are matched on the equality of their propensity scores. The estimated ATT using nearest neighbor method and radius estimation methods is described by Table 4 below.

Table 4 Table showing ATT estimation, using nearest neighbor matching estimation method on Income and expenditure using Nearest Neighbor method and radius methods

Outcome variables	Nearest Neighbor Matching(NNM) method			Radius Estimation methods		
	ATT	Std. Err.	t-value	ATT	Std. Err.	t-value
Income	11009.90***	3602	3.06	7744.40***	1884.8	4.2
Expenditure	8415.70***	3839	2.19	5174.50***	1604.7	3.23

Source: calculated from survey data using stata, 2013

The table 4 above summarizes the outcome variables which are income and expenditures of the adopters and non-adopters. From the table, it is clear that the average treatment effect on the treated (ATT) of income is 11,009.90ETB with t-value 3.06, indicating the effective level of significance. So it is concluded in this analysis that the agricultural technology adoption has positive income effect on the farm households of the study area. These results are similar to result found by Solomon (2010). Table 4, above also shows the result of matching analysis of outcome variable expenditure. As it is clearly displayed on the table, the difference between the mean expenditure of the group of 72 adopters and the matched group of 12 controls (non-adopters), ATT on

expenditure of the households is 8415.70ETB is the effect of adoption decision, which is the average expenditure difference between adopters and non-adopters with t-value 2.2 that is also significant.

Estimation of ATT using radius method (table 4.4) above resulted positive and significant average income difference of 7744ETB with t-value 4.11 and positive and significant Average expenditure difference of 5174.5ETB with t-value 3.23 were found. Both calculation methods indicated that adoption of modern agricultural technologies creates positive average income differences between adopters and matched non-adopters of modern agricultural technologies. Hence adoption of modern agricultural technologies has positive income and consumption expenditure 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 agricultural technology adoption has positive welfare effect on the life of the adopters. This result is consistent with the findings of Mendola (2007) who identified a strong and positive effect of agricultural technology adoption on farm household's wellbeing.

Sensitivity test for estimated average treatment effects (ATT)

Sensitivity analysis is a strong identifying assumption and must be justified. Hence, 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 (Becker & Caliendo, 2007). After ATT of the data collected is found, it is important to test whether the estimated ATT is effective or not. Dehejia(2005), on the reply to Smith and Todd, identified that, a researcher should always examine the sensitivity of the estimated treatment effect to small changes in the propensity score specification; this is a useful diagnostic on the quality of the comparison group. Hence based on this principle, in this analysis sensitivity is tested to check whether unobserved variables have effect on the result by creating biases or not. According to Dehejia(2005),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 5 below. As it can clearly seen from the table, the significance level is unaffected even if the gamma values are relaxed in any desirable level even up to 50%.This shows that ATT is insensitive to external change. Hence there are no external cofounders (variables) which affect the result above calculated for ATT above.

Table 5 Table showing sensitivity test of external effect on ATT

Gamma	σ^+	σ^-
1	0.00	0.00
1.05	0.00	0.00
1.1	0.00	0.00
1.15	0.00	0.00
1.2	0.00	0.00
1.25	0.00	0.00
1.3	0.00	0.00
1.35	0.00	0.00
1.4	0.00	0.00
1.45	0.00	0.00
1.5	0.0000	0.00

Source: Own Survey Data

4. Conclusions

Adoption of modern agricultural technologies is influenced by many factors. These factors differ with different farmers living in different geographical environments and different socio-cultural point of view and in different economic environments with different farming investment capitals. The adoption of the technologies on the other hand has positive effect on the life of the adopters by improving their incomes and consumption expenditures thereby improving their levels in food security and poverty lessening. In this study, factors determining the farm household's adoption decision and impacts of the adoption on the lives of the adopters were analyzed. From the descriptive part of the analysis it was identified out that the sample households of the study area, adopters of the technologies are found to be: younger, more educated than non-adopters; have more accessibility to extension service, off-farm incomes and credit services. This indicated that the woreda leaders, financial institutions and policy makers have to take these conditions when they plan their development programs. The result of the logit regression showed that on the farmers' decision of technology adoption shows the following main points. The variable, household heads' education level was found to be one of the significant factors that affected the decision of the farmers positively and significantly at 1% significant level. This indicates that the farm household head's education has great influence in enforcing his/her decision to adopt the modern agricultural technologies.

Credit accessibility of the farmers is the other strong significant factor. It determined positively and significantly at 1% significant level. This means that availability of credit facilities is very important to farmers in adopting the agricultural technologies.

The other strong significant factor which was identified in this study is the attitude of farm households towards the cost of inputs to farming, cost of improved seed and fertilizer in this case. That is farmers who consider cost of the inputs as fair are more adopters while the reverse is true for the farmers thinking the cost as unfair or above its equilibrium market prices. Farm size and income from off-farm labour participation are the other two factors that enhanced the farm households' decision in the participation of modern farming methods. According to this study analysis, farmers with large farm size were found to be adopters of the modern technologies. This is because the large farm size makes efficient use of other investment capitals such as machineries which are inefficient on small farms because of returns to scale. The effect of off farm income appears to be positive in empirical analysis of this study because farmers with additional income get more financial resources to invest in the new technologies. Besides having more resource, the farm households also try to compensate the time used in the off-farm labour by productivity increase of the farm output through adopting the new technologies. The empirical analysis in this research indicates the negative relationship between household size and decision to adopt the modern technologies at 5% significant level. This might emanate from the dependency of more household members being dependent on the income of the household heads and the farm incomes which would have been invested on the new technologies might have been diverted to the consumption expenditure on a significant amount.

As it is seen from the nearest neighborhood and radius calculation of ATT above, it is found that adoption of modern agricultural technologies has positive income and consumption expenditure effect on the adopters of the technologies. That means as the farmers adopt and practice the new technologies, their lives in case of income and consumption were improved indicating positive effect of modern agricultural technologies on the adopters. Hence, encouraging farmers towards technology adoption is mandatory in any agricultural development activities.

The positive farm income and consumption expenditures identified above in the propensity score match analysis are identified as net benefits that framers obtained as a result of their effective and valuable decisions in adopting and implementing the modern agricultural technologies, the improved seeds and chemical fertilizers. However some factors are identified as determinant factors in the analysis conducted above using logistic analysis. The effects and level of their influences on the farmers are analysed and concluded as below. Education found to be the positive and significant factor. It can be concluded from this fact that educated farm households are more flexible in adapting to the modern way of farming activities. Moreover it is easier for them to accept the scientific findings in the field of agriculture than those with lower education levels and also they can easily be trained in the application of the technologies more quickly and efficiently. They can also evaluate the positive outcome that can be obtained from accepting and practicing the modern technologies than their counter parts (less educated). That is educating farmers is very important to achieve agricultural lead strategy of economic growth and to speed up the efforts of food security of the farmers and other citizens of the country. The positive and significant of credit on adoption decision indicates that the farmers obtain the necessary capital at the exact farming season. Furthermore, they get budgets for necessary requirements at the time they need to be safe from selling their produce when it is too cheap. For example when they need enough money for education of their children but the time is not suitable for proper marketing, they need credit which they can repay after selling their produce at proper market prices. This on the other hand will make the more profitable in their farming activities and leads them towards technology adoption.

Those farmers who think the cost as unfair, lack the ability to calculate the profit of farm production. They couldn't understand that as cost increases the price of their farm outputs increases simultaneously so that the profit rather than decreasing remains unchanged or rather increases. But those farmers lacking business concepts as they were also the less educated, think profit as output on their farm lands before deduction of cost of inputs and taxes. That means they cannot identify output from production and profit from production as a result lack of business concept. Hence depending on this fact, it is recommended that besides increasing of farmers' education, the concerned bodies have to train those farmers in the business concepts like that of profit calculations in the way they can understand at their level.

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