Factors Influencing the Adoption of Improved Sorghum Varieties in Awbere District of Somali Regional State, Ethiopia

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Abstract: Sorghum is the most important cereal crop in the Awbere District, where the grain is used for human consumption and the stover for animal fodder. Sorghum is produced traditionally using oxen plow, seed broadcasting and threshing by animals. Package based extension program in the Somali Region was started in the year 1996 in Jijiga Zone, including Awbere District and since then, a number of improved sorghum varieties were disseminated to farmers. The purpose of this study was to identify factors that influence the adoption of improved sorghum varieties in Awbere District. Both primary and secondary data were used whereby the primary data were collected from 180 households in 2010. Descriptive statistics and logistic regression model were employed to analyze data. The findings of the study indicated that age and distance to input market were negatively and significantly related to improved sorghum varieties whereas farm size and type of house owned were found to have been positively and significantly related to improved sorghum varieties. The results of the study confirm that farmers who are better in economic status (having larger farm size and better quality house) and have access to market information can be greater technology adopters. Moreover, targeting younger farmers may enhance the adoption of new agricultural technology in the area.

Keywords: Adoption; Improved Sorghum Varieties; Awbere District; Socio-Economic Factors; Institutional Factors

1. Introduction

The majority of the households (85%) in Ethiopia are smallholders who live in the rural areas and depend on agriculture as their major economic activity. They are involved in crop and/or livestock production, where livestock provide drought power for crop production and crop residues are used as an animal feed (CSA, 1999).

Sorghum is a major staple crop in the semi arid regions of Ethiopia, particularly in the Somali Regional State. Sorghum does not only provide grains for human consumption, but also stover which is used as forage for livestock, building materials for housing and as fuel for cooking (IIRR, 2002). Even though sorghum has multiple uses, its production is constrained by traditional farming techniques, and poor complementary services such as extension, credit, access to market, and infrastructure.

In the early 1990s to boost agricultural production a large extension program was started in Ethiopia with the introduction of modern agricultural technologies and agronomic practices. Consequently, inorganic fertilizer use has doubled from 75,000 MT in 1993 to 150,000 MT in 2002, with annual average growth of 5%. Between 1993 and 2003 cereal production has increased on average by 5.1% (FAO, 2004). As part of the extension program, sorghum varieties were introduced into a sorghum growing areas of the Somali Regional State starting from 1992. The technology package included drought tolerant short maturing sorghum varieties (such as Gambella, Birmash, Dinkmash, Kobomash, Seredo, 76 T1 #23 and Teshale), inorganic fertilizer (Urea and DAP), and improved agronomic practices (seeding rate, plant spacing, fertilizer application etc.) (RBoA, 2002). Awbere District is one of the areas where the technology package mentioned above was introduced. The District is known as a principal producer of sorghum and maize.

Agricultural extension service providers of the region is believe that institutional factors such as access to agricultural extension services, access to improved farm inputs i.e. seeds and fertilizers, access to credit facilities and related arrangements made by the Somali Regional Agricultural Bureau have helped in enhancing the adoption of improved sorghum varieties among the small-scale subsistence farmers in the region in general and Awbere District in particular. Even though, extension activities on improved sorghum varieties dissemination have been accomplished over the past years in the region, the level of adoption of the new technologies and the benefits generated as a result of the intervention has not been assessed and evaluated in the District. Therefore, the objective of this study is to identify factors affecting the adoption of improved sorghum varieties in Awbere District of the Somali Regional State.

2. Research Methodology

2.1. The Study Area

Awbere District is one of the six districts in Jijiga Zone of the Somali Regional State. It is located northwest of the Jijiga District (Fig. 1) and its altitude ranges from 1200 to 1660 meters above sea level (masl). The climate of the District is semi arid marked by seasonal variations and it receives an annual rainfall that varies from 400 to 900 mm. The area experiences bimodal type of rainfall classified as short rainy season (from July to September) and main rainy season (from March to April). The mean annual temperature is 14 ^{0}C with mean minimum and maximum temperatures of 20 and 25 ^{0}C, respectively (JZOA, 2001). According to the CSA (2008), roughly

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88% of the inhabitants of Awbere District are agro-pastoralists with a population of 299,336 persons (165,148 male and 134,188 female). The people in the Awbere District are mainly from Somali tribe and Islam is the main religion.

The farming system in the Awbere District is mainly agro-pastoralism. Increasingly, agro-pastoralists are becoming settled farmers. Agro-pastoralists in the District produce sorghum, maize, wheat and chat through traditional agronomic practices with the use of oxen plow, seed broadcasting, hand thinning and threshing by animals. The average production levels of sorghum and maize in the district are 1500 and 1900 kg ha^{-1}, respectively (Teka and Azeze, 2002). The low amount and erratic distribution of rainfall, and high evapotranspiration limited the crop production in the area to the use of drought tolerant crop species and/or varieties (Eshetu and Teriessa, 2000).

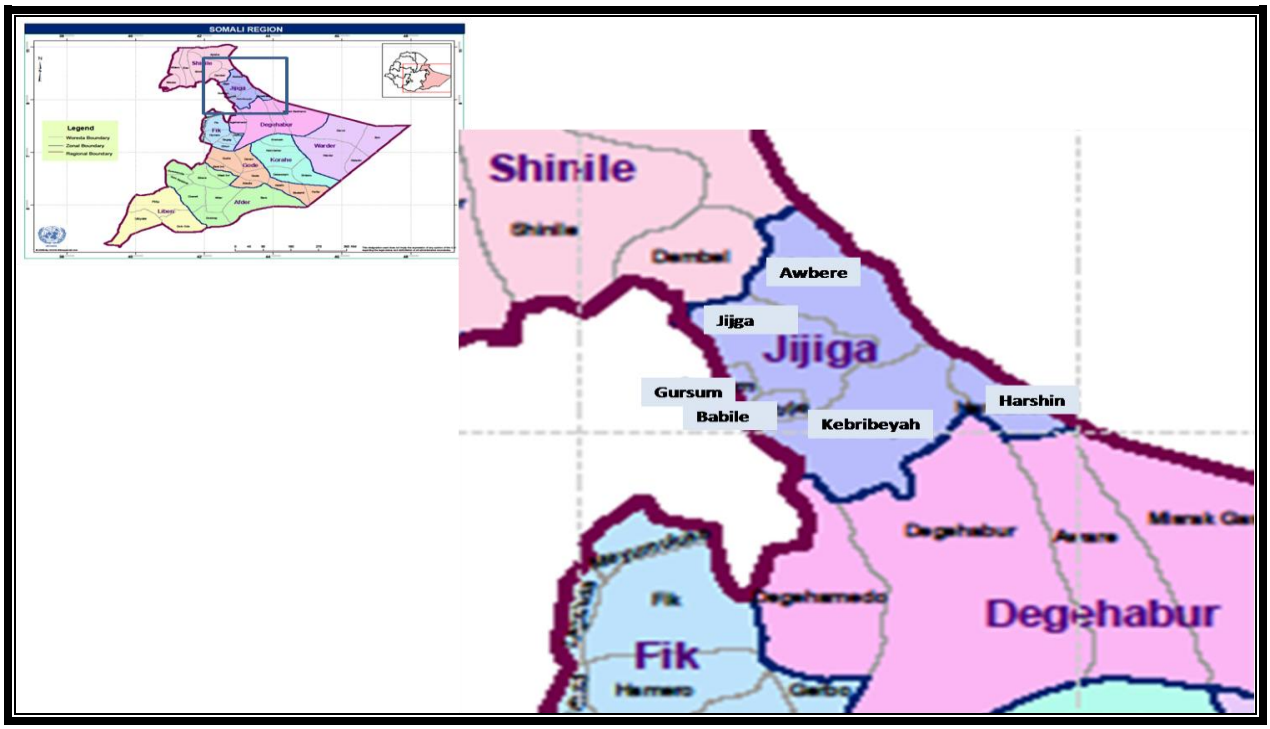

Figure 1. Location map of the study district (Awbere District)

2.2. Sampling and Data Collection

Primary data were collected during January to February 2010 by interviewing 180 sample household heads from eight randomly selected *Kebeles* of the Awbere District. Probability proportional to size sampling technique was used to select sample households[1]. Enumerators were trained on the contents of the interview schedule and pre-testing of the interview schedule was conducted on some randomly selected farmers. On the basis of the pre-test, some modifications were made on the interview schedule. Individual interview with sorghum growers was carried out by trained enumerators through use of structured interview schedule.

2.3. Analytical Framework

The primary data collected were analyzed using descriptive statistics (percentage and mean) and the Logistic Regression Model. Binary choice models, also known as univariate dichotomous models, are the most commonly used models to analyze technology adoption decisions (Verbeek, 2003). These models essentially describe the probability that a technology will be adopted directly. The common binary choice model that emerges is either the Probit or the Logit model. In this study, the Logit model was chosen to analyze factors influencing farmers' decisions to adopt improved sorghum varieties, since both the Probit and Logit models yield similar parameter estimates and it is difficult to distinguish between them statistically (Aldrich and Nelson, 1984). The Logistic Regression (sometimes called the Logistic or Logit model) is a type of predictive model that can be used when the target variable is a categorical variable with two categories (Mood, 2009).

In this study, the Logit model was used to estimate the probability of adoption of improved sorghum varieties that takes either one of the two values of Y = 1 for adoption and Y = 0 for non-adoption of improved sorghum varieties. The functional form of the model is presented as follows:

$$Prob(Y=1) = \ln\left[\frac{P_i}{1-P_I}\right] = \frac{e^{(\beta' X)}}{1+e^{(\beta' X)}}$$

[1]A Somali household is defined as a man, his wife, their children and any other person who is dependent on that household for living

where B'X is defined as:

$$\ln\left(\frac{P_i}{1-P_I}\right) = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots+\beta_iX_i+U_i$$

where β_o is the constant, $\beta_1,\beta_2, \beta_3 \ldots\beta_i$ are the coefficients of the independent variables to be estimated, X_1, X_2, $X_3 \ldots X_i$ are independent variables, and U_i is the error term with zero mean and constant variance.

2.4. Variables in the Model

The Logit model discussed above suggests many important hypotheses related to the relationship between the adoption of improved sorghum varieties; and socio-economic and institutional factors. The model assumes that the dependent variable which is adoption of improved sorghum varieties depends on the independent variables of age of household head, education level, size of farm land owned, number of shoats (sheep and goat) owned, type of house owned, distance to input market, contact with extension agents, access to credit and radio ownership. A list of all independent variables used in the logit model along with their measurements and hypothesized signs is given in Table 1.

Table 1. Independent variables, hypothesized signs and their measurements.

Independent variable	Expected sign	Variable measurement unit
Age	+/-	Year
Education	+	Binary variable: 1 = Able to read and write, 0 = Otherwise.
Household farm size	+	*Qodi* (0.25 ha)
Shoats ownership	+	Number
Type of house owned	+	Categorical: 1 = Traditional tent, 2 = Thatched house, 3 = Corrugated iron house
Distance to input market	-	Distance from residence to the nearest input market (km)
Contact with extension agent	+	Contacts with extension agent per year (Number)
Access to credit	+	Categorical: 1 = Has access to credit and 0 = Otherwise
Radio ownership	+	Binary variable: 1 = Owns radio and 0 = Otherwise.

3. Results and Discussion

3.1. Socio-Economic Characteristics of Adopters and Non-Adopters of Improved Sorghum Varieties

Out of the 180 households interviewed, 37.2% were adopters and 62.8% were non-adopters of improved sorghum varieties. Out of the adopters of improved sorghum varieties, 44 (65.7%) were illiterate, and 23 (34.3%) can read and write. Only nine (8%) of the non-adopters can read and write (Table 3). This shows that adopters were more educated than non-adopters, and better educated farmers show better positive response to improved technology adoption. The educational status of the household members shows that 30 (44.8%) household of the adopters and 53 (46.9%) household of the non-adopters had at least a literate member in their household. The existence of a literate in the household enhances the technology adoption, since the information delivered by members of the household to the household head is highly accepted than other sources of information, because of the trust that exists between them.

The survey results show that the average household size of the adopters was 4.9 and non-adopters was 5.6 persons (Table 2), showing a slight difference between adopters and non-adopters, but the t-test statistics showed no significant difference. Doss *et al.* (2002) also did not find a clear relationship between household size and use of improved varieties.

In terms of age, the adopters were younger in age than non-adopters. It is generally accepted that younger farmers are more innovative than older ones. Mean age of adopters was 32.5 years and of non-adopters was 41.4 years (Table 2). The average age of non-adopters is larger by nine years over the adopters. The age structure of the sample farmers showed that the largest proportion of the respondents, 73% of the adopters were in the age group of 20 to 35 years and 75% of the non-adopters were above 35 years.

In the study area every farmer starts practicing farming at an early age of 15 years while living together with parents. On the average, the adopters had 16 years of farming experience while the non-adopters had 24 years (Table 2). The finding of this study, as the t-test statistics shows the adopters' and non-adopters' significant difference in their farming experience, is consistent with literature, which confirms that experienced and older farmers are reluctant to change their farming techniques. This study has identified that about 28.4% of the adopters had less than 10 years of farming experience whereas 16% had more than 30 years of farming experience. Most of the adopters (61%) had a farming experience ranging between 11 and 30 years while most of the non-adopters (64%) had a farming experience ranging between 20 and 45 years.

Table 2. Relationship between continuous variables and mean adoption of improved sorghum varieties.

Continuous variables	Adopters (n = 67)	Non-adopters (n = 113)	T-test	
			T-value	P-value
Age of household head (year)	32.46	41.36	-6.758	0.000
Household family size (No.)	4.91	5.57	-1.635	0.104
Farm size in *Qodi* (0.25 ha)	19.82	12.63	4.834	0.000
Farming experience (year)	16.16	24.45	-6.284	0.000
Distance to input market (km)	56.19	68.15	-7.933	0.000
Number of shoats (No.)	14.01	8.12	2.945	0.004
Yearly on-farm income (Birr)	47.84	40.75	0.445	0.657
Amount of credit taken (Birr)	348.15	287.18	1.181	0.241

The crop land holding of the sample respondents ranges from 2 to 50 *Qodi* (0.5 to 12.5 ha). The average crop land holding of the adopters of improved sorghum varieties was larger by 7.19 *Qodi* (1.8 ha) than the non-adopters of improved sorghum varieties (Table 2). Fifty one percent of adopters had crop land of 15 to 32 *Qodi*, whereas 70.8% of the non-adopters had 7 to 20 *Qodi* of crop land. This indicates that farmers having larger farm land will decide to adopt new technologies by testing on a portion of land without worrying about endangering the family food security (Ramasamy *et al*., 1999).

Sheep and goats are mostly sold when farmers need cash to buy improved seeds, food for the family and clothes for children; whereas camels and cattle are reared for milk production and prestige; and rarely sold. The average shoat holding of the adopters is 14 heads whereas the average shoat holding of the non-adopters is 8 heads (Table 2). This indicates that the average shoat holding of the adopters is larger by six heads per household over the non-adopters.

Regarding the type of house owned, 20.9 and 61.2% of the adopters live in corrugated iron and soil roofed house, respectively, whereas 49.6% of the non-adopters live in traditional house and only 8% live in corrugated iron house (Table 3). This indicates that the technology adopters live in better houses.

The sample respondents reported that the only source of income is from the sale of crop or animals. The yearly average income of adopters and non-adopter was 47.84 Birr and 40.75 Birr, respectively (Table 2). This information seems exaggerated due to the existence of food aid in the study area which makes the farmers reluctant to tell their actual income.

Out of the 180 sample farmers, 113 farmers did not use improved sorghum varieties during the year 2009 main cropping season and the perception most of them had regarding the yield of improved sorghum varieties was lower than the local cultivars. Sixty four percent of the non-adopters did know the production potential of improved sorghum varieties while 15% of them think its yield is inferior to the local cultivars. Twenty one percent of the non-adopters know that improved sorghum yield is superior to the local and the reason for the non-adoption was lack of improved sorghum seed. But, the adopters of improved sorghum varieties had positive perception towards the yield potential of the improved varieties. The response of the adopters regarding yield perception of improved sorghum varieties was 53 (79.1%) superior and 14 (20.9%) inferior (Table 3).

Sorghum yields are substantially higher for farmers who use inorganic fertilizer (Wubeneh and Sanders, 2001). The results of this study showed that hat only few farmers of both the adaptors (20.9%) and the non-adopters (17.7%) used inorganic fertilizers in their field (Table 3) while the rest (majority) of the respondent farmers did not apply fertilizers. The reasons provided by the farmers for not using mineral fertilizers on their farmlands were cash shortage to purchase (12.2%), unavailability of fertilizers (28.9%) and, unaffordable cost and unavailability of fertilizers (40%).

3.2. Institutional Factors

Regarding the distance taken to travel from home to the nearest input market place, the sample farmers reported that they had to travel an average of 63.7 km (adopters 56 km and non-adopters 68 km). This shows that the adopters were nearer to the input market than the non-adopters by about 10 km. The nearest input market in the study area is Jijiga town.

With regards to access to credit the percentage of those who had access to credit was higher for the adopters (68.7%) than for the non-adopters (34.5%) (Table 3). The source of credit for the respondents is mainly from friend farmers (23%), relatives (17.8%) and neighboring farmers (15.6%). The average credit amount taken over last year by the adopters was 348 Birr whereas the non-adopters on the average took about 287 Birr (Table 2).

Only 25.4% of the adopters and 19.5% of the non-adopters had contact with extension agents (Table 3). This is because the Regional Livestock, Crop and Rural Development Bureau gave less emphasis to extension service delivery. The extension agents in the study area do not have transportation facilities (motorcycle and bicycle) to travel to *kebele*s far away from their base. As a result, the extension agents are forced to travel few kilometers on foot to deliver extension information and advice.

Table 3. Relationship between categorical variables and adoption of improved sorghum varieties.

Categorical variables	Adoption (n)		Chi-square	
	Adopters	Non-adopters	X^2-value	P-value
Education of household			21.906	0.000
Illiterate	44	104		
Read and write	23	9		
Household having literate	30	53	5.660	0.341
Yield perception			76.450	0.000
Unknown	0	72		
Inferior	14	17		
Superior	53	24		
Use of fertilizers			0.280	0.596
Yes	14	20		
No	53	93		
Type of house owned			19.635	0.000
Traditional	12	56		
Soil roofed	41	48		
Corrugated iron	14	9		
Use of credit			19.674	0.000
Yes	46	39		
No	21	74		
Contact with extension agent			1.605	0.000
None	50	91		
Once	15	21		
Twice	2	1		
Radio owning			11.556	0.001
Yes	36	32		
No	31	81		

Among the mass media, radio was the only media used in the study area. Respondents who own radio constituted 37.8% (53.7% of the adopters and 28.3% of the non-adopters) of the sample (Table 3). Sixty two percent of the respondents prefer listening to agriculture program (64% of the adopters and 60% of the non-adopters). This can be a good opportunity to prepare extension information for farmers and broadcast through radio.

In general, the adopters of improved sorghum varieties were more educated, younger in age, had larger farm size, had more number of shoats, had better house, own radio and had positive attitude towards improved sorghum varieties when compared to the non-adopters, which are statistically significant with t-test and chi-square as depicted in Tables 2 and 3, respectively.

3.2. Factors Determining the Adoption of Improved Sorghum Varieties

Nine independent variables that were hypothesized to have an influence on adoption decision of improved sorghum varieties in the study area were included in the Logit model. Of these, four variables (age, the size of farm land, type of house owned and distance to input market) were found to have significant influences on the adoption decision of improved sorghum varieties as presented in the Logit model results shown in Table 4.

Table 4. Binary Logit estimates of adoption of improved sorghum varieties.

Independent variables	Coefficient	Wald statistics	Exp(B)	Significance
Constant	4.571	1.918	96.650	0.166ns
Age	-0.182	10.140	0.833	0.001**
Education level	1.669	2.060	5.304	0.151ns
Farm size	0.073	2.874	1.076	0.090*
Distance to input market	-0.112	8.144	0.894	0.004**
Number of shoats	0.030	0.631	1.030	0.427ns
Type of house owned	1.888	7.739	6.605	0.005**
Use of credit	0.002	2.452	1.002	0.117ns
Contact with extension agent	1.141	2.561	3.130	0.110ns
Owning radio	0.095	0.017	1.099	0.895ns

**, and * = Significant at less than $P \leq 0.01$ and $P \leq 0.10$ probability levels, respectively; ns = Non-significant at more than $P > 0.10$ probability level.

Regarding the fitness of Logit model, the chi-square of 62.94 appeared statistically significant, indicating that selected independent variables reduced the log likelihood ratio of the model. The classification table correctly predicted 84.8% of the adopters and 82% of the non-adopters, whereas the model correctly predicted 80.8% of the observations.

The age of the household head was found to be negatively and significantly related to the adoption of improved sorghum varieties, indicating the reluctance of the older farmers to change their farming techniques. This finding is similar with the study results of Million and Belay (2004) and Feleke and Zegeye (2006). Hence, younger farmers are more optimistic and risk takers to adopt new technologies whereas older farmers are pessimistic and resistant to change in their farming practices.

The other factor showed significant and positive influence was size of farm land, showing that farmers with larger farmland size can experiment with new technologies on a portion of their land. This finding is similar to the results reported by Mariam *et al.* (1993), Huque *et al.* (1996), Nkonya *et al.* (1997) and Ramasamy *et al.* (1999). Hence, framers who have better economic status and resources (land and better house) are more likely to adopt new agricultural technologies. Type of house owned had the highest odds ratio of adoption and had significant and positive influence on the adoption of improved sorghum varieties, indicating that economically better-off farmers are most likely to adopt improved varieties.

Distance to input market was also found to be negatively and significantly related to the adoption of improved sorghum varieties (Table 4) indicating that farmers far away from market centers are less likely to adopt improved sorghum varieties than those who are located near to input market centers. Tesfaye *et al.* (2001), Shiyani *et al.* (2002) and Feleke and Zegeye (2006) have also reported similar findings from their respective similar studies.

4. Conclusion

In this paper, demographic, socio-economic and institutional factors, which influence farmers' adoption decisions, were examined in the Awbere District of the Somali Regional State. The Logit model results indicates that the adoption of improved sorghum varieties is influenced by the age of household head, farm size, distance to input market and type of house owned.

The results of the study indicated that age of household head influenced the adoption of improved sorghum varieties negatively and significantly. This is because younger farmers are more likely to adopt a new technology, as they are more optimistic and risk takers than older farmers. Hence, introduction of new agricultural technologies in the area may be successful if it focuses on younger farmers.

Farm size is also found to affect the adoption of improved sorghum varieties positively and significantly. This is due to the fact that farmers owning larger farmlands can allocate a portion of their land to test improved crop production technologies. Hence, targeting farmers owning larger farm size may enhance the adoption and facilitate the dissemination of new agricultural technologies in the study area.

Farmers' wealth as proxy by type of house owned indicates the ability of farmers to agricultural inputs as this variable shows positive and significant effect on the adoption of improved sorghum varieties. Hence, better-off farmers can easily take and adopt improved agricultural technologies.

Access to information makes farmers to be aware of and get better understanding of improved agricultural technologies, which facilitates change in the behavior of farmers and ultimately leads to decision to take risk for technology adoption. Farmers who are nearer to market can obtain information regarding agricultural inputs, such as improved sorghum seed, which is clearly seen in the results of the Logit model. Hence, provision of market information may facilitate the transfer of new agricultural technologies in the area.

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