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DETERMINANTS OF SMALLHOLDER TEFF FARMER'S ROW PLANTING TECHNOLOGY ADOPTION IN SOUTHERN ETHIOPIA, IN CASE OF DUNA DISTRICT IN HADIYA ZONE

Negese Tamirat[1]
Department of Economics, Jimma University, Jimma, Ethiopia
Email: negesefb@gmail.com; Tel: +251954608773

Abstract: *This study was conducted in Duna district, Hadiya Zone, Southern Nations Nationalities and Peoples Region (SNRS). The aim of the study was to identify factors affecting adoption of teff row planting technology among farmers in the study area. To achieve these objectives, six teff producing kebeles among the seventeen teff producing kebeles were selected and a total of 355 rural small sample farm households were selected. Selected households were interviewed to generate primary data in 2019. Both descriptive statistics like mean, standard deviation, percentages and frequency distribution, and binary logit model were employed to determine factors that influence the adoption of row planting technology behavior of farmers. A sum of eleven independent variables for the binary logit model was used, out of which seven variables were found to significantly influence the adoption of row planting technology of teff crop. These are: sex of household head, education of household head, family size of household head, holding of livestock, use of credit, extension services access and attending farmers' training center. The study recommends that any effort in promoting row planting technology of teff crop production should consider the social, economic, institutional and psychological characteristics for better adoption of row planting teff crop production technology.*

Keywords: Adoption, Production, Teff, Row Planting Technology, Binary Logit Model

1. INTRODUCTION

Agriculture has been and continues to assume center stage in economic policy of many Less Developed Countries (LDCs) in general and Sub-Saharan Africa (SSA) in particular. Consequently, growth in the agricultural sector has been critical to achieving poverty reduction

and income growth creating spillover effects to the remaining sectors [1]. However, production and productivity of the agricultural sector in SSA and much of the developing world is generally low due to poor technological adoption [2 - 4]. Agriculture is by far the largest sector of Ethiopia's economy serving as a basis for the country's food security and source of livelihood for over 80% of its people. The sector accounts for about 50% of the Gross Domestic Product (GDP), 90% of the total export revenue, 85% employment of the country's labor force and accounts 70% of raw materials requirement of the country's industries [5]. Consequently, it has been the core element of the country's Agriculture Development Led Industrialization (ADLI) strategy for many years [6].

In mindful of poor agricultural performance problems such as subsistence oriented, rain fed, traditional farming practices, reduced soil fertility, unreliable climatic conditions, poor infrastructure, environmental degradation and land scarcity; the government of Ethiopia launched a strategy which is known as the Agricultural Development Led Industrialization (ADLI) in 1993 that sets out agriculture as a primary stimulus to generate increased output, employment and income for the people and as the spring board for the development of the other sectors of the economy [7]. Following ADLI, one of the major programs formulated by the Ethiopian government is the national extension package program known as Participatory Demonstration and Training Extension System (PADETES). The promotion campaign was rolled out in different phases. In 2011, the Ministry of Agriculture (MoA), with the support of the Agricultural Transformation Agency (ATA), provided this package and extension to 1,400 farmers. On-farm experiments were done in 90 Farm Training Centers (FTC) at the local, kebele administrative level in the four main teff producing regions of Ethiopia of Tigray, Oromia, Amhara and Southern Nations, Nationalities, and Peoples (SNNP). The results of this promotion drive an increase of 75% in teff yield [6]. In 2012, this experiment was extended to almost 70,000 farmers from 1,337 FTCs. Data collected from 15,800 households that participated in this "pre scale-up" phase indicated that teff yields had increased by 70% over the national average [8]. In 2013, the program was rolled out nationwide to reach 2.5 million farmers.

Teff is Ethiopia's most important staple crop and it has the largest value in terms of both production and consumption in Ethiopia, and the value of the commercial surplus of teff is

second only to coffee [9], but national average product levels are low. It is mainly characterized by rain fed, subsistence oriented, smallholder production system and traditional farming practices. Teff is used in Ethiopia to produce the nation's staple dish enjera and is also used to brew local beer. It has high protein; fiber and complex carbohydrates content, relatively low-calorie content, and are gluten free [6].

Broadcast planting method is the most widely employed practice among smallholder farmers in Ethiopia. These method of seed by hand at high speed a practice with potentially low productivity. In particular, broadcasting seeds is likely to lead to a fall in yield due mainly to the difficulty in hoeing and hand weeding; and the competition with weed resulting from the uneven distribution of the seeds. Teff is among the crops commonly cultivated using the broadcast planting possibly explaining the considerably low levels of yield associated with teff production. Consequently, adoption of row planting technology could be quite beneficial in terms of enhancing the productivity and yield levels. Such planting technologies allow for reduced seed rate along with increased space between seedlings, which in turn have been shown to achieve important production increments over broadcasting sowing. More importantly, the technologies allow for better weeding, decreased competition between seedlings, and better branching out and nutrient uptake of the plants [10 & 11].

The adoption of row planting teff crop technology enhances agricultural productivity and improve environmental sustainability is instrument for achieving economic growth, food security and poverty alleviation in study area and as well as the country. The row planting technologies are often adopted slowly and several aspects of adoption remain poorly understood despite being seen as an important route out of poverty in most of the developing countries [12]. Despite the significance of teff in the livelihood of many small farm households and income generating teff crop in the study area, it is only recently that few studies have been done on teff. However, most of these studies have focused on marketing and were limited to a specific area and production aspects. Systematic and adequate information on the process of adoption of teff production technology not well identified. Further, in the study area there is no empirical study conducted on determinants of adoption teff row planting technology. Therefore, this study was conducted to assess factors affecting adopting teff row planting technology in Duna Woreda.

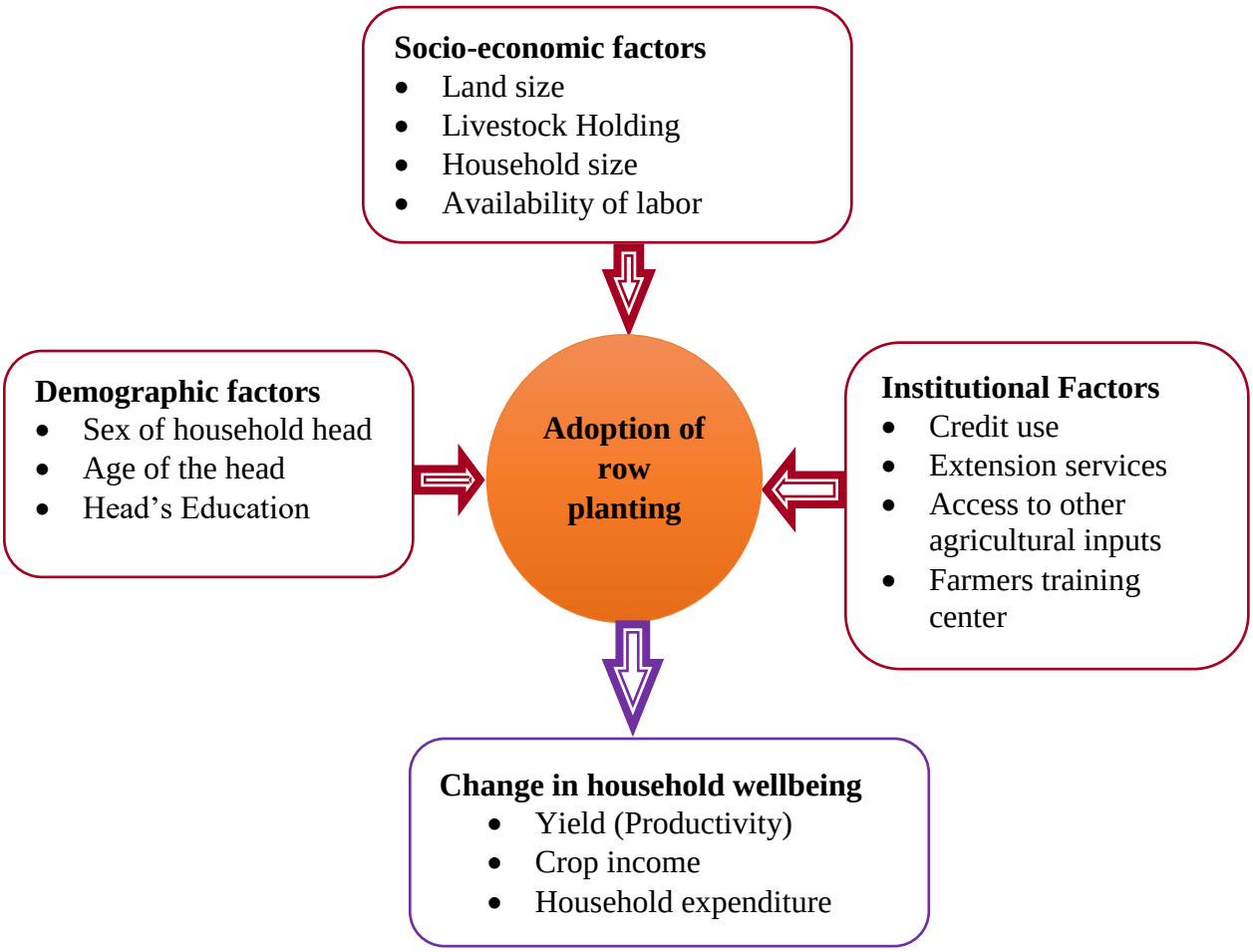
2. LITERATURE REVIEW

Factors determining adoption of row planting technology of teff crop can be categorized as institutional, demographic, economic and social factors. There is a growing body of literature focusing on factors affecting adoption of agricultural technology of teff crop productivity [13], revealed that socio-economic factors, institutional, demographic and social factors affecting adoption of agricultural technology of teff crop yield. Several adoption research findings have pointed to the fact that [14], in Ghana using logit model who found that, cultivated land size, access to credit services, and extension services significantly influence technology adoption decisions of small farm households in Ghana. [15], small farm management practices and improved agricultural technology positively affect the probability of participation in an agricultural extension program. [16] in Uganda panel data using probit model, shows that small farm household heads with low educational level and small land holdings are less likely to adopt improved agricultural technology. In particular, numerous studies have been conducted focusing on the factors affecting adoption of row planting technology of teff crop. Part of the literature has focused on specifically teff cultivation [17 - 18, 6] factors like us Sex of household head, Family size of household head, Level of education of households, Livestock ownership, use of credit services, recommended agricultural input, Availability of farm labor, Extension services, and Attending training at TFC affects adoption of row planting technology of teff crop.

Our estimation strategy was guided by the conceptual framework. Accordingly, households' decision to adopt agricultural technologies is affected by a number of factors. Demographic characteristics like sex of household head, age of household head and education level of household head; socio-economic variables like family size of household head, livestock ownership and family labor of household head; institutional variables like extension service accesses, use of credit, use of recommended agricultural inputs and Farmers training center are some of the factors documented in extant literature as key determinants that influence adoption of row planting teff crop technology. Adoption of row planting technology in turn enhances farmers' teff crop productivity and hence increase farmers' teff crop income. The conceptual

framework presented, the inter-relationship among them expected to influence the intensity of adoption of row planting teff crop technology in the study area.

Figure 1: Conceptual framework (based on literature)



3. METHODS

3.1 The study area

The study was conducted in Duna Woreda, located in the South Nations, Nationalities, People's Region (SNNPR) of Ethiopia. Duna Woreda is one of the 11 Woredas of Hadiya Zone and geographically located between 7 ^{0} 37′19′′ N latitude and 37 ^{0} 37′ 14′′E longitudes. The total population of the Woreda is 148,566, of which 75,383 (50.74%) is male and 73,183 (49.26%) is female. The total number of household in the Woreda is 18,752, majority of which (18,109 (95.57%) are male headed and 643 (3.43) are women headed households. The Woreda has an agriculturally suitable land in terms of topography. Agroecologically, the Woreda is classified into three zones: Dega (55%), Weina Dega (10%) and kola (35%). The annual rainfall varies from 1500 mm to 1896 mm. The area receives a bimodal rainfall where the low rains are between March and April while the high rains are from July to September. The large part of Duna Woreda topographically falls within the southeastern highlands of Ethiopia, the elevation within the Woreda ranges from 2,970m mean sea level Sengiye which is the highest mountain in Hadiya Zone and 1000m mean sea level at the wagabata above which is the lowest place in the Woreda. The average elevation of the Woreda is taken as to be 1985m from the mean sea level.

For the majority of the farm households in the Woreda, agriculture is the crucial source of income for their livelihood. More than 95% of the population depends on the agricultural sector for their livelihood with the traditional farming system. Agriculture is dominated by subsistence farming were limited usage of improved agricultural technologies such as row planting technologies and recommended agricultural inputs, which significantly limits teff crop yield. Duna district was considered appropriate for the study for many reasons. First, Duna Woreda is one of the districts with a high potential for teff production. Secondly, it is one of the districts where row planting technology has been introduced and well under implementation for teff production. There are also strong research and extension interventions embracing teff producers in the Woreda. Moreover, newly released improved teff varieties and teff row planting techniques were relatively widely disseminated and practiced in this Woreda.

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3.2 Sampling Techniques

The study applied both non-probability and probability sampling techniques to select the sample from a given population. Take into account the resource available, from 17 teff producers and adopters of teff row planting technology rural kebeles of Duna Woreda; six kebeles (Balija, S. Wagabata, L. Wagabata, H. Wagabata, Mish Duna and Olawa) were selected based on their agro-ecological zone compared to the remaining kebeles of the Duna Woreda. The sample size was determined based on the simplified formula given by [19]. Where n = the sample size, N = the population size, and e = the level of precision. N= the total number of households in the selected Kebeles (3200 HHS), and e= acceptable error margin 5%. Based in this, the required sample size was determined as follows:

$$n = \frac{N}{1+N(e^2)} = \frac{3200}{1+0.05^{*}0.05^{*}(3200)} = 355$$

The required sample size was 355 and to select from each stratum groups, the study used proportionate selecting producers; Out of total selected 355 sample size, 200 non row planters of teff crop and 155 row planters of teff crop sample small farm household were selected. How it would be selected in proportionally farm household sample size from each stratum group stated in the (table 1).

Table 1: Distribution of sample size by kebele and adoption status

Kebele	Number of households (N_i)	Probability Proportional Sample (PPS) Size				
		Adopters		Non- adopters		Total Sample (n_i)
		N_a	n_a	N_{na}	n_{na}	
Balija ($Kebele_1$)	562	262	28	300	34	62
S. Wagabata ($Kebele_2$)	510	230	25	280	32	57
L. Wagabata ($Kebele_3$)	530	240	26	390	33	59
H. Wagabata ($Kebele_4$)	540	240	26	290	33	59
Mish Duna ($Kebele_5$)	505	230	26	275	32	58
Olawa ($Kebele_6$)	553	258	27	295	33	60
Total	3200	1460	155	1740	200	355

Source: own computation based on data (2019); n_i= total number of households selected from kebele I (I = 1, 2, 3, 4,5,6); N_i= total number of households in kebele i; N_a = Total number of adopters; N_{na}=Total number of non-adopters; n_a = adopting households selected; n_{na} = non-adopting households selected

3.3 Data Collection

The data for study was collected from both primary and secondary sources. Cross-sectional data was collected from the survey of randomly selected sample farmers. For the primary data collection, specifically designed and pre- tested questionnaire based on the objective of the study, and trained data enumerators was used. The questionnaires schedule was tested at 24 randomly selected farm households in the study area. Both quantitative and qualitative information were collected. The data collection included households' demographic and socioeconomic characteristics (family sizes, age and sex structures, education, etc), land holding (agricultural, grazing, teff land, and others), farm inputs utilization (seeds, fertilizers, herbicides and fungicides, labor utilization, credit, extension services), farm outputs, input and output prices, agronomic practices including crop rotation, teff row planting and its inputs and output, and etc. Secondary information like population number, agricultural inputs and outputs, farm use pattern, rainfall amounts (annual mean and cropping season), temperature and agroecology, etc were also collected. The survey was carried out in the months of May and June 2019.

3.4 Binary logistic regression model

The logistic function was invented in the 19th century for the description of the growth of populations and the course of autocatalytic chemical reactions, or chain reactions [20]. Binary logistic regression was incorporated to analyze relationships between a dichotomous dependent variable and independent variables. Our focus here was on binary logistic regression for two groups. Logistic regression combines the independent variables to estimate the probability that a particular event will occur that is a subject will be a member of one of the groups defined by the dichotomous dependent variable. Logistic regression is fitted using method of planting as dependent variable, the listed socioeconomic variables as explanatory variables which is assumed to determine practice of teff row planting and teff productivity, and it would be used to

identify the factors that determines the farmers' adoption status. The response variable is binary, taking values of one if the farmer adopts and zero otherwise. However, the independent variables are both continuous and discrete.

The justification for using logit is its simplicity of calculation and that its probability lies between 0 and 1. Moreover, its probability approaches zero at a slower rate as the value of explanatory variable gets smaller and smaller, and the probability approaches 1 at a slower and slower rate as the value of the explanatory variable gets larger and larger [21]. The function form of model is specified as follows:

$$P=E(Y=1/Xi) = \frac{1}{1+e^{-(\beta o+\beta i Xi)}} \quad \text{.....(1)}$$

This will be writing as follows, z_i is equal to $\beta_0 + \beta_i X_i$

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

$$1 - P_i = \frac{1}{1+e^{zi}} \quad \text{.....(3)}$$

The probability that a given household is row planter of teff is expressed in equation two, while the probability for a non-row planter of teff is expressed in equation three.

Therefore, we can write as

$$\frac{P_i}{1-P_i} = \frac{1/1+e^{-zi}}{1/1+e^{zi}} = \frac{1+e^{zi}}{1+e^{-zi}} = e^{zi} \quad \text{.....(4)}$$

The ratio of the probability that household is row planter to the probability of that it is a non-row planter of teff.

$$L_i = \ln \frac{P_i}{(1-P_i)} = z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \quad \text{.....(5)}$$

Where, Z_i= function of explanatory variables (X), Bo= an intercept, B_1, B_2, B_3…… Bn are slope of the equation in model, L_i = log of the odds ratio = Z_i and X_i= vector of relevant characteristic or independent variables.

Table 2: List of explanatory variables used for the analysis

Definition	Type	Expected sign
Education level in years of schooling (years of school)	Categorical/dummy	+

Age of household head (years)	Continuous	-
Family size (number)	Continuous	+
Size of cultivated land (ha)	Continuous	+
Livestock owned (TLU)	Continuous	+
Participation in extension services (1 = Yes)	Dummy/binary	+/-
Availability of farm labor (1 = Yes)	Dummy/binary	+/-
Use of credit (1 = Yes)	Dummy/binary	+/-
Sex of household head (1 = Male)	Dummy/binary	+/-
Use of recommended agriculture inputs (1 = Yes)	Dummy/binary	+/-
Attending training at farmers training center (1 = Yes)	Dummy/binary	+/-

Source: own computation based on data (2019)

4. RESULTS AND DISCUSSION

4.1. Description of Teff Planting Methods

The number of sample farmers who practiced planting teff in a row was 45.32% while those who used the conventional planting method comprise 54.68% of sample farmers from the total randomly selected 355 sample farmers.

Table 3: Sample farm households by adoption status of teff planting method

Planting method	Frequency	Percent
Non – adopters	200	54.68
Adopters	155	45.32
Total	355	100

Source: own computation based on data (2019)

As regard to the age of household heads, average age of the sample household head was found to be 56.422 years where the minimum is 28 and the maximum is 81. The average sample household age of adopters of row planting is 53 and the corresponding figure for non-adopters of row planting is 57. The mean age difference between adopters and non-adopters of row planting is 4. The mean and stander deviation of household education were 2.149 and .878 respectively.

According to education level of the household heads majority sample household heads are literate. Regard to the family size of sample household heads family size ranges between 3 and 9. Average family size is 5.419 people per household heads. Average family size of household heads between adopters and non-adopters of row planting teff technology were 5.10 and 4.00, and difference between adopters and non-adopters of row planting of teff technology is 1.10. As regard to the landholding of the sample household heads varies from .125 ha to 3 ha with an average figure of 1.784 ha. The average livestock holding in Tropical Livestock Unit for the sample households (including cattle, horse, donkey, mule, sheep and goats, and chicken) was 7.798 TLU with the minimum and the maximum holdings of 7 TLU and 17.8 TLU respectively. Average livestock holding in Tropical Livestock Unit for adopters and non – adopters were 11.02 TLU and 8.32 TLU respectively.

Table 4: Summarized list of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Rpth	355	.473	.499	0	1
Sexh	355	.653	.476	0	1
Ageh	355	56.422	13.375	28	81
Edu	355	2.149	.878	1	4
Clsize	355	1.784	.854	.125	3
Fsize	355	5.419	1.367	3	9
Tlu	355	7.798	4.274	7	17.8
Usecrids	355	.588	.492	0	1
Rai	355	.532	.499	0	1
Afl	355	.616	.486	0	1
Atc	355	.578	.434	0	1

Source: own computation based on data (2019)

4.2 The Attitude of the farmer adoption of row planting

People have different attitude to do a certain task depending on their historical background, need for change; and social, economic and political environments. Program adopter households were

also having different motives to practice the row planting programs and even to select from the options available. Most adopters were, 95 percent of the households were participating in the programs because of the awareness creation activities carried out by the Woreda Officials, Agriculture and Rural Development officers and Development agents. About 5 percent of the households were also joined row planting technology because of the initiation and pressure created by their family members and neighbors. As adopters responds row planting of teff helped them to increase productivity and income of teff crop and to decrease amount fertilizers and seeds of teff.

The non-adopter households were forward different reasons for not participating in the row planting of teff. The reasons for 10% respondents were lack of personal interest to participate in row planting of teff, 38% respondents said our cultivated land is not suitable for row planting of teff due to logging water, hence we don't have confidence to sow the available land we have in row and 52% respondents said we don't have enough labor force, not suitable sowing and takes time. In finally they said that as much as possible government should support farmers by distributing row panting of teff machine to substitute labor force and to decrease time expense.

Main factors that affecting adoption of row planting of teff crop

Sex of household head: this variable is significant at 1% significance level and in terms of sex there is significant difference male and female in participating row planting of teff. Odds ratio is 3.051 (Table 5). Its implication is being other things constant; the male households are about three times more likely to participate in row planting of teff as compared to female household headed. The possible explanation is that female household head take many times to be awarded in new agricultural technology, because in the rural area in most of time women are expected to do homework rather others. Due to that they could not attend any administrative meeting in given kebele to get new information in aspect of any useful things.

Education level of household heads: this variable is positive relationship with row planting technology and significant at 5% probability level. Marginal effect is 0.03 (Table 5), that implies the being other things constant, as year of schooling of household head increased by one, the probability of household being row planter increase by 3%. Possible explanation is

education helps household to increase productivity through promoting awareness on possible advantage of modernizing agriculture and on working efficiency, diversify income, adopting new technology which are used to improve teff crop productivity and information from development agents. Therefore, educated is better to participate in row planting of teff than illiterate one.

Family size of household: this variable is positive relationship with row planting technology and significant at 5% probability level. Marginal effect is 0.080 (Table 5), that implies the being other things constant, as the family size of household head increased by one, the probability of household being row planter increase by 8%. This positive relationship tells us that a large number of family size of household heads more likely to participate in row planting technology as compared to household heads who have small family size. As household heads who have large family size were able to provide a large number of labors from their family members. Teff row planting technology require more labor in the production, to increase teff crop yields. This suggests that large family is the major variable in influencing decisions of households to participate in row planting teff crop technology.

Tropical Livestock unit (TLU): this variable is significant at 10% level of significance in odd ratio, robust and marginal effect' result. It has positive relationship with row planting of teff technology. As stated, (Table 5), marginal effect is 0.011 for tropical livestock unit implies that, other things kept constant, as the number of live stocks increase by one TLU, the probability of household being row planter increase 1.1%. That means specially having many oxen make him or her possible to participate in row planting of teff crop. It could also indicate that adopters have better access to financial source through sell of livestock which could be used to purchase farm inputs, such as seed and fertilizer, and livestock used for minimizing risk. The main reasons are household head that has many TLU will have high income and he/she will use his/her oxen for plowing so it is easy for them to participate.

Use of credit service: this variable is positively related with row planting technology and significant at 10% probability level. Its odds ratio is 2.00 (Table 5), The implication is that the result is expected since use of credit service is major source of income for agricultural input expenditure in the rural area, hence a household heads who got credit is about two times more

likely participate in row planting technology as compared to household heads who did not get credit. Small farm household heads who have the opportunity of getting credit for agricultural inputs, more participate than those who have no access. The possible explanation is that household heads who got credit; they would use row planting technology more easily to enhance households' teff crop yields.

Access to extension services: it is positively related with row planting teff technology. This variable is significant at 1% probability level. Odds ratio is 2.847 (Table 5), this is that a household heads who are involved in extension services is about two times more likely to participate in row planting teff crop as compared to household heads who are not involved in extension services. The main reasons for possible factor in farmers 'decision to participate in row planting technology and their level of production since farmers receive a number of services from extension services, including technical services on its production.

Attending farmers training center: this variable is positively related with row planting technology and significant at 1% probability level. Its odds ratio is 2.174 (Table 5). It tells us that the household heads who attend farmers training center are about two times more likely to participating in row planting of teff as compared to household heads who did not attend farmers' training center. The possible explanation is that attending farmers training center gives information on working efficiency and how adopt new technology which are used to improve teff crop production from development agents.

Table 5: Estimation result of teff production technology adoption binary logit model

Variable	Robust Coefficient	Odds Ratio	P>| z |	(dy/dx
AGEHH	-0 .002	0.989	0.698	-0.002
SEHH	1.106***	3.051	0.003	0.227
FSIZE	0.324**	1.383	0.020	0.080
EDU	0.130**	1.140	0.033	0.030
CLSIZE	3.563	35.288	0.305	0.886
TLU	0.046*	1.047	0.058	0.011

CRUHH	0.690*	1.994	0.087	0.170
RAI	0.542	1.720	0.163	0.127
AFL	0.173	1.189	0.703	0.040
EXTEN	1.046***	2.847	0.003	0.236
FTC	0.772***	2.174	0.006	0.181
Cons	-5.061	0.0064	0.000***	

LR chi2 (11)	61.50	Pseudo R2	0.354
Prob > chi2	0.000	Log likelihood	-87.75
Number of obs = 355	*** P < 0.01,	** P < 0.05 and * P <0.10	

Source: own computation based on data (2019). Inferential statistics (such as chi-square and t-tests) were employed to provide further insights on factors affecting households' adoption decisions.

Multi collinearity Test: Prior to running the logistic regression model to estimate propensity scores matching model, the explanatory variables were checked for the existence of severing multi collinearity problem. A technique of Variance inflation factor (VIF) was calculated to detect the problem of Multi collinearity among continuous explanatory variables. Accordingly, the VIF (Xi) result shows that the data had no problem of multi collinearity. This is because, for all continuous explanatory variables, the values of VIF were by far less than 10. Furthermore, correlation matrix shows that there is no high correlation between all explanatory variables. This also detects that there is no multi collinearity problem so that all the explanatory variables were included in the model.

5. Conclusion and Policy Implication

The objective of this study was to evaluate the factor that affects adoption row planting teff crop technology. Binary logit model and cross-sectional survey data were employed to attain the objective of the study. The study applied cross sectional household level data collected in 2018/2019 cropping season from 355 samples of small farm household. The main factors affecting adoption of row planting teff crop technology are the sex of household head, education of household head, family size of household head, holding of livestock, use of credit, extension services access and attending farmers' training center were found to be important variables to

determine farmers' tendency to adopt. Therefore, it is used to scaling up the best teff crop row planting technology and practices of the adopters to other farmers can be considered as one option while introducing new agricultural practices and technologies is another option.

Understanding the factors that hinder adoption of agricultural technology is essential in planning and executing technology related programs for meeting the challenges of teff production in our country. Therefore, to enhance row planting of teff adoption by farmers, it's important for policy makers and planners of new technology to understand farmers need as well as their ability to adopt technology in order to come up with technology that will suit them. It is better to encourage row planting technology adoption because the results of this study signified that application of row planting of teff increase substantially both the productivity and income of adopters.

The females should go in hand to hand with males to improve productivity and income of household. Ethiopia Federal Government said that without female participation, we cannot bring sustainable development and growth. However, in study area female households headed were less likely to participate in row planting as compare to male households headed. To reduce this problem, the local government should create the necessary awareness among the females rather than male still participation ratio become equal, relatively. The fact that, female household headed in Ethiopia lack the necessary means to get extension advices because they expended more time on non-marketable homework and not attended administrative meeting in their own area. Improved teff production technology involves the use of different practices, which require knowledge, and skill of application and management. Education was found to have a strong relation with the adoption of row planting of teff production technology as it enhances teff crop yields. Therefore, due emphasis has to be given towards strengthening rural farmer's education at different levels for small farm households using farmers training centers. Increasing the number of cooperatives organization in the rural area in which the farmers will be able to get credit are basis in enhancing the adoption of row planting teff technology. Further, it is apparent from the study that if farmers get credit more easily, they would use row planting technology to enhance teff crop yields. Thus, the credit facility should target poor farmers especially those who were not adopting the row planting technology due to lack of operating capital. This may

encourage the farmers to do commercial farming practice in which they can build their asset to implement the adoption of row planting of teff technology on their farms.

The agricultural research and extension activities need to consider additional agronomic practices along with the row planting method in order to increase teff production, and for the successful promotion, adoption and scaling up of good agronomic practices and extension should contact farmers individually as well as in group to be awarded in terms of row planting of teff is suitable to improve household production. In order to attain food security of the nation policy makers should devise more effective farmers' training mechanisms and provide more applicable teff production mechanizations effective on the process of teff production. The introduction of the above measures into the picture of technology adoption, therefore, could enhance the number of adopters and the cropped area under row planting technology. Hence, expansion in the level of technology adoption would consequently result in substantial teff productivity and income on a sustainable basis.

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