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RESEARCH ARTICLE

DETERIMINANTS OF FARMER'S ADOPTION OF FULL EXTENSION PACKAGE ON IMPROVED TEFF TECHNOLOGY: THE CASE OF DENDI DISTRICT, WEST SHOWA, OROMIA REGIONAL STATE, ETHIOPIA

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ABSTRACT

Adoption of full extension package is seen as a key driver to increase agricultural production in Ethiopia. However, there is lack of empirical evidence on the adoption of full extension package on teff by farmers. A study was conducted in Dendi district, Ethiopia. The data for the study were generated by employing both qualitative and quantitative data collection methods. Semi-structured interview schedule was used to collect primary data from the respondents. To generate qualitative data, focus group discussion and key informant interview were employed. Binary logistic model was used to analyze the factors influencing full package adoption on improved teff technology among sampled farmers. The results of binary logit model indicated that educational level, total livestock owned, frequency of training, and knowledge level were found to have positive and significant influence on the adoption of full extension package of improved teff technology while land size, input price and total social participation were found to have negative and significant influence on the same. In conclusion, it is imperative to improve farmers' access to information and extension advices and credit services to increase the adoption. Moreover, attention has to be given to create suitable and modern teff line sowing equipment. Hence, development interventions should give emphasis on improvement of such factors to increase adoption of full extension package on improved teff technology.

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INTRODUCTION

Agriculture continues to be a fundamental instrument for sustainable development, poverty reduction and enhanced food security in developing countries. It is a vital development tool for achieving the Millennium Development Goals (MDG), one of which is to half by 2015 the share of people suffering from extreme poverty and hunger (World Bank, 2008). In Africa, agriculture is a strong option for spurring growth, overcoming poverty and enhancing food security. Agricultural productivity growth is also vital for stimulating growth in other sectors of the economy. Thus, one of the fundamental ways of improving agricultural productivity is through the introduction and use of improved agricultural technologies (World Bank, 2008). According to Duflo *et al*. (2000) the rapid population growth has made Africa to be no longer viewed as a land abundant region where food crop supply could be increased by expansion of land used in agriculture.

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Large areas in Africa are increasingly becoming marginal for agriculture and arable land has become scarce in many African countries. This makes the need for intensification of land use through use of productivity enhancing technologies like fertilizer application for achieving food security. Yet, the rate of increase in fertilizer use has been substantially lower in Africa than in Asia and Latin America (Byerlee, 1997). Similar observations are also made by (Ariga *et al*., 2006). Agricultural technologies have the potential to improve the livelihood of farmers in developing countries by increasing the productivity of land and labor.

However, the amount of fertilizer applied by most farmers in Ethiopia was below the recommended levels and has not resulted in achieving the intended outcomes until the 1990s in the Ethiopian economy (Belay, 2003). Teff has enormous potential for growth as it is the second most widely produced and consumed cereal in Ethiopia. The CSA (2010) data show that teff ranked first in terms of area coverage (accounting for 28% of the cereal area) and is second to maize in terms of volume of production among cereals, accounting for about 20

per cent of the total cereal produce in the category. According to Seyfu (1989) teff has remained an important crop to the Ethiopian farmers for several reasons: i) the price for its grain and straw are higher than other major cereals; ii) the crop performs better than other cereals under moisture-stress and waterlogged conditions; iii) its grain can be stored for a long period of time without being attacked by weevils; iv) there is no disease epidemic that has threatened its performance; v) 'Injera' made of teff flour is a staple diet of most Ethiopians, while the straw provides a nutritious feed for cattle, and vi) the straw is used as a binder of mud used for plastering walls of local houses. The average growth rate of Meher (main rainy) season teff production over the past few years has been around 11% per year (CSA, 2013). Increased productivity is believed to contribute about 6% of the growth, while about 5% was attributed to expansion in the area cultivated to teff.

Recently it has been proved that the traditional sowing technology is a major constraint to increased teff productivity (Berhe *et al.,* 2011). Farmers typically plant teff by broadcasting, scattering teff seeds by hand at a high seed rate. Alternative planting methods, such as row planting or transplanting the seedlings, in which the seed rate is reduced and more space between plants is given, are seen as being superior to traditional broadcasting method (Berhe *et al.,* 2011 and Fufa *et al.,* 2011). Experiments on these alternative planting methods in controlled settings have shown large and positive impact on teff yields (Berhe *et al.,* 2011 and Fufa *et al.,* 2011). As a consequence, in 2013 the Ethiopian government rolled out a nationwide campaign to promote the use of improved technologies for teff production, including row planting, aiming to scale up their adoption to almost 2.5 million teff farmers.

Teff is Ethiopia's most important staple crop, but the national average yield level is low. In the production year 2012-2013, yields were 14 Qt/ ha, significantly lower than other cereals, such as maize (31 Qt/ha), sorghum and wheat (both 21 Qt/ha) (CSA, 2013). This low teff yield is seemingly explained by the limited knowledge on improved teff technologies. By planting seeds in rows at a low seed rate (5 kg/ha) compared to traditional practice of broadcasting seeds at a high rate (25-30 kg/ha), yield is shown to improve significantly on-station. Field demonstrations of row planting of teff showed that yields increase on an average by 70 per cent compared to the national average (ATA, 2013). According to Dendi district Agricultural office (2015), improved teff technology production involves use of different extension packages such as improved variety, seed rate, spacing, fertilizer rate, row sowing, good land preparation, hand weeding and herbicide application at the recommended rate.

However, effective improvement in production and productivity depends on the extent to which a household has applied the recommended package of practices. In the study area, it was found that farmers did not adopt the complete package of practices recommended by the research system. This may be due to different factors which appeared to have some bearing on the farmers' decision to adopt the improved teff technology production package. But, there are limited empirical studies in the study area about the determinants of the adoption of the improved teff technology recommended as a package. The general objective of this study was to assess the determinants of farmers' full extension package adoption on improved teff production in the study area.

MATERIALS AND METHODS

Dendi district was selected purposively from West Shoa Zone since it is one of the high teff producing areas. In this district, there are 23 Peasant Associations. Four teff producing Peasant Associations (PAs) (two from better performance and two from limited performance) in the district were purposively selected out of the 23 PAs based on the full package adoption. Then respondents were selected using random sampling technique taking into account the proportional size (number of households) of each Peasant Association (PA).

The sample size was determined by employing the following formula (Yemene, 1967):

$$n = \frac{N}{1+N\,(e)^2}$$

Where;
n =designates the sample size
N= designates total number of households
e =designates maximum variability or margin of error 8 % (0.08)
1=designates the probability of the event occurring.
Accordingly,

$$n = \frac{N}{1+N\,(e)^2}$$

$$n = \frac{3632}{1+3632(.o8)^2}$$

$$n = 149.83 \sim 150$$

Hence, 150 respondents were selected (Table 1).

In order to meet the objectives of the study, the data were collected both from primary and secondary sources. The primary data were collected from sample respondents using a semi-structured interview schedule and key informants interview.

Table 1. Distribution of sampled households by adoption categories and sex

No	Pas	Full package adopters			Partial package adopters			Total		
		M	F	T	M	F	T	M	F	T
1	Sarawa Debisa	20	2	22	26	3	29	46	5	51
2	Chalalaka Bobe	12	1	13	10	3	13	22	4	26
3	Faji Galila	16	3	19	17	5	22	33	8	41
4	Wamura Seko	10	2	12	18	2	20	28	4	32
	Total	58	8	66	71	13	84	129	21	150

Source: *Computed from survey data, 2015*

For the sake of triangulating the data that were collected from the respondents, qualitative data were collected from extension unit of peasant association (PA) by conducting focus group discussions (FGDs). Accordingly, four FGDs were conducted with 10 members in each extension unit of sampled PA through interview guided checklist.

In most of the studies on adoption, the dependent variable can be effectively captured using binary choice models. Binary choice models are appropriate when the decision making choice between two alternatives depends on the characteristics of the problem. The interest of the study was to analyze the factors influencing the decisions of households to adopt full extension package on improved teff technology. The response to question such as whether a household has adopted full extension package or not could be yes or no, which is a typical case of dichotomous dependent variable. Hence a binary logistic model was used to analyze the factors influencing full package adoption on improved teff technology among sampled farmers.

Model specification

Following Maddala (1992), Green (2008) and Gujarati (2003) the logistic distribution for the adoption decision of full extension package on improved teff technologies can be specified as:

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

Where, Pi is a probability of adoption of full extension package on improved teff technologies for the ith farmer and ranges from 0 to 1. e- Represents the base of natural logarithms and Zi is the function of a vector of n explanatory variables and expressed.

$$Zi=\beta_0 +\sum\beta_i x_i \quad \text{---------- (2)}$$

Where βo is the intercept and βi is a vector of unknown slope coefficients.

The relationship between Pi and Xi, which is non-linear, can be written as follows:

$$Pi = \frac{1}{1+e^{\beta 0+\beta_i+x_i\text{-------}\beta_n x_n}} \quad \text{---------- (3)}$$

The slopes tell how the log-odds in favor of adopting the technology changes as independent variables change.

If Pi is the probability of adopting given technologies, then 1-Pi represents the probability of not adopting and can be written as:

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

Dividing equation (1) by equation (4) and simplifying gives:

$$\frac{Pi}{1\text{-}pi} = \frac{1+e^{zi}}{(1+e^{-zi})} = e^{zi} \quad \text{---------- (5)}$$

Equation (5) indicates simply the odd-ratio in favor of adopting the technologies. It is the ratio of the probability that the farmer will adopt the technology to the probability that he will not adopt it. Finally, the logit model is obtained by taking the logarithm of equation (5) as follows.

$$Li = Ln\left(\frac{p_i}{\quad}\right)$$

$$1\text{-}p_i = z_i = \beta_0 +\beta_1 x_1+\beta_2 x_2\text{----------}\beta_n x_n \quad \text{---------- (6)}$$

Where Li is log of the odds ratio, which is not only linear in X, but also linear in the parameters:

Thus, if the stochastic disturbance term Ui is taken into account, the logistic model becomes:

$$Z_i = \beta_0+\beta_1 x_1+\beta_2 x_2 + \text{----- } \beta_n x_n + u_i \quad \text{---------- (7)}$$

This econometric model is estimated using the iterative Maximum Likelihood Estimation (MLE) procedure due to the nonlinearity of the logistic regression model. The MLE procedure yields unbiased, asymptotically efficient, and normally distributed regression coefficients (parameters).

RESULTS AND DISCUSSION

Determinants of farmer's full extension package adoption of improved teff technology

The results of the binary logic model estimates for factors affecting farmers' full extension package adoption on improved teff technology are presented in Table 2.

Table 2. Binary logit model estimates for factors affecting farmers' full extension package adoption on improved teff technology

Variables	βcoff.	S.E	Wald	df	Sig	Odd ratio
Age	-.039	.085	.207	1	.649	.962
Education level	1.121	.498	5.061	1	.024**	.326
Farming experience	.029	.092	.100	1	.752	1.030
Total livestock owned	1.447	.715	4.093	1	.043**	4.251
Land size holding	-2.483	1.313	3.573	1	.059*	.084
Active labor force	-.075	.288	.068	1	.795	.928
Off-farm activities	.108	.813	.018	1	.894	1.114
Input price	-2.760	.633	18.999	1	.000***	.063
Frequency of extension contact	.523	.432	1.468	1	.226	1.687
Frequency of training participation	.793	.442	3.218	1	.073*	.453
Frequency of field days participation	-.211	.469	.202	1	.653	.810
Knowledge level	1.374	.794	2.997	1	.083*	3.253
Total social participation	-1.436	.326	19.429	1	.000***	.238
Total information seeking behavior	-.020	.249	.007	1	.935	.980
Constant	25.655	6.320	16.480	1	.000	933

Source: model output. ***Significant at<.01, ** significant at <.05 and* significant at <1.

Age of the household head

It was one of the factors that affect the decision of farmers. The mean age of full package adopters was 40.95 and whereas it was 45.52 for partial package adopters with a standard deviation of 8.7 and 8.32 for full adopters and partial adopters respectively. The survey results indicated that as the age of the farmer increases, his or her ability to adopt new technology decreases and therefore it was concluded that age affected the adoption of full package of improved teff technology negatively, as hypothesized in this study. The finding of this study did not comply with the findings of Tesfaye and Alemu (2001) and Alamitu (2011).

Educational level

This refers to the educational background of the farmers. The variable is found to be significant at less than 5% significant level. This variable had positive effect on the decision of the farmer to adopt the full extension package of improved teff technology. The odds ratio of 0.326 indicates that keeping the effects of other factors constant, a unit increase in educational level results in the increase of adoption of full extension package of improved teff technology by 0.326 units. Most of the farmers are different in their status of education. The survey results indicated that the full package adopters had better educational level than partial package adopters. This implies that an educated household adopted the improved teff technology package as recommended than less educated household. The finding is similar with the results of Negera and Getachew (2014) who reported that there was a positive relation between adoption and education level of the head of householders.

Total live stock owned

Most farmers have cattle as a source of income for their livelihood. It was statistically significant and had positive effect on the decision of farmers to adopt the full extension package of improved teff technology. Its p-value is .043 at less than 5% significance level. The value of odds ratio indicates that for a unit increase in total livestock, the farmers' decision to adopt the full extension package of improved teff technology increase by 4.251 units. In most cases, livestock is the main source of income for the rural people which help them to improve their livelihood. Specially, the farmers sold their cattle to buy necessary agricultural inputs to increase the productivity and production of their farms. Full package adopters of improved teff technology had average livestock holding of 11.725 TLU and partial package adopters had 6.85 TLU. In this study, majority of the full package adopters had more livestock than partial package adopters and they adopted the improved teff technology as recommended than partial package adopters those holding less livestock. During the focused group discussion the farmers reported similar result that having more livestock helped them to apply the recommended rate of improved teff technology package. The result of this study is in agreement with earlier adoption studies such as Degnet and Belay (2001) and Habtemariam (2004). In their studies, they reported that livestock holding has a positive and significant influence on adoption of agricultural technologies.

Land size

The results of the model revealed that land holding was negatively related with adoption of full extension package of improved teff technology at less than 1% significance level. This shows that an increase in the land holding size of the farmers results in decrease in the adoption of full extension package of improved teff technology. The odds ratio 0.084 implies that keeping other things constant, the decision of farmers to adopt decreases by 0.084 as the land size of the adopter increases by one unit of land.

Input price

Farmers should get the inputs at reasonable price. This variable is most important and it was statistically significant and had negative effect on the decision of farmers to adopt the full extension package of improved teff technology. Its p-value is .000 at less than 1% significance level. The value of odds ratio indicates that a unit increase of the input prices, the farmers' decision to adopt the full extension package of improved teff technology lowers by 0.063. Input price is the main determinant factor in agricultural activities. Because it is directly related to the purchasing power of farmers and it affects the decision of the farmers to adopt the technologies. For this study purpose, the inputs considered were chemical fertilizers (DAP and UREA), improved teff seed and herbicide (2.4D). Majority of full package adopters (54.5%) reported that the input price was expensive while majority of partial package adopters (60.7%) reported that the input price was very expensive. The result of this study indicated that the view of the full package adopters and partial package adopters was different on the input price. This implies that the input price influenced the adoption of full package of improved teff technology.

Frequency of training

One of the ways through which farmers can get information about improved technologies is by participating in extension events. These events include extension activities such as training and field visits. In this study, the frequency of participation of farmers in training was considered as one aggregate variable. Results of the finding indicated that participation in training was positive and significantly related to adoption of full extension package of improved teff technology at less than 10% significance level. Training is one of the methods of transferring knowledge to the farmers by the extension service. Training is helping to fill the existing knowledge gap in the interesting area of an individual. The frequency of participation in training was high for 90.0 per cent and medium for 9.1 per cent of full package adopters respectively, while 15, 78.6 and 6 per cent of the partial package adopters had the frequency of participation in training as low, medium and high respectively. The survey results indicated that the full package adopters of improved teff technology had high frequency of participation in training than the partial package adopters. The result of this study is in agreement with the findings of Tesfaye and Alemu (2001) and Teshale *et al*. (2006).

Knowledge level

This refers to the knowledge level of farmers about the improved teff technology. This variable was statistically significant and had positive effect on the decision of farmers to adopt the full package of improved teff technology. Its p- value is .083 at less than 10%. The value of its odds ratio indicates that a unit increase in the knowledge of the farmers toward the improved teff technology, the adoption of full extension package of improved teff technology increases by 3.253. Adopters should have higher level of knowledge about the new technology. Full package adopters of improved teff technology should have higher level of knowledge about each component of full package and the recommendation rate. It was found that among the full package adopters, 57.6 per cent had medium knowledge level and 42.4 per cent had high knowledge level while 90.5 per cent and 9.5 per cent of partial package adopters had medium and high knowledge level respectively. This evidence indicates that the full package adopters of improved teff technology had better knowledge about the teff technology than partial adopters.

Total social participation

Membership and frequency of participation in different social organization is the other important variable expected to have relation with adoption of full extension package of improved teff technology. In this study, participation in social organization had negative influence on adoption of full extension package of improved teff technology at less than 1% significant level. The results of this study indicated that for a unit increase in social participation, the decision to adopt full extension package adoption of improved teff technology decreases by 1.436 units. Participation in social organization influences the decision of farmers in the adoption the improved agricultural technologies. The survey results indicated that the average score for sample households on social participation was 8.5, while the mean score of social participation for full package adopters was 8.68 and for partial package adopters it was 6.92. From this one can conclude that the full package adopters have high social participation than the partial package adopters. This result is in agreement with the finding of Rahmeto (2007).

Conclusion

There were many factors that influenced the decision of the farmers to adopt the full package of improved teff technology. These factors are personal, demographic, economic, and socio-psychological in nature. The results of binary logit model indicated that educational level, total livestock owned, frequency of training, and knowledge level were found to have positive and significant influence on the adoption of full extension package of improved teff technology while land size, input price and total social participation were found to have negative and significant influence on the same. In conclusion, it is imperative to improve farmers' access to information and extension advices and credit services to increase the adoption. Moreover, attention has to be given to create suitable and modern teff line sowing equipment. Hence, development interventions should give emphasis on improvement of such factors to increase adoption of full extension package on improved teff technology.

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