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Determinants Affecting Adoption of Malt-Barley Technology: Evidence from North Gondar Ethiopia

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Abstract Considerable numbers of studies have been conducted on various technologies. However, adoption and intensity of adoption on malt- barley technology has not been carried out in the country. Production of commercial crops could give adequate yields if it is supported with improved technologies and suggested packages. The focus of study was examining determinants of adoption of malt-barley technology in Debark and Wogera districts of North Gondar. The sample size of the study was 120 respondent farmers. Both qualitative and quantitative data were collected from primary and secondary sources. Interview schedules, focused group discussions, key informant interviews, and personal observations were the major data collection methods. Descriptive statistics, inferential tests and Tobit econometric model were administered for analysis. The result explained that education, access to improved seed and training affected adoption of malt-barley technology positively and significantly while social status of household heads influenced the technology significantly but negatively. Even though majority of adopters had better adoption indices, the technology couldn't disseminate in large number of beneficiaries and potential producing areas. As a result, the rate of adoption was low and slow. Therefore, this study suggested that farmers should be exposed to training and access to improved seed.

Keywords: *adoption, malt-barley, Tobit, seed, agriculture, technology*

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1. Introduction

About 82.4% of population in Ethiopia is engaged in agriculture. Crop and livestock production is the major source of food, raw materials and foreign exchange earnings [17]. Barley (*Hordem Vulgare*) is the most staple food and subsistence crop in the country; cultivated in more than 800,000 ha between 2000 and 3500 meter above sea level. Despite the suitability of production for barley in general and malt-barley in particular it has not been stretched out as expected [10]. Ensuring food security is the basic right of people to the food they need is one of the greatest challenge facing almost all communities [4].

The top barley producer countries in the world are German, France, Ukraine, Russia, Spain, Canada, Australia, Turkey, United Kingdom and United States [14]. The natural productions of distributions include Eastern Greece, Turkey, Libya, Egypt, Afghanistan and West Pakistan. Zemede (1996) was reviewed and quoted in Mulatu and Grando [10], the first Ethiopians to have ever cultivated barley is believed to be in 3000 BC. Although Arsi and Bale zones are the known barley producers that have been supplying for brewery factory, their supply of raw materials alone couldn't able to keep with expanded capacity [9]. In *Amhara* region, West and East *Gojam*, North and South *Gondar*, and *Awi* zones are the major potential producers of malt-barley [10].

Many studies in Ethiopia indicate that barley has been used for various purposes such as increasing for breast milk, remedy for gastritis and healing of the broken bones and fractures [7]. The straw of the crop is used for feed, thatching roofs and bedding, bio-fuel, and prevention of algae growth in ponds and water ways [12]. It can be prepared for soup, stew, bread and biscuit. The flour also has been used for supplementary feed to honey bee colonies [16]. In the study areas adaptation and demonstration of malt-barley was conducted in 2005 and consequently since 2006 production of the crop was started at farmers' field. However, the adoption and intensity of adoption of malt-barely technology has not been evaluated [10]. Adoption is a decision to use and implement a new idea or technology [13]. Intensity of adoption is refers to the level of adoption of a given technology. In this study, intensity of adoption for malt-barley refers to the amount of input applied per ha for a given technology.

Participatory varietal selection, trail adaptation, demonstration, promotion and adoption are the key procedures for malt-barley production. Producing of malt-barley has both a private benefit and societal profit. There are some evidences for a comparative advantage in production of malt-barley grain in Ethiopia. The total capacity of six breweries in Ethiopia is 2.7 million hecto-liters (HL) per annum. The amount of malt needed to produce is about 45,679 tons of malt at every year. Only 32.8 % of this demand was satisfied from domestic sources while the remaining quantity is imported from abroad. Thus, Ethiopia is spending over 120 million Birr to import this amount of malt every year. Many adoption studies have been conducted in different parts of the country at different times for various commodities and interventions. However, adoption of malt-barley technology has not been studied until these days. Therefore, this research was aimed at investigating the determinants and intensity of adoption of malt-barley technology. Studying of adoption on malt-barley technology provide insight for producers, researchers and development stakeholders who can offer alternative solutions for major constraints of the research findings.

2. Methods and Data

2.1. Sample Size and Methods of Sampling

The research design was non-experimental based on multi-stage sampling procedures. First, *Wogera* and *Debark* districts were selected purposively among the six malt-barely producer districts in North *Gondar* zone due to the fact that the potential of malt-barley production. *Wogera* and *Debark* are located at 40 and 100 km respectively from North *Gondar* to Northeast. Second, three peasant association, *Adisge Miligebsa* at *Debark*, and *Dabir Lideta* and *Ishak Debir* at *Wogera* district were selected purposively owing to production potential of the crop based on information from North *Gondar* Department of Agriculture and Rural Development.

In the third stage, households in the selected peasant associations' were listed and stratified in to adopters[1] and non-adopters of malt-barley technology. In the last stage, although an adequate size of sample observation for adoption studies is 80 to 120 [2]. Hence, 120 sample households were selected in systematic random sampling proportionality to size using the list of sampling frame from each categories of stratified unit. Sampled respondents of 39 and 81 were adopters and non-adopters respectively.

2.2. Data Sources and Methods of Data Collection

Both primary and secondary data were collected and used for this study. Secondary data were collected from different sources and offices who were supposed to have adequate information for this study. Primary data were collected from sampled respondent farmers on demographic, economical, social and bio-physical characteristics in which farmers operate and variables hypothesized to influence adoption and intensity of adoption in malt-barley technology. Structured interview schedule was pre-tested and necessary amendments were made prior to conducting the formal survey. Nine enumerators who had local knowledge and language were recruited and trained on methods of data collection prior to the actual survey. Subsequently, the survey was conducted under the close supervision of the researcher. Both qualitative and quantitative data were gathered from respondent farmers, development agents, community leaders and district agricultural experts. The survey was conducted from January to May; 2013. Collection of primary qualitative information was managed through five focused group discussions; fifteen key informants and direct observation.

2.3. Methods of Data Analysis

Descriptive statistics, inferential tests and econometric model were used for analysis to meet the objective of the study. Descriptive statistics such as mean, standard deviation, percentage and frequency were applied while Chi-square and T-test were used for discrete and continuous variables, respectively. Tobit econometric model and adoption index were applied to analyze the determinants and intensity of households' adoption in malt-barley technology respectively. Tobit model is an extension of Probit model developed by James Tobin in 1958 [5].

Probit model is estimating the probability of adoption as a function of other explanatory variables. The interest of Tobit model is finding out not only the probability of adoption but it can also indicate the intensity of adopters in malt-barley technology. It describe the relationship between a non-negative dependent variable Y_i and an independent variable (or vector) X_i. The dependent variable of the study was proportion of area under malt-barley technology in the total area of farmers' land holding sizes that represent the observed malt-barley. Tobit model is also known as censored regression model or limited dependent variable regression model because of the restriction put on the values taken by the regressand [6]. It is intuitively clear that if one estimates a regression line based on the observed values only, the resulting intercept and slope coefficients are bound to be different than if all the observations were taken in to account [5].

Tobit model is better to other dichotomous regression models (Logistic and Probit) in that the later only attempts to explain the probability of adoption of malt-barley technology of farm households rather than the intensity of adoption. Nevertheless, it may not provide enough information about the level of adoption index that farmers adopted it. A given farmer may adopt the technology with an application of minimum requirement of packages or some others may apply inputs as per the recommended once. Hence, the index ranges from 0 to 100%. Therefore, either Binary Logistic or Promit models couldn't examine the intensity of adoption of a given technology.

2.4. Specification of Tobit Model

Tobit econometric model was applied for analyzing explanatory variables of adoption and intensity of adoption as shown at equation (1).

$$\begin{aligned} Y_i^* &= \beta X_i + u_i \quad \mathrm{i} = 1, 2 \ldots \mathrm{n} \\ \mathrm{Y_i} &= \mathrm{Y}^* \mathrm{if}\ \mathrm{Y}^* > 0 \\ &= 0 \text{ if } \mathrm{Y}^* 0 \end{aligned} \qquad (1)$$

Where, Y_i is the observed dependent variable, in this case adoption of malt-barley technology. Y_i* is the latent variable which is not observable. X_i is vector of factors determining adoption of malt-barley technology and its intensity. β is vector of unknown parameters to be estimated and u_i is residual that are independently and normally distributed with mean zero and a constant variance .

The model parameters are estimated by maximizing the Tobit likelihood function of the following form [1,8]:

$$L = \prod_{yi^*>0} \frac{1}{\alpha} f\left(\frac{y_i - \beta_i X_i}{\alpha}\right) \prod_{y_i^*>0} F\left(\frac{-\beta_i X_i}{\alpha}\right) \quad (2)$$

Where f and F are respectively, the density and cumulative distribution functions of Y_i^*, $\prod_{y^*_{i\le 0}}$ means the product over those i for which $Y_i^* \le 0$ and $\prod_{y^*_{i>0}}$ means the product over those i for which $Y_i^* > 0$.

Thus, a change in X_i (exogenous variables) has two effects. It affects the conditional mean of Y_i* in the positive part of the distribution, and it affects the probability that the observation will fall in that part of the distribution. The software STATA was used to compute the Tobit econometric model. Many authors proposed the following techniques to decompose the effects of explanatory variables into adoption and intensity effects. Thus, a change in X_i (explanatory variables) has two effects.

1. The marginal effect of an explanatory variable on the expected value of the dependent variable is:

$$\frac{\partial E(Y_i)}{\partial X_i} = F(z)\beta_i, \quad (3)$$

where $\frac{\beta_i X_i}{\sigma}$ is denoted by z, Maddala [8].

2. The change in probability of adoption malt-barley technology, as independent variable X_i changes is:

$$\frac{\partial F(z)}{\partial X_i} = f(z)\frac{\beta_i}{\sigma} \quad (4)$$

3. The change in intensity of adoption with respect to the change in an explanatory variable among adopters is:

$$\frac{\partial E(Y_i / Y_i^* > 0)}{\partial X_i} = \beta_i \left[1 - Z\frac{f(z)}{F(z)} - \left(\frac{f(z)}{F(z)}\right)^2\right] \quad (5)$$

Where, F(z) is the cumulative normal distribution of Z, f(z) is the value of the derivative of the normal curve at a given point i.e. unit normal density, Z is the z-score for the area under normal curve, β is a vector of Tobit maximum likelihood estimates and ∂ is the standard error of the error term.

2.5. Intensity of Adoption

Intensity of adoption of malt-barely technology for those of adopters can be computed using the following formula considering five package components. The adoption index of individual farmers can be computed:

$$AI_i = \sum\left[\left(\frac{AT_i}{RT_i}\right) IS_i\right]$$

Where AI_i is adoption index of i^{th} farmer, AT is the level or quantity of input the farmer actually applied, RT is the recommended level or quantity of an input he ought to apply, IS_i is the proportion of score attributable to a particular input (as given by percentage for each innovation). After summing up for all the elements of the package of recommendations, a maximum obtainable adoption score is fixed at 1 or 100% [15]. Based on the above general formula, the following specific formula was applied for this study:

$$AI_i = \sum_{j=1}^{m} \left(\frac{CL_{ji}}{TLji} + \frac{WA_{ji}}{WRji} + \frac{CA_{ji}}{CR_{ji}} + \frac{FA_{ji}}{FR_{ji}} + \frac{SA_{ji}}{SR_{ji}}\right)$$

Where

AI = adoption index of the i^{th} farmer, i= 1, 2, 3….n; n is total number of farmers

j= 1, 2, 3… m; m is total number of hectare of grown crops

CL= cultivated land and TL= total land

WA= weeding applied and WR=weeding recommended

CA= cultivation frequency applied and CR= cultivation frequency recommended

AF= Amount of fertilizer applied per ha and RF= Amount of fertilizer recommended per ha

AS= Amount of seed rate applied per ha and AS= Amount of seed rate recommended per ha.

2.6. Definition of Variables and Working Hypotheses

The dependent variable is adoption of malt-barley technology measured in adoption index. Different empirical studies expressed adoption in ratio, index, percentage or log form depending on the purpose of the study. For instance, Tiamiyu, *et al.* [15] used adoption index in their study on "Technology Adoption and Productivity Difference among Growers of New Rice for Africa in Savanna Zone of Nigeria". In this study, adoption of malt-barley technology was taken as a dependent variable. Farmers' decision to adopt and the intensity of adoption in a given period of time was hypothesized to be influenced by various factors in which farmers produce improved seed varieties and those selected variables are presented as follows:

Sex of household head (SEXHH): It refers to a biological nature of human being of maleness or femaleness of the head of the household having a binary value. If the household head is male, it takes a value of 1; 0 otherwise. Due to various reasons such as access to information, land, improved seeds and credit men are better adopters of technologies than women. Therefore, it is expected that male household head is positively influence adoption and the extent of use of malt-barley technology.

Age of the household head (AGEHH): It is a continuous variable measured in years along with hypothesized as a factor for a given technology to adopt it. Younger farmers may adopt newly introduced technologies and ideas than older farmers.

Educational status of household head (EDUHH): It is a categorical variable represented as no education, primary, secondary and tertiary level of the household heads. Theoretically education increases the probability that household's adoption of technologies. It was therefore expected to influence adoption and intensity of adoption of malt-barley technology positively.

Total family size (FAMSIZE): Size of family is a continuous variable measured in numbers of members who are living within the family and hypothesized that if farmers have large family size may adopt the technology better than small family size.

Land holding size (LANDSIZE): The size of land holding of respondents measured in hectare represented as a continuous variable. The size of the land holding of the household is an important variable influencing the decision of adoption whether a farmer adopt malt-barley or not. The probability and intensity of adoption of malt-barley has a positive correlation with size of land holding. It was, therefore, hypothesized that as the size of the land increases, the probability and intensity that the farmer adopt a given technology was expected to increase. However, large farm size made low adoption in Vietnam according to the findings of Chi and Yamada [3].

Number of oxen owned (OXEN): It is a continuous variable that refers to the number of oxen the respondents owned measured in tropical livestock unit. It is the most important factor to cultivate the land of malt barley technology. If framers have more number of oxen, they can cultivate and produce malt-barley and influence adoption positively.

Off-farm/non-farm income (OFFARM): Income is a continuous variable measured in Birr. Households may earn income from various sources in addition to revenues from their land they have. Thus, it was hypothesized that off-farm/non-farm income influence adoption of malt-barley production positively.

Access to credit (CREDIT): This is a dummy variable that takes the value of 1 if the household is accessible to credit and 0 otherwise. Credit is considered as an important source of investment and households who have better access to credit can have better adoption decision. However, small holder farmers are not affordable unless they are supported with loans. Hence, credit was hypothesized as positive influential factors towards adoption of malt-barely technology.

Access to improved seed varieties (SEEDVAR): Access is a dummy variable whether farmers are accessible to improved seed varieties they need or not. It has a value of 1 if the farmer is accessible to improved seed and 0 otherwise. It was preferred only taking accessibility of improved malting barley seed varieties for this study.

Contact with development agents (CONTDA): It is the frequency of contact of development agents with farmers to access technical support, training, supervision and other extension services. It was treated as a categorical variable. Contacts between development agents and farmers increase the probability of adopting of new technologies increases. Hence, it was hypothesized that it would have positive correlation with adoption of malt-barley technology.

Distance of households' residence to the market (MARKET): Distance is a continuous variable measured in hours and refers to place of the farmer's house from the market. Proximity of the market from their residence determines for their input to purchase and sell their produce. It was therefore, hypothesized that as the farmer is closer to the market, the higher will be the chance to adopt the technology. It also enables farmers to access more information at the market place.

Participation in training (TRAIN): Training is one of the means by which farmers acquire new knowledge and skill. It is a dummy variable which have a value of 1 if the famer had been participated in training at least once in the last three years and 0, otherwise. Hence, participation in training is expected to positively influence in adoption of malt-barley technology.

Social status of the household head (SOCIAL): Social status refers to the leadership position in formal or informal organization or institution in the community. It is a dummy variable that takes the value of 1 if the household head is socially participated at least in one of various social statuses and 0 otherwise.

3. Result and Discussion

3.1. Descriptive Statistics

Table 1. Value of explanatory variables between adopters and non-adopters

Variable	**Adopters (N=39)** Mean	**Non-adopters (N=81)** Mean	**t-value /** X^2	**Sig. value**
Age of the HH in years	43.05 (12.25)	42.41(13.29)	0.25	0.803
Total family size	6.79 (2.17)	5.92(2.21)	2.02	0.045
Total land holding in ha	1.33 (0.76)	0.94(0.70)	2.79	0.006
Oxen owed in TLU	1.02 (0.84)	0.7 (0.69)	2.21	0.029
Off-farm/non-farm income in birr	1.57 (3058)	6.79(2307)	1.76	0.081
Market distance in hours	15.83 (8.07)	14.30 (7.05)	1.06	0.293
Sex of household head$^+$			0.22	0.486
Educational status $^+$			23.77	0.005
Access to credit$^+$			22.71	0.000
Access to improved seed$^+$			35.7	0.000
Contact of development agents$^+$			30.38	0.000
Participation in training $^+$			53.49	0.000
Social status of household head$^+$			33.59	0.009

Figures in parenthesis refer to standard deviation; + refers to discrete variables.
Source: Own Survey, 2013.

Sex of households: The distribution of respondents indicate that out of 39 adopters 2 females and 37 males were included while among 81 non-adopters 6 females and 75 males were drawn in. In many studies [11,16] including this one, participation of female headed household were very low

Family size: Above 60 and less than 15 ages were about 45% while people with active labor force were about 55%. About 52.6% and 47.4% respectively, the total female family members were greater than that of male family members. An average family size of respondent farmers was about 6.2. Adopters had an average family size of 6.8 while non-adopters had 5.9. At this point, there are two connotations. First, in the study area there is high fertility rate. Second, adopters had more family members than their counter parts. An inferential statistics of independent T-test also showed, there was significant difference between adopters and non-adopters (t-value =2.02; $p<0.05$).

Land holding size: An average land holding size of malt-barley adopters had more land (1.33 ha) per household than non-adopters (0.93 ha). The average landholding of adopters in malt-barley production is significantly larger than households of non-adopters (t-value = 2.788; $p<0.01$). This result showed landholding size of the sample respondents significantly influenced their decision of adoption in malt-barley technology.

Oxen possession: Adopters had greater oxen than non-adopters in possession with mean value of 1.02 and 0.70 respectively and a mean difference was significance at 10% probability level (t-value = 2.211; $p< 0.05$).

Off-farm/ non-farm income: Although 59% and 83% adopters and non-adopters were not involved in such activities, it is statistically significant at 10% (T-value 1.758; $p<0.1$).

Educational status: About 18% of adopters and 56.8% non-adopters were not literate respectively. It implies that 82% of adopters and 43.2% of their counter parts were literate. The figure also showed that about 44% of the total farmers in the study areas were not educated at least in elementary schools. About 51.6% and 4% were literate in elementary and high school levels respectively. Educational status was significant at (X^2=23.77; $p<0.01$) 1% probability level. This result is consistent with the findings of Chi and Yamada [3].

Access to credit: About 84.6% adopters had access to credit while the rest were not accessed to it. About 38.3% of non-adopters were accessible for credit while 61.7% were not accessible. Overall about 53.3% of respondents were accessible for credit. Almost 95% of adopters and 37% of non-adopters were accessible for malt-barley technology. It was highly significant at (X^2=22.71; $p<0.001$) 1% probability level.

Access to improved seed varieties: The more access for improved seed varieties is the better decision of adoption. Chi-square result showed that it is significant at 1% probability level (X^2= 35.7; $p<0.001$).

Contact with development agents: Frequency of contact with development agents was made as categorical or discrete explanatory variable and the result demonstrated that this variable was statistically significant at (X^2=30.38; P=0.001) at 1% probability level.

Participation in training: The result of chi-square is significant at 1% probability level (X^2 =53.49; $p<0.001$). Trainers at peasant association level were experts from district agricultural office, development agent, and other non-governmental organizations.

Social status of household head: As Chi-square test showed that it was significant at 5% X^2 = 33.594; $p<0.01$) at 1% probability level.

The result of descriptive statistics indicates that male farmers were participated more than female headed households. Adopters had more average family size (6.8), land size (1.33ha), and oxen possession than non-adopters. In addition, adopters were more accessible for credit, training, contact with development agents and improved seed varieties than their counterparts. Therefore, household physical asset is an influential factor for adoption of technologies. The result obtained from key informants, group discussion and personal observation substantiated descriptive statistics. Farmers who have large family size specifically more active labor force and outsized farm land either their own or rented in are the base of livelihoods which contribute for food security.

Table 2. Descriptions and values of variables in the model

variables	Values and its description	Types of variables
Dependent variable		
Y1=MALTADOP	Adoption of malt-barley technology (Index)	Continuous
Explanatory variables		
X1=Education (EDUHH)	Educational status (years)	Categorical
X2=Family Size(FAMSIZE)	Total family size of the household (number)	Continuous
X3=Farm Land Size (LANDSIZE)	Farm land size of the household (ha)	Continuous
X4=Oxen ownership (OXEN)	Oxen possessed (TLU)	Continuous
X5=Off-farm/Non-farm income (OFFARM)	Income earned in off-farm/non-farm activities (Birr)	Continuous
X6=Access to Credit (CREDIT)	Use value 1 if the response yes, 0 otherwise	Dummy
X7=Access to improved seed variety (SEEDVAR)	Use value 1 if the response yes, 0 otherwise	Dummy
X8=Contact with development agents (CONTDA)	Use value 1 if the response yes, 0 otherwise	Dummy
X9=Participation in Training (TRAIN)	Use value 1 if the he/she trained , 0 otherwise	Dummy
X10=Social Status of the Household head (SOCIAL)	Take value 1if he/she participated, 0 otherwise	Dummy

Source: Own survey, 2013.

3.2. Econometric Analysis

Descriptive statistics explained main differences between adopters and non-adopters in malt-barley technology. However, results showed that averages in groups. Therefore, it needs a precise figure for those significant variables. Consistent values for determinants and intensity of adoption in malt- barely technology, an econometric model was applied. This is to identify important explanatory variables that affect smallholder farmers' decision to adopt and intensity of adoption in malt-barley technology.

3.3. Determinants of Adoption of Malt-barley

The Tobit model estimated results of explanatory variables that were expected to determine the probability of households' adoption in malt-barley technology. Prior to running the model, the presence or absence of multi-collinearity was checked using variance inflation factor for continuous and contingency coefficient for discrete explanatory variables. Hence, ten variables were entered to the model and four variables were found to significantly affect adoption at different probability levels. Social status, access to improved seed varieties, participation in training and educational status of the household head were found to be significant determinants affecting the probability and intensity of adoption in malt-barley technology. These significant explanatory variables are presented (see Table 3).

Table 3. Maximum likelihood estimates of Tobit model

Variable	Coefficients	Standard error	t-ratio	Exp(β)
EDUHH	0.06190	0.02379	0.89**	0.9399
FAMSIZE	0.01866	0.02108	0.13	1.0188
LANDSIZE	0.00850	0.06480	-0.08	1.0085
OXEN	-0.00527	0.06383	-0.08	0.9947
OFFARM	-0.00002	0.00001	-1.45	0.9999
CREDIT	0.10093	0.13459	-0.75	1.1061
SEEDVAR	0.47332	0.14077	3.36***	1.6053
CONTDA	-0.01178	0.03039	-0.39	0.9882
TRAIN	0.81599	0.13461	6.06***	2.2614
SOCIAL	-0.00361	0.01363	-2.65***	0.9963
Constant	-0.17706	0.35548	-0.50	0.8377

Log likelihood ratio=-64.94 and Pseudo R^2= 0.4426

, * represent probability level at 5% and 1% respectively

Source: Own survey result, 2013.

Educational statuses significantly affect the likelihood of adoption of malt-barley technology in the positive direction at 5% significance level. The result showed as education increase by one level the household head would increase the probability of their adoption by 6%. Household heads with high level education have better probability of adopting malt-barley technology than non-adopters as shown above (Table 3).

The probability of adoption and of use of malt-barley technology tends to increase with increase in access of improved seed varieties (significant at 1% level). Improved malt barley seed varieties were significantly influence adoption of malt-barley technology as it has been hypothesized in prior. The result of regression analysis revealed that as the access of improved seed increase, the probability of adopting of malt-barley technology increases by 60%. It indicated that access to improved seed varieties is the crucial determinant for adoption of malt-barley technology. From this result it can be assured that those farmers who have access to improved seed technology were more credible to adopt improved malt barley technology than those who have no access to it. This result is consistent with the findings of Mulugeta [11].

The result of Tobit regression analysis pointed out that training of farmers in relation to malt- barley technology enabled them for making decision of better adoption. As the frequency of training increases by one, the odds ratio of adoption increases by 126%. It implies that training is very important factor that influence adoption of malt-barley technology and it is significant at 1% probability level.

Although social status of the household head was hypothesized as a positive determinant variable, the result of regression analysis showed negative correlation. The figure indicated as participation for social status increases by one, the probability of adoption decrease by 0.4%. The probable reason may be as far as the farmer devoted and involved in social, managerial and political activities in a given community, it hindered the production possibilities of malt-barley technology which results in low adoption rates.

3.4. Intensity of Adoption in Malt-barley Technology

Intensity of adoption was computed by taking five major package components or activities for malt-barley technology. Area under cultivation, weeding frequency, cultivation frequency, seed rate and rate of fertilizer application were taken for the purpose of computing adoption index. Adoption quotient of each practice was calculated by taking the ratio of the actual applied rate to the recommended rate of practices that indicated the extent to which an individual farmer had been adopted malt-barley technology. The result is shown below (Figure 1).

Adoption index is used to categorize adopters into different levels as low, medium and high. The actual adoption index score ranges from 0 to1. An index score 0 implies that non-adopters who were not used malt-barley technology or he/she might produce for one to two years and may not continue. An index 1 indicates adopters who were applied all practices according to scientific recommendations. The result revealed that 5% of farmers were adopt the technology with an adoption index of less than 0.7 (70%) while 46% of farmers were adopt the technology with an adoption index of 0.71 to 0.80 (71-80%). About 41% of farmers could adopt the technology in 0.81 to 0.90, and about 8% of farmers were applied the technology with an index of 0.90 to 1.00. This group of farmers is referred as innovators. It showed that almost all adopters were used the technology successfully.

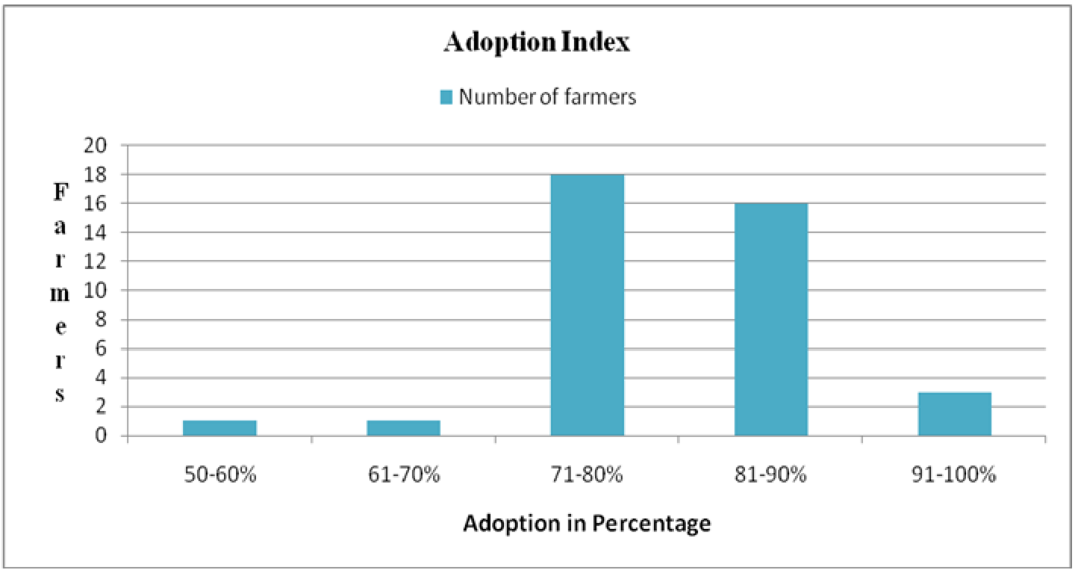

Figure 1. Intensity of Adoption; Source: Own survey result, 2013

4. Conclusion and Implications

Malt-barley is a commercial commodity which renders greater advantage of production potential and marketing opportunities. Despite many research studies have been conducted, the extent to which farmers have been adopted these technologies and intensity of their uses has not been studied. This finding showed that the crop has been produced for about ten consecutive years though it has been produced in small number of hectare of land at highlands of North *Gondar*. The demand and supply side of malt-barley production was not harmonized i.e. there is a high demand of malt for breweries at low level of supply due to this fact malt has been imported from abroad. Improved seed variety, educational status and training influenced adoption of malt-barley technology significantly and positively.

Analysis of the surveyed data showed for farmers to be the best producers not only improved seed varietal selection but frequency of cultivation, weeding and fertilizer application also determines their adoption level and production system. By and large, institutional arrangements are the basis of malt-barley production by which input accessibility could be addressed. Furthermore, farm management of farmers is paramount important consideration for malt-barley production. As policy implications, study on comparative advantage of the crop and institutional linkages are identified gaps that need to be carried out for further studies.

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