DETERMINANTS OF IMPROVED TECHNOLOGY USE IN DAIRY PRODUCTION IN CASE OF NORTH GONDAR

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ABSTRACT

Background: *Ethiopia has large potential for dairy production development due to the country's favorable climate which supports use of improved and high yielding animal breeds. There are also huge dairy market problems, which leads to decline dairy production. Therefore, the focus of this study was to analyze the adoption of improved dairy technology and to assess the extent of adoption.*

Method: *Primary data was gathered from 290 respondents in sample kebeles. It was gathered through semi structured interview schedule and checklists. Tobit and logit econometric model were used to analyze the factors of adoption status of improved dairy technology and its intensity in North Gondar Zone.*

Results: *The study revealed that 62% (181) of farmers in North Gondar Zone were dairy technology adopters. The logistic regression output indicates improved dairy technology adoption was influenced by local cow ($P<0.01$), extension services ($P<0.05$) and dairy cooperative ($P<0.1$) positively. Whereas the owning of livestock size ($P<0.1$) and milk production per day ($P<0.05$) had a negative effect on the above listed technology adoption. On the other side Tobit model result shows the extent of improved breed dairy cow adoption was affected by livestock size ($P<0.01$), expenditure and*

training on milk production positively while local cow and dairy cooperatives (P<0.05), had negative effect on it.

***Conclusion**: In Ethiopia, dairying is a means of providing an additional source of food, income to small and marginal producer and employment. Therefore, monitoring and evaluation on the overall structural functions of the dairy cooperatives on dairy farming is advisable. In addition to that developing milk processors and market linkage is better for adopting improved dairy cows in North Gondar Zone.*

Key words: *Dairy cooperatives;* Improved technology; Dairy production*; North Gondar Zone*

1. Background of the Study

The global dairy market is vastly dominated by European, American, Australian, and New Zealand markets. It is easily one of the most distorted agricultural sectors because of the producer subsidies that are in place in many developed countries which encourage surplus production. Dairying is a means of providing an additional source of employment and income to small and marginal farmers. The smallholder farmers produce about 93% of dairy products (Tsehay, 1998.

Most of the milk supply is distributed from producer to consumer through informal means in both rural and urban areas. The informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhoods. Market infrastructures and marketing facilities are not well developed in the country. This, in turn, reduces incentives to participate in economic transactions and results in subsistence rather than market-oriented production systems. Therefore, improving the position of smallholders to actively engage in the market is one of the most important development challenges.

In Ethiopia, fresh milk sales by smallholder farmers are important only when they are close to formal milk marketing facilities, such as government enterprise or milk groups. Farmers far from such formal marketing outlets prefer to produce other dairy products instead, such as cooking butter and cottage

cheese. The vast majority of milk produced outside urban centres in Ethiopia is processed into dairy products by the households, and sold to traders or other households in local markets (Debrah and Berhanu, 1991).

Most of the milk is produced in the rural areas, while the profitable market for it exists largely in the urban centers. The major portion of the milk comes from small dairy farmers with few milk animals located in the rural areas. What is produced on the animal farm has to reach the market, and the nearer the market the lesser would be the transportation charges and the lesser would be loss due to spoilage. Hence, milk being the most perishable commodity, requires an efficient marketing and market outlet. (Gezachew, 2005)

In Ethiopia the growth in milk production was mainly due to the increase in herd size (60%). Only 40% of the increase was due to improvement in productivity per animal resulting from technological intervention. This is not surprising since, dairy production in the country is principally dependent on indigenous Zebu breeds. Therefore, integration of cross breed cattle to the sector is imperative for dairy development in the country. This can be achieved through promotion of large private investment in dairy farm and s0mallholder's dairy production. The government should promote integration of cross breed cattle in to the smallholder sector through improving their access to improved cattle bred, artificial insemination service, veterinary service and credit. Also, shortage of support, low quality and scarcity of feed are major constraints to dairying in the country (Mohamed et al., 2003).

Peri-urban and urban dairy production system is becoming an important supplier of milk products to urban centers, where the demand for milk and milk products is remarkably high. As a result of this, peri-urban and urban dairying is being intensified through the use of cross breed dairy cows, purchased and conserved feed and stall-feeding. These production systems are favored due to the proximity of the production sites to centers of high fresh milk demand, easy access to agro-industrial by- products, veterinary services and supplies (Azage et al., 2005).

On the other hand, modern dairy farming practices cover a range of intensive management practices and zero grazing. This production system also involves the use of exotic crossbreed genotypes that give high yield as compared to the traditional dairy farms. Both practices are confronted with the problem of competing for scarce resources. Nonetheless, these resources have to be optimally and efficiently utilized on the bases of their marginal value productivity in order to get maximum income from dairy enterprises.

Efficient milk production is a key to sustainable development of dairying. Feed cost can be a major burden to use animals of good genetic merit. High disease incidence in the context of developing countries also compounds the main problem of research. In summary development and extension services in animal breeding, feeding and animal health are the core elements to underpin efficient milk production.

In Ethiopia, dairying is a means of providing an additional source of food, income to small and marginal producer and employment (Ndambi et al., 2006). Milk provides relatively quick returns for small-scale livestock keepers (Polak et al., 2008) and is a balanced nutritious food important for household food security.

According Azage Tegegne,(2011), to Ethiopia has a huge potential for dairy development in Africa. The large and diverse livestock genetic resources, existence of diverse agro-ecologies suitable for dairy production, increasing domestic demand for milk and milk products, better market opportunity, and proximity to international markets indicate the potential and opportunities for dairy development in the country. However, dairy development has been hampered by multi-faceted, production system-specific constraints related to genotype, feed resources and feeding systems, access to services and inputs, low adoption of improved technologies, marketing and absence of clear policy support to the sector. Thus, in order to mitigate challenges that limit productivity and thereby exploit the untapped potential, it is necessary to assess level of adoption of improved dairy technology, identifying factors of adoption of improved dairy technology and the extent of it. Therefore, such information is critically important in

designing policy interventions to influence farmer behavior in ways that accelerate the adoption of the technologies and indicate future research and technology development Strategies.

2. RESEARCH METHOD

2.1 Description of the Study Area

The study was conducted in North Gondar Zone. North Gondar is bordered on the south by Lake Tana, Mirab (West) Gojjam, Agew Awi and the Benishangul-Gumuz Region, on the west by Sudan, on the north by the Tigray Region, on the east by Wag Hemra and on the southeast by Debub Gondar. Towns and cities in Semien Gondar include Dabat, Debarq, Emfranz, Gondar, Gorgora and Metemma. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this Zone has a total population of 2,929,628, an increase of 40.26% over the 1994 census, of whom 1,486,040 are men and 1,443,588 women; with an area of 45,944.63 square kilometers, Semien Gondar has a population density of 63.76. While 462,700 or 15.79% are urban inhabitants, a further 2,148 or 0.07% are pastoralists. A total of 654,803 households were counted in this Zone, which results in an average of 4.47 persons to a household, and 631,509 housing units. The weather conditions of these zones are characterized Dega and Woiyna Dega and kola there are mixed farming systems (i.e. livestock rearing and crop productions). According to zone agriculture department, the crop production systems are characterized through rain fed and irrigation. Farmers used rain fed mainly for Dairy Production the main sources improved breed (Gersi, Holistin Birijan) and local breeds are available in the zone.

2.2. Data Requirements and Data Source

Primary data

Primary data was collected through personal and face-to-face interview using semi-structured and pre-tested interview schedule that was filled up by recruited and trained enumerators under the close supervision of the researchers.

Secondary data

Secondary data was obtained from various sources such as reports of bureau of agriculture at different levels, NGOs, CSA, Woreda administrative office, previous research findings, Internet and other published and unpublished materials, which is relevant to the study.

2.3. Sample Size and Sampling Method

2.3.1. Farmers' sampling method

To select respondent farmer's multi-stage sampling technique was used. In the first stage, out of the 23 total woreda of North Gondar, six Woredas were selected purposively based on its' dairy production potentials such as Metema, Demiby, Lay Armachio, Tach Armachiho, Wegera and Debark. In the second stage from the selected Woreda 20 milk producing kebeles were selected randomly based on proportion to the total number in the Woreda. Finally, 290 farmers who produce milk were selected randomly based on proportion to number of milk producing farmers.

2.4. Methods of Data Collection

Semi structure interview schedule was prepared for dairy producing farmers and the interview schedule was tested with the enumerators prior to the actual data collection. Along with the formal survey, using group discussion, key informant discussions and also direct observation were undertaken along the market chain.

2.5. Methods of Data Analysis

Both descriptive statistics and econometric analysis were used for the analysis of the data.

Econometrics analysis

Both binary logistic regression and tobit model were applied .The model specification for each model were constructed as follows.

Stata 14 version was statistical soft-ware used to analyze the data and descriptive and inferential statistics; and econometric model was implemented. Regarding the decision of choosing the model type to be applied, in case of binary treatment, while estimating probability of adopter versus non-adopter, both binary logit and probit models often give similar result. As a result, the statistical similarities between the two models make the choice between them difficult (Shimelis,

2003).However, binary logistic regression model was an econometric model applied and best fitted to identify factors affect adoption of improved diary technologies because of its being of preferable. It is a linear probability model for binary response where the response probability is evaluated as a linear function of the explanatory variables (Maddala, 1983; Wooldridge, 2003. In view of this, the binary logistic function is selected for this study.

The functional relationship between the dependent and independent variables is shown as follows:

$Y = x\,\beta + \varepsilon$

Where,

$Y = \begin{cases} 1 \text{ refers adopters} \\ 0 \text{ refers non adopter} \end{cases}$

This refers identify the determinants that determine the probability of dairy technology adoption. These models specify a functional relation between the probability of participating in adoption of dairy technology and various explanatory variables

x= explanatory variables (such as: level of education of the household head (educ), sex of the respondent (sex), development agents visit frequency (visitDA), distance of market from farmers' home (dismkt), livestock size (TLU), dairy cooperative (coop), etc.).

β refers the coefficient to be estimated in the mode

ε =refers the error term

As a result, the cumulative logistic probability model is showed as follows (Gujarati, 2004).

$\Pr(Ti=1|X_i) = \frac{e^{zi}}{1+e^{zi}}$..... (a)

Where T refers probability of adopter

$Zi = B_0 + \sum B_i x_i + u_i$..... (b)

Where, i=1, 2, 3.....n

B_0=intercept

B_i refers coefficients or estimators of regression to be estimated

u_i= error term, and

x_i=pre-intervention characteristics

Probability of sampled households' belong to the non-adopter group

$1 - T_i = \frac{1}{1+e^{zi}}$.....(c)

Then the odds ratio can be written as:

$\frac{T_i}{1-T_i} = \frac{1+e^{zi}}{1+e^{-zi}} = e^{-zi}$..... (d)

The equation $\frac{T_i}{1-T_i}$ is simply the odds ratio in favor of adopter. It was simply the ratio of the probability that the household would be adopter to the probability that he/she would not be adopter. In conclusion, by using the natural logarithm of the above equation, the following equation can be driven:

$$L_{i=}Ln\left(\frac{T_i}{1-T_i}\right) = Ln\left(e^{B_0+\sum_{j=1}^{n} B_j x_{ji}}\right) \quad = \quad Z = B_0 + \sum_{j=1}^{n} B_j x_{ji}$$

Where L_i refers log of odds ratio in favour of adopter, which is not only liner in x_{ji} but also linear in the parameters

The Tobit model

The most common censored regression model is the Tobit model which expresses the observed level in terms of an underlying latent variable. The use of the Tobit model is intuitive because the parameter estimates will be biased and inconsistent if OLS is used. The degree of bias will also increase as the

number of observations that take on the value of zero increases. The Tobit model can be specified as (Tobin, 1958; Long, 1997; Cameron and Trivedi, 2009; Greene, 2012):

$$Y_i = X\beta + £_i$$

$$x\beta + £_i \ , if\ Y_i^* > 0$$

$$Y_i = \qquad 0\ , \quad if \quad Y_i^* < 0$$

Where Y_i is the dependent variable and the x's are vectors of covariates determining the intensity of the dependent variable. The following table shows the summary of variables (Table 1).

3. RESULT AND DISCUSSION

In this part of the study, results and discussions are presented. This part is classified in to two sections. The first section presents about the characteristics of the sample households, main formal sources of rural credit and its status in terms of giving training and amount of loan able to give. The second section on the other hand presents the econometric analysis results.

3.1. Descriptive results

3.1.1. Household characteristics

The mean family size of sample farm households was estimated to be 5.6 and 5.3 for adopters and non-adopters respectively although there is non-significant mean difference in family size among adopters and non-adopters, which is evaluated using independent sample t-test at 10% level of significance (Table 2). A significant and negative relationship is observed between age and adoption of dairy technology at 10% significance level. The mean dairy farming experience of farmers for adopters and non-adopters were approximately 11 and 18 years respectively. The relation of this variable with the independent variable was negatively and significantly at 1% significant level (Table 2).

3.1.2 Adoption status of dairy technology by marital status in North Gondar

The survey was tried to show dairy technology adoption status by marital status. The total numbers of non-adopters of dairy technology were 109(38%), whereas 181 households (62%) were dairy technology adopters. Among the total adopters, 155 (85.7 %) were married, 13(7.2%) and 8(4.4%) were single and widowed respectively. As we understood from the bar graph, around 53 % of the total respondents were married and they were adopters. Therefore marriage had the positive significant impact on agricultural technology adoption by smallholder farmers in North Gondar zone (figure1).

3.2. Econometrics Analysis

Before running the logistic and tobit regression analysis, the variables which were included in the model were checked for the existence of multicollinarity,heteroscedasticity and outlier problems. First, we have checked the multicollinarity problem associated with the explanatory variables. There are two methods to check the multicollinarity problems. For continuous variables, variance inflation (VIF) is used to detect the problems of multicollinarity. The VIF value less than four are believed to have no serious problems related to multicollinarity. All continuous explanatory variables did not have serious multicollinarity problems because the values of VIF for each were below 1.6. The second method of detecting multicollinarity problem is through contingency coefficients for high degree of association for discrete variables. Correlation coefficients with an absolute value higher than 0.75-0.8 are taken as an indicator of multicollinarity. Based on the regression output, there was no serious multicollinarity problem in discrete variables because the contingency coefficients were below 0.75. Therefore, all of the independent variables were included in the model.

In the second, the problem of heteroscedasticity was checked by using the white test. The test for heteroscedasticity after regression suggests that the errors were of the same variance. The null that the errors have constant variance was not rejected. Therefore, there was not the problem of hetroschedasticity in this data set.

White's test for Ho: homoskedasticity

against Ha: unrestricted heteroskedasticity

chi2 (202) = 221.33

Prob > chi2 = 0.1671

Lastly, problem of outlier is tested after post estimation. Outlier can be identified if the absolute value of their studentized residual exceeds two. According to the test, there was the outlier problem in this data set. This problem was corrected by directly dropping the three observations in which their absolute value of studentized residual was greater than two. Because of this, our number of observation was reduced to 290 from 295.

3.2.1. Factors of adoption of improved dairy technology

The study revealed that number of local cow, DA visit frequency, total livestock unit except local cow, farmers' cooperative, distance of nearest market and amount of milk production per day significantly affects adoption of improved dairy technologies. However, there was no statistical evidence to conclude variability in availability of market information, experience of dairy farming, age of the household head, size of land farm, off farm income, access to credit and marital status affect adoption of dairy technologies (See Table 3).

Local cow (localcow): In rural context, livestock holding is an important indicator of household wealth. In addition, livestock is considered to be a source of income, food and drafting power for crop cultivations. Like that number of local cows has a lion share for farmer's agricultural activity. The number of local cow owned by farmers was positively associated with adoption decision in in this study. As the logistic regression model result indicates in (Table 3), this variable has a positive and significant correlation with the probability of improved dairy technology adoption at 1% level of significance. The marginal effect result also shows that keeping other things constant, when number of local cow increase by one number the probability of improved dairy technology adoption increase by 96%. The result is also supported by earlier studies

The coefficient of frequency of agricultural development agents **(vistibyda)** is positive and statistically significant which is consistent with hypothesized sign. The implication behind this is as a farmer frequently got extension visit, the likelihood to adopt the improved livestock technology increases by 5%. The finding corroborate with the study conducted by Kaaya et al., 2005 and Dehinenet et al., 2014.

TLU except local cow (TLU): The reason why we exclude local cow from TLU was to see how much local cow affect the dependent variable lonely. The total number of livestock unit except local cow owned by a farmer is among the variable that was expected to influence adoption of improved dairy technology by small holder dairy farmers positively; it was also expected that household heads with large total number of livestock unit being encouraged to be improved dairy technology adopter. However the result was found that a negative and significant relationship which indicated that as the number of TLU of the household increase by 1 unit, the probability of being improved dairy technology adopter decreased by 25%. The finding is consistent with the result of [16].

Dairy cooperative (coop): This variable is statistically significant at less than 10 % significant level with unexpected sign. The result predicted that farmers who were cooperative members are more unlikely to participate than those who are not. The marginal effect of the variable cooperative membership status of the household 0.09 indicates that the probability of being adopter decreases by 9 % with one unit increase in the cooperative participation status of the household head. The similar finding is found in the result of (L M Mburu, 2007)

Distance of market from farmers' home (dismkt): The sign of the coefficient of this variable showed a negative relation with the probability of dairy technology adoption and is significant at less than 10% percent probability level. This indicates that an increase in the distance of market from farmers' home decreases the likelihood for the household to become dairy technology adopter. As a farmer is nearer to the market, there would be a higher chance to get new skills and knowledge because of access to information about dairy technology. However, if the market is very far the result is the reverse one. The marginal effect

of the variable indicates that the probability of being adopter about 0.1 % with one kilo meter increase in distance of market.

Amount of milk production per day (milkperday): Based on the above model results, coefficient of this variable was significant at less than 5% probability level. The marginal effect of the variable i.e.0.39 shows that the probability of being adopter decreases by 39 % with an increase of milk production by one liter. Farmers' households who have large amount of milk production per day were more unlikely to be adopters. The reason is that if the demand of their large produced milk is so poor, farmers want to search other business opportunities/farming practices like beef production, irrigation and other non-farm activities rather than focusing on adopting improved dairy technology. They could decrease number of breed cow what they already have for decreasing of feeding costs, shifting to other business alternatives and for other reasons. Because of this, the variable had a negative relation with the dependent variable in North Gondar Zone.

3.2.1. The extent of adoption of improved dairy technology

According to Tobit model results (Table 4) the following are the significant factors that affect extent of adoption of improved dairy technology

Distance of nearest market (dismkt): It is the location of farm household from the nearby market to buy dairy inputs and sale of products. It is measured by kilometer and continuous variable. Distance from the market center was expected to affect the adoption of dairy technologies negatively. Households located near to market tend to buy inputs and they can have easy access to sale their dairy products. The farthest the market distance, the least the dairy technologies could be happened; the closer the market to farm household the lesser would be the transportation charges and loss due to spoilage better access to market information and facilities. This improved return to labor and capital; increase farm-gate price incentive to participate in dairy technologies adoption. While the remains are constant, as market distance increases, intensity of improved dairy adoption was decreased by 10% (SHIBESHI, 2014)

Training about dairy production (mtraining): based on the bellow model results, coefficient of the variable is significant at less than five percent probability level. The marginal effect of the variable 0.56

shows that the extent of adopting improved breed cow increases by approximately 56 % with increase of training by one unit. If farmers' training aims at communicating information, knowledge and skills, replacing old attitudes by new ones, exchanging opinions and experiences can adopt an improved agricultural technology easily. The ability of a dairy farmer to practice and generate more income from dairying largely depend on the effective adoption of improved dairy technology practices that leads to increase productivity (Luyobya, 2014)

Farmer's agreement (agreement) was found positively driving the intensity of adoption of improved dairy technology practices. Other factors kept constant, having formal or informal agreement was found to favor the farmers' likelihood of adoption of the package by the factor of 42 %, and the result was statistically significant at 10% level. This could happen given the fact that agreement were among the strongest variables that play important role in adoption of improved dairy technologies. This result was consistent with the result with (Widmar, 2014).

Dairy cooperative members (coop) were found to have better access to extension services and greater agricultural technology adoption than non-members in Ethiopia ((Bolton, 2019)). However, in this study, this variable has a negative effect on increasing of number of improved breed cows in North Gondar. The reason is that the dairy cooperatives which are found in this study area were not that much active during the study time. Although there are cooperatives there the productivity and actively participation was so poor and that is why cooperative had a negative effect on extent of improved dairy technology adoption.

Livestock size (TLU): According to Logit model, the variable was statistically significant at 10 % significant level showing a negative relationship between livestock size and adoption of improved dairy cows. However in the Tobit model livestock size affected the extent of improved dairy breed adoption positively and significantly at 1% significant level (Table). Keeping other things constant, as livestock size except local cow increases by one TLU, the extent of adopting improved dairy breed cow increased by 25%. This result is consistence with the study of ((Wuletaw Mekuria, 2017))

Number of local cows (localcow) has decreased the extent of adoption of improved livestock technologies with negative and significant coefficient. This means that with increase in local cows holding by one unit, the farmer will have additional 0.95 more improved breed cows. The farmers themselves felt pressure to switch from the local breeds to the modern and efficient dairy or beef breeds (Hiemstra, 2010). This means owning of local cows and breed cow have a negative relationship.

Amount of birr for consumption of the household (mntcons) affects the extent of adoption of improved breed dairy cows positively and significantly which is consistent with the hypothesized sign. The possible reason behind could be household expenditure increases the interest of farmers to increase the number of breed dairy cows to generate income. Farmer's interest become high to diversify income sources if there is high expenditure in home. For this, investing on dairy technology is highly acceptable and that is why the expenditure has positive effect on extent of improved breed dairy cow adoption

4. CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

This study has identified key factors that affect farmer's improved dairy technology adoption status and its extent. Improved dairy technology adoption was influenced by several factors such as local cow, extension services, dairy cooperative, and distance from market center, milk production per day and livestock size. Among those variables owning of livestock size and milk production per day has a negative and significant effect on the above listed technology adoption. On the other side the extent of improved breed dairy cow adoption by small holder farmers was affected by livestock size, expenditure and training on milk production positively whereas local cow and dairy cooperatives have negative effect on it. In this study area, the authors argued that livestock size except cow was not the important factor for farmers to adopt the technology however, this variable was an influential factor to increase the number of improved breed dairy cows after a farmer is adopter. Before farmers are being of adopter, their adoption status is affected by number of local cow negatively and positively

respectively. After being of adopter the extent of adoption was affected by this variable negatively. This indicates that the number of local cows were become decreased and subtitled by breed ones and vice versa which means the two breed type cows have a negative relations.

4.2 RECOMMENDATION

On the basis of this study, the following recommendations are suggested for overcoming challenging factors hindering the adoption of improved dairy technology. It is also used for policy makers and implementers to follow correct pathway to promote the adoption of different agricultural technologies. The recommendations of this study are forwarded as follows:

The results of the study revealed that amount of milk production per day influences the adoption of improved dairy technology negatively and significantly. Processing of produced milk and distribution of the output leads the farmers to be beneficial and profitable. Therefore, developing milk processors and market linkage is better for adopting improved dairy cows in North Gondar Zone.

Authors also shown that, technological adoption among farmers requires an external financial source through credit. Farmers who have access to credit tend to adopt and utilize the extent of dairy cow technology more than those who do not have access to credit. Therefore, barriers on the supply-side of credits (high interest rate, short term full loan repayment, amount of limited loan size and etc.) should be overcome if a genuine to increase production and food self- sufficiency among smallholders is to be achieved via increasing of improved dairy cows.

Training on milk production for farmers is one of the factors that affect the extent of adopting improved dairy technology positively therefore, training related with dairy production for farmers should be encouraged.

Dairy cooperative and the extent of adopting improved dairy cows were negatively and significantly related. Therefore, it needs high attention by assessing the overall structural functions of the dairy cooperatives on dairy farming in North Gondar Zone.

The authors finally recommend further research has to be done on larger sample size for better understanding to examining personal, socio-economic, institutional, and situational and other factors affect adoption of improved dairy technology and its extent using time series data.

Abbreviations

BoA: Bureau of Agriculture; DA: Development Agent; GDP: Gross Domestic Product; CSA : Ethiopian Centeral Statistcs Agency; TLU:Total Livestock Unit; UoG: University of Gondar;

Authors' contributions

GAA and YSD developed the proposal; prepared research questionnaire, performed data management, coding, wrote the report and preparing the manuscript. BTA and FB prepared research questionnaire, analysis, editing and evaluating the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The author wants to declare that they can submit the data at any time based on publisher's request. The datasets used and/or analyzed during the current study will be available from the author on reasonable request.

Consent for publication

The authors have agreed to submit for Environmental Systems Research journal and approved the manuscript for submission.

Ethics approval and consent to participate

Ethical clearance letters were collected from University of Gondar research and community service directorate and North Gondar Zone administrative office to care for both the study participants and the researchers. Before data collection and field visit, each districts and sub districts have got official letters. The study area was already informed the reason why the study has done and by whom. There was high clarity of objectives and other study issues for all study participants and others. Because of that the research was done without compromising anybody's interest.

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