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Determinants of Improved Barley Adoption Intensity in Malga District of Sidama Zone, Ethiopia

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Abstract: The study was conducted in Malga district of Sidama Zone in Ethiopia to describe the socioeconomic characteristics of households and identify factors governing the intensity of barley adoption. The district was known with barley production. The study used both primary and secondary data. Multistage sampling techniques were used to select three peasant associations and 129 barley producing households. Descriptive statistics (mean, standard deviation and frequency) was used to describe variables under consideration whereas econometric model (Tobit) was applied to and identify the factors governing the adoption of improved barley. The result of analysis revealed that age, farm experience, oxen, membership of cooperative, distance to all weather roads and annual income were found to be significant variables affecting the intensity of barley adoption. Therefore, infrastructural development, providing inputs access, creating financial viability and strengthening farmer's organization are areas that need policy attentions.

Keywords: Intensity, Improved, Tobit, Adoption

1. Introduction

The agriculture and rural development policy direction of Ethiopia is to enable farmers use modern agricultural technologies and new agricultural practices efficiently and effectively thereby increasing production and productivity. Agricultural Growth Programme (AGP) and regular extension system have been making significant efforts in identifying and scaling up best agricultural practices to all farmers so that average productivity of smallholder farmers is transformed to the level of that of model farmers. Adoption of improved technologies offers a myriad of potential advantages for increasing productivity and income for smallholder farmers. However, none of these advantages were the only and immediate drivers for adoption of agricultural technologies by smallholders. Rather there were push and pull factors which encourage or discourage households to use improved technologies. Various models and approaches have been attempted and tested to identify drivers of adoption of technologies by potential clients. Some of the models try to study clients' characteristics and how these factors influence adoption of technologies [11, 18] while others explore the attributes of technology and its influence on the adoption of technology [11, 17]. Some schools of thought approach the issue by combining the clients, technology attributes and institutional factors [13] to understand the drivers of adoption and what factors drive its speed of diffusion and the path it follows.

To these effects, exploring the drivers for agricultural technologies adoption of smallholder farmers is believed to be vital to speed up the uptake and diffusion of the practices. Understanding adoption is still a challenge and drivers of adoption were poorly understood. This is both at farmers' level, which practices were adopted and which is not? But also looking at vertical scaling, how adoption takes place in the more institutional setting [6]. Thus, this study focuses on specifically identify the drivers and inhibitors for improved barley adoption intensity of smallholder farmers in study area. The specific objectives of the study were:

- To describe the socio-economic characteristics of households growing barley in the study area; and
- To identify factors governing the intensity of improved barley adoption in the study area.

2. Methodology

2.1. Study Area

This study was conducted in Malga district of Sidama Zone that found in the Southern Nations Nationalities and Peoples Region in Ethiopia. The district is divided in to 23 kebeles and has 3 rural towns. The district has an average annual temperature varies from 12-20°C. The average annual rainfall received by the district ranges from 1201-1600mm. The district located at an altitude ranges between 1501-3000masl and known with two main agro-ecological zones namely highland (78.3%) and midland (21.7%). The total area of the district is 32,651ha of which 18,177ha is cultivated land. In highland part that accounts the highest proportion of the district, enset (staple food); barley (cereal crop); potato (root crop); and vegetables like cabbage and carrot are among major crop grown in the district. The district has an estimated total populations of 109,793 persons of which of 55,676 were males and the rest 54, 117 were females [4].

2.2. Data Sources and Collection Method

This study was used cross sectional data collected in 2015. The study used data generated from both primary and secondary sources. Primary data were collected from smallholder farmers growing barley during the production season. This contains both quantitative and qualitative data collected from selected households with structured questionnaire. This questionnaire was pre-tested to verify the validity, improve the quality and its contents. Data collection was made with well experienced and trained enumerators. Household characteristics, resource endowments, infrastructural and institutional services were among data generated with this structured questionnaire. Secondary data were also used for this study. This data were collected through checklists and review of district reports, central statistical authority, proceeding and journals.

2.3. Sampling Procedures and Sample Size

This study employed multiple stage sampling method. In first stage, district was purposively selected based on barley production potentials and accessibility to interventions and data collection. In second stage, with the support of district office of agriculture officials, barley producing peasant associations of the district was purposively identified and of which three peasant associations were randomly selected. In third stage, with the help of the respective peasant association level officials, sampling frame (barley farmers) were identified out of which 129 households were randomly selected for interview using probability proportional to size.

2.4. Analytical Framework

Different analytical techniques were employed to describe the socioeconomic profiles of the respondents and indentify factors affecting the intensity of improved barley adoption in study area. Both descriptive statistics and econometric model were employed. Descriptive statistics such as mean, standard deviation and frequency were used to summarize the result of the variables under consideration. Tobit model was employed to analyze factors determining the intensity of improved agricultural technologies adoption among smallholder farmers growing barley. Dependent variable is improved barley adoption intensity which is measured as an area allocated for improved barley to the total area allocated for barley production.

It was specified as:

$$improved\ barley\ adoption\ intensity\ = \frac{area\ covered\ by\ improved\ barley\ varieties\ (ha)}{total\ area\ covered\ by\ both\ improved\ and\ local\ varieties\ (ha)}$$

Improved barley adoption intensity= f (sex, age, education, family size, farm experience, number of oxen, TLU, farm size, extension contact, credit access, distance to all weather roads, distance to the nearest market, membership to cooperative, annual income and dependency ratio).

SPSS version 21 was used for data entry and management whereas STATA-12 was used for data analysis both descriptive and econometric analysis.

3. Result and Discussion

3.1. Demographic and Socioeconomic Characteristics

The summary of statistics of the basic socio-economic characteristics of the barley farmers are presented in Table 1. In the study area the numbers of female head households are very low and result also showed that 93% of the respondents are male headed. On average, the age of farmers was about 47.27 years with respondents age ranges from 25-82 years. This implies the majority of smallholder farmer's ages are in the category of active labour forces. The average family size was about 7.8 with a minimum of 1 and maximum of 23 members. The majority of the barley farmers in the study area are literate (80.63%). The average farm size of the respondents was about 1.43 hectares, with the minimum and maximum of 0.13 and 14 hectares respectively. On average, the intensity of improved barley by stallholder farmers was 0.5224 implies out of the total area covered by barley about 52% of the area was covered by improved varieties. The average amount of fertilizers applied for barley used by farmers was 73.23kg/ha for DAP and 36.5kg/ha for urea. This indicates that fertilizers by smallholder farmers in the study area was far below national recommendation rate for both DAP (100kg/ha) and urea (100kg/ha). About 60% of the households were plant barley with row planting and membership to cooperative.

Table 1. *Variables description and their descriptive statistics.*

Variable	Description	Mean	Std. Dev
Improved barley adoption intensity	Area under improved barley divided to total barley production during the production season	0.5224	0.468
Gender	Sex of the household head where; 1=male, 0=female	0.9302	0.256
Age	Age of the household head in years	47.271	12.78
Education	Educational status of the household head where; 1= literate, 0=illiterate	0.8062	0.397
Family size	Total family size of the household (persons)	7.8682	3.336
Dependence ratio	Dependence ratio (household members aged less 15 + aged above 65) / productive labour force (household member between 15-65 age group)	0.8288	0.929
Farm experience	Farm experience of household head in years	26.984	12.94
Oxen	Number of oxen owned	0.5736	0.966
TLU	Total tropical livestock unit excluding oxen	6.4991	7.356
Farm size	Land holding size in hectare	1.4342	1.475
	Frequency of extension contact (1=high, 2= medium, 3= low)		
Extension contact	Medium extension contact (yes=1; 0= otherwise)	.5078	.5019
	Low extension contact ((yes=1; 0= otherwise)	.10156	.3032
Extension training -(1=yes)	Extension training use (1=participate, 0= not participate)	0.7829	0.414
Credit access	Access to credit where 1=yes, 0=no	0.5814	0.495
Cooperative membership	Membership to cooperative 1= yes, 0=no	0.5969	0.492
Distance to all weather road	How far the household resident from all weather roads in km	0.9805	1.891
Distance to the nearest market	How far the household resident from the nearest market in km	2.9185	2.86
Distance to the FTC (km)	How far the household resident from Farmers Training Centre in km	1.7896	2.065
Annual income	Annual income of the household in Birr (crop income + livestock income + nonfarm and off farm income)	12.007	21.55
Row planting	Row planting (1=yes)	0.5969	0.492
DAP use	DAP utilization (kg/ha)	73.296	34.25
Urea Use	Urea utilization (kg/ha)	36.507	20.15

Farmers who had accessed credit would help them to overcome financial constraints and create an opportunities to use farm inputs (fertilizer, improved seeds, pesticides). The result of analysis indicates 58% of respondents were accessed credit. Annual income used for this study is expressed in terms of returns obtained by the household from crop and livestock and the number of household members working off-farm in Ethiopian Birr. Cash is required for initial investments many new agricultural technologies. Total annual income (000Birr) was a continuous variable, which showed the total income of the household during the period. The mean of 12.0076 indicates that the mean annual income of the household was 12,007Birr.

3.2. Determinants of Barley Adoption Intensity (Tobit Model)

The decision and intensity of farmers to use technologies is a complex phenomenon and can be seen as a function of two mutually exclusive processes. The first stage involves about making the decision to adopt the technology, while the second stage involves about deciding on the level (i.e. the intensity or extent of use of that particular technology), given that adoption has taken place [12, 16]. Hence, in this line, the use of econometric models such as logit (to see the decision to adoption) and Tobit (to see the extent of technology adoption) enable to come up with conclusive findings for agricultural technology adoption. However, this study employed Tobit model to identify the determinants of the improved barley adoption intensity at household levels.

The presence of outliers, the problem of multicollinerity, heteroscedasticity and endogenety are major problems in cross sectional data. As a result there is a need to be check and addressed before analysis. The existence of heteroscedasticity in the error terms does not pose a serious problem in terms of obtaining consistent estimates as it only causes a bias in the estimates of standard errors and used robust standard error. Variance inflation factors (VIF) was computed for all explanatory variables that were used in the Tobit model and the result shows VIF were less than 10 that indicating multicollinerity was not a problem.

The result of the analysis revealed that the overall fitness of the model had found to be statistically significant at less than 1% probability level. Hence, the result of Tobit model shows that age, farm experience, oxen, membership to cooperative, annual income and distance to all weather roads presented in (Table 2) were found to be significantly influencing the intensity of improved barley adoption in the study area.

Table 2. *Determinants of improved barley use intensity.*

Barley use intensity	Coef.	Robust Std. Err.	t	P>t
Age (years)	-0.02**	0.0097	-2.06	0.041
Education (1=literate)	-0.159	0.1688	-0.94	0.35
Family size (person)	-0.029	0.0208	-1.41	0.162
Farm experience (years)	0.0156*	0.0091	1.7	0.092
Oxen (number)	0.1594**	0.0795	2	0.047
Tropical Livestock Unit excluding oxen (TLU)	-0.016	0.0108	-1.46	0.147
Farm size (ha)	0.0087	0.0542	0.16	0.872
Credit access (1=yes)	-0.139	0.1264	-1.1	0.274
Distance to all weather roads (km)	-0.154***	0.059	-2.61	0.01
Distance to nearest market (km)	-0.002	0.0069	-0.36	0.722
Membership to cooperative (1=yes)	0.3919***	0.1458	2.69	0.008
Frequency extension contact (high)				
Medium	-0.006	0.1318	-0.04	0.964
Low	-0.266	0.2381	-1.12	0.266
Annual income (000 Birr)	0.0084**	0.0036	2.34	0.021
Dependency ratio	-0.086	0.0933	-0.92	0.358
_cons	1.2436	0.4041	3.08	0.003

*, **, &*** are significance level at 10, 5 & 1% respectively.

The result of analysis revealed that age of the household would have a negative impact on the intensity of improved barley use adoption and found to be statistically significant at 5% probability level. A one year increase to the household age would decrease the intensity of improved barley adoption by 2%. This implies that as the household get old might reduce trust towards new technologies adoption as new technologies need financial investments (seed, fertilizers, chemicals, and labour) and intensive field managements. Similar result with the study by [3] pointed out that age had negative impact on crop adoption.

Farming experience was found to be positively influencing the intensity of improved barley use and statistically significant at 10% significance level. This means as farm experience of the household increase by one year the intensity of improved barley adoption increases by 1.6%. This is as expected because more experienced farmers might have better skills and access to new information about improved technologies. It could also imply that knowledge gained over time from working in uncertain production environment may help in evaluating information thereby influencing their adoption decision and intensity. Oxen owned were also found to be positively and statistically significant influences the intensity of barley adoption at 5% significance level. An increase of household oxen owned by one would increases the intensity of barley adoption by 15.9%. This implies that oxen ownership increases the probability of households to allocate more land for barley production.

Membership to cooperative had found to be positively influences the intensity of improved barley use adoption. It was statistically significant at less than 1% level. Being membership to cooperative would increase the intensity of improved barley use adoption by 39.2% as compared to non-membership to cooperative. Thus, being membership to cooperative would improves smallholder farmers to have better access to input services (fertilizers, seed, and chemicals), and technologies transfer among the farmers. This result confirm with the study by [1] that found the positive role of cooperative membership on technology adoption by smallholder farmers in Ethiopia. Hence, farmers could easily adopt technologies and apply them on time through cooperative membership. Membership to cooperatives allowed farmers to access affordable inputs that led to increased agricultural production and thereby farm income [14, 15]. Various studies also reported cooperative membership had a positive influence on technology adoption through enhancing access to information on improved technologies, material inputs of the technologies such as fertilizers and pesticides, and credit for the purchase of inputs and payment of hired labour [8, 9].

Total annual income was found to be positively and statistically significant at 5% level. This indicates there is positive relationship between barley adoption and annual income. It implies that when the total annual income of the household increases by 1,000Birr would increases the intensity of improved barley adoption by 0.84%. This finding confirms with many authors results that reported annual income has positive influence on technology adoption. This result in line with the study by [5] that reveals farm income was expected to provide farmers with liquid capital for purchasing productivity enhancing inputs such as improved seed and fertilizers, and this was expected to lead to a significantly higher adoption intensity and expenditure on purchased inputs among households. Similarly [2, 7] also found that total income has positive effect on technology adoption.

Distance to the all weather roads had found to be negatively and significantly at less than 1% significant level. This implies that farmers who are distant from all weather roads have less likelihood to adopt the improved barley use. As distance to all weather roads from farmers' resident increases by one kilometer the intensity of improved barley adoption would decreases by 15.4%. Distance to all-weather road, which was a proxy for market inaccessibility was found to have a negative and significant influence on intensity of technology adoption, indicating that farmers far away from all-weather were less likely to adopt technology than those who were located closer to all-weather roads. The probable reason could be farmers far away from the all weather roads were not motivated to produce barley due to poor access to information, infrastructures and extension services. The argument was that farmers far away from all-weather roads tended to be less market-oriented and pursued subsistence oriented objectives. This result goes along with the study done by [10] that found as market distance and use of inorganic fertilizer had a negative relationship.

4. Conclusions and Recommendation

Technologies play an important role in economic development and adoption of agricultural technologies is a key policy focus in order to bring change to the agricultural sector. A deeper understanding of the factors that play a positive role in wider adoption of technologies or inhibit technology adoption helps policy makers and other stakeholders design effective strategies. The result of the study revealed that age; farm experience; oxen; annual income; membership to cooperative; and distance to all-weather roads were found to be factors determining the intensity of improved barley adoption in the study area.

Age of the household decreases the intensity of improved barley adoption whereas the farm experience increases the intensity of improved barley adoption. This indicates that as farm experience get increases the household acquires new information, know the benefits of new technologies and develop confidence to use improved technologies. Thus, concerning bodies should give emphasis to involve farmers to exercise and use new technologies through demonstration, training and field days. Income is a proxy variable for capital availability for investment. It was found that households with higher annual gross income would be in a better position to adopt technology as they could invest in improved seed, fertilizer, pesticides and hire labour for various farming operations. Therefore, governmental and non-governmental organization should work on how to develop financial position (saving and investing their resources) and or create financial access (credit) of the smallholder farmers.

Distance to the all-weather roads from residence of the household was also found to be negatively determining the intensity of improved barley adoption. One way forward to increase market and transportations access of rural people is to improve the infrastructures like market points and roads constructions. As a result, rural people could be easily accessible to transportation services and visit to nearby market (inputs and outputs market). Therefore, national and regional level concerning bodies should invest on improving rural road infrastructure through development and maintenances of the rural roads networking that provide services all year round. Cooperative membership was also positively and significantly influences the intensity of improved barley adoption. Memberships to farmer organizations are more likely to be aware of new practices and technologies as they are easily exposed to information. Promoters of farmer groups should direct efforts in ensuring the efficacy of the strategy in enhancing productivity thereby improving the welfare of farmers. Farmers' organization should be strengthened and much effort should undergo to capacitate their human and financial resources so that they can be the center for technology transformation as well as for the overall development of the agricultural sector. So that, the concerned bodies should formulate a strategy for rewarding and recognition for those farmers who are genuinely successful and be goal oriented.

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