

Factors Affecting Adoption of Wheat Row Planting Technology: The Case of Sodo Zuriya Woreda, Wolaita Zone, Southern Ethiopia. December, 2016

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Abstract
This study was conducted in Wolaita Zone, Southern Ethiopia. Its aim was to find out the status of adoption of wheat row planting technology and to study factors that affect the adoption among farmers in the study area. In order to achieve these objectives, 124 rural households were selected randomly following probability proportional to sample size technique. The sample households were interviewed using interview schedule. Both primary and secondary data were used. The data were analyzed by using descriptive statistics like mean, standard deviation, percentages and frequency distribution. Inferential statistics such as t-test and chi-square (χ^2) tests were also used to describe characteristics of adopter and non adopter households. The survey result shows that about 55.65% and 44.35% of sample respondents were found to be adopter and non adopter of wheat row planting technology respectively. A binary logistic regression model resulted in five significant variables among 17 variables. These were sex of the household head, education status, household size in adult equivalent, oxen ownership, and participation in agricultural training and demonstrations. The model estimate correctly predicted 79% of the sample cases, 85.5% adopters and 70.9% non adopters. Therefore, the findings of the study suggest improvement in illiteracy levels and designing and implementing adult education strategies, introduction and promotion of appropriate livestock packages, and strengthening of farmers training centers (FTCs) for proper functioning in terms of training delivery and arrangements of demonstrations to suit the felt needs the farmers.
Keywords: Row planting technology, Adoption, Wheat, Binary Logistic Regression model.

1. Introduction

Accounting for a fifth of humanity's food, wheat is second only to rice as a source of calories in the diets of consumers in the developing countries. Wheat is an especially critical "stuff of life" for approximately 1.2 billion "wheat dependent" and 2.5 billion "wheat consuming" poor men, women and children who live on less than USD 2 per day; and for approximately 30 million poor wheat producers and their families (CIMMYT, 2012). If population growth continues at double to the growth of wheat production, there will likely be serious difficulties in maintaining wheat food supply for future generations (Dixon *et al.,* 2009; CIMMYT, 2012).

In 2010, African countries spent more than US$ 12.5 billion on importing 32 million tons of wheat. Demand for wheat in Africa is growing faster than for any other food crops. Demand for wheat in the developing world is expected to increase by 60% by 2050 (Rosegrant and Agcaoili, 2010; CIMMYT, 2012). The challenges of globally low and fluctuating wheat production, rising consumer demand and higher food prices require efforts that dramatically boost farm-level wheat productivity and reduce global supply fluctuations. Productivity growth is considered to be one of the long term solutions to these challenges (Diao *et al.,* 2008).

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 (Challa, 2013). Agricultural technologies include all kinds of improved techniques and practices which affect the growth of agricultural output (Jain *et al.*, 2009). According to Loevinsohn *et al*. (2012) 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. By virtue of improved input/output relationships, new technology tends to raise output and reduces average cost of production which in turn results in substantial gains in farm income (Challa, 2013).

Adopters of improved technologies increase their productions, leading to constant socio-economic development. Adoption of improved agricultural technologies has been associated with: higher earnings and lower poverty; improved nutritional status; lower staple food prices; increased employment opportunities as well as earnings for landless laborers (Kasirye, 2011). Adoption of improved technologies is believed to be a major factor in the success of the green revolution experienced by Asian countries (Ravallion and Chen, 2004).On the other hand, non-adopters can hardly maintain their marginal livelihood with socio-economic stagnation leading to deprivation (Jain *et al.*, 2009).

Ethiopia is an agrarian country where more than 80% of the total population depend directly or indirectly on agriculture. Agriculture contributes for about half of the GDP and for more than 90% of foreign exchange earnings. Cereals (mainly tef, wheat, maize, and sorghum) are dominant in different parts of the country satisfying about 70% of the average Ethiopian's calorie intake (Howard, *et al.,* 1995, Abebe, 2000). While agricultural productions are still taking place using traditional methods, efforts have been made by the Ethiopian governments to improve situations through dissemination of improved agricultural technologies to farmers.

In Ethiopia, the major challenges facing agriculture are low productivity, low use of improved farm inputs, and dependency on traditional farming and rainfall. As a result, food insecurity and poverty are prevalent in the country. Wheat is one of the major food crops with low productivity. It is the second important cereal crop with annual production of about 3.43 million tons cultivated on area of 1.63 million hectares (CSA, 2013). It occupied about 17% of the total cereal area with average national yield of 21.10 q/ha. This is the lowest yield compared to the world average of 40 q/ha (FAO, 2009). The low yield has made the country unable to meet the high demand, and the country remains net importer despite its good potential for wheat production (Rashid, 2010). Increasing yield and meeting the high demand has become the main concern of government's agricultural policy and extension activities.

Agricultural extension activities have been concerned with the promotion, adoption and scaling up of wheat row planting practices; and adoption of the practice is seen as the factor for wheat yield enhancement in the country. As a result, manual planting of wheat in row has become one of the agronomic practices of smallholder farmers in the country (Berhanu et al., 2014). The conventional planting method, that is broadcasting seed by hand at high seed rates, reduce yield because uneven distribution of the seeds makes hand weeding and hoeing difficult, and plant competition with weeds lowers wheat growth and tillering. This causes wheat yield reduction. However, row planting with proper distance between rows and plant density allows for sufficient aeration, moisture, sunlight and nutrient availability leading to proper root system development thereby improving production and productivity (Berhanu *et al.,* 2014). However, since the introduction of the technology in the study area in 2013 by the Regional Bureau of Agriculture, contrary of the efforts of the extension system, some farmers were not making use of row planting technology.

In Ethiopia, according to Central Statistical Authority (CSA, 2011) average national productivity of wheat is 1.84 ton/hectare which is too low compared to the potential productivity of 4 to 8 ton/hectare at farmers' field. In an effort to improve wheat productivity and production, the Minster of Agriculture (MoA) through Regional Bureau of Agriculture (RBoA) had introduced a row planting of wheat crop in 2012 all over the regions. However, the introduced technologies are not widely accepted by farmers in different parts of the county as expected. The same thing is also true for the study area. This indicates that there are different factors directly or indirectly influencing the adoption of technologies that believed to bring change in smallholder farmers' productivity. But the reasons why farmers do not accept the wheat row planting technology is not yet well understood. The status of adoption of the recommended technology among the target farmers is not determined. Factors that limit adoption of the new technology are not well assessed. Therefore, the main focus of this study was to assess the status to which the wheat row planting technology is adopted by farmers, and to identify the factors influencing adoption of the recommended technology. Number of studies has been undertaken on row planting technology of wheat in different parts of the world and very few in Ethiopia. However, as far the knowledge of the researcher is concerned; factors affecting the adoption of row planting technology of wheat were not conducted in the study area.

2. Research Methodology

2.1. Description of the Study Area

The research area, Soddo Zuriya district, is one of the 12 districts of Wolaita Zone in Southern Ethiopia. The district is sub divided into 31 kebeles (small administrative units). Agriculture is the main stay of people in the district. Agro ecologically the Woreda (district) categorized into middle altitude (Woinadega) 65% and high altitude (Dega) 35%, it is suitable for diverse agricultural production. Crop and livestock production are the major sources of income in the district. The total area of the district is 41927 hectare and out of which the total 22326 (53.26%) hectare land is used for annual crop production, 5429 (12.95%) hectare is covered by permanent crops, 2022 (4.43%) hectare is covered by forest, and 2710 (6.47%) hectare is used for other purposes such as grazing. Out of 186779 total population, 91847 (49.17%) are male and remaining 94932 (50.83%) are females, and the total average household size is six.

2.2. Sampling Techniques

A purposive sampling and three stages probability sampling procedures were used for sample selection. In the first case, Soddo Zuriya *Woreda (study district)* which is the major wheat producing *district* within Wolaita Zone was purposively selected. There are strong research and extension intervention programs embracing wheat producers in the area. Moreover, newly released improved wheat technology and improved farming practices were relatively more disseminated and practiced in this area. In the second stage, a list of major wheat producing *kebeles (small administrative units)* within the district were obtained. In the 3rd stage, three wheat producing *Kebeles* were selected from the list of wheat producing *Kebeles* through simple random sampling technique. Then the adopters and non adopter households' list was prepared on a format before selecting the sample households. Finally, systematic sampling technique was applied to select 124 sample households from the selected three rural *Kebeles.*

Sample Size Determination

The number of sample households was determined based on the formula given by Kothari (2004) just through estimating the tolerable error margin and fixing the confidence level. Therefore, having 0.05 and 95% tolerable error margin and confidence level, the following formula was used to determine the sample households.

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

Where: n= the minimum number of sample size within the range of acceptable error margin.

N= the total number of wheat producing households in the selected *Kebeles*

z= confidence level (95%) and which is 1.96

e= acceptable error margin (0.05)

p= proportion of sampled population (0.11)

q= estimate of the proportion of population to be sampled (0.89)

2.3. Sources and Methods of Data collection

The data for this study was collected from both primary and secondary sources. The primary data sources were the sample respondent households' heads, who have the dominant share in the decision of the selection and application of wheat row planting technology. On the other hand, the secondary data was collected from various secondary sources like *Kebele, Woreda* and Zonal Agricultural coordination offices. Primary data was collected with the help of survey by means of structured interview schedule for the quantitative data. Pre-test of interview schedule was made among the non respondent households. The qualitative data was obtained through organizing the focus group discussion session with the group members who are supposed to have clear insight about the row planting wheat technology and its local implementation. Moreover, personal interview was conducted with the *Woreda*and Zonal agricultural extension communication experts.

2.4. Method of Data Analysis

The data was analyzed with the help of descriptive statistical tools like, and mean, percentages, standard deviation, maximum and minimum. The inferential statistics like t-test (help to see difference between households in relation to independent variables) and $\chi 2$ tests were administered to see the influence of independent variables on the dependent variable. To find out the significant independent variables, binary logistic regression econometric model was applied since the independent variable has binary outcomes.

2.4.1. Model Specification

One of the purposes of this study is to assess the factors that affect the adoption of row planting technology of wheat. The dependent variable in this case takes a dichotomous variable, which take a value of zero for non adopters households and one for the adopters ones.

When one or more of the independent variables in a regression model are binary, we can represent them as dummy variables and proceed to analyze. Binary models assume that households belong to either of two alternatives and that depends on their characteristics. Thus, one purpose of a qualitative choice model is to determine the probability that a household who fall in one of either alternatives (in this study the alternatives were adoption and non adoption).

The Probit and Logit models are commonly used models in adoption studies. However, the Probit probability model is associated with the cumulative normal probability function. Whereas, the Logit model assumes cumulative logistic probability distribution. The advantage of these models over the linear probability model is that the probabilities are bound between 0 and 1. Moreover, they best fit to the non-linear relationship between the probabilities and the independent variables; that is one which approaches zero at slower and slower rates as an independent variable (Xi) gets smaller and approaches one at slower and slower rates as Xi gets large (Train, 1986).

Usually a choice has to be made between Logit and Probit models, but the statistical similarities between the two models make such a choice difficult. Gujarati (1988) illustrated that the logistic and Probit formulation are quite comparable. It does not matter much which function is used except in the cases of where the data are concentrated in the tails following points. For this study the Logit model is selected, though both Logit and Probit models may give the same result. The logistic function is used because it represents a close approximation to the cumulative normal distribution and is simpler to work with. Moreover, as Train, (1986) pointed out a logistic distribution (Logit) has got advantage over the others in the analysis of dichotomous

outcome variable in that it is extremely flexible and easily used function (model) from the mathematical point of view and lends itself to a meaningful interpretation and relatively inexpensive to estimate.
Following Pindyck and Rubinfeld (1981) the cumulative logistic probability function is specified as:

$$\mathrm{Pi} = \mathrm{F(Zi)} = \mathrm{F}[\alpha + \sum(\mathrm{BiXi})] = [\frac{1}{1+e^{-[\alpha+\sum(BiXi)]}}] \text{ ------------------------------------ (1)}$$

Where:
e represents the base of natural logarithms (2.718)
xi represents the i^{th} explanatory variable
Pi is the probability that a household is being adopter xi,
α and βi are regression parameters to be estimated
Interpretation of the coefficients will be understandable if the logistic model can be written in terms of the odds and log of odds (Hosmer and Lemeshow, 1989). The odds ratio is the probability that a household would be adopter (Pi) to the probability that it will be non adopter(1 - Pi).

$$(1 - P) = \frac{1}{1+e^{zi}} \text{ --- (2)}$$

And putting using natural logarizm:

$$Zi = Ln\left(\frac{Pi}{1 - Pi}\right) = \alpha + \beta 1x1 + \beta 2x2 + \text{---} + \beta nxn \text{ --------------------------- (3)}$$

Where:
Zi represents is a function of explanatory variables xi
α is the intercept
β's are the slope parameters in the model

Table 1: Summary of hypothesized independent variables and their expected signs

Independent variable	Variable description	Measurement	Expected Sign
Age of HH head	Age of the household head, measured in years.	Continuous	-
Sex of HH head	Sex of the household head, 1 for male and 0 for female.	Dummy	+
HH size in AE	Number of household/family members who live under the same household, measured in AE.	Continuous	-/+
Education level	Education level of the head of the household	Continuous	+
Farmland size	Size of crop land, measured in hectares	Continuous	-
Livestock Ownership in TLU	Total number of livestock owned by the household	Continuous	+
Oxen ownership	Number of oxen the household owned, measured in number	Continuous	+
Extension Contact	Number of DA visit in a year (frequent visit and contact favors adoption)	Continuous	+
Agricultural training, demonstration and field days	Attending the modular skill training at FTC, 0=non participants, 1=participants (attendance favors adoption)	Dummy	+
Access to and utilization of Credit	Access and making use of the credit=1, non access and non using credit=0	Dummy	+
Fertilizer Utilization	Utilization of inorganic fertilizer=1, non utilization=0	Dummy	+
Perception and attitude	Perception towards the technology 0, very disagree, 1, disagree, 2, neutral, 3, interested, 4, very interested.	Ordered	+

3. Result and Discussion

This part presents the findings and discusses of the descriptive and model output. First part contains analysis related with the description of variables in terms of descriptive and inferential statistics. Next part displays and deals with the findings from the logistic regression model with respect to the factors which affect the adoption of the wheat row planting technology.

3.1. Descriptive statistics

According to descriptive analysis, some variations were observed between adopters and non-adopter of wheat row planting in terms of household demographic characteristics, socio-economic and institutional factors (Table 2 and 3). The two groups differ to some extent in their farm experience, level of education, land size, livestock possession, access to credit, extension contact, sex and participation in training. The study revealed that adopters have better educational background than non adopters. In terms of farm experience, average farm experience of adopter was about 23.47 years while non-adopters comprise 20.3 years of farm experience. Average farm size of adopters' was more than non-adopters. Livestock ownership was another important household's characteristic. Average livestock owned by the total sampled households was 2.71 TLU. Proportionally, adopters owned almost twice greater livestock than non adopters. Variations were also observed in other socio-economic and institutional factors (see Table 2 and 3).

Table 2: Descriptive statistics for continuous explanatory variables

Variable	Adoption category						t-value
	Adopter		Non Adopter		Total		
	Mean	SD	Mean	SD	Mean	SD	
Age	39.68	8.12	42.12	9.102	40.77	8.631	-0.078
Education	6.14	3.82	3.62	3.664	5.02	3.944	2.308**
Family size	4.97	2.0	3.65	1.63	4.389	1.96	2.837***
Farming Experience	23.47	9.89	20.3	6.89	23.5	9.05	1.606
Land size in Ha	.80	0.624	0.680	0.4	0.74	0.51	-0.384
Livestock (TLU)	2.71	1.75	1.94	0.92	1.37	1.48	1.727*
Oxen	1.22	0.66	0.8	0.62	1.03	0.67	2.282**
Extension Contact	4	1.55	3.12	1.22	3.6	1.47	2.101**

Source: Own survey. *, **, and *** represents significant at 10%, 5%, and 1% significance levels, respectively.

T- tests and chi-square (Table 2 and 3) tests were used to make sure presence or absence of difference between the two groups of farmers, when appropriate. The mean values of the continuous variables in both categories were compared using t-test. According to the t-values, out of 8 continuous variables, the two categories were found to differ significantly in 5 of them. The computed t-values indicate the mean differences for five variables, namely family size, number of tropical livestock units, number of oxen owned, education and extension contact. Similarly, the mean differences for extension contact and livestock ownership were found to be significant at 5% and 10% probability level respectively (Table 2).

On the other hand, a chi-square test was used to examine the existence of statistically significant differences between the discrete variables of the two categories. Accordingly, discrete variables were considered and the two categories were found to be different in terms of 2 of the 3 discrete variables (Table 3). More specifically, the chi-square test reveals that participation in training and sex were statistically significant at 1% probability level.

Table 3: Descriptive analytical results for discrete explanatory variables

Variable	Response	Adoption category						$\chi 2$-value
		Adopter		Non Adopter		Total		
		Number	Percent	Number	Percent	Number	Percent	
Sex	Male	63	91.3	53	96.4	116	93.55	-0.259 ***
	Female	6	8.7	2	3.6	8	6.45	
Credit	Yes	52	75.4	44	80	96	77.4	-0.979
	No	17	24.6	11	20	28	22.6	
participation in training	Yes	58	84	24	43.6	96	66.13	22.325***
	No	11	16	31	56.4	28	33.87	

Source: Own survey, 2016. *** represents significant at 1% significance levels.

3.2. The model result on determinants of adoption of wheat row planting technology

Before entering the variables in to the model, the multicollinearity problems were checked in terms of Variance Inflation Factor (VIF) for continuous and contingency coefficients for dummy and discrete variables respectively. As a rule of the thumb, when the variables having VIF values less than the cut off value (10) are believed to have no multicollinearity problems and those with VIF of above 10 are assumed to have a multicollinearity problem. Therefore, since, in this study, the computational results of the VIF for continuous variables confirmed the non-existence of association between the variables and were included in the model.

Besides, as a rule of thumb, the threshold for contingency coefficients for dummy and discrete variables is 0.75. The values below 0.75 indicate the existence of weak association and above 0.75 indicates strong association of variables. However, the results obtained in this study regarding dummy and discrete variables were less than 0.75. Therefore, this indicated that there was no any multicollinearity problem detected.

Moreover, the goodness of model fit was measured in terms of count R^2, which works on the principle that if the predicted probability of the event is greater than 0.50, the event will occur; otherwise the event will not occur. The model result show the correctly predicted percent of sample household is 79%, which is greater than 0.50.

Additionally, the sensitivity and specificity, which correctly predicted adopter and non adopter households, were found to be 85.5% and 70.9% respectively indicated that the model had estimated the adopters and non adopters correctly.

Out of 12 independent variables which had been expected to be significantly related with the adoption status of wheat row planting technology, five variables were found statistically significant (Table 16).

Table 4: Logistic estimates of factors affecting the adoption of wheat row planting technology

Variables	Coefficients (B)	S.E	Wald statistics	Odds ratio	Significance level
Constant	-2.402	1.751	1.883	0.090	0.170
Age HH	-0.019	0.045	0.182	0.981	0.670
Sex HH	3.270	1.218	7.203	26.304	0.007***
Household size (AE)	0.349	0.153	5.226	1.418	0.022**
Farming experience	-0.034	0.052	0.421	0.967	0.516
Education level HHH	0.128	0.072	3.144	1.137	0.076*
Landholding size	-0.374	0.479	0.611	0.688	0.434
LS ownership (TLU)	0.263	0.190	1.924	1.301	0.165
Oxen ownership	0.911	0.435	4.389	2.486	0.036**
Extension contact	0.262	0.212	1.524	1.300	0.217
Participation in Training	1.596	0.556	8.227	0.203	0.004***
Fertilizer Utilization	0.251	0.432	1.221	0.354	0.135
Credit Utilization	0.705	0.592	1.418	2.023	0.234
- 2 Log likelihood				109.771	
Pearson Chi-squared (χ^2)				60.456	
Correct prediction of all sample (*Count* R^2) (%)				79	
Sensitivity/ Correct prediction of adopters (%)				85.5	
Specificity/ Correct prediction of non adopters (%)				70.9	

Source: Model output, 2016. Note: ***, **, and * represents Significant at less than 1%, 5% and 10% probability level respectively.

The logit model results used to study factors influencing adoption of wheat row planting technology in Table 4. Among the 12 variables used in the model, 5 variables were significant with respect to adoption of wheat row planting technology with less than 10% of the probability level. These variables include sex, family size, education, oxen ownership, participation in training, whereas the rest 7 explanatory variables were found to have no significant influence on the adoption. The effect of the significant explanatory variables on adoption of wheat row planting technology in the study area is discussed below:

Sex of the Household head was found significant at less than 1% probability level in explaining the status of adoption of wheat row planting technology. The positive coefficient for sex of the household head implies that it has a positive relationship with the male household heads. That means male headed households have the higher probabilities of being adopter than their female counterparts. Therefore, if other factors are assumed to be constant, the probabilities of male household heads to be adopter increase by a factor of 26.304. This can be reasoned out that male household heads would have better strength and labor and access to agricultural information regarding the new technologies as compared to female household heads. Most agricultural input decisions in Ethiopia are influenced by decision of the male household heads and hence this study also had come to similar finding (Roy *et al*., 1999).

Household Size in AE was significant at less than 5% probability level and positive in explaining the household adoption status. This reveals that when household size increases, the probability of the household being adopter of the technology will increases. Therefore, if other factors are constant, an increase of a single adult equivalent increases households' likelihood of being adopter by a factor of 1.418. This indicates that the technology being labor intensive thereby demanding more household labor. Other studies also indicated that the family with large number is more involved in adopting the new technologies which demand intensive labor force during their farm production provided that low dependency ratios (Getahun *et al*., 2000).

Education status of the Household heads is significantly related at less than 10% probability level and the odds ratio in favor of being adopter increase by a factor of 1.137 when other factors remain constant. The positive relationship implies that households who attended more grades had the higher probabilities of being adopter 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 household's 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 (Tesfaye and Shiferaw, 2001).

Oxen Ownership: Oxen ownership positively influenced the probability of adoption of wheat row planting technology at less than 5% significance level. This result suggests that, those farmers who owned more oxen have better chance to adopt the technology than those who have owned small number of oxen. Wheat row planting technology requires a well-prepared soil and readymade ridges that fulfills the recommended row to row size. Therefore, farmers need to own at least one pair of oxen to prepare land. Other things being held the same, the odds ratio of 2.486 for the number of oxen owned indicates that, the odds ratio in favor of adopting the wheat row planting technology increases by a factor of 2.486 as the number of oxen increases by one unit. According to Yishak (2005), farmers need to own at least one pair of oxen to be able to prepare their land well thereby boost their production and productivity.

Participation in Agricultural Training: It was found that exposure to information in relation to participating in agricultural training and attending demonstration had positively and significantly influenced the probability of adoption of wheat row planting technology at less than 1% significant level. The result of logit model in relation to this variable shows that farmers who have opportunity to participate training and attend demonstration of wheat row planting technology are more likely to be adopter than those farmers who have no similar opportunity. In another words, the result indicates that farmers who are exposed to formal extension information have a higher probability towards adoption than those with less exposure. When farmers practically observe a new practice they can weigh the advantage and disadvantages of the new technology. This can facilitate adoption and helps them to implement the new technology properly. Other thing held constant, the odds ratio in favor of adopting wheat row planting technology increases by a factor of 0.203. This result goes along with the study done by Yishak (2005).

4. Conclusions

The result of this study showed that about 55.64% and 44.35% of the sample households were found to be adopter and non adopter of wheat row planting technology respectively. Besides, adopter households were characterized by male, more family size measured in AE, higher school grades, more number of oxen ownership, and participants in agricultural training and demonstration sessions when compared to non adopter household.

This study indicated that female headed households had negative relationship with the adoption of wheat row planting technology. This means female headed households have lesser probabilities of being adopter than male household heads. On the other hand, family size and adoption status of the wheat row planting technology was strongly and positively related. This could be due to the labor intensive nature of the technology. Furthermore, it was found that households' education status significantly affects the adoption of wheat row planting technology. The result shows that the technology is more likely to be adopted by farmers who attended the higher school grades. This implies that better educated household heads are in a position to understand and interpret what ever technology easily and implement on their own farms.

Oxen ownership affected significantly and related positively with the adoption of wheat row planting technology. The possession of more oxen assists the households in combating the shortfall of labor requirements from land preparation up to planting and sowing. This in turn helps the households in meeting the cash requirements for seeds, fertilizers and other inputs through selling them at needy seasons. On the others hand it could also be source of cash to be paid as a wage for additional daily laborer required.

At last, the study had found that participation in the agricultural training and demonstration as a key factor in determining the adoption of wheat row planting technology. Therefore, concerned bodies must arrange a short term training session for the technology to be adopted by the vast majority households.

Based on the findings of the study, the following recommendations were suggested.

- Literacy campaigns and adult education strategies must be designed and implemented to improve the households' literacy level.
- Appropriate livestock packages need to be introduced and promoted in the study area in order to make farmers accumulate capital as a cattle and design household assets building mechanisms. This may be, for instance, through improved veterinary service, feed and water development as deemed necessary.
- Training and awareness creation programs through farmers training center (FTC) method as well as result demonstrations should be arranged before the implementation of the newly introduced technologies.
- Concerned bodies should give due attention and assistance during a peak labor demanding seasons and technology introduction.
- Decisions and measures need to be implemented in order to make the technology labor extensive since the study area is known by its dense population; it is difficult to increase household size as a response against the new technology. Thus, this could be done through designing appropriate agricultural tools that assist

during planting or sowing season in order to facilitate the adoption of wheat row planting technology.

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