Determinants of pastoral communities for adoption of forage production technology in Yabello rangeland, Southern Ethiopia

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ABSTRACT

Forage production has been regarded as one of the suitable strategies for increasing feed availability for enhanced livestock production among pastoralist communities in the rangeland of Yabello. There are factors for determining the adoption of these practices and these vary with different socio-demographical issues within the pastoral household. This study was therefore conducted to assess the socio-economic and demographic factors influencing households’ participation in forage production in Yabello rangeland of Southern Ethiopia. Data were collected from 210 households and 6 extension workers (making a total of 216 interviewers) through interviews using semi-structured questionnaire. The results showed that gender of household head, education, social/development group membership and access to extension services were the most important factors influencing households’ participation in forage production. There is need for technical support to the pastoralist households towards starting and/or joining existing social groups, through which extension and training services aimed at enhancing forage production in the Yabello range land can be offered.

Key words: Forage production, pastoralists household, Yabello, technology adoption.

INTRODUCTION

The pastoral rangelands of Ethiopia are located around the peripheral or the outer edge of the country, almost surrounding the central highland mass (Alemayehu, 2004). Livestock in Ethiopia is dependent primarily on native grasslands and crop residues (Kassahun, 2008). According to Alemayehu (2003), Ethiopia’s Livestock feed resources are mainly natural grazing and browse, crop residues, improved pasture, and agro-industrial byproducts. The feeding systems include communal or private natural grazing and browsing, cut and- carry feeding, hay and crop residues. The availability and quality of forage are not favorable year round. As a result, the gains made in the wet season are totally or partially lost in the dry season (Kidake et al., 2016). Inadequate feed during the dry season is a major problem that causes decline in the productivity of ruminants (Joosten et al., 2014). Traditional knowledge of pastoralist in natural resources management and utilization has been playing important role in improving and developing range land use system in Ethiopia. The pastoralists have been using the traditional grazing management in order to cope up with the relatively arid condition of the environment, prevent overgrazing and ensure the sustainability of the resources base. Pastoralists use flexible grazing strategies. Overall, their gazing management is the result of their cumulative knowledge about resources, assessment of range condition and distribution of rainfall (Tilahun et al., 2017). These traditional practices are good experiences on the basis of which it is possible to develop improved pastoral system. But, currently the challenge of rangeland degradation is beyond the knowledge of the community to manage on their local practice. As a result, the utility or potential utility of the range land declined in an alarming state (Hasen, 2013). The major cause of rangeland degradation and
forage reduction on the Yebello rangeland area are drought, erratic rainfall, Bush encroachment, Over population, overstocking and different anthropogenic factors (Gamedo et al., 2006). These major causes lead to poor quality pasture, which is a major constraint to livestock production in the study area (Daniel, 2010). Forage degradation has been pointed out as the most limiting factor for livestock production in the Yabello rangeland area ASALs of Kenya (Ayana et al., 2012). Reduced livestock productivity and increased mortality are the main effects arising from lack of livestock feed. The far reaching effects of this are low production of milk and meat, increased vulnerability of pastoral livelihoods and high poverty levels among the pastoral communities (Joosten et al., 2014). Being the most important requirement for livestock production, availability of high quality forage directly reflects success in livestock production (McOpiyo et al., 2013) and therefore pastoral livelihoods. The need to increase livestock productivity in the Yabello has led to high demand for not only adequate but also better quality forage thus calling for improved forage production practices (Manyeki et al., 2015). To address the problem of pasture scarcity, a number of forage production technologies have been introduced in collaboration by the government of Ethiopia and China (project name; Technology integration and demonstration of rangeland rehabilitation in lowland of Ethiopia) mainly in the Yabello rangeland. However, uptake of these technologies by pastoralist has been found to be dependent on various factors. There are no past studies that reported the constraints of adaptation of technological based forage production for sustainability utilization for livestock production in the study area. Therefore, the aim of this study was to assess factors influencing the adoption of forage production practices among pastoral communities in the Yabello rangeland area.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Dida Tuyura, Danbal-Waccu and Arero kebele of Yabello district, Borana zone, southern Ethiopia in 2019. It is situated at 566 km south of Addis Ababa along Addis – Moyale road. The area of Yabello town is 5426 km², and located between 4°30’55.81” and 5°24’36.39” north latitude and between 7°44’14.70” and 38°36’05.35” east longitude, the altitude is about 1000-1500 m, with maximum altitude of 2000 m. Climate type is arid and semi-arid, annual average temperature is 19-26°C. The rainfall of the area is characterized as bi-modal. Thus, the 73% of rainfall occur in March to May, the 27% of rainfall occur in September to November (Dalle et al., 2015). The potential evapotranspiration is 700-3 000 mm (Billi et al., 2015). The study area also is dominated by savannah vegetation containing mixtures of perennial herbaceous vegetation.

Sampling procedure and data collection

Three (3) kebeles (Dida Tuyura, Danbal-Waccu and Arero kebele) were purposively selected from Yabello district based on past experience showing willingness to adopt various technologies directly or indirectly used for scale up forage production including the ongoing project (Technology integration and demonstration of rangeland rehabilitation in lowland of Ethiopia). In each of the three kebeles, 70 households were sampled using systematic random sampling resulting in selection of 210 households for the interviews. Also, from each kebele, two (2) agricultural and livestock extension workers were selected of total 6 professionals used for both interviewed data collection and also as guidance of understanding the context to guide the design of the study approach and development of data collection tools. In total, the data were collected from 216 individuals. A pre-tested questionnaire was administered to the selected households through face-to-face interviews to capture information on socio-economic and demographic characteristics of the respondents. This was done with the help of 6 extension workers who had been selected and adequately trained to give them full understanding of the questionnaire and the objectives of the study. In addition, Four (4) focus group discussions each comprising 15 participants, and 10 key informant interviews were conducted in each study site in order to get clarification and better understanding of the information gathered from household interviews (Ngenga et al., 2016). The key informants were selected mainly based on their age, forage production experience, willingness of acceptance implementation of the service given by local extension worker, livestock production capacity and the main service providers drawn from government institutions and non-governmental organizations.

Data analysis

Descriptive and inferential statistical analyses were done using Statistical Package for Social Science (SPSS) version 22. Descriptive statistics including means, standard deviation (SD), frequencies and percentages were generated for the selected socio-demographic characteristics of the sampled households. Binary logistic regression was done to determine factors that influence participation in fodder production.

Description of variables (both dependent and independent)

The dependent variable used in the logit regression model
was participation in forage production. The sample was classified into forage producers and non-producers based on the question whether the respondent was producing forage or not. The value of “1” was assigned to forage producing respondent, while “0” was assigned to a non-producing respondent.

As seen in Table 1, the independent variables are age, gender and education of household head, size of land owned by household, herd size owned by the household, access to extension services, and membership to forage producing group involvement, which hypothesized to influence the dependent variable, that is, forage production methods.

### Age of household head

Age of household head is a key factor that is expected to directly influence availability and access to production and livelihood resources (Lugusa, 2015). According to different studies, square of age is negatively associated with uptake of new technologies and this indicates that the potential of household to exercise new technology is likely to decline after a certain age (Omollo, 2017). This was said when younger household farmers were compared with old household farmers: younger households are more risk takers and highly willing and initiative to change their lifestyle and farming practice through practice and adoption of new technology and need to improve their income source. So based on this past experience, for this study, we hypothesized that age has a negative relationship with adoption of forage production technology. So, the age of the household that participated in our study were categorized and assigned the value of 1 if 30 years or less, 2 if 31 – 40 years, 3 if 41 – 50 years, 4 if aged between 51 and 60 year, 5 if 60 –70 years and 6 if above 70 years.

### Gender of household head

In most African country including Ethiopia, females have limited opportunity to access and participate in household farming practice including livestock production as compared with male. With regards to this aspect, women headed households are constrained by limited access to Natural resources and technology adaptation practice (Wasonga, 2009). So, in this study, we hypothesized that male headed household are more chance to involve and adapt forage production technology as compared with female headed household. In this study, we assigned value of 1 to male headed households and 2 to female Headed households.

### Education level of household head

Measured in terms of the number of years spent by respondent in school, education creates great acceptance and an opportunity for pastoral and agro-pastoral households to diversify their livelihood sources (Muyanga, 2008). Better educated household has better understanding and perceives the benefit of new technology and apply it without any more doubt. As a result, household level of education has a positive impact on forage technology adaptation and practice and we assigned the value of 0 if not educated, 1 if attained primary education, 2 for secondary education and 3 for household heads with tertiary education, for this study.

### Household land size

Land size of the household determines the amount of land planned for forage production purpose. This indicates that if the household have more/large land size, the land size planned for forage production purpose too will be large and if total land size is small, the part that is used for forage production will be small. As a result, the hypothesis indicates that the land size has positive association with forage production and its technology adaptation and as such, was assigned a value of 1 if 10 acres or less, 2 for 11 – 20 acres, and 3 if greater than 20 acres for this study.

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**Table 1:** Variables hypothesized to influence pastoralist participation on forage production technology

| Variable | Description | Expected influence on participation of forage production |
|----------|-------------|--------------------------------------------------------|
| AGH      | Age of household head (Number of years) | - |
| GEH      | Gender of the household head (Male=1, Female=2) | ± |
| EDH      | Education level of the household head (0=No education, 1=Yes, 2=Secondary, 3=Tertiary) | + |
| HLS      | Household land size (Number of acres) | + |
| MFP      | Membership to forage producing participation group (1=Yes, 0=No) | + |
| PG       | Household herd size (Total TLU) | + |
| AES      | Access to extension services (1=Yes, 0=No) | + |

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Membership to forage producing and participating group

When the households were collected together in the form of group, it increased the capacity of group members to access services such as credits, extension and information. Participation in such groups is believed to strongly facilitate adoption of new technologies (Salasya et al., 1996). As a result, in this study, we hypothesized that membership to social/development group has a positive influence on adoption of forage production technology practices by households and we assigned the value 1 to households that are members of such groups, while 0 was assigned to households that are not members of a group.

Household herd size

Herd size of a certain household has become symbol of the wealth status of that family and we hypothesized that participation in forage production with adoption of new technology is dependent on number of livestock a household owns, and that there is a positive relationship between the two. It is measured in terms of the total number of livestock owned by a household converted into Tropical Livestock Units (TLUs), where 1 TLU was equated to 250 kg mature live animal (Wasonga, 2009). In this study, one bull was equivalent to 1.29 TLU, a cow = 1 TLU, a calf = 0.4 TLU and a sheep or goat = 0.11 TLU. Conversion of livestock numbers into TLU equivalent enables standardization of different animal kinds and classes into a universal unit, thus aiding comparisons between household herds (Wasonga, 2009).

Access to extension services

Capacity building of pastoralists is highly used to adopt new technologies by offering them basic and technical skills and knowledge on various production technologies. The current study hypothesized that access to extension services on forage production together with sensitization on the importance of the practice positively relates to adoption of forage production techniques. Therefore, we assigned, in this study, a value of 1 to household heads with access to extension services and 0 to household heads with no access to such services.

Specification of the binary logit regression model

The model choice for a study is based on the nature of the dependent variable and the objective of the study. The dependent variable in this study was binary that assumed two values; 1 if the respondent was producing forage by using technology and 0 if otherwise. This kind of variable is normally estimated using logit or probit models, both of which estimate parameters using maximum likelihood approach. While probit model assumes normal distribution error term, the logit model takes a logistic distribution of the error term. This study used the binary logit model due to consistency of parameter estimation associated with the assumption that error term in the equation has a logistic distribution (Ravallion, 2001). The behavioral model described in the equations (Gujarati, 1995) below was used to evaluate the factors that influence participation in forage production:

\[ Y_i = \frac{e^{t_i}}{1 + e^{t_i}} \] (1)

This means that there is a functional relationship (f) between the survey observation \((Y_i)\) and the stimuli \(t_i\), where,

\[ t = b_0 + \sum b_i X \] (2)

\(Y\) is the response for the \(i\)th observation with binary variable 1 = producers and 0 = non-producers. \(t_i\) is the stimulus index for the \(i\)th observation. It is presumed that there is a threshold index for each household, \(t_i\) such that if \(t_i > t\) the household is observed as a participant in forage production and if \(t_i \leq t\) then, the household is a non-participant. The probability of such a household participating in forage farming technology was computed using Equation 3:

\[ P_i = \frac{e^{t_i}}{1 + e^{t_i}} \] (3)

The model for the factors hypothesized to influence households’ decision whether to participate in forage production or not was then re-written as:

\[ Y = \ln\left(P(X_i) / (1-P(X_i))\right) = \beta_0 + \sum \beta_i X_i \] (4)

Where \(Y\) = the natural log of the probability of participating in forage production \((P)\), divided by the probability of not participating \((1-P)\).

\( \beta_0 = \) coefficient of factors influencing participation in forage production.

\(X_i = \) factors that are hypothesized to influence participation in forage production.

\(e_i = \) error term.

The linear regression model for this study was specified as shown in the Equation 5.

\[ Y = \beta_0 - \beta_1 \text{AGH}\pm + \beta_2 \text{GEH} + \beta_3 \text{EDH} + \beta_4 \text{SZL} + \beta_5 \text{HLS} + \beta_6 \text{SMFP} + \beta_7 \text{AES} \pm \] (5)

Several binary logistic regressions were conducted with participation in forage production as the regress, until the best fit of the model was obtained. The variables that best
Table 2: Multicollinearity test for the explanatory variables included in the model.

| Variable                  | Tolerance (1/VIF) | VIF  |
|--------------------------|-------------------|------|
| Age                      | 0.776             | 1.288|
| Gender                   | 0.951             | 1.051|
| Education                | 0.706             | 1.416|
| Household land size      | 0.530             | 1.886|
| Group membership         | 0.797             | 1.254|
| Household herd size      | 0.724             | 1.381|
| Access to extension services | 0.718           | 1.392|
| Mean VIF                 |                   | 1.381|

Socio-demographic characteristics of the sampled households

Table 3: Descriptive statistics for the hypothesized variables used in the model.

| Variable                              | Producers(N=131) | Non-producers (N=85) | Chi-square | p-value |
|---------------------------------------|------------------|-----------------------|------------|---------|
| Mean age of the household head in years | 50.47±10.28      | 50.94±11.94           | 47.684     | 0.526   |
| Years of education                    | 9.14±3.99        | 5.80±4.13             | 53.699*    | 0.000   |
| Household land size (acres)           | 33.93±41.54      | 48.72±57.54           | 96.620*    | 0.007   |
| Household herd size (TLU)             | 19.97±29.75      | 17.47±25.79           | 53.373     | 0.421   |
| Gender of households head             |                  |                       |            |         |
| Male                                  | 97 (74.0)        | 47 (55.3)             | 8.157*     | 0.004   |
| Female                                | 34 (26.0)        | 38 (44.7)             |            |         |
| Group membership                      |                  |                       |            |         |
| Yes                                   | 97 (74.0)        | 20 (23.5)             | 52.989*    | 0.000   |
| No                                    | 34 (26.0)        | 65 (76.5)             |            |         |
| Access to extension services          |                  |                       |            |         |
| Yes                                   | 103 (78.6)       | 16 (18.8)             | 74.518*    | 0.000   |
| No                                    | 28 (21.4)        | 69 (81.2)             |            |         |

defined the estimated model was determined based on the coefficient of determination ($R^2$); adjusted $R^2$, chi square value, the direction of influence of the independent variables, as well as the number of significant variables in the model.

Multicollinearity statistical test: Variance inflation factor

It was important to ensure that the explanatory variables used in the binary logit model do not correlate with one another, a situation known as multicollinearity, which occurs when two or more independent variables are linearly related. Multicollinearity usually occurs in all sample data, necessitating the need to test the level of its severity in the exogenous explanatory variables (Koustitoyiannis, 1973). This was done through the test of the Variance Inflation Factor (VIF). Multicollinearity was then eliminated through excluding or merging some variables during analysis so as to obtain a thrifty model. Long (1997) expression for empirical estimation of VIF was followed:

$$VIF = \frac{1}{1 - R_i^2} \quad \ldots \ldots \ldots \ldots \ldots (6)$$

Where $R_i^2$ is the $R^2$ of the artificial regression with the $i^{th}$ independent variable as the dependent variable.

RESULTS AND DISCUSSION

Result of multicollinearity test

The VIF of the explanatory variables was found to range from 1.051 to 1.886 with a mean of 1.381 as shown in Table 2. The fact that the VIF’s for the independent variables were less than five (<5) provided satisfactory justification for their inclusion in the logit model (Maddala, 2001) as there was no serious problem of multicollinearity.

The impact of socio-demographic features of the household on the forage production and practice of new technology is shown in Tables 3 and 4. Regarding age, there was no difference ($p > 0.05$) in mean age between forage producers (50.47±10.28 years) and non-producers (50.94±11.94 years). The results showed that forage producers were significantly ($p < 0.01$) more educated with...
mean of 9.14 ± 3.99 years of education than non-producers whose mean age was 5.80 ± 4.13. Households that adopted forage production were significant (p < 0.01) as compared to smaller average land sizes (33.93 ± 41.54) acres with large average land size (48.72±57.54) acres, but larger herds sizes(19.97 ± 29.75 TLU) than non-producers who had averagely larger land sizes on average (48.72 ± 57.54) acres and smaller herds (17.47 ± 25.79 TLU).  

Most (74%) of the forage producer households were male headed as compared with 55.3% for non-producers. In addition, most (74%) of the forage producers were members of certain social groups as compared with only 23.5% of the non-producing households (Table 3). More (78.6%) forage producers had access to extension services than non-producing households (18.8%). From these result, we can understand that gender, education level, size of land owned, group membership and access to agricultural extension services are important factors that may influence participation in forage production among the pastoralist communities in the study area. These results are in agreement with the finding of Kaliba et al. (1998) who reported similar factors amongst others to be primarily important in influencing the adoption of agricultural technology.

### Results of the binary logit regression

Table 4 shows the results of the binary logit regression model. Seven variables were tested of which five were found to significantly influence forage production uptake by households. The independent variables were found to explain 57% (R²= 0.57) of the variation in households” participation in forage production in the study areas. Gender of the household heads had a positive and significant (p< 0.05) influence on households” participation in forage production, implying that the male headed households were more likely to participate in forage production than those headed by females. This could be explained by the fact that men have better access and control over important resources such as livestock, land and financial capital than women (Olila, 2013). In addition, this finding could be associated with the high labour requirements of the practice and the domestic responsibilities of women in the societies which limit their time and access to agricultural information, trainings and extension services (Kidake et al., 2016). The marginal effects show that facilitating both genders participation would increase the chances of adopting forage production technologies by 20%. 

Education level of the household heads showed a positively significant (p < 0.05) influence on the possibility of a household participating in fodder production, suggesting that household heads with higher education levels have higher chances of undertaking fodder production, unlike their counterparts with no or less education. Participation in a group and access to extension services showed positively significant (p < 0.01) influence on households” participation in forage production. This implies that household heads who participated in groups and with better access to agricultural and extension services were more likely to adopt forage production technology. Specifically, the marginal effects showed that group membership of an individual increases their probability of adopting forage production technologies by 29%, while a unit increase in access to extension services increases adoption of forage production chances by 49%. This could be linked to the fact that working in organized pastoralist groups has many benefits such as easier and enhanced access to financial and extension services (Olila, 2013), as well as free or subsidized inputs such as startup grass seeds. Government institutions, as well as NGOs, have successfully implemented many agricultural development programs through working with pastoralist groups. Household herd size was found to have a positive and significant (p < 0.05) relationship with adoption of forage production, indicating that households with large herds have higher probability of adopting forage production than those with smaller herds. This is because, under the current situation where there is decline in natural pastures due to climate variability and change, sustaining large herds call for strategies to avail extra feed resources, and therefore

| Variable                      | β           | Wald         | Exp (β)      | Marginal effect | p-value |
|-------------------------------|-------------|--------------|--------------|-----------------|---------|
| Age                           | -0.034 (0.021) | 2.688 | 0.966 | 0.008 (0.005) | 0.104   |
| Gender                        | 0.878** (0.420) | 4.367 | 2.407 | 0.200 (0.976) | 0.040   |
| Education                     | 0.141* (0.052) | 7.326 | 1.151 | 0.003 (0.115) | 0.007   |
| Household land size           | -0.007 (0.005) | 1.537 | 0.993 | -0.001 (0.001) | 0.217   |
| Household herd size           | 0.015** (0.008) | 2.988 | 1.015 | 0.003 (0.002) | 0.085   |
| Group membership              | 1.318* (0.403) | 10.699 | 3.736 | 0.289 (0.085) | 0.001   |
| Access to extension service   | 2.333* (0.414) | 31.706 | 10.306 | 0.492 (0.074) | 0.000   |
| Constant                      | -1.235 (1.340) | 0.850 | 0.291 | - | - |

Statistical significance level: *1%, **5% and ***10%; Chi-square (DF=7) = 117.99 (p<0.001); -2log likelihood=171.577; Cox and Snell R² = 0.421; Nagelkerke R² = 0.570; N=216; Standard error in parentheses.
making adoption of various production technologies necessary. Traditionally, pastoralist households with large herds tend to remain mobile especially in the dry seasons when pasture is scarce. However, the challenge of diminishing communal grazing fields due to changing land use and tenure have restricted mobility as a coping strategy. This situation could be regarded as a catalyst to the establishment of forage farms by livestock keepers with larger herds.

Conclusion

The results of this study show that gender, group membership and access to extension services are the most important factors that determine households participation in forage production in the study areas. Household heads that have access to extension services and are also members of social groups have the highest chances of adopting forage production. This is due to the fact that extension workers and other supporting organization prefer to reach out to the producers through organized groups. On the basis of the results of this study, interventions aimed at facilitating households’ participation in forage production should support formation and strengthening of forage producing groups as way of enhancing information sharing, as well as increasing producers’ access to agricultural information and extension services. Based on this finding, it is recommended that efforts towards out-scaling forage production should target access to extension services and support households to start and (or) join existing groups, which are known to be avenues for accessing extension services with the ultimate goal of ensuring sustainable and efficient forage production in the drylands.

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