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Research Article

# Farmers Perception and Adoption of Row Planting Technology of Teff: The Case of Dera Woreda, South Gondar Zone of Amhara Region, Ethiopia

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## ABSTRACT

In the context of Ethiopia, agriculture specifically crop production takes a lion's share of the economy. Although, supporting this sector through introducing new agricultural technologies, like row planting, boost production. Utilization of this improved technology remained very low in Ethiopia. This study aimed to analyze determinants of row planting technology adoption, intensity of the adoption and perception towards row planting technology by using cross sectional data collected through structured interview schedule from 201 sampled respondents. The Tobit model was used to analyze determinants and intensity of adoption and Ordered Probit model was used to analyze the perception of producers toward row planting technology. The estimated result showed that: sex, education, household size, off-farm activity, training about row planting, and participation of on-farm trials were found significantly and positively affect both the adoption decision and intensity of row planting technology of teff. Whereas, farm size and fertilizer use were found negative and significant effect on both the adoption decision and intensity. The Ordered Probit model result revealed that age, education, household size, off-farm activity, improved seed and training about row planting were found significant and positive effect on farmers' perception towards row planting technology of teff. Accordingly, the study recommends that those significant factors in adoption decision and intensity use of row planting technology of teff need to be considered during policies and strategies preparation and implementation.

**Keywords:** Adoption; Intensity; Row planting; Perception; Teff; Tobit

## INTRODUCTION

Agriculture is a proven path to prosperity. No region of the world has developed a diverse modern economy without first establishing a successful foundation in agriculture (AGRA, 2017). The notion is quite important for Africa where, close to 70%-80% of the population is involved in agriculture as smallholder farmers working on parcels of land, on average, less than 2 hectares [1]. As such, agriculture remains Africa's surest bet for developing inclusive economies and creating decent jobs mainly for the youth. Africa wide, farms smaller than 2 ha produce about 30% of total agricultural output, while 4-20 ha produce another 50%.

In sub-Saharan Africa, the majority of agricultural producers are relatively poor, smallholder farmers with limited use of basic technologies such as adequate seeds and fertilizers. Though subsistent and often affected by climate including climate variability, Ethiopia's agriculture continues an important source of livelihood and primary occupation for majority of smallholder rural youths (63%) and the overall population. Since 2010, agriculture stands the second most dominant sector next to service sector of the country's economy. It provides employment for 80% of the total labors force and contributes 42.7% to GDP and 70 percent to foreign exchange earnings.

Agricultural technologies include all kinds of improved techniques and practices which affect the growth of agricultural output, play immense role in increasing food productivity. The most common areas of technology development and promotion for crops include new varieties and management regimes; soil as well as soil fertility management; weed and pest management; irrigation and water management. According to new technology tends to raise output and reduces average cost of production

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which in turn results in substantial gains in farm income.

Despite large efforts that have been made to broadcast new farming technologies in different parts of the country, the decision of smallholder farmers to adopt vary widely across different agro-ecologies and within the same agro-ecology based on various technical and non-technical factors affecting and determining their decision.

An investigation on location specific regarding appropriate agricultural technology is essential to improve the adoption system and to support the assumption on adoption decision. Therefore, this study is conducted with the aim of producing empirical data that can provide clear understanding on the farm households' to adopt row planting technology of teff. Consequently, determinants in smallholder farmers' adoption of row planting technology of teff the case of Dera Woreda of south Gondar administrative zone is the main objective of this study [2].

## MATERIALS AND METHODS

### Description of the study area

The study was conducted at Dera Woreda, which is one of the 11 woredas in the South Gondar Administrative zone of Amhara Region, located between the coordinates of 11045'N 37030'E. Its altitude ranges from 1452 to 2749 meter above sea level and significant difference in altitude can be observed even in a short distance. The Woreda consisting of Dega and Woinadega agro-climatic zones which encompasses 234.586 square kilometers (15%) and 1290.654 square kilometers (85%), respectively. The average annual rainfall and temperature is 1250 millimeter and 19 degree centigrade, respectively (DWARDO, 2018) [3].

The capital town of Dera named Ambe same lies 45 kilometer east of Bahir Dar which is the capital city of Amhara National Regional state and 610 kilometer north of Addis Ababa, the capital city of Ethiopia. Dera woreda bordered on the south by the Abbay River which separates it from the Mirab Gojjam Zone, on the west by Lake Tana, on the north by Fogera woreda, on the northeast by Misraq Este woreda, and on the east by Mirab Este woreda. Towns in Dera include Ambe Same, Arb Gebeya and Hamusit. For administrative purpose the woreda is divided into 32 administrative units (Kebeles) in which 6 of them are urban kebeles while the remaining 26 are rural kebeles (Figure 1).

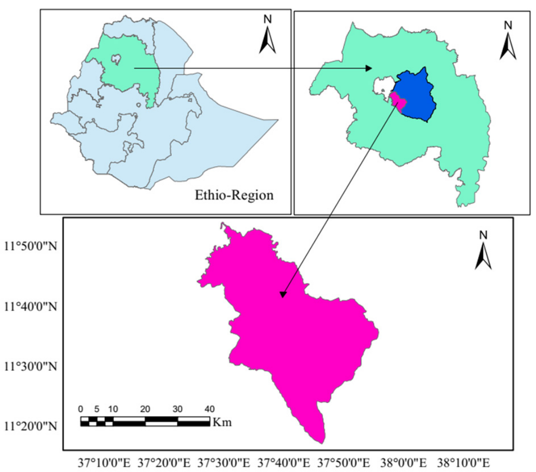


**Figure 1:** Description and map of the study area. **Note:** (■) Dera Woreda, (■) South Gondar, (■) Amhara Region.

### Sampling technique and sample size determination

The study followed a multi-stage sampling procedure to select Woreda, Kebeles and farmers. In the 1st stage Dera Woreda is purposively selected on the basis of potential production and higher coverage of teff. In the 2nd stage, of the total kebeles found in the Woreda 14 potential teff producing kebeles were identified. Kebeles with no or little teff production were not considered for sample selection.

In the 3rd stage, 4 kebeles namely; Gelawudiwes, Derba-Wochit, Wutmira and Sana were selected from the list of potential teff producing kebeles through lottery method. Then household head lists from the corresponding each sampled kebeles administrative office was used as a sample frame for selecting the sample households. Finally, systematic random sampling technique was applied to select 201 sample household heads for interview purpose from the selected four kebeles proportionally.

In this study both primary and secondary data which is qualitative and quantitative in nature were employed. The main source of primary data was the interviewed sample farmers' in the sampled kebeles [4]. In addition, the informants such as woreda's agricultural experts, kebele's administrators and development agents (DAs) were used as source of primary data. Furthermore, Dera woreda agricultural and rural development office, population census and annual reports from Central Statistics Agency (CSA); and research reports on teff from Ethiopian Agricultural Transformation Agency (ATA) and other published and unpublished materials were used as sources of secondary data.

### Method of data analysis

After coding and feeding the collected primary data into the computer, SPSS version 20.0 and STATA version 14.0 software packages were employed for the analysis. The data was analyzed using descriptive statistics and econometric models.

**Descriptive statistics:** Descriptive statistics like mean, standard deviation, percentages, frequency, minimum and maximum analysis were used to examine and understand the demographic and socioeconomic, and institutional variables of sample respondents. Furthermore, the mean differences of continuous variables between adopters and non-adopters were computed using t-tests. While the existence of associations of dummy variables on the two adoption categories were computed using the Pearson's chi-square ($\chi^2$) value.

**Specification of econometric models:** The dependent variable of this study is whether the farmer adopted row planting technology of teff or not and if they adopted, how much to adopt was also questioned. Therefore, to analyze this objective the fitted model is specified from below.

**Tobit model:** The rationale to use the standard Tobit model than other adoption models such as Logit or Probit is to overcome the deficiency of those models to determine intensity of adoption. Looking into the empirical studies in the literature, many researchers have employed the Tobit model to identify factors influencing adoption and intensity of technology use, the advantage of the Tobit model is that, it does not only measure the probability of adoption of technology but also take into account the intensity of use.

**Ordered probit model:** The dependent variable of the second objective of this study is perception which is measured by Likert scale. Since its inception, the Likert-type scale has been widely used in economics to gather information about attitudes, feeling and perception. The Likert-type scale ranks the responses and thus making it possible to order them [5]. The Likert-type scale used to measure the perception of farmer's towards the adoption of row planting technology of teff, have five ranks (strongly disagree, disagree, neutral, agree and strongly agree).

## RESULTS AND DISCUSSION

### Determinants of adoption and intensity use of row planting technology of teff

This section analyzes the question; what factors influence the probability of adoption and the use intensity of row planting technology of teff? The dependent variable for this question is continuous, which is the proportion of area planted by row planting from the total teff farm land. The proportion of row planted teff from the total teff farm land has a censored distribution since it is zero for those not adopting (here after called non-adopters). This suggests that standard Tobit estimation should be used. Therefore, Tobit model is fitted to identify factors affecting the adoption probability and the use intensity of row planting technology of teff.

The model had F-static value of 20.1 with a degree of freedom of (14,187) in the parenthesis and significant at 0.000. Since it was not equal to zero, it means that at least one of the variables' coefficient is not equal to zero. The probability of getting the F-test statistic (Prob>F) is 0.000. Thus, testing at 0.05 (Stata default), then 0.000<0.05 which leads us not to accept the null hypothesis that all the regression coefficients in the model are equal to zero. This shows that the model was a good fit and that at least one of the coefficients is not equal to zero [6].

The model had a pseudo log likelihood value of 40.39. It had a pseudo R2 of 0.49 which means 49 percent of the variation in the dependent variable was explained by the variation in the explanatory variables incorporated in the model. Out of the total 14 explanatory variables used for the model estimation, 8 variables were statistically significant. Among those: sex, education, household size, off-farm activity, participate in on-farm trials and training of row planting affected both the probability of adoption and use intensity of row planting technology of teff positively. Factors such as farm size and chemical fertilizer affected both probability of adoption and use intensity of row planting technology of teff negatively.

**Marginal effects of Tobit model:** Using a decomposition procedure suggested by McDonald and Moffitt (1980) the results of Tobit model can be used to assess the effects of changes in the explanatory variables into probability of adoption and intensity use of row planting technology of teff. Maximum likelihood estimates of Tobit model are summarized from above Table 1. The model was significant at less than 1% level implying the appropriateness of the model to estimate the relationship between the dependent variable with at least one independent variable. From the model, a total of 8 variables were found to significantly determine probability of adoption and intensity use of row planting technology of teff.

Tobit coefficients are not interpreted directly as the ordinary least squares coefficients [7,8]. The difficulty in interpreting the coefficients arise because the usual output from a Tobit model provides only one coefficient for each independent variable despite the presence of two types of cases in the analysis (adoption probability and use intensity). Such that by itself, a Tobit coefficient cannot directly describe these two effects. Therefore, in this study separated marginal effect commands were used for adoption probability and intensity use of row planting technology of teff.

**Sex:** The model result revealed in Table 2, sex of the household head is significantly and positively affected both probability of adoption and use intensity of row planting technology of teff at less than 5% level of significance. Holding other regresses constant in the model, a unit shift of sex from female to male, the conditional probability of the household head being adopter of row planting technology of teff is increased by 17.6% whereas the intensity use of row planting technology of teff is increased by 1.4%.

**Table 1:** Maximum likelihood estimation of Tobit Model. **Note:** *** and ** indicates the variable is statistically significant at 1% and 5% level of significance respectively.

| Variables | Coefficient | Robust STD error | T-value | P-value |
|---|---|---|---|---|
| Age | 0.0008 | 0.0018 | 0.43 | 0.699 |
| Sex | 0.0677** | 0.0279 | 2.42 | 0.016 |
| Education | 0.0139** | 0.0066 | 2.08 | 0.039 |
| Household size | 0.0449*** | 0.0102 | 4.38 | 0 |
| Farm size | -0.0283*** | 0.0106 | -2.65 | 0.009 |
| Number of livestock | 0.0098 | 0.0084 | 1.17 | 2.45 |
| Off-farm activity | 0.0600** | 0.0233 | 2.57 | 0.011 |
| Fertilizer | -0.0004** | 0.0002 | -2.15 | 0.033 |
| Extension contact | 0.0152 | 0.0097 | 1.57 | 0.119 |
| Credit | 0.0237 | 0.0296 | 0.8 | 0.424 |
| Improved seed | 0.0263 | 0.0246 | 1.07 | 0.288 |
| Participate in on-farm trials | 0.1695*** | 0.0335 | 5.05 | 0 |
| Trained row planting | 0.1476*** | 0.0271 | 5.25 | 0 |
| Number of plots | -65 | 0.0134 | -0.49 | 0.626 |
| Constant | -0.291 | 0.1097 | -2.65 | 0.009 |

**Table 2:** Maximum likelihood estimation of ordered Probit Model. **Note:** *** and ** indicates the variable is statistically significant at 1% and 5% level of significance respectively.

| Perception | Coefficient | Robust STD error | Z | P>/Z/ |
|---|---|---|---|---|
| Age | 0.065*** | 0.021 | 3.7 | 0.002 |
| Sex | -0.031 | 0.261 | -0.12 | 0.904 |
| Education | 0.182*** | 0.058 | 3.12 | 0.002 |
| Household size | 0.667*** | 0.113 | 5.9 | 0 |
| Farm size | -0.108 | 0.11 | -0.98 | 0.327 |
| Tropical livestock unit | -0.092 | 0.076 | -1.22 | 0.224 |
| Off-farm activity | 0.408 | 0.214 | 1.9 | 0.057 |
| Extension contact | -0.034 | 0.081 | -0.42 | 0.672 |
| Improved seed | 0.900*** | 0.216 | 4.16 | 0 |
| Fertilizer | -0.002 | 0.002 | -1.23 | 0.219 |
| Participate in on-farm trials | 0.281 | 0.251 | 1.12 | 0.264 |
| Trained row planting | 0.570** | 0.23 | 2.47 | 0.013 |
| Number of plot | 0.062 | 0.135 | 0.47 | 0.642 |
| /Cut 1 | 0.998 | 0.727 | - | - |
| /Cut 2 | 4.768 | 0.936 | 0 | - |
| /Cut 3 | 4.987 | 0.934 | - | - |
| /Cut 4 | 7 | 1 | - | - |

The positive relationship implies that male household heads would have better strength and access to agricultural information regarding the agricultural technologies as compared to female household heads. Since, due to the cultural habits most agricultural input decisions in Ethiopia are influenced by decision of the male household heads. This finding is consistent.

**Education status of the household head:** The model result revealed in Table 1 educational status of the household head is significantly and positively affected both probability of adoption and use intensity of row planting technology of teff at less than 5% significant level. Keeping other variables constant in the model, if we increase the education level of the household head by one schooling year, the conditional likelihood of the household head being adopter of row planting technology of teff is increased by 4.3% while the intensity use of row planting technology of teff is increased by 0.3%.

The positive relationship implies that household head who attended more schoolings had the higher probabilities of being adopter of this technology since they can easily analyze the benefits of new technology and also can understand written information through reading and implementing them in their farms thereby fulfilling the households' food security. The higher the educational level of household head, the higher probability of being adopter and the more food secure the household is expected to be. Therefore, the same relation had been found from other study.

**Household size:** The household size is statistically and positively significant at less than 1% level of significance. Keeping other regressors constant in the model, if we increase the household size by one adult equivalent, the conditional likelihood of the household head being adopter of row planting technology of teff is increased by 13.9% while the intensity use of row planting technology of teff is increased by 1%. This indicates that row planting technology of teff is being labor intensive thereby demanding more household labor. Other studies also supported that the household with large number is more involved in adopting the new technologies which demand intensive labor force during their farm production provided with low dependency ratios.

**Farm size:** The model result revealed in farm size is statistically and negatively significant at less than 1% level of significance. Keeping other variables constant in the model, if we increase farm size by one Timad the conditional probability of the household head being adopter of teff row planting technology is decreased by 8.7% whereas the intensity use of row planting technology of teff is decreased by 0.6%. These negative impacts suggest that smallholder farmers may be trying to utilize their limited resource (land) more efficiently to increase production and productivity by applying row planting methods while large farmers want to increase production by applying the traditional way of planting (broadcasting) on larger areas. This finding is in line with other studies.

**Participate in off-farm activities:** The model of farm activity participation was statistically and positively affected both the adoption probability and the use intensity of row planting technology of teff at less than 5% level of significance. Keeping other variables constant in the model, a unit shift from non-participant to participants of household head in off-farm activities the conditional probability of the household head being adopter of row planting technology of teff is increased by 19.4% while the intensity use of row planting technology of teff is increased by 1.4% This positive impacts suggest that farmers participated in other off-farm activities earn additional income and acquire improved technologies.

**Fertilizer:** The model result revealed in fertilizer utilization is significantly and negatively affects both the adoption probability and the use intensity of row planting technology of teff at less than 1% significance level [9]. At ceteris paribus, if we increase amount of fertilizer use by 1 kilogram the conditional probability of the household head being adopter of row planting technology of teff is decreased by 0.13% whereas the use intensity of row planting technology of teff is decreased by 0.01%. This is unexpected result and contrary to the prior expectation. This negative impact is suggest that fertilizer application also needs additional labor forces parallel with row planting of teff seeds.

**Participation in on farm trials:** The model result revealed in participation in on-farm trials was significantly and positively affected both the adoption probability and the use intensity of row planting technology of teff at less than 1% level of significance. At ceteris paribus, a unit shift from non-participant to participant of household head in on-farm trials the conditional probability of the household head being adopter of row planting technology of teff is increased by 58.6% whereas the intensity use of row planting technology of teff is increased by 5.4%.

The reason behind is that farmers who participate in field visit and attend demonstration of teff row planting technology have better knowhow about this technology. This implies, when farmers practically observe a new practice they can weigh the advantage and disadvantages of the new technology. This can facilitate the level of adoption and helps them to implement the new technology properly.

**Trained row planting:** The model result revealed (Table 1) that training of row planting is significantly and positively affected both the adoption probability and the use intensity of row planting technology of teff at less than 1% level of significance. At ceteris paribus, a unit shift from non-trained to train the conditional probability of the household head being adopter of row planting technology of teff is increased by 49% whereas the intensity use of row planting technology of teff is increased by 4.1%.

This implies that farmers who participated in training of row planting can get knowledge on recommended seed rate, width of row, use of planting material (preparations of plastic bottle), recommended fertilizer rate and related information about teff row planting technology were more likely to be adopter than those farmers who have no similar opportunity. This finding is consistent with the study.

## Factors affecting farmers' perceptions towards row planting technology of teff

This section analyzes the second research question; do farmers' perceive similarly towards row planting technology of teff? Ordered Probit model is fitted to identify factors affecting farmers' perception towards row planting technology of teff. The dependent variable for this question is ordinal and measured by Likert scales such as; strongly disagree, disagree, neutral, agree and strongly agree.

Ordered probit regression, like other discrete choice models use maximum likelihood estimation, which is an iterative procedure. The first iteration (iteration 0) is the log likelihood of the null or empty model; that is a model with no predictors. At the next iteration, the predictors are included in the model. At each iteration, the log likelihood increases because the goal is to maximize the log likelihood. When the difference between successive iterations is very small, the model is said to have converged, in this model the iteration procedure stops at (iteration 5), and the results are displayed.

The results of an ordered probit regression on perceptions of the farmers towards row planting technology of teff are presented below. A total of 14 explanatory variables, of which 8 were continuous and 6 were dummy variables, were included in the model. The selection of those explanatory variables for the model was done through literature review of previous related works. The pseudo log likelihood of the fitted model at the last iteration (iteration 5) is -133.81. It is used in the Wald Chi-square test of whether or not all predictors' regression coefficients in the model are simultaneously zero and in tests of nested models [9].

The McFadden's pseudo R-squared (Pseudo R2) is 0.386. This shows that 38.6% of the variation in the dependent variable (perception) was explained by the variation in the explanatory variables. The cut points (thresholds) used to differentiate the adjacent levels of the response variable. A threshold can then be defined to be points on the latent variable, continuous unobservable phenomena, which result in the different observed values the dependent variable used to measure the latent variable. There are 4 cut off points in the fitted model, which is one less of the number of categories.

**Cut 1:** This is the estimated cut point on the latent variable used to differentiate the level of perception strongly disagree from disagree, neutral, agree and strongly agree level of categories when values of the predictor variables are evaluated at zero. Subjects that had a value of 0.998 or less on the underlying latent variable that would be classified as strongly disagree.

**Cut 2:** This is the estimated cut point on the latent variable used to differentiate strongly disagree and disagree level of perception from neutral, agree and strongly agree when values of the predictor variables are evaluated at zero. Subjects that had a value of more than 0.998 and less or equal to 4.76 on the underlying latent variable would be classified as disagree.

**Cut 3:** This is the estimated cut point on the latent variable used to differentiate strongly disagree, disagree and neutral levels of perception from agree and strongly agree when values of the predictor variables are evaluated at zero. Subjects that had a value of more than 4.76 and less than or equal to 4.98 on the underlying latent variable would be classified as neutral.

**Cut 4:** This is the estimated cut point on the latent variable used to differentiate strongly disagree, disagree, neutral and agree level of perception from strongly agree when values of the predictor variables are evaluated at zero. Subjects that had a value of more than 4.98 and less than or equal to 7.00 on the underlying latent variable would be classified as agree. Subjects that had the value of above 7.00 on the underlying latent variable would be classified as strongly agree.

## Marginal effects ordered probit model for each outcomes

The ordered probit coefficients cannot be interpreted directly without further calculation as suggested by Greene (2002). Therefore, in order to know the amount of change in perception due to a unit change in the explanatory variable, marginal effects were used. Marginal effects were calculated by taking separate commands for each outcomes/categories of perception. A negative value shows that an increase in the explanatory variable reduces the probability that perception would be in that specific category while a positive value increases the probability that perception would be in that specific category.

**Source:** Computed from model result, 2021.

**Age:** According to the model age is one of the potential variables which is statistically significant and positively affected farmers perception towards row planting technology of teff at less than 1% level of probability. Keeping other regressors constant, if we increases age of the household head by one year about 0.004% less likely to being placed in strongly disagree and about 2.55% less likely to being disagree about 0.15% more likely to being placed in neutral, about 2.26% more likely to be placed in agree and about 0.14% more likely to be placed in strongly agree level of category [10]. This implies, as the age of the household head is increase by one year, they more likely to perceive row planting technology of teff positively. This finding is consistent with found that age is a proxy measure of farmers' skill in decision making have a positive impact on perceptions towards the attribute of a new technology.

**Education:** According to the model result education is positive and statistically significant and affected farmers' perception towards row planting technology of teff at less than 1% probability level. At ceteris paribus, if we increase the education level of the household head by one year (formal schooling) about 0.011% less likely to being placed in strongly disagree about 7.17% less likely to be placed in disagree about 0.42% more likely to be placed in neutral about 6.35% more likely to be placed in agree and about 0.4% more likely to be placed in strongly agree level of agreement. The positive perception suggests that more educated farmer can easily understand the benefit and cost of row planting technology of teff. This finding is consistent with found that education improves access to information and potentially improves understanding and interpreting the attributes of new technologies.

**Household size:** According to the model result revealed in household size is positive and statistically significant variable and affect farmers' perception towards row planting technology of teff at less than 1% level of probability. At ceteris paribus, if we increase size of the household by a single adult equivalent about 0.041% less likely to being placed in strongly disagree about 26.18% less likely to be placed in disagree about 1.56% more likely to be placed in neutral about 23.19% more likely to be placed in agree and about 1.46% more likely to be placed in strongly agree level of agreement.

The positive perception suggest that row planting technology of teff is being labor intensive especially at the time of sowing thereby demanding more household labor with low dependency ratio. This finding is consistent with that household size is an indicator of livelihood pressure, the higher the pressure, the positively perceived and more need to adopt innovative technologies [11].

**Improved seed:** According to the model result revealed in improved seed is statistically and positively significant which affect farmers' perception towards row planting technology of teff at less than 1% probability level. At ceteris paribus, a discrete change of the household head from non-user to user of improved seed about 0.059% less likely to being placed in strongly disagree about 34.56% less likely to being placed in disagree about 1.34% more likely to being neutral about 30.47% more likely to being in agree and about 2.79% more likely to being strongly agree.

The positive impact suggest that the household head who uses improved seed varieties of teff such as quncho and magna were sowing at low seed rate because of its length and branched out capability are suitable for row planting at a recommended seed rate. Therefore, household heads that use improved teff varieties were perceived positively towards row planting technology of teff [12].

**Training of row planting:** According to the model result revealed in training of row planting is also another potential variable which is statistically significant and it affects farmers' perception towards row planting technology of teff positively at less than 5% significance level [13]. It is a dummy variable that a discrete change of household head from non-participant to participant (0 to 1) in training of row planting of teff about 0.029% less likely to being strongly disagree about 22.34% less likely to being disagree about 0.89% more likely to being neutral about 19.83% more likely to being agree and about 1.64% more likely to being strongly agree level of category.

The positive impact suggest that farmers' who participated in training can get knowledge on recommended seed rate, width of row, use of planting material (preparations of plastic bottle), recommended fertilizer rate and related information about teff row planting technology [14,15]. This finding is consistent with (Nigeria, 2010) who found out that training brought about a change in attitude of farmers lead to good perception.

## CONCLUSION

Currently, Ethiopia is searching and doing a promising ways to come out of poverty and food insecurity. In such efforts, widespread adoption of new farming technologies that can enhance agricultural production is paid special attention. Today, row planting of major crops such as teff production is among the top new technology given priority and suggested for farmers at household level expecting increased productivity of the crops in the country.

Therefore, this study was conducted with the aim of producing empirical data that can provide clear understanding on factors affecting smallholder farmers' adoption decision and intensity use of row planting technology of teff as well as farmers' perceptions to this technology on Dera Woreda of South Gondar zone, Amhara Region, Ethiopia. The study was based on the data collected from the interview rural household heads during March-April 2021. Four potential teff producing kebeles were selected from the Woreda and a total of 201 households were interviewed in the study.

The collected data were analyzed using descriptive statistical tools such as mean, percentage, and standard deviation, minimum, maximum and frequency to describe the respondent characteristics based the available explanatory variable in relation to the adoption and the intensity use of row planting technology of teff. The descriptive statistics result shows that from the total sample of 201 respondents about 32.8% of the respondents were adopters with the mean intensity use of 0.07 units while 67.2% of the respondents were non adopters.

Additionally, inferential statistics like $\chi^2$-test and t-test also used to see the existence of association of dummy variables with the two adoption categories and mean difference of continuous variables between the two adoption categories of the sample households respectively.

According independent two tailed t-test result; variables such as age, education, household size, tropical livestock unit, farm size and number of extension contact shows that there are statistically significant mean difference between both adoption categories of row planting technology of teff at less than 1% and 5% level of significance. The chi square ($\chi^2$) result, uses of improved seed, participation of off-farm activities, training of row planting and participation of on-farm trials have statistically significant association with of the two adoption categories of row planting technology of teff.

On the other hand, the econometric Tobit model was used to identify factors affecting the adoption decision and intensity use of row planting technology of teff. The model was chosen because of its advantage over other adoption models in dealing with a dependent variable with censored distribution and generating information for both probability of adoption and intensity of use of the technology.

The result from the econometric regression Tobit model indicated that, 8 of the 14 explanatory variables were significantly influencing the probability of adoption and intensity use of row planting technology of teff namely; sex, education, household size, and off-farm activity, participate in on-farm trials and trained row planting affects positively at less than 1% and 5% level of significance. Factors such as; farm size and fertilizer affects negatively both the probability of adoption and use intensity of row planting technology of teff at less than 1% and 5% level of significance.

Additionally, result from ordered probit model revealed that out of 14 potential explanatory variables 5 variables were significantly influencing farmers' perceptions towards row planting technology of teff.

Finally, we recommend for further researchers that adoption is a dynamic process involving changes in farmers' perceptions and attitudes as acquisition of better information progresses and farmers' ability and skill improve in applying new technology. Therefore, panel data can be addressed the given problems.

## REFERENCES

1. Abeje A, Ayen K, Awoke M, Abebaw L. Adoption and intensity of modern bee hive in Wag Himra and North Wollo zones, Amhara Region, Ethiopia. Agric Resour Econ. 2017; 3(1): 5-26.
2. Baidu-Forson J. Factors influencing adoption of land-enhancing technology in the Sahel: Lessons from a case study in Niger. Agric Econ. 1999;20(3):231-239.
3. Duncan CS, Khattak AJ, Council FM. Applying the ordered probit model to injury severity in truck-passenger car rear-end collisions. Transp Res Rec. 1998;1635(1): 63-71.
4. Hahn ED, Soyer R. Probit and logit models: Differences in the multivariate realm. J Roy Stat Soc. 2005; 67:1-12.
5. Geremew,K, Abdi B, Muzeyin A, Workineh M. Analysis of smallholder Farmer's adoption and continued application of Teff row planting technique in Wolaita. Int J Adv Res. 2016; 4(9):1369-1376.
6. Headey DD. The evolution of global farming land: Facts and interpretations. Agric Econ. 2016; 47(S1): 185-196.
7. Herrero M, Thornton PK, Power B, Bogard JR, Remans R, Fritz S, et al. Farming and the geography of nutrient production for human use: A trans disciplinary analysis. Lancet Planet Health. 2017; 1(1):e33-e42.
8. Likert R. A technique for the measurement of attitudes. Archives of Psychology . 1932.
9. Lowder SK, Skoet J, Raney T. The number, size, and distribution of farms, smallholder farms, and family farms worldwide. World Dev. 2016; 87:16-29.
10. Mudombi S. Socio-economic determinants of smallholder farmers' adoption of improved sweet potato: Case study of Wedza community in Zimbabwe. Econ Papers. 2004; 634-639.
11. Aphunu A. Fish culture training programme in Delta State, Nigeria. Agr-Sci J Trop Agri. 2010;9(2):131-136.
12. Sheahan M, Barrett CB, Sheahan MB. Understanding the agricultural input landscape in sub-Saharan Africa: Recent plot, household, and community-level evidence. Pol Res Wor Pap. 2014; 7-14.
13. Teferi T. Adoption of improved sorghum varieties and farmers' varietal trait preference in kobo district, northwolo zone, Ethiopia. J Agric Econ. 2020; 114-122.
14. Vidogbéna F, Adégbidi ABEA, Tossou R, Assogba-Komlan F, Martin T, Ngouajio M, et al. Exploring factors that shape small-scale farmers' opinions on the adoption of eco-friendly nets for vegetable production. Environ Dev Sustain. 2016; 18(6): 1749-1770.
15. Yadav SB, Daipuria, OP, Chauhan SV. Impact of training programs on adoption of organic farming practices. Assmt. 2011;22(50):26-67.