ASSESSMENT OF IMPROVED BIOMASS COOK STOVES IN ETHIOPIA: UTILIZATION PRACTICES AND ADOPTION FACTORS; THE CASE OF MERAWI, KOLELA DISTRICT

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ABSTRACT

Although decades of dedicated effort have been made on dissemination of improved cook stoves by governmental and non-governmental organizations in low-income countries, it remains tough to achieve the adoption of improved cook stoves for wider utilization. Predominantly, traditional open fire cooking system has been the major cooking system for foremost segments of Ethiopian population for centuries. Currently, different stockholders have shown exertions to address this traditional cooking system through distribution of fuel saving cook stoves at national and regional levels. The aim of this study is to examine the improved cook stoves adoption status, its coverage and factors affecting adoption in Amhara regional state in the case of Merhawi, Kolela district. A structured cross-sectional survey assessment in 123 household through in depth interview was conducted in the district. A predictor socio –economic variables such as age, family size, income level, role of stake holder involvement, education level, farm land size and decision making at house hold level for the user's choice, clean cooking preference and adoption status were deployed for investigation. Statistical analysis of linear regression and cross tabulation frequency factors were also employed to identify factors associated with the status of adoption using IBM SPSS, 20. The linear regression analysis result shown that age, family size, income level, role of stake holder involvement in the locality have a strong positive relationship with ICs stove adoption at p value<0.05. On the contrary, education level, farm land size and decision making at house hold level have no strong interaction with adoption.

Keywords: Improved, Biomass, Cook Stoves, Three Stone Open Fire System, Adoption Factors, Kolela District.

INTRODUCTION

Approximately, three billion people (38.46%) in the world lack access to modern energy infrastructure and use biomass solid fuels such as wood, charcoal, crop residues or dung for cooking (Tamire et al., 2018). In most of the developing nations, the energy demand per household is covered mainly by woody biomasses. For instance, agricultural residues, animal dung, and charcoal are among principal solid biomass fuels used in rural households for cooking and lighting (Thacker et al., 2015). Like many sub-Saharan Africa, Ethiopia's energy supply is heavily dependent on biomass (>90%) biomasses and consumed in traditional way for energy sources (Tucho & Nonhebel, 2015). Three-stone stoves are still the most prevalent way of cooking in the developing countries leading indoor air pollution and deforestation (Arthur et al., 2010). Cooking in many developing countries like Ethiopia usually carried out by burning traditional biomass using traditional stoves or three stone open firing which makes it the system is terribly in-efficiently uses 5–10% of the potential energy of the biomass fuel during the cooking process and usually emit high levels of pollutants (Tamire et al., 2018). Consequently, the current inefficient cooking system employed results fuel-wood shortage issue that has been frequently addressed so far. To address this traditional use of fuels, significant and devoted efforts have been made on the advancement of cook stoves over the last-to -recent decades (Tucho & Nonhebel, 2015; Mekonnen et al., 2020). Moreover, the government of Ethiopia is continued wide-spread of fuel saving improved cook stove technologies to reduce pressure on forests and the adverse impact of indoor air pollution for the last decades (Cooke et al., 2008). Furthermore, the smoke released by open air burning of biomass contributes approximately 3% of the total global burden of disease, 1.6 million premature deaths every year, which includes 0.9 million children death under age of five (Ewart et al., 2003).

According to Mehetre et al. the improved cook stoves achieved fuel savings of 35–50% compared to conventional stoves reducing household expenditures (Mehetre et al., 2017). Hence, 300 kg/year of charcoal per family could be saved and achieved healthier cooking environment. In addition, the use of ICs pause the conventional inecient cooking trend and moved large populations away from practices resulting in unacceptably high GHG emissions, indoor air pollution and deforestation (Mehetre et al., 2017).

Currently, numerous strategies are designed to reduce fuel wood consumption and GHGs emission by implementing Improved Cook Stoves (ICS) and changing the cooking behaviors of the societies (Mamuye et al., 2017). Particularly, 9 million distribution and adoption of improved cook stoves was done by the national improved cook stove program of Ethiopia and planned to disseminate 31 million stoves before 2030 (Paul et al., 2018). These program introduced an active ICS production and sales sector with current annual sales of approximately 66,000 injera ICS (Mirt) and 16,000 rocket-type ICS woodstoves (Lackech) (ESMAP, 2013) (Amaha et al., 2017). However, the adoption of ICS has not been far progressive as it depends on the sociocultural settings in developing countries (Onyeneke et al., 2017).

Over all, in Ethiopia there have been few recent assessments of economic evaluation on demand and supply side on ICs. Several physical projects on development and dissemination of improved cook stoves has been implemented with very little promotion work and user preference assessment studies prior preamble of models. Likewise, the status of distributed ICs, utilization trends, adoption rates and impacts on the end-users have not been frequently assessed and compared with the prevailing cooking practices. Moreover, intervention on cleaner cooking technologies adoption, fuels, and implementation of community-based efficient fuel management practices in the country as a nation is paramount. In addition, cost -benefit analysis of household energy choice and clean cooking systems adoption factors assessment would be done for promoting green and clean cooking technology interventions at national level. To these ends, the objective of this research is to investigate the onsite household cook stove cross-sectional survey assessment on ICs coverage's, challenges and detrimental factors of adoption in the study area. The key assessment results, utilization practices and adoptions factors of the improved cook stove technologies are discussed and reported for further action implementation and interventions for government energy policy makers to clean technology.

METHODS AND MATERIALS

Description of Study Area

The assessment was conducted in Mecha District, Kollela kebele, which is located in Amahara Region of Ethiopia. Mecha district is west Gojjam zone in Amhara regional state, North west of Ethiopia located at latitude 11º30'N and longitude 37º29'E about 525 km North West of Addis Ababa and 34 km South East of Bahir Dar the capital city of Amhara region. It is one of the thirteen woredas found in West Gojam Administrative Zone, which is located 30 kms south-west of Bahir Dar town, the capital of Amhara Region as indicated in Figure 1. Kolela kebele is one of the research and community service sites of Bahir Dar University found in Mecha Woreda. This kebele has five sub-kebeles (Abizarta, Debir Mender, Gafra, Lalo and Addis Alem) having total of 1030 household level. The rough estimation of population density of the resident is 4720 (2400 females and 2320 males) live within the province. Agriculture is the lifeline of the district's economy employing all over of the residents. Biomass is still predominant energy sources of the households and modern energy cook stoves are not common in the stud In addition, the district is off grid and all residential households use solar battery cells as main energy source for home lighting system.

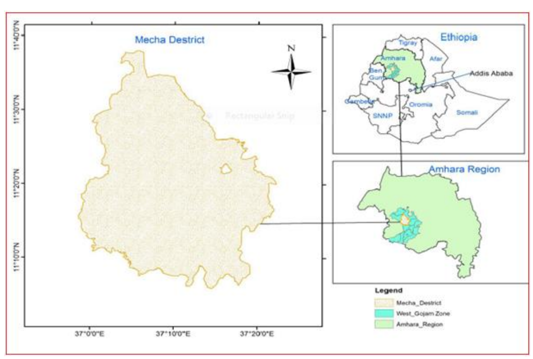

FIGURE 1
MAP OF THE STUDY AREA

Population

All residents who are head of house hold were considered as source (target) population in the district and those who were in the selected kebeles marked as the study population.

Data Sources, Types and Quality Assurance Mechanisms

The major sources of data include both primary and secondary. The primary information was gathered through structured household survey session. All data regarding the status of improved cook stove adoption were gathered *via* face-to-face interview using a structured questionnaire adapted from literature works (Naing, 2003). The enquiry form was initially designed for the respondents of household to reflect on the size, income level, energy sources, the cooking technology, ICs coverage, facts over the socio-demographic traits, and socio-economic determinants of adoption of improved cook stoves. Prior to in depth interview with respondents, the interviewers were oriented for one day on the nature and details of the questionnaire as well the approach to the interviewee. The questionnaire then conducted with both women and men head of household.

Sample Size & Sampling Procedures

The district comprises five sub-kebele (Abizarta, Gafra, Debir mender,Lalo and Addis Alem) villages. All the small villages were selected purposively for investigation of the energy consumption patterns, determinants on coverage and adoptions of improved biomass cook stove. Assessment of ICs coverage within residents of villages in the district was purposively conducted on target 178 head of households on average of 5 people per household (890 target total population). The representative population size of target population N, 178 households at 95% confidence level and ± 5% Precision level was taken using Eq. (2.1) (Naing, 2003b).

$$\mathbf{n} = \frac{\boldsymbol{N}}{\mathbf{1+N}(\boldsymbol{e})^{2}} \quad (2.1)$$

From the Eq. (2.1) representative size “n” (123) households was obtained and the assessment was conducted by allocating given sample size to different stratum (sub-villages) in proportion to population size of each stratum. The portion of total number of respondents from each cell (strata) was decided as per Eq. (2.2) (Naing, 2003).

$$\boldsymbol{ni} = \boldsymbol{n}\frac{\boldsymbol{Ni}}{\boldsymbol{N}} \quad (2.2)$$

Where n represents sample size, Ni represents population size of the ith strata, N represents the population size. The size of the sample in each village, were analyzed *via* the technique of stratified sampling whereby multiplying by the sample size of each group size and divide by the total population size (target population/household). The sample frame representative household levels and respondent per each sub-village are illustrated in the Table 1

Statistical Analysis and Tools

The field data were statistically evaluated using Microsoft Excel and (IBMS Statistics 20 statistical software). A multivariate linear regression with least significant difference at level of significance (cut of $P \leq 0.05$) was used to separate differences among the treatment of means. In addition, Watson Goodness of fit and a decision was made at $p>0.05$ during linear regression analysis.

Table 1
SAMPLE FRAME AT HOUSEHOLD LEVELS AND RESPONDENT PER EACH SUB-VILLAGE

Kebele	Cell/ sub-Villages	Representative Household	Population	Respondent per villages
	Abizata	49	246	34
	Gafra	42	210	29
	Deber Mender	33	165	23
Kolela	Lalo	31	155	21
	Adis Alem	23	115	16
Total		178	890	123

RESULTS

The improved biomass cooks stoves utilization condition and coverage observations during field assessment findings are shown in Table 2.

Table 2
TYPES OF COOK STOVE FREQUENCY DISTRIBUTION OF HOUSE HOLD IN THE DISTRICT

Type of Cook Stove used for Cooking Per Respondents					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
	Three-stone stove	99	80.5	80.5	80.5
	Lakech(Gonzye)	7	5.7	5.7	86.2
	Mirt	5	4.1	4.1	90.2
	charcoal stove	11	8.9	8.9	99.2
	Biogas stove	1	0.8	0.8	100
	Total	123	100	100	

As shown in Table 2, descriptive frequency analysis of the household survey result of 123 respondents revealed (5.7% of the respondents were using Lakech (Gonzye) stove , 4.1%

Mirt, 11% charcoal stove and majority of (80.5%) are still using three stone open firing systems as models presented in Fig. 2. Based on this frequency analysis a total of 99 (80.5%) of the respondents which uses traditional three stone stove were found to be non-adopters. whereas those respondents uses either of the improved cook stoves 24 (19.5%) are considered as adopters.

FIGURE 2

STOVE TYPES A) MIRT STOVE B) LAKECH (GONZYE) STOVE C) CHARCOAL STOVE D) THREE -STONE OPEN FIRE (PHOTO CREDIT BY THE PRESENT AUTHORS)

The findings were in line with previous investigation and illustration that the almost all populations in rural communities in developing countries uses biomass energy in traditional open fire system (Barstow et.al, 2016; Magitta et.al, 2018). This is perhaps due to the observed fuel-wood abundance and lower dissemination rate of ICs, which can lead the local populations to adopt traditional fuel stoves. The major factors of marginal ICs utilization practices and coverage assessment findings in the district discussions are discoursed in the next section.

DISCUSSIONS

The effect of each variable on reason of Non -adoption /adoption of ICs has been investigated and presented here with a clear emphasis on its role as driver /barrier of improved biomass cook stove based on the study considered in the specified district. In this regard, thematic analysis has been conducted as eight socio –economic variables were considered as the users choice and preference of clean cooking system as : age, education level, family size, decision (sex of the house hold heads), farmland size, economy(income level), stakeholders participation, and users involvement. Economy level, stakeholders participation, and users involvement have been evaluated with dependent variables of (reason for adoption/non adoption of ICs (with 95% confidence level by comparing the population means) and obtained as shown in Table 3. It is clearly noticed that age, family size, income level, role of stake holder involvement in the locality have a strong positive relationship with dependent variable since p value<0.05. On the contrary, education level, farm land size and decision making at house hold level have no strong interaction with the dependent variable(reasons for non –adoption) as p-value>0.05. Regression, the predictor variables (Age, Education level, Family size, Decision and Farmland size.

Table 3
LINEAR REGRESSION ANALYSIS OF FACTORS FOR ICS ADOPTION (MODEL SUMMARY ANOVA REGRESSION COEFFICIENTS)

MODEL SUMMARY

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.482[a]	0.233	0.179	1.11261	1.656

a. Predictors: (Constant), Users involvement in utilization of ICs, age distribution , Family size, education level, Income level in ETB Birr per year, Decision making at household level, Farm land size in ha, Role of stake holder involvement in the locality

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42.797	8	5.35	4.322	.000b
	Residual	141.121	114	1.238		
	Total	183.919	122			

***Note**:a. Dependent Variable: reason for adoption/non adoption of ICs

b. Predictors: (Constant), Users involvement in utilization of ICs, age distribution, Family size, education level, Income level in ETB Birr per year, Decision making at household level, Farm land size in ha, Role of stakeholder involvement in the locality

COEFFICIENTS

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
	(Constant)	1.729	0.813		2.127	0.036
	age distribution	0.08	0.129	0.053	0.616	0.539
	education level	0.035	0.109	0.028	0.324	0.747
	Family size	0.315	0.136	0.199	2.313	0.023
	Farm land size in ha	-0.047	0.156	-0.027	-0.303	0.762

	Decision making at household level	-0.21	0.156	-0.118	-1.352	0.179
	Income level in ETB per year	0.319	0.077	0.359	4.137	0
	Role of stake holder involvement in the locality	-0.339	0.152	-0.237	-2.231	0.028
	Users involvement in utilization of ICs	0.237	0.141	0.177	1.687	0.094
a. Dependent Variable: Reason for adoption/non adoption of ICs						

Age

The role of age on cook stove preference is shown in cross tabulation descriptive analysis Table 4. The analysis revealed that younger individuals are more likely to use clean cooking systems than older individuals. In other words, the older the woman, the greater her intention to stick to traditional cooking systems which is also confirmed by (Muneer & others, 2003; Mamuye et al., 2018; Akomolafe & Ogunleye, 2017) and concluded ,Younger individuals are more probably resemble to adopt ICS because they are more open to percept new technologies and flexibly changing their cooking behaviors.

Table 4
AGE DISTRIBUTION AND TYPE OF COOK OF COOK STOVE FOR COOKING CROSS TABULATION

		Type of Cook Stove Model for Cooking					
Variable		**Three-stone stove**	**Lakech (Gonzye)**	**Mirt Stove**	**charcoal stove**	**Biogas stove**	**Total**
Age distribution	21 - 30	4	0	0	0	0	4(3.3%)
	31 - 40	34	1	0	3	1	39(31.7%)
	41 - 50	41	4	2	3	0	50 (40.65%)
	above 50	20	2	3	5	0	30(24.4%)
Total		99(80.5%)	7(5.7%)	5(4.1%)	11(8.9%)	1(0.8%)	123

Family Size

Similarly, the implication of average family size for both improved cooking stove adopters and open fire cooking system was favors to be in the range of family size (5-7). The mean family size of adopters was 12% and that of the non-adopters was 51% with family size ranging between 5 and 7 for both groups Table 5). This suggests that the choice to perceive ICS was more probably influenced by the size of the household. In contrast to this finding, the size of the family was a noteworthy obstruction for adoption of ICS in (Dodela, Ethiopia, Mamuye et al., 2018). Another study, in Mexico had similar findings (Pine et al., 2011) and in depth explained that households with larger family size spent huge money for purchasing biomass fuel, resulting to the large degree of adoption of improved cook stove.

Table 5
DESCRIPTIVE CROSS TABULATION OF FAMILY SIZE AGAINST TYPE OF COOK STOVE FOR COOKING

		Type of cook stove model for cooking					
Variable		Three-stone stove	Lakech (Gonzye)	Mirt Stove	charcoal stove	Biogas stove	Total
Family size	<2	9	0	0	0	0	9(7.3%)
	2 – 4	29	4	0	0	1	37(30.1%)
	5 – 7	51	2	2	1	0	63(51.2%)
	8 – 10	10	3	3	0	0	14(11.38%)
Total		95(77.2%)	7 (%)	9(7.9%)	11(8.9%)	1 (%)	123

Income Level

In this study, following descriptive statistics of cross tabulation, the income level with respect to types of cook stove used, the influence of income level on ICS adoption has a strong relationship with the income level of the house hold. Which is adoption of ICS was also affected by household income as it may be defined as the annual earnings of a household obtained from all sources (like, income obtained from: crop production, livestock and livestock products, salary, etc.)

Table 6
DESCRIPTIVE CROSS TABULATION OF INCOME LEVEL OF RESPONDENTS AND TYPES OF COOK STOVE USE FOR COOKING

Variable		Type of cook stove model used for cooking: Three-stone stove	Lakech (Gonzye)	Mirt	charcoal -stove	Biogas stove	Total
Yearly Income level (ETB Birr)	6000 - 10,000	19	1	2	3	1	26(21.1%)
	11,000 - 15,000	16	0	1	3	0	21(17.1%)
	16,000 - 20,000	16	2	0	1	0	18(14.6%)
	above 20,000	42	5	2	1	S	49(38.3%)
Total		98(79.7%)	8(6.5%)	6(4.9%)	11(8.9%)	1(0.8%)	123

*Note: ETB indicates in Ethiopian Birr

As seen in Table 6, above 30% of adopter respondents lies at highest economic level (20,000 ETB). This indicates income level of the household has an implication to afford the cost of ICS. Due to the fact that adoption of ICS is relatively strongly affected by the income level that can affords for the cooking technology options. This finding was inconsistent with an assessment conducted by (Levine et al., 2013) which indicated that the cook stove's price was a decisive factor that affects the decision for adoption.

Another study by (Lewis & Pattanayak, 2012; Mekonnen et al., 2008; G & A, 2014) also confirmed that households with higher income are more likely to adopt ICS than lower income household which implies the value of ICS was a vital adoption barrier. While, the low income users cannot afford ICs implies the price of ICS was a determinant factor of adoption (Fullerton et al., 2008). Thus the enabling of a more efficient fuel use may thus be a crucial strategy in promoting green economy of the nation and poverty alleviation in addition to other socio – economic benefits (Pine et.al, 2011). A studies by (Grant Axén, 2012; Troncoso & Al, 2007), also supports there is a strong correlation between lack of access of biomass solid fuels with adoption of ICS.

Education Level

The level of education of the household head is a significant variable found to impact adoption of the ICS. As illustrated in Table 7, the community base survey result of this study shown that 48.8% of the households have formal education, and of these, 20% were improved cook stove adopters.

Table 7
DESCRIPTIVE CROSS TABULATION EDUCATION LEVEL OF RESPONDENTS AND TYPES OF COOK STOVE USE FOR COOKING

		Type of Cook Stove Model used for Cooking					Total
Variable		**Three-stone stove**	**Lakech(Gonzeye)**	**Mirt**	**charcoal stove**	**Biogas stove**	
Education level	Under primary	51	2	3	7	0	63(51 %)
	Junior	4	1	0	1	1	7(5.7%)
	Primary	44	4	2	3	0	53(43.1%)
Total		99(80.5%)	7(5.7%)	5(4.1%)	11(8.9%)	1(0.8%)	123

On contrary, 51 % (63) of the households did not attend formal education and only 19.05% (12) of them were ICS adopters. The extents of family units with formal education gets formal education pre-receive ICs more than those who did not attend formal education. This shows that educated households have a better probability of using improved cook stoves. This could be attributable to the awareness that education gets concerning about cost comparisons of energy and the health issues of women with traditional stoves (Mekonnen et al., 2008).

Another study has also confirmed that the implication of education in ever-changing household cooking preferences from traditional to improved cooking technologies. Previous studies shown that highly educated people resembles to adopt improved cook stoves more regularly than non /or less educated people which is consistent with studies of (Jan et al., 2017; Puzzolo et al., 2016; Brooks et al., 2016; Mamuye et al., 2018).

Decision of the Household

The decision at household level is also another factor on primary choice and utilization OD cook stove technology options. The decision making powers on the adoption of cook stoves for cooking is presented in Table 8. It can be noticed that, out of 123 household respondents, males led 15, Females led 14 and 94 led by both. Of these households male-led households, 20% (3) were adopters of ICs while 12 (80 %) were non-adopters.

Table 8
DESCRIPTIVE CROSS TABULATION DECISION MAKING AT HOUSEHOLD LEVEL ON TYPE OF COOK STOVE FOR COOKING

Variable	**Type of Cook Stove Model used for Cooking**	**Total**

		Three-stone stove	Lakech (Gonzeye)	Mirt	charcoal stove	Biogas stove	
Decision making at house hold level	Husband	12	1	0	1	1	15(12.2%)
	Wife	11	1	1	1	0	14(13.4%)
	Both	76	5	4	9	0	94(76.4%)
Total		99(80.5%)	7(5.7%)	5(4.1%)	11(8.9%)	1(0.8%)	123

However, out of the 14 female-lead households, 21.4% (3) were adopters of improved stove and only 78.6 % (11) were non-adopters. The larger of respondents who did adopt improved cook stoves were likely equal for male-headed and female headed households. Comparatively, male -headed households were more likely to adopt ICS as compared to women headed families. One reasonable justification for this could be that female household heads had greater power to make financial decision as compared with females in male-headed households. Still were masculine (male –controlled)society such as Ethiopia, financial decisions are most often made by a husband in a male-led household (Beyene & Koch, 2013; Mekonnen et al., 2008) ,which results in the adoption of ICS can be affected by letdown to recognize and aim women for their role for the program of ICS dissemination activities.

Farmland Size

Likewise, the household survey results of farm land size against the types of cook stove used for cooking illustrated in Table 9. The more the respondents have large hectare of land, the more they are unwilling to use the ICS, This is due to the concern for biomass fuel is not as such their issue as if they can access solid fuel in their large hectare of land which is directly related with fuel availability and their intention to adopt ICS decreases when households have free access fuel wood (e.g., near to the forest). The quantitatively Table 9 shows, out of 123 respondents 19 of them have large hectare of land (>3), of these 9(47.36%) of them are adopters and 10(52.64%) non-adopters. In comparison respondents who have small farmland size (1-3 hectare) resembles to be non-adopters, 84(82.69%) and 18(17.3%) adopters. This result is more likely in agreement with previous studies (Wang & Baili, 2015; Poddar & Chakrabarti, 2016; Joshi & Bohara, 2017; Mudombi et al., 2018).

Table 9
DESCRIPTIVE CROSS-TABULATION OF FARM LAND SIZE IN HECTARE AGAINST TYPE OF COOK STOVE USED FOR COOKING

Variable	Type of cook stove model used for cooking					Total
	Three-stone stove	Lakech (Gonzeye)	Mirt	charcoal stove	Biogas stove	

Farm land size in hectare	1	53	2	3	5	1	64(52%)
	3-Feb	31	4	1	4	0	40(35.2%)
	4-Mar	9	1	2	2	0	14(11.4%)
	>5	1	2	2	0	0	5(4.1%)
Total		94(76.4%)	9(7.3%)	8(6.5%)	11(8.9%)	1(0.8%)	123

Stake Holder Participation

With regards to stakeholder participation in the district for promoting the ICS, out of the 123 respondents the active involvement of stakeholder most likely affects the perception and adoption of the community. The argument is supported in Table 10. As displayed in the table 10, among the non-adopter respondents (users of three stone open firing systems) reflects the role of stake holder involvement in the locality is in the qualitative range of very low- low could results low adoption rate of ICs.

Table 10
DESCRIPTIVE CROSS TABULATION OF ROLE OF STAKEHOLDER INVOLVEMENT IN THE LOCALITY AND TYPE OF COOK STOVES FOR COOKING

Variable		Type of Cook Stove Model used for Cooking					Total
		Three-stone stove	Lakech (Gonzye)	Mirt	charcoal stove	Biogas stove	
Role of stake holder involvement in the district	Very low	17	0	0	0	0	17(13.8%)
	Low	58	1	0	1	1	61(49.6%)
	Medium	12	0	2	1	0	15(12.2%)
	High	12	3	3	9	0	27(21.9%)
	Very high	0	3	0	0	0	3(2.4%)
Total		99(80.5%)	7(5.7%)	5(4.1%)	11(8.9%)	1(0.8%)	123

In contrast, the accessibility of stoves *via* stake holder involvement (high and very high) were found to be 18 respondents which is most likely adopts ICS of Lakech, Mirt , Charcoal and Biogas stoves as compared to that of very low and low . The present findings were confirmed also by previous investigation with clear conclusion of low awareness about health and environmental risks associated to traditional stoves acts as a barrier to the adoption of ICS (Kulindwa et al., 2018; Kapfudzaruwa et al., 2017; Annegarn, 2017). Significantly, as the stakeholders are actively engaged in community-based ICS dissemination which may increases households' intention to adopt ICS. In addition, periodic maintenance and repairing costs represent a barrier to adoption.

Users Involvement and Perception

It can be clearly noticed in Table 11, user's involvement and perception has been also taken as a typical predictor variable for the status of adopting ICs.

Table 11
USERS INVOLVEMENT IN UTILIZATION OF ICS AGAINST TYPE OF COOK STOVE FOR COOKING CROSS TABULATION

		Type of cook stove model used for cooking					Total
Variable		Three-stone stove	Lakech (Gonzye)	Mirt	charcoal stove	Biogas stove	
Users involvement and perception in utilization of ICs	Very low	16	1	0	1	0	18(14.6%)
	Low	55	3	1	8	0	67(54.5%)
	Medium	15	2	3	1	1	22(17.9%)
	High	12	0	1	1	0	14(11.4%)
	Very high	1	1	0	0	0	2(1.62%)
Total		99(80.5%)	7(5.7%)	5(4.1%)	11(8.9%)	1(0.81%)	123

As shown in cross tabulation of user's involvement and perception in utilization of ICs against types of cooking in used Table 11, the household and the survey result indicates, 85(69.1% out of 123 respondents) belongs to the respondents whose response is in the range of very low –low, of these ,71 (83.5%) are stick on traditional open fire system. On the other side, out of 38(30.9% out of 123 respondents) corresponds for respondents whose response is in the range of medium – very high. In-comparison there is 11% increment of adopter percentage for respondents of (medium- very high) users' involvement and perception in ICS correspondent's than that of very low –low consumers' (15.3%). Standing on this result there is a gap between adopter and non-adopters of the stove regardless of information about the stoves at household level, users' adequate knowledge on the benefit of the stoves and lack of differentiation between the traditional stove and improved biomass stoves. This result is in good agreement with (Keese et al., 2017).

CONCLUSION, POLICY IMPLICATION AND FUTURE WORKS

The need for getting energy access is still a limitation in many developing countries including Ethiopia and millions of peoples principally Women's and children's spent their time in biomass collection and traditional food cooking systems. Based on these and discussions presented in discussion section the following conclusions can be drawn.

1 Age, family size, income level, role of stake holder involvement) in the district have a strong positive relationship with dependent variable since p value<0.05.

2 On the contrary, education level ,farm land size and decision making at house hold level have no strong interaction with the dependent variable(reasons for non –adoption) as the decision is being made on p-value>0.05.
3 The majority out of the respondents; (80.5%) are still using three stone open firing systems and the ICs adoptions are at early stage as 5.7% were using Lakech (Gonzye) stove ,4.1% Mirt, 11% charcoal (traditional)
4 Key challenges and barriers for adopting/non-adopting for rural communities in the district is the availability biomass solid fuel source and lack of awareness on ICs.
5 Upgrading the use of more effective advertisement and secure cooking frameworks among family units is therefore, an issue of imperative significance for sustainable use of energy sources and safeguard the environment from pollution.

To this end, it is recommend that the government has to be aware and intervened in its energy policy to safe guard the environment from excess deforestation by implementing improved cook stove dissemination program at large.

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