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Factors Determining Adoption of Improved Wheat Varieties by Smallholder Farmers in Ethiopia

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ABSTRACT: The study determined the level and factors that influence adoption of improved wheat variety adoption among smallholder farmers in Ethiopia. The study used household level cross sectional data collected during 2015/16 cropping season. The survey involved 1611 smallholder farmers drawn by random selection from thirteen agro-ecologies in four regions in the country. The four regions represent 99.3% of the wheat growing areas, 99.6% of the wheat producer and 99.4% of the wheat production in the country. In the analyses, descriptive statistics and a Probit regression model were employed. A descriptive analysis shows that, 83.7% of the sample households were adopters and have grown at least one improved wheat variety during the production season. The econometric analyses of improved wheat variety adoption behavior of smallholder farmers revealed that Tropical livestock unit (TLU), received training, education level of the HHH and awareness on improved varieties positively and significantly related with the adoption of using improved varieties. While, Experience of growing Wheat and Land holding size improved adoption of improved wheat varieties suggesting credit would be crucial for enhancing adoption of using improved wheat varieties. Hence, strategies to enhance adoption of use of improved wheat varieties need to focus on factors that showed higher marginal effects.

KEY WORDS: Adoption, improved variety, wheat Ethiopia

1. INTRODUCTION

Wheat is the main staple food crops in highland areas of Ethiopia (Schneider et al 2010). It is estimated that an average person in Ethiopia consumes about 29.6 kilos of wheat per year (Berhanu et al., 2011) which stands third next to maize and sorghum, 37.7 and 32.2 kilos per year, respectively.

According to the Food policy report 2020 vision developed by International Food Policy Research Institute (IFPRI) in 1999, the world's farmers will have to produce 40 percent more grain in 2020, most of which will have to come from yield increases. In Ethiopia, 85 improved wheat varieties were released since 1974 through its research centers. According to Central Statistical Authority (CSA) 2015/2016 average national productivity of wheat is progressed to 2.54 ton/hectare which is too low compared to the potential productivity of 5 ton/hectare at farmers' field (Fisseha Z. et al., 2020). This is because the uptake of these wheat technologies in the country by farmers is low and this growth is largely attributed to area expansion than increased productivity.

Adoption of technological innovations by farmers in developing countries has attracted considerable attention; this is because the majorities of less developed countries' population derive its livelihood from agricultural production and also because introduction of many new technologies in these countries has been met with only partial success as measured by rates of adoption (Feder, et al., 1982).

The adoption of new agricultural techniques is a key route out of poverty for many in the developing world. Yet, agricultural innovations have often been adopted slowly and some aspects of the adoption process are still poorly understood.

Adoption is a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages (Bahadur and Siegfried, 2004). Farmers can only adopt modern agricultural technologies if they are aware of the availability and benefits of these technologies and their inherent characteristics.

The importance of smallholder farming is due to the number of farmers involved and their contribution to the economy. In 2010/11 cropping season 97 percent of the total grain land was harvested by smallholder sub-sector. Increase and sustainability in wheat productivity, will need to take place in smallholder sub-sector. This is only achievable if enhanced efforts to encourage farmers to adopt improved wheat production technologies are undertaken.

Achieving Potential yield of the crop is great for increasing production through improved varieties and other farming innovations as well as improved policies. Better yields for these crops would bring significant benefits to the food systems in developing countries, particularly to poor producers and consumers.

To this end determining the factors behind the low adoption of improved wheat varieties has a vital importance in improving and enhancing the uptake of wheat technologies.

2. MATERIALS AND METHODS

2.1. The Study Area

The study was conducted in four major wheat producing regions in Ethiopia. The regions share the larger volume in terms of producers, the area they are planted and volume of production obtained from private peasant holdings.

Table1: Production Characteristics of the study area

	Regions	Area in Hectare	Production in tones	Productivity in tones
	Ethiopia - All regions (2015/16)	1,664,564.62	4,219,257.22	2.53
1	Amhara	545,106.10	1,221,904.31	2.24
2	Oromia	872,252.80	2,459,375.14	2.82
3	Tigray	102,847.97	176,096.64	1.71
4	SNNPR	133,419.80	334,633.93	2.51
	Four regions (2015/16)	1,653,626.67	4,192,010.02	2.54
	Share	99.3%	99.4%	

Source: Computed by the researcher (Data from CSA Agricultural Sample Survey, 2015/2016)

2.2. Data Type and Sources

Data collected by Ethiopian Institute of Agricultural Research (EIAR) and the International Maize and Wheat Improvement Center (CIMMYT) during 2015/16 was used for the analysis. The study is based on the cross-sectional farm level data collected through a structured questionnaire. Secondary data: country's statistical report, crop variety register, annual reports, research papers, website, books and unpublished reports were also used in the analysis.

2.3. Sampling Techniques

The sampling unit of the study was small-scale wheat farmers. Households from four regions were sampled using multistage sampling procedure. A total of 123 peasant associations from four regions were selected purposively due to their potential in the cultivated land as well as in wheat production and in the number of producing farmers. Finally, 1611 respondents were selected and interviewed by using systematic random sampling techniques from 13 different agro ecological zones in 61 districts.

2.4. Method of Data Analysis

Descriptive and Econometric analysis were used to analyze the data. Descriptive statistics were employed to describe the demographic, socio-economic and institutional characteristics of the wheat farmers. Probit Regression Model was employed to determine the probability of a farmer to adopt a given technology. The data was analyzed using STATA software.

Probit Regression Model

In order to explain the behavior of a dichotomous dependent variable we have to use a suitably chosen Cumulative Distribution Function (CDF). The estimating model that emerges from the normal CDF is known as the Probit Model. Similar to the logit model but producing a different estimate of parameters, Grouped data are used to estimate the rate of change of a probability. A farmer (i) adopts improved wheat varieties if the expected utility from adoption (U_a) is higher than the corresponding utility from non-adoption (U_{na}), i.e. $U_a - U_{na} > 0$. Let A^*_i be the latent variable that captures the benefit from adopting improved wheat varieties by the i^{th} farmer. Following Greene (2003) probit regression model will be specified as follows:

$$A^*_i = Z_i\alpha + \varepsilon_i \text{ where} \quad \text{---------- (1)}$$

$$Y_i = \begin{cases} 1 & \text{if } Z_i\alpha + \varepsilon_i > 0 \\ 0 & \text{otherwise} \end{cases}$$

Where Z is vector of household, farm and village level variables that affect the decision to adopt and/or not adopt improved what varieties and ε is an error term.

Coefficients and Marginal Effects

Estimated coefficients do not quantify the influence of the right hand side variables on the probability that the left hand side variable takes on the value one. Estimated coefficients are parameters of the latent model.

The marginal effect of a right hand side variable is the effect of a unit change of this variable on the probability P(Y = 1|X = x), given that all other right hand side variables are constant: Variation of marginal effects may be quantified by the confidence intervals of the marginal effects.

$$\frac{\partial p(y_i = 1 | x_i)}{\partial x_i} = \frac{\partial E(y_i | x_i)}{\partial x_i} = \varphi(x'_i \beta)\beta$$

The slope parameter of the linear regression model measures directly the marginal effect of the right hand side variable on the left hand side variable. The marginal effect depends on the value of the right hand side variable.

3. RESULTS AND DISCUSSION

3.1. Descriptive Results

Experience of growing Wheat: Sampled age of respondents was aged between 18 to 90 years. Most of the sampled HHHs were relatively old. The mean age of the household head is about 46 years with 17.8 years of average farming experience. Farmer's experience in wheat activities were ranged from one to seventy two years.

Family size: The majority (91.6%) of sampled respondents were male headed households. The family size of the sampled households was on average about 6.6 persons. On average, the family size of adopters was 6.6 and 6.3 persons for non-adopters. This shows that adopters were endowed with more labor as compared to non-adopters.

Ownership of plot: 86.3 percent of total operated area was under owner-operated land. On the other hand, contracted land (either cash rented, sharecropped, gifted or borrowed) were observed to operate on 154.4 ha which covered 13.7 percent substantially smaller than the average size of owner-operated land.

Tropical livestock unit (TLU): Average livestock holding per household in the study area was 5.43 TLU (Tropical Livestock Unit). Adopters owned more TLUs (5.47) than non-adopters (5.21) TLUs.

Received training: 90.7% of the respondents had access to extension services on wheat production in the scheme. The results of this study show that only 37.1% of the farmers in the study area received training.

Education level of HHH: 1011 of the respondents were attended formal education of which 874 (86.4%) were adopters. From the total of 262 non adopters 47.7% of the HH heads not attended any formal school at all.

Land holding size: The average land holding size per household in the study area was 1.54 ha. The majority of the farmers (63.6%) own below average land holding size (1.54 ha). There is no significant difference in average land holding between adopters and non-adopters

Membership of Institutions: This is a dummy variable which is measured as 1 if the household is the member and participate in the institutions or 0 otherwise. Households who participate in the institutions account 1% of the sampled households during study period.

Received credit: Use of credit is rare in the study area. Only 6.9 percent of the farmers used credit to overcome their financial shortages in wheat production. A majority (89.2%) of them were adopters.

Awareness on improved varieties: Descriptive statistics of this variable indicate around 74.7% of the farmers have information about improved varieties either through radio, mobile, extension agents and neighboring farmers. The majority (88%) of the farmers who have information about improved wheat variety adopted improved wheat variety.

The first step towards the adoption of a new farm practice is knowledge of its existence. About 90% of the respondents are aware of the existence of improved wheat varieties with slight variations across agro-ecologies (Table 2).

Table 2: Distribution of adopters of wheat varieties

No.	Regions	Adopters = 1 Non-Adopters = 2	Number of farmers	Production In tones	Plot Size	Yield (tones/ha)
		1	373	273.71	201.28	1.36
1	Amhara	2	136	82.52	65.09	1.27
		Total	509	356.23	266.37	1.34

		1	734	1,349.67	646.69	2.09
2	Oromia	2	103	104.64	86.4	1.21
		Total	837	1,454.31	733.09	1.98
		1	175	116.44	80.05	1.45
3	Southern Ethiopia	2	6	11.60	5.64	2.06
		Total	181	128.04	85.69	1.49
		1	67	57.11	34.46	1.66
4	Tigray	2	17	15.19	11.44	1.33
		Total	84	72.30	45.9	1.58
		1	1349	1796.922	962.48	1.87
	Four regions	2	262	213.9535	168.57	1.27
		Total	1611	2010.8755	1131.05	1.78

Source: Own Computation, 2012

Results indicate that of the total samples were taken 16% of wheat farmers were non-technology adopters, implying significant potential in wheat production that can be developed. By shifting these farmers to the adopters, the average yield would increase by 0.6 tons per hectare controlling others factors remains constant or unchanged.

3.2. Empirical Results

Determinants of the adoption of improved Wheat variety

Probit regression model estimated to assess the determinants of adoption level. The estimated parameters on the model presented in Table 4.10 only indicate the direction of the effects that the variables have on adoption levels. As shown in the table 3, among the farmer-specific characteristics, Tropical livestock unit (TLU), Received training, Education level of HHH and Awareness on improved varieties have a positive and significant effect on adoption of improved wheat varieties. However, experience in growing wheat and land holding size has a negative and significance effect on technical efficiency level of the farmers.

T**able 3: Tobit regression (Adoption of Improved Wheat Varieties)**

Variables	Coef.	Std. Err.	T	P>|t|
Experience of growing Wheat	-0.488110***	0.171346	-2.85	0.004
Family size	-0.002129	0.111483	-0.02	0.985
Ownership of plot	0.006383	0.011398	0.56	0.575
Tropical livestock unit (TLU)	0.078894*	0.041666	1.89	0.058
Received training	0.044182**	0.017959	2.46	0.014
Education level of HHH	0.022712***	0.008573	2.65	0.008
Land holding size	-0.278847**	0.113600	-2.45	0.014
Membership of Institutions	0.012414	0.039929	0.31	0.756
Received credit	0.003521	0.024641	0.14	0.886
Awareness on improved varieties	0.067814***	0.008918	7.60	0.000

Note: *** Significant at 1%, ** Significant at 5% and * Significant at 10%

The Marginal Effect Analysis:

The results from the probit model were subjected to post estimation test using marginal effect analysis in order to estimate the trivial change from each factor that influences adoption. Quantification of the marginal effects of these variables is important in order to estimate the change that will occur with respect to a change in one unit of that variable Table 4.

Table 4: Marginal effects after Probit (Adoption of Improved Wheat Verities)

Variables	dy/dx
Experience of growing Wheat	-0.1132219
Family size	-0.0004938

Ownership of plot	0.0014807
Tropical livestock unit (TLU)	0.0183002
Received training	0.0102484
Education level of HHH	0.0052682
Land holding size	-0.0646812
Membership of Institutions	0.0028795
Received credit	0.0008166
Awareness on improved varieties	0.01573

Experience of growing wheat: had a negative effect on adoption of improved wheat verities at 1% significant level. A unit change in the year of experience of growing wheat would decrease the probability of a farmer to adopt improved wheat varieties by 11.3 percent. Results revealed that younger farmers are more innovative than the older ones and younger farmers were more educated and risk taker as compared to the older farmers. Therefore, younger farmers were able to access information on improved wheat varieties and adopt improved varieties as compared to older farmers. The finding was consistent with Chi and Yamada (2002).

Possession of Livestock (TLU): has a positive and significant effect on adoption of improved wheat verities at 10% significant level. A unit change in the number of oxen owned by households would increase the probability of a farmer to adopt improved wheat varieties by 0.04 percent. Results revealed that farmers holding high livestock units enable farmers to access and purchase agricultural technologies. Farmers with high livestock units are also expected to be less risk averse as they have the capacity to cope with risks associated with the use of a technology. Therefore, farmers who have more number of livestock units are more likely to adopt improved verities. Yirga and Hassan (2008) found the same.

Training: had a positive and significant effect on adoption of improved wheat verities at 5% significant level. A unit change in number of training received by the household head in an increasing order would increase the probability of a farmer to adopt improved wheat varieties by 1.02 percent. Results revealed that training through either a visit or a training course provides farmers knowledge and builds confidence of decision to adopt improved varieties and improves the correct utilization of the technologies to produce the maximum output. Yirga C. et al. (2013) found the same that training to have a positive relationship with farmer's adoption of improved varieties.

Education Level of the Household Head: had a positive effect on adoption of improved wheat verities at 1% significant level. A unit change in the years of education level of households would increase the probability of a farmer to adopt improved wheat varieties by 0.53 percent. The result revealed that more educated farmers are able to perceive and interpret and respond to new information and adopt improved technologies much faster than their counterparts. More educated farmers are able to access information on a given technology, assess and understand the attributes of that technology and enhanced the ability to assess risks associated with the use of a given technology. These results were in agreement with the findings reported by (Yirga and Hassan 2008); Yirga C. et al. (2013).

Land Holding Size: had a negative and significant effect on adoption of improved wheat verities at 5% significant level. A unit change in the size of land in the household head would decrease the probability of a farmer to adopt improved wheat varieties by 6.47 percent. The result revealed that farmers holding larger land size can produce more amount of grain required by their family and to cover the cost of inputs selling the grain from the production gained largely attributed to area of farm than increased productivity. However, farmers with small land size can show interest of adopting technologies as a coping mechanism to produce more per area of land. These results were in agreement with the findings reported by Yirga C. et al. (2013) that found land holding size to have a negative relationship with farmer's adoption of improved varieties.

Awareness on improved varieties: had a positive and significance effect on adoption of new improved varieties at 1% significant level. A unit change in the frequency of the households got awareness on improved varieties would increase the probability of a farmer to adopt improved wheat varieties by 1.57 percent. HHH who got awareness with new improved varieties through research centers, agricultural extension workers, media, field days, demonstrations and neighboring farmers are the means through which agricultural technologies are transferred from researchers to farmers. Therefore, farmers who have access to these services enabled the up-take of technology. The finding was consistent with Dadi, et al, (2001); Feleke and Zegeye, (2006).

4. CONCLUSION AND RECOMMENDATION

The adoption process of agricultural technologies depends primarily on access to information and on the willingness and ability of farmers to use information channels available to them. About 90% of the respondents are aware of the existence of improved wheat varieties. However, 6.3% of the farmers who were informed about improved varieties were not shows willingness to adopt

the improved varieties. Adopters are significantly different from non-adopters with respect to many of the variables considered in the study. Among the variables considered in the analysis, possession of livestock, training, education level of the household head and awareness on improved varieties found to have a positive and significant relationship with farmer's adoption of improved varieties while experience of growing wheat and farm size (or land holding) had a negative effect on adoption of improved wheat verities. Finally, the result obtained shows that there is an opportunity for the non-adopters in the study area to increase their productivity by 0.6 t/ha if the adopt the improved wheat varieties. Therefore, the study suggested the need for policies and strategies of the government should give attention towards all of the aforementioned variables on raising adoption in the study area.

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