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Determinants of *Teff* Row Planting Technology Adoption: The Case of North Shewa Zone, Oromia National Regional State, Ethiopia

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ABSTRACT

Row planting is one of the technologies introduced in Ethiopia to improve production and productivity of the major crops. However, the rate of adopting the technology decline from time to time. Thus, this study aims to identify factors affecting adoption level and intensity use of *Teff* row planting technology in the selected districts of North Shewa Zone, Ethiopia. Multi-stage random sampling techniques were used to select 400 respondents. Adoption index, independent sample mean t-test, chi-square test and double hurdle model were used for data analysis. The results of adoption index reveals that among 400 sample households, 79.8% was non-adopter while 20.2% were adopter of *Teff* row planting technology. A total of 10 variables were hypothesized to affect the adoption level and intensity use of *Teff* row planting technology in the study area. Among these, 6 variables had significant effect on adoption level of *Teff* row planting technology while 4 variables had significant effect on the intensity use of *Teff* row planting technology. Accordingly, the experience of household in *Teff* production, education level of household head, family size, extension contact, credit utilization and demonstration site visit had positive and significant effect on the adoption level of *Teff* row planting technology adoption at 1, 1, 5, 1, 1 and 1% significance level respectively. Moreover, family size, education level of household head, frequency of extension contacts and demonstration site visit had positive and significant effect on the intensity use of *Teff* row planting technology at 10, 1, 1 and 1% significant level respectively. Hence, in order to increase the households' adoption level and intensity use of *Teff* row planting technology in the study area, strengthening the extension services, improving the education level of the households, strengthening the credit services and expanding the demonstration site should be the focus area of the policy makers.

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Introduction

The agriculture sector is the most important sector for sustaining growth and reducing poverty in Ethiopia. It accounts for 80% of employment, 90% of foreign exchange earnings and 38.8% of gross domestic c product (NBE, 2015). In spite of these contributions, this sector is characterized by low agricultural production and productivity (World Bank, 2016). Cereals, pulses and oil seeds are the major crops grown in Ethiopia. Among these, cereals were the major food crops in terms of the area coverage and volume of production obtained. Among cereals, Teff was dominant in terms of area coverage and second only to maize in production. Despite the large area coverage at national, regional and zonal level, the productivity of Teff was low (17.48, 17.88 and 16.61 qt/ha) respectively when compared to the recommended rate (CSA, 2017/18). Some of the factors contributing to low productivity of Teff were lack of high yielding cultivars, weed, traditional sowing methods and water logging (Hailu et al., 1992; Fufa, 1998; Vandercasteelen et al., 2013).

The demand for the crop has been increasing due to rapid population growth, urbanization and expansion of food processing industries (Dorosh and Rashid, 2013). The country is thus unable to meet the high demand and remains a net importer despite the potential to increase production (Rashid, 2010). The research systems together with other stakeholders have played a major role in delivering improved technologies for increasing productivity of crops in the country (Biftu et al., 2016). Efforts have also being underway by the national agricultural research system through which a number of technologies have been released for the farming community. In spite of these efforts, a productivity gain has not been impressive. One major factor contributing to low productivity of crops in the country in general and study area in particular was low adoption improved technologies (Hassen et al., 2012; Ahmed et al., 2014). As the resource endowment, agro-ecological setting, socio-economic and cultural characteristics of the farming communities vary from one area to another, the adoption decisions towards a given technology are also very variable. Therefore, this study identifies the determinants of adoption level and intensity use of Teff row planting technology in the study area.

Research Methodology

Sampling Techniques and Sample Size Determination

Multi-stage random sampling techniques were employed to select sample farmers. In the first stage, Hidabu Abote, Wera Jarso and Debra Libanos districts were purposively selected based on *Teff* production potential. In the second stage, two *kebeles* (the smallest unit of administration in the Ethiopian government structure) were purposively selected from each sample districts based on the *Teff* production potential. In the third stage, households' in the sample kebeles were proportionally distributed based on their size and randomly selected for interview. The sample size was determined by using Yamane (1967) formula.

$$n = \frac{N}{1+N(e)^2} = \frac{208{,}226}{1+208{,}226(0.05)^2} = 400 \qquad (1)$$

Where;
n = is sample size
N = refers to the total number of *Teff* producing farmers in the sample districts
e = is the desired level of precision (in this case 0.05)

Types of Data and Method of Data Collection

Both primary and secondary data were used. The primary data was collected through structure questionnaires. Besides, secondary data was gathered through reviewing records of published and unpublished documents. In addition, focus group discussion comprising of male and female, literate and illiterate, nearby urban and very remote farmers were conducted to supplement primary data.

Method of Data Analysis

Descriptive Analysis

Descriptive statistics such as percentage, frequency, mean and standard deviations were used to describe the demographic, institutional and socioeconomic characteristics of the respondents. In addition, inferential statistics such as t-test and chi-square test was used to compare socioeconomic, demographic and institutional variables between adopter and non-adopter of technology. Moreover, adoption index was used to measure adoption level of sample farmers'.

Adoption index (AI) is calculated by dividing area allocated for *Teff* production using row planting to total cultivated area for *Teff* production by the i[th] farmer. The rational for calculating adoption index is to identify households' adoption level of *Teff* row planting technology in the study area. Following the work of Alemitu (2011); Rahmeto (2007); Abraham and Tewodros (2014), adoption index for each sample farmer is calculated as:

$$AI_i = \frac{\text{Area under teff row planting technology}}{\text{Total area allocated for teff production}} \qquad (2)$$

Where;
AI_i = is adoption index of the i[th] farmer and
i = represent respondents (farmers)

After AI score is calculated for all sample farmers', respondents were classified into adopter and non-adopter of *Teff* row planting technology depending on their AI value. The actual adoption index score ranges from 0 to 1. AI score of 0 implies non-adopter while AI greater than 0 and ≤ 1 implies adopters of *Teff* row planting technology.

Econometric Analysis

After classifying sample farmers in to adopter and non-adopter of *Teff* row planting technology using adoption index, the next step is estimation of factors affecting adoption level and intensity use of Teff row planting technology. Previous studies were used econometric models like Tobit, Heckman two stage and double hurdle models to analyze factors affecting adoption level and intensity use of Teff row planting technology. However, likelihood ratio (LR) tests were conducted to identify the appropriate econometric model for the analysis. Following Greene (2003), the usual likelihood ratio (LR) test is specified as follow:

$$LR(\lambda) = -2\ln[L(H_o)] - \ln[L(H_1)] \qquad (3)$$

Where;
$L(H_0)$ −Denotes the likelihood function value under the null hypothesis H_0
$L(H_1)$ −Denotes the likelihood function value under the alternative hypothesis H_1

Thus, if the value of $LR\,(\lambda)$ exceeds the critical/tabulated X^2 statistic at 5% significance level, then the null hypothesis is rejected in favor of the alternative and vice versa.

The likelihood ration test result showed that, double hurdle model is appropriate for analyzing factors affecting adoption level and intensity use of Teff row planting technology (Table 4). Double hurdle model is specified as follow:

$$d_i = \begin{Bmatrix} 1, if\ d^*_i > 0 \\ 0, if d^*_i \leq 0 \end{Bmatrix} \qquad (4)$$

$$y_i = \begin{Bmatrix} y^*_i, if d^*_i > 0 \\ 0, if\ other\ wise \end{Bmatrix} \qquad (5)$$

Where;
$d^*_i =$ Represent a non-observable variable which determines whether the individual i is adopter or non-adopter of row planting technology
$y^*_i =$ Represent the value which corresponds to the latent variable

Results and Discussions

Descriptive and Inferential Analysis Results

Sex of household head

The result depicted in Table 1 shows about 22.49% and 77.51% was male headed adopter and non-adopter while about 85.59% and 14.41% was female headed non-adopter and adopter of *Teff* row planting technology respectively. This implies that male headed households are more adopter of *Teff* row planting technology than female headed. Moreover, the chi-square test result show that, sex of household head was statistically significant at 10% significance level. This implies that there was a significant relationship between being male headed and adoption level of *Teff* row planting technology.

Education level of household head

The result in Table 2 show that, the average education level of adopter and non-adopter household was 2.11 and 0.16 grade respectively implying that adopter households were attended more education than non-adopter. The independent sample t-test result also revealed that, there was a significance mean difference in education level between adopter and non-adopter households' at 1% significance level.

Experience of households in Teff production

The average experiences of adopter and non-adopter households' were 24.85 and 23.19 years respectively. The result of independent sample t-test confirms that, there was no statistically significance mean difference in the experience of households' between adopters' and non-adopters' (Table 2).

Family size

The average family size of adopters' and non-adopters' households' were 5.18 and 3.85 adult equivalent respectively. The independent sample t-test result shows that, there was a significant mean difference in family between adopter and non-adopter households' at 1% significance level implying that adopter households' were owned large family size than non-adopters (Table 2).

Livestock size

Livestock size is the indicators of wealth status of the households in the study area. The average livestock ownership of adopter and non-adopter household was 7.85 and 7.53 Tropical livestock unit respectively implying that there is no variation in livestock ownership between adopter and non-adopter households. The t-test result also show that, there was no statistically significant mean difference in average livestock size between adopter and non-adopter household (Table 2).

Farm size

Farm size represents the total farm land in hectare owned by smallholder farmers in the study area. It is a proxy variable for risk taking ability of the farmers to adopt new technology. The result of the survey revealed that, the average farm size owned by adopter and non-adopter of households' were 2.84 and 2.21 hectares respectively implying that there was a significance mean difference in farm size ownership between adopter and non-adopter households' at 1% significance level. This implies that adopter of the technology were owned large farm size than non-adopter (Table 2).

Distance to farmer training center (FTC)

The average distance of adopter and non-adopter households' from FTC was 6.60 and 6.88 kilometer respectively implying that, there was no statistically significance mean difference in distance of households' to FTC between adopter and non-adopter of the technology (Table 2).

Credit utilization

The average amount of credit obtained by adopter and non-adopter households was Birr 2413.58 and 425.42 respectively implying that there was a significant mean difference in the amount of credit utilized between adopter and non-adopter households at 1% significance level. This result also implies adopters of the technology were obtained large amount credit than non-adopter (Table 2).

Frequency of extension contact

The effort to disseminate new agricultural technologies like row planting requires effective communication between the extension worker and farmers at the grassroots level. Hence, the frequency of extension contact was hypothesized as the potential force which accelerates the effective dissemination of adequate agricultural information to the farmers thereby enhancing farmers' decision to adopt new technologies. The survey result shows that, the average extension contact of adopter and non-adopter household was 2.24 and 0.73 respectively implying that there was a significant mean difference in the frequency of extension contact between adopter and non-adopter households' 1% significance level. This result also shows that, adopter households have made more extension contact than non-adopters (Table 2).

Demonstration site visit

The average demonstration site visit (*Teff* row planting technology) made by adopter and non-adopter household was 1.93 and 0.34 respectively. The result of independent sample t-test also confirm that, there was a significant mean difference in the number demonstration site visit between adopter and non-adopter households' at 1% significance level implying that adopter households have made more number of demonstration site visit than non-adopters (Table 2).

Adoption Level of Teff Row Planting Technology in the Study Area

Adoption levels of sample households' were computed using adoption index formula specified in equation 2. Among 400 sample households', about 79.8% and 20.2% were adopter and non-adopter of *Teff* row planting technology respectively (Table 3). This implies that most of the sample households were not using row planting technology for sowing *Teff*.

Table 1. Descriptive and inferential analysis results of dummy variables

Variable		Adopter		Non-adopter		χ^2 value	P-value
		Frequency	%	Frequency	%		
Sex	Male	65	22.49	224	77.51	3.240	0.072*
	Female	16	14.41	95	85.59		

Source: Computed from survey data (2020), * represent statistical significance at 10%

Table 2. Descriptive and inferential analysis results of continuous variables

Variables	Adopter		Non-adopter		t-value	P-value
	Mean	SD	Mean	SD		
Livestock size	7.85	4.55	7.53	4.06	0.591	0.555[NS]
Education level	2.11	2.91	0.16	0.66	10.969	0.000***
Family size	5.18	1.72	3.85	1.10	8.461	0.000***
Experience	24.85	14.19	23.19	12.46	1.040	0.299[NS]
Credit Utilization	2413.58	2030.93	425.42	1202.65	11.342	0.000***
Extension Contact	2.24	1.01	0.73	0.73	15.321	0.000***
Demonstration site visit	1.93	1.05	0.34	0.59	18.185	0.000***
Farm size	2.84	1.81	2.21	1.11	3.924	0.000***
Distance to FTC	6.60	11.22	6.88	12.68	-.181	0.857[NS]

Source: Computed from survey data (2020); SD: Standard Deviation; *** represent significance level at 1%, and NS: represent not significant

Table 3. Adoption level *Teff* row planting technology

Adoption level	Frequency	%
Non-adopter	319	79.8
Adopter	81	20.2
Total	400	100.0

Source: Survey result (2020)

Table 4. Model selection test

Model	LR value	χ^2 value at 5%	Decision
Tobit (Ho) vs. double-hurdle (H_1)	284.4	18.3	Reject Ho

Source: Survey result (2020)

Econometrics Analysis Result

Model selection test

The likelihood ratio (LR) test formula specified in equation 3 was used to select the best model for analyzing factors affecting adoption level and intensity use of *Teff* row planting technology. Accordingly, the log likelihood function value of Tobit model, probit model and truncated model was -121.7.,-45.8 and 66.3 respectively. The calculated test statistic was: LR (λ) = -2(-121.7-(-45.8+66.3) = 284.4. The tabulated chi-square value at 5% significance level and 10 degree of freedom (which is equal to the number of explanatory variables included in this study) was χ^2 (10) = 18.3. Since, the calculated LR value is greater than the tabulated chi-square value, the null hypothesis, which state that Tobit model best fit our data, was rejected and vice versa. This implies that, double hurdle model best fit the data.

Factors Affecting Adoption Level and Intensity Use of Teff Row Planting Technology

Family size had positive and significant effect on adoption level and intensity use of *Teff* row planting technology at 5% and 10% significance level respectively. The result implied that, as family size increase by one unit, the probability of adopting and allocating extra land for *Teff* row planting technology increase by 26.1% and 1.56% respectively (Table 5). This is because, row planting is labor intensive and hence the household with relatively large family size would adopt the technology than others. This means that, the availability of active labor in the family members determines the adoption level and intensity use of *Teff* row planting technology. The result is supported by the finding of Geremew et al. (2016) and Tafese (2016).

As expected, the experiences of households' in *Teff* production had positive and significant effect on the adoption level of *Teff* row planting technology at 1% significance level implying that as experience of households' head increase by one year, the probability of adopting *Teff* row planting technology increase by 9.5% (Table 5). This is because; experienced farmers can gain knowledge from working over a period of time thereby influencing them to use the technology. This result is in line with the finding of Awotide *et al.* (2014) and Bayisa (2014).

Education level of household head had positive and significant effect on the adoption level and intensity use of *Teff* row planting technology at 1% level of significance. The result show that, as education level of households' increase by one year, the probability of adopting and allocating extra land for *Teff* row planting technology increase by 40.5% and 8.1% respectively (Table 5). This because, educated farmer is more competent and able to access and assimilate information regarding various advantages and disadvantages of the technology than the others. This finding is supported by the finding of Bayisa (2014), Behailu (2014) and Tafese (2016).

Credit utilization had positive and significance effect on adoption status of farmers at 5% significance level. The result further indicated that, as the amount of credit used increased by one unit, the probability of adopting *Teff* row planting technology increase by 0.02% (Table 5). Most farmers fear to use improved technologies because they do not have the necessary financial resources to adopt the technologies. Hence, credit utilization helps farmers to purchase the necessary inputs thereby influencing them to adopt the technology. This finding is in line with the finding of Bayisa (2014), Behailu (2014) and Mesafint (2017).

As expected, frequency of extension contact had positive and significant effect on the adoption level and intensity use of *Teff* row planting technology at 1% and 5% significance level respectively implying that as the number of extension contact increase by one unit, the probability of households' adoption decision and intensity use of *Teff* row planting technology increase by 55.5% and 7.8% respectively (Table 5). This is because households' who had more extension contact have more access to information and hence, participate in various training related to row planting technology than the others. This result is supported by the finding of Behailu (2014) and Yalemwork (2018).

Demonstration site visit had positive and significance effect on the adoption level and intensity use of *Teff* row planting technology at 1% level of significance. The result show that, as demonstration site visit increase by one unit, the probability of households' to adopt and allocate extra land for *Teff* row planting technology increase by 67.9% and 11.9% respectively (Table 5). This is because demonstration site provides practical knowledge and skill for smallholder farmers' which helps them to adopt the technology. This result is supported by the finding of Mesafint (2017).

Table 5. Maximum likelihood estimation of double hurdle models

Variables	First hurdle (Probit model)			Second hurdle (Truncated model)		
	Coef	Std. Err	P	Coef.	Std. Err.	P
Constant	-5.9983***	0.8589	0.000	-0.1969**	0.0931	0.034
Family size	0.2614**	0.1192	0.028	0.0156*	0.0086	0.069
Sex	-0.0832	0.3051	0.785	0.0308	0.0314	0.326
Experience	0.0951***	0.0199	0.000	0.0007	0.0018	0.967
Education	0.4058***	0.0945	0.000	0.0811***	0.0110	0.000
Livestock size	0.0168	0.0375	0.654	0.0021	0.0035	0.557
Credit	0.0002***	0.0008	0.005	2.22e-06	7.68e-06	0.773
Extension contact	0.5556***	0.1429	0.000	0.0787***	0.0239	0.001
Demonstration site	0.6792***	0.1411	0.000	0.1194***	0.0351	0.001
Distance to FTC	0.0003	0.0136	0.978	-0.0019	0.0014	0.151
Farm size	0.0226	0.1410	0.873	-0.0104	0.0203	0.608
Sigma				0.1195***	0.0106	0.000
Number of obs.	= 400			Number of obs.	= 81	
LR chi2(10)	= 314.20			Lower limit	= 0	
Prob > χ^2	= 0.0000			Upper limit	= + infinity	
Pseudo R^2	= 0.7743			Wald chi^2 (10)	= 398.12	
Log likelihood	= -45.8028			Prob > chi^2	= 0.000	
				Log likelihood	= 66.3029	

*, **, *** represent the significance level at 10%, 5% and 1% respectively, Source: Model output (2020)

Conclusions and Recommendations

This study identifies that majority of smallholder *Teff* producers in the study area are not adopting row planting technology. Among 10 hypothesized explanatory variables to affect adoption level of *Teff* row planting technology six variables namely family size, experience of household head in *Teff* production, education level of household head, frequency of extension contact, credit utilization and number of demonstration visit had positive and significant effect on the adoption level of *Teff* row planting technology. This implies that, households' who had more number of family size, more experience in *Teff* production, attend more education, more contact with extension agents, used credit and visit *Teff* row plating technology demonstration site were adopter of the *Teff* row planting technology than the others. However, 4 explanatory variables namely family size, education level, frequency of extension contact and demonstration site visit had positive ad significant effect on intensity use of *Teff* row planting technology implying that, household who had more family size, attend more education, more contact with extension agents and visit *Teff* row planting technology demonstration site were allocated more land for *Teff* row planting technology the others respectively. Therefore, to improve households' adoption level and intensity use of *Teff* row planting technology in the study area, improving education level of the households, strengthening the frequency of extension contact with the farmers, expanding the demonstration site of *Teff* row planting technology and strengthening the credit service should be the focus of policy makers.

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References

Abreham K, Tewodros, A. 2014. Analyzing Adoption and Intensity of Use of Coffee Technology Package in Yergacheffe District, Gedeo Zone, SNNPR, Ethiopia. International Journal of Science and Research 3(10):231-706.

Ahmed H, Lemma Z, Endrias G. 2014. Technical efficiency of maize producing farmers in Arsi Negelle, Central Rift Valley of Ethiopia: Stochastic Frontier Approach. Journal of Agriculture and Forestry 60(1):157-16.

Alemitu M. 2011. Factors Affecting Adoption of Improved Haricot Bean Varieties and Associated Agronomic Practice in Dale Woreda, SNNPRS. MA Thesis, Hawassa University.
Awotide B.A, Abdoulaye T, Alene A, Manyong V.M. 2014. Assessing the extent and determinants of adoption of improved cassava varieties in south-western Nigeria. Journal of Development and Agricultural Economics. Vol. 6(9), pp. 376-385, DOI: 10.5897/JDAE2014.0559.
Bayisa G. 2014. A Double-Hurdle Approach to Modeling of Improved Teff Technologies Adoption and Intensity Use in Case of Diga District of East Wollega Zone. Global Journal of Environmental Research 8 (3): 41-49.
Behailu G. 2014. Assessment of Factors Affecting Farmers' Adoption level of Row Planting Technology and Yield Improvement on the Production of *Eragrostis Teff*: The Case of Minjar Shenkora Woreda, Amhara Region, Ethiopia. MSc. Thesis, Addis Ababa University.
Biftu A, Diriba B, Bayisa T, Getachew F. 2016. Participatory Demonstration and Evaluation of Bread Wheat Technologies: The experience of FRG/FREG approach in Bale and West Arsi zones of Oromia Region.
Central Statistics Authority (CSA), 2017/18. Agricultural sample survey. Report on area and production for major crops for private peasant holding, meher season, Addis Ababa, Ethiopia.
Dorosh P, Rashid S. 2013. Food and Agriculture in Ethiopia: Progress and Policy challenges. University of Pennsylvania Press.
Fufa H. 1998. Variations of morph-agronomic characters and grain chemical composition of released varieties of tef [Eragrostis tef (Zucc) Trotter]. J. Genet and Breed.
Geremew K, Abdi B, Muzeyin A, Workineh M. 2016. Analysis of Smallholder Farmer's Adoption and Continued Application of Teff Row Planting Technique in Wolaita Zone, Southern Ethiopia. International Journal of Advanced Research. DOI:10.21474/IJAR01/1736
Greene W.H. 2003. *Econometric Analysis*, 5th ed. Pearson Education Inc., Upper Saddle River, New Jersey.
Hailu B, Franzel S, Mwangi W. 1992. Constraints to increasing wheat production in the smallholder sector. pp. 201-211. In: Steven, Franzel and Helen van Houten (eds.). Research with farmers: Lessons from Ethiopia. Wallingford, UK: C.A.B International for IAR.
Hassen B. Bezabih E, Belay K, Jema H. 2012. Determinants of Chemical Fertilizer Technology Adoption in North Eastern Highlands of Ethiopia: The Double Hurdle Approach. Journal of Research in Economics and International Finance 1(2):39-49.
Mesafint T. 2017. Determinants and Intensity of Adoption of Teff Row Planting In Minjar Shenkora Woreda, Ethiopia. MSc thesis presented to St. Mary's University.
National Bank of Ethiopia (NBE), 2015. Annual reports of national bank of Ethiopia on economic growth and development of Ethiopia.
Rahmeto N. 2007. Determinants of Adoption of Improved Haricot Bean Production Package in Alaba Special Woreda, School of Graduate Studies, Haramaya University.
Rashid S. 2010. Staple food prices in Ethiopia. Maputo, Mozambique.
Tafese T. 2016. Adoption and Intensity of Row-Seeding (Case of Wolaita Zone). Open Access Library Journal, 3: e2443. http://dx.doi.org/10.4236/oalib.1102443
Vandercasteelen J, Mekdim D, Bart D, Lemayehu S. 2013. Scaling up Adoption of Improved Technologies: The Impact of the Promotion of Row Planting on Farmers' Teff Yields in Ethiopia. LICOS Discussion Paper Series pp. 1-2.
World Bank (WB), 2016. World development indicators, agriculture and rural development
Yalemwork A. 2018. Determinants of Adoption of Wheat Row Planting: The Case of Wogera
District, North Gondar Zone, Amhara Regional State, Ethiopia. Journal of Agricultural Science and Food Research. 9:4
Yamane T. 1967. Statistics, an introductory analysis, 2^{nd} Edition. New York, USA