Determinants of adoption of improved sorghum package in agro-pastoral households of Somali Region of Ethiopia: A gender perspective

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The study analysed determinants of adoption of improved sorghum package between male-headed and female-headed households. The specific objectives were to analyse adoption differentials of improved sorghum package, and to identify factors that affect adoption decision of improved sorghum package by male and female-headed households. Purposeful sampling method was employed to select Woreda of sorghum growers with greater number of female-headed households with the aim to involve the required number for the analysis. A multi-stage stratified random sampling technique was used to select four PAs out of 23 PAs in the Woreda and households to be interviewed were derived proportionally to the size of the number of household in each PAs. Cross-sectional research design was applied to collect data from a total of 180 respondents in this study whereby 90 were female-headed and 90 were male-headed households. Pre-tested structured interview questionnaire was used for collecting the essential quantitative data. The Logistic Regression model results revealed that the adoption of improved sorghum package is biased by gender, where Female-Headed Households adopt the package relatively less. Regarding factors affecting adoption decision, non-farm activity had a significant and positive influence on the adoption decision of improved sorghum package, whereas distance to market had a significant and negative influence on the adoption decision for Male-Headed Household. Extension contact, family active labour force, attitude toward sorghum package had a significant and positive influence on adoption decision of Female Headed Household, whereas cosmopolitaness influences negatively. Therefore, policy should address gender disparities in extension services and access to resources that exist because of socio-cultural and institutional factors limiting the adoption of technologies for Female Headed Household. Thus, enhancing efficient delivery of extension with due consideration of the participation of female headed household would improve the livelihood of the households.

Key words: Adoption, gender, agro-pastoral, sorghum package, Somali Region.

INTRODUCTION
Ethiopia is fundamentally an agrarian country and agriculture is Ethiopia’s most important sector, crucial for...
the country’s food security and the livelihoods of its people. The sector is the largest contributor to the overall economy and is fundamental to Ethiopia’s overall development. The agriculture sector continues to be the most dominant aspect of the Ethiopian economy, accounting for nearly 42% of GDP, 80% of employment, and 83.9% of foreign export earnings (Matouš et al., 2013).

Despite of its contribution to the national GDP by large, agriculture in Ethiopia is subsistence. Smallholder farmers are cultivating 95% of their farmland using mostly traditional farming practices and inadequate improved technology can be found in the low productivity Ethiopian agriculture (Zerihun et al., 2014). Productivity in the agricultural sector has been hampered and food insecurity in the rural households of the country aggravated mainly by, among others, low level of technological development or utilization, low adoption rate of modern agricultural technologies, resource degradation, and gender bias.

For past decades, tremendous efforts have been made by the Ethiopian Agricultural Research Systems and Minister of Agriculture and Rural Development (MoARD) to develop and disseminate agricultural technology packages to different regions of the country using on-farm verification, pre-extension demonstration, popularization, training and extension publications. In the Somali region of Ethiopia, package based extension program was started in 1996 in two zones, namely Fafan and Siti. The technologies which were assumed to be appropriate to Jijiga Woreda had been introduced from agricultural research centers of the country. The technologies that had been introduced and distributed to agro-pastorals were different varieties of improved sorghum, namely, Gambella, Birmash, Dinkmash, Kobomash, Seredo and 76 T1 #23 (RBoA, 2002).

Despite most studies on gender division of labour in agricultural sector revealed that up to 40% of farming activities are done by women, especially in food production and processing (FAO, 2011). A closer look at the different extension approaches reveals that technologies have been implemented without the participation of the people for whom they have been designed. Given the poor performance of agriculture, a significant number of people have suffered from food shortage. Obviously, women and their children are the usual victims of such problems. There is ample evidence that the access of rural women to agricultural services is particularly poor, as documented in the Gender in Agriculture Sourcebook, women have unequal access to key agricultural inputs such as land, labor, knowledge, fertilizer, and improved seeds (WomenUN, 2015).

Failure to recognize the roles, differences and inequities between men and women poses a serious threat to the effectiveness of the agricultural development (Worldbank, 2009). Increasing women’s access to land, livestock, education, financial services, extension, technology and rural employment would boost their productivity and generate gains in agricultural output and food security (FAO, 2011). Therefore, the study was conducted with the objective of identifying factors affecting adoption decision of improved sorghum package by male and female headed households.

RESEARCH METHODOLOGY

Description of the study area

Somali Region is one of the largest regions in Ethiopia. The specific survey area, Jijiga Woreda, is one of the ten Woredas of Fafan zone and it is located at the Northeast part of Somali Region. Its altitude ranges from 1,600 to 1,700 m above sea level and it receives an annual rainfall varying from 500 to 600 mm (Figure 1). The area experiences bimodal type of rainfall that occurs from March to late May and from July to mid-October (JZOA, 2001). The mean minimum and maximum temperature ranges from 16 to 20°C. The total population of Jijiga Woreda is 276,816; of this, the rural population constitute 151,232 of which 69,310 is female and 81,922 is male; and there are two farming systems in the Woreda, viz, agro-pastoral and sedentary farming systems (CSA, 2008).

Type and data sources

For this study, both primary and secondary data sources were used. Primary data were collected from sample respondents (both male headed and female headed households in the selected PAs, DAs and key informants) through pre-tested structured interview schedule. Secondary data sources were the various documents (government policy documents) and reports (official and research reports) that are readily available and also those documents written based on the evidences from the study area.

Sampling technique

The study adapted purposive and multi-stage random sampling procedures with the rural households as the ultimate sampling unit for acquiring primary data. Jigjiga Woreda was selected purposively as a representative of the agriculturally potential area in the region. Multi-stage sampling techniques were followed to select PAs and households for the study. In the first stage, four peasant associations (PAs) participating in extension activities and with more number of female-headed households were selected purposively. In the second stage, 180 farm household heads were selected with probability proportional to size from the selected PAs with ensuring at least 50% FHH in the sample.

Methods of data collection

For this study, pre-tested interview schedule consisting of different types of questions related to the topic of the research and relevant variables was used for collecting the essential data. Group discussion has been used to crosscheck the data collected through formal survey and also to generate additional contextual data. Prior to the final administration of the interview schedule, six enumerators who have knowledge about the area and those who are well acquainted with culture and language of the society were selected, trained and employed for the data collection.

Based on the responses obtained from pre testing adequate non-sample respondents, essential amendments were made on
pertinent issues such as ordering and wording of questions and coverage of the interview schedule. As a result, some questions were deleted; those found important had been incorporated in the final version of the interview schedule. Then using the pre-tested structured interview schedule, primary data were collected.

Data analysis method

Adoption is a decision to make full use of an innovation at best appropriate course of action available (Rogers, 2010). For this study, in order to categorize farmers into adopters and non-adopters of the sorghum package, adoption index of individual farmer was calculated. The adoption index (AI) varies from 0 to 1 depending up on farmer’s degree of adoption of the package components. On the basis of adoption index, respondent farmers were classified into adopter and non-adopter. Farmer who was using seed plus two or more (50%) of the component was considered as adopter otherwise the farmer was considered non-adopter. Once the sampled households are categorized as adopter and non-adopter households following their calculated adoption index, adoption thus became the dummy dependent variable which is affected by different factors. Therefore, adoption in this study takes value of 1 if the sampled household is adopter and takes the value 0 if the sampled household is non-adopter.

Al = Number of practices used by the farmer/Total number of practices in the package

where Al is adoption index of ith farmer.

The households’ data were analyzed using econometric model, so as to draw meaningful inferences about the problem under investigation. The logit and probit modes guarantee that the estimated probabilities will lie between an interval of 0 - 1 (Gujarati and Porter, 1999). Because of this and other advantages, the logit and the probit models are the most frequently used models when the dependent variable happens to be dichotomous (Liao, 1994; Maddala, 1986).

For this study, logit model was used to identify the determinants of gender disparity in adoption of sorghum package. Hereunder, the functional formula of the logit model was specified following (Gujarati and Porter, 1999; Aldrich et al., 1984) the functional form of logit model was specified as follows:

\[
P_i = E(Y_i / X_i) = \frac{1}{1 + e^{-(\beta_0 + \beta X_i)}}
\]

(1)

\[
P_i = E(Y_i / X_i) = \frac{1}{1 + e^{-Z_i}}
\]

(2)

where \( P_i \) is a probability of adopting a given sorghum package for the ith farmer and ranges from 0 to 1; \( Z_i \) is a functional form of n explanatory variables (X) which is expressed as:

\[
Z_i = \beta_0 + \sum_{i=1}^{n} \beta_i X_i, i = 1, 2, 3 \ldots \ldots n
\]

where \( \beta_0 \) is the intercept and \( \beta_i \) are the slope parameters in the model. The slope tells how the log-odds in favor of sorghum package adoption change as independent variables change by a
unit. If \( P_i \) is the probability of adopting a given sorghum package, then \( 1 - P_i \) indicates the probability of not adopting, which can be given as:

\[
1 - P_i = \frac{1}{1 + e^{z_i}}
\]  

(3)

Dividing Equations 2 by 3 and simplifying gives:

\[
\frac{P_i}{1 - P_i} = e^{\beta z_i}
\]

(4)

Equation 4 indicates the odds ratio in favour of adopting improved sorghum package. It is the ratio of the probability that a farmer would adopt the package to the probability he/she would not adopt. Lastly, the logit model is obtained by taking the natural logarithm of Equation 4 as follows:

\[
L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n
\]

(5)

where \( P_i \) = the probability that \( Y = 1 \) (that the event occurs or probability of adoption); \( 1 - P_i \) = the probability that \( Y = 0 \) (that the adoption does not occur); \( L \) = the natural log of the odds ratio or logit; \( \beta_i \) = the slope, measures the change in \( L \) (logit) for a unit change in explanatory variables \( X \); \( \beta_0 \) = the intercept. It is the value of the log odd ratio, \( \frac{P_i}{1 + P_i} \), when \( X \) or explanatory variable is zero.

Thus, if the stochastic disturbance term \( (U_i) \) is taken into consideration the logit model becomes:

\[
L_i = \beta_0 + \beta_1 X_1 + u_i
\]

(6)

**Operational variables**

**Dependent variables**

Sampled households’ adoption decision of improved sorghum package is the dependent variable in this study. This is a dummy variable taking value of 1 or 0 depending on the calculated value of the adoption index that a given sampled household gets. A sampled household who is using seed plus two or more (50%) of the component is considered as adopter and the dependent variable takes the value 1 and otherwise is considered as non-adopter and takes the value 0. Adoption index of individual farmer was calculated using the formula:

\[ AI_i = \text{Number of practices used by the farmer} / \text{Total number of practices in the package} \]

where \( AI_i \) is adoption index of ith farmer.

**Explanatory variables in the model**

Farmers’ decision to adopt or reject the sorghum package is expected to be influenced by different factors such as household characteristics, socioeconomic and physical environment in which farmers operate. The model assumes that the dependent variable of this study depends on the age and education level household head, size of farm land owned, the household’s active labour force, livestock holding, off-farm income, non-farm activity, wealth status, extension contact, access to credit, market distance, extent of domestic chores, Cosmo politeness, and attitude towards sorghum package. The codes, definitions, direction of influence, measurements and summary statistics of the hypothesized explanatory variables are presented in Table 1.

**RESULTS**

In order to identify the most important factors which determine household’s sorghum package adoption from the hypothesized potential variables, binary Logit model was estimated by employing SPSS Version 16.0.

As indicated in Tables 2 and 3, the value of the VIF for continuous variables and contingency coefficient for discrete/dummy variables revealed that there was no problem of multicollinearity or association between the continuous and categorical variables, respectively, and thus, all of the explanatory variables were included into logistic analysis. Regarding the fitness of Logit model, the chi-square of 67.99 and 58.014 appeared statistically significant for MHH and FHH, respectively, indicating that selected independent variables reduced the log likelihood ratio of the model. The classification table correctly predicted 83.3 and 95% of MHHs adopters and non-adopters, respectively and 73.1 and 93.8% of female Headed household’s adopter and non-adopters, respectively. The model correctly predicted 91.1 and 87.8% of MHHs and female headed household’s observations.

Among the thirteen selected independent variables for the model, four for female headed households and two for MHHs were significant with respect to sorghum package adoption. These variables include market distance (DISMARK) and non-farm (NONFARM) for MHHs and family active labour (FACTLAB), extension contact (EXTCONT), Cosmo politeness (COSMO) and attitude toward sorghum package (ATTITUDE) for female headed households. The remaining explanatory variables were found to have non-significant influence on sorghum package adoption for both female headed households and MHHs.

**DISCUSSION**

Distance to market was found to be negatively and significantly related to the adoption of improved sorghum package for MHH (Table 4) indicating that farmers located nearer to market centres will have a higher probability of getting information and access to inputs and thereby adopting improved sorghum package. More specifically, The odds ratio for market distance indicate that keeping the influence of all other factors constant,
Table 1. Explanatory variables, hypothesized signs and their measurements.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Variable</th>
<th>Expected sign</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>-</td>
<td>Continues variable in years</td>
</tr>
<tr>
<td>2</td>
<td>Education level</td>
<td>+</td>
<td>Dummy: 1 for literate, 0 for illiterate</td>
</tr>
<tr>
<td>3</td>
<td>Family labor force</td>
<td>+</td>
<td>Continuous variable in number of active labor force in the household</td>
</tr>
<tr>
<td>4</td>
<td>Farm size</td>
<td>+</td>
<td>Measured in hectares</td>
</tr>
<tr>
<td>5</td>
<td>Non-farm income</td>
<td>+</td>
<td>Dummy: 1 for participating, 0 for not participating non-farm activity</td>
</tr>
<tr>
<td>6</td>
<td>Off-farm income</td>
<td>+</td>
<td>Dummy: 1 for participating, 0 for not participating off-farm activity</td>
</tr>
<tr>
<td>7</td>
<td>Size of livestock holding (TLU)</td>
<td>+</td>
<td>Continuous number of TLU in the HHs</td>
</tr>
<tr>
<td>8</td>
<td>Wealth status</td>
<td>+</td>
<td>Based on local wealth indicators farmers Labeled as 1:rich, 2:medium, 3:poor</td>
</tr>
<tr>
<td>9</td>
<td>Extension contact</td>
<td>+</td>
<td>Dummy variable in that if the farmer gets extension service it is coded as 1 and 0 otherwise</td>
</tr>
<tr>
<td>10</td>
<td>Access to credit</td>
<td>+</td>
<td>Dummy variable in that, if the farmer gets credit service coded as 1 and 0 otherwise</td>
</tr>
<tr>
<td>11</td>
<td>Market distance</td>
<td>-</td>
<td>Measured in terms of kilometers</td>
</tr>
<tr>
<td>12</td>
<td>Extent of domestic chores</td>
<td>-</td>
<td>Continues by calculating mean score of household out of 14 domestic chore activities</td>
</tr>
<tr>
<td>13</td>
<td>Cosmopoliteness</td>
<td>-</td>
<td>Dummy variable in that if the farmer has access to outside it is coded as 1 and 0 otherwise</td>
</tr>
<tr>
<td>14</td>
<td>Attitude towards sorghum package</td>
<td>+/-</td>
<td>Measured using a summated rating (likert) scale</td>
</tr>
</tbody>
</table>

Source: Own, Hypothesized Relationship of Dependent and Independent Variables.

Table 2. Variance inflation factor (VIF) for continuous explanatory variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>MHH</th>
<th>FHH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>Tolerance</td>
</tr>
<tr>
<td>Age</td>
<td>0.213</td>
<td>0.787</td>
</tr>
<tr>
<td>Family active labor force</td>
<td>0.359</td>
<td>0.641</td>
</tr>
<tr>
<td>Farm size</td>
<td>0.035</td>
<td>0.965</td>
</tr>
<tr>
<td>Market distance</td>
<td>0.167</td>
<td>0.833</td>
</tr>
<tr>
<td>Attitude toward package</td>
<td>0.308</td>
<td>0.692</td>
</tr>
<tr>
<td>Domestic chores</td>
<td>0.161</td>
<td>0.839</td>
</tr>
<tr>
<td>TLU</td>
<td>0.096</td>
<td>0.904</td>
</tr>
</tbody>
</table>

being an adopter of sorghum package will decrease by a factor 0.873 as the distance increases by a single kilometre. The finding is in agreement with the findings of Kassa et al. (2013), who reported similar findings from their respective studies. However, it was found that there is negative but insignificant influence on adoption decision for female headed households, because as the prevailing gender division of labour, going to market is the daily routine activity of women, regardless of market distance.

In line with our expectation, non-farm income of households showed positive and significantly related to adoption for MHHs. This indicates having extra income from non-farm activity
providing financial benefit to farmers in turn positively influence farmers to invest on sorghum package technology. According to this finding, as the non-farm income level of household heads increases by one unit the likelihood of adopting sorghum package increases by a factor of 0.121. However, FHH non-farm activities were shown non significant. This might be due to that, majority of women in the study area use to expend their income for their household immediate consumption needs rather than for improved package.

The result of the logit estimate in relation to extension contact showed that there is positive and statistically significant influence in the adoption decision of FHH. It was found that, FHH farmers who received visits by extension agents adopt technologies than others. More specifically, as one unit increase of contact to extension, the odds in favour of adopting improved sorghum package increases by a factor of 11.638. This agrees with the finding of Bekele (2015) and Egge et al. (2012) who found the speed of adoption is greatly influenced by the intensity of technical information received from extension agents. However, in the model result, male headed household (MHH) extension contact showed non-significance in relation to adoption because of most male farmers were unwilling and resistant to practice the extension message that they were receiving from Development Agents (DAs).

The other factor found positive and significantly related with adoption of sorghum package for FHH was household’s labour force. This indicates, large active labour force provides sufficient labour for farming operation and those farmers who have access to labour are more likely to adopt improved sorghum package than those who lack labour. The odds ratio indicates that keeping the influence of all other factors constant, being an adopter of sorghum package will increase by a factor of 1.922 as the family labour increases by a single unit. This result is convergent with the findings of Asmelash (2014). However, it is found that there is positive but insignificant influence on adoption decision for MHH. The probable reason for this is that, MHH farmers use their labour for the generating of non-farm income like that of labour for other farm to gain extra income for the household.

Attitude of farmers was hypothesized to influence adoption of sorghum package. The result of logit model shows that attitude towards sorghum package is positively and significantly related with adoption of the technology. The finding implies that those individuals who have favourable attitude towards sorghum technology usually create positive environment to accept new ideas and innovations.

Cosmopilite individuals adopt new practices earlier than other community members. On the basis of such assumption, the exposure of respondents to outside world was expected to positively affect the adoption of sorghum package. However, the logit model result shows that cosmopoliteness in the study area is negatively and significantly related with adoption for FHH. This might be that, the more they go outside the more they tend to focus community activity and pay less attention to their crop. However, this variable’s influence on the adoption decision of MHH is statistically non-significant. The possible reason for this is that, MHH in agro-pastoral spend more time on social and community affairs like conflict resolution and visit to relatives.

**CONCLUSION AND RECOMMENDATIONS**

Agricultural scientists and researchers have developed number of technologies that can increase the productivity
of farmers, but farmers’ especially female farmers often did not use these technologies, because the technologies did not meet their needs. Moreover, needs and priorities of women farmers especially FHH have been rarely considered in the past in the research and development of agricultural technologies. Based on the main findings of the study, the following recommendations are forwarded.

Farmers’ deviation from recommended package practices was found partly due to poor extension service. Moreover, there are rigid cultural taboos that discourage women farmer’s involvement in extension service and limits women participation in extension events that are conducted. Therefore, policy makers and government officials need to assure farmers’ accessibility to proper extension services equally for both men and female households. This can be achieved by revisiting extension service so as to improve farmers’ access to information and extension advice and establishing FTC centres which are not far from the household territory.

Distance from market centres is one of the factors influencing adoption of sorghum package. These variables were found to affect the adoption negatively. Farmers were found very far away from market centres not motivated to adopt the package. Therefore, it is important to take some risk minimizing measures. This can be done by organizing the farmers into marketing cooperatives and establishing connections with wholesalers in the towns.

Non-adopter of sorghum package was found to be influenced among other things by income position of male farmers such as availability of non-farm activity in the study area. Therefore, organizing farmers into cooperative unions like saving and credit and creating income generating activities may enhance their income and improve their level of adoption in improved sorghum package.

The result of the study indicates that, women farmer’s attitude toward sorghum package influences sorghum adoption positively and significantly. Therefore, increasing farmer’s awareness on improved sorghum package through awareness creation meeting, using religious and community elders as bridge for transferring and popularizing improved package and using field days for showing the advantage of new sorghum technologies is recommended.

Large active labor force provides sufficient labor for farming operation, the result of the study indicated that, women farmer’s awareness on improved sorghum package positively and significantly. Family with high active labor force is more likely to adopt a new technology such as use of improved sorghum package. Hence, introduction of new agricultural technology in the area may be successful if the technology generators and developers take into consideration the labour aspect of the target households.

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**Table 4. Logistic regression estimates household’s adoption of sorghum package.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>MHH (N=90)</th>
<th>FHH (N=90)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>S.E.</td>
</tr>
<tr>
<td>AGE</td>
<td>0.005</td>
<td>0.036</td>
</tr>
<tr>
<td>EDUCA</td>
<td>2.436</td>
<td>1.658</td>
</tr>
<tr>
<td>FAMACTLAB</td>
<td>0.240</td>
<td>0.270</td>
</tr>
<tr>
<td>FARMSIZ</td>
<td>0.116</td>
<td>0.121</td>
</tr>
<tr>
<td>MARKDIS</td>
<td>-0.136</td>
<td>0.040</td>
</tr>
<tr>
<td>EXTCONT</td>
<td>0.801</td>
<td>1.375</td>
</tr>
<tr>
<td>COSMOPOLITE</td>
<td>-1.492</td>
<td>1.044</td>
</tr>
<tr>
<td>ATTSUM</td>
<td>0.234</td>
<td>0.151</td>
</tr>
<tr>
<td>OFFARM</td>
<td>-0.260</td>
<td>1.224</td>
</tr>
<tr>
<td>NONFARM</td>
<td>2.113</td>
<td>1.240</td>
</tr>
<tr>
<td>DOMCHOR</td>
<td>-0.009</td>
<td>0.341</td>
</tr>
<tr>
<td>WEALTH_STAT</td>
<td>1.508</td>
<td>1.976</td>
</tr>
<tr>
<td>TLU</td>
<td>0.049</td>
<td>0.097</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.627</td>
<td>5.485</td>
</tr>
</tbody>
</table>

-2 Log likelihood ratio: 46.576, 50.193
Pearson Chi-square ($\chi^{2}$): 67.996, 58.014
Correctly predicted: 91.1, 87.8
Likelihood of adopter: 83.3, 73.1
Likelihood of non-adopter: 95, 93.8

Significant at *P<0.1; **P<0.05; ***P<0.001.
CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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