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Assessing Factors that Challenges the Dissemination of Improved Cook Stove in Selected Rural Kebeles of Adiyo Woreda, Kaffa Zone, SNNPRS

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Abstract

Over 94 percent of energy consumption in Ethiopia comes from biomass fuels along with traditional cooking technologies and this pattern has major effect on livelihood and deforestation in the country. To overcome these problems the government of Ethiopia and International development organizations, have recently ramped up efforts to promote the use of Improved Cook Stoves (ICS) in the country. However, the dissemination of the ICS is very low in the study area so far. Thus, the purpose of this study was to asses factors that Challenges the dissemination of ICS utilization among rural households in the case of Adiyo Woreda Kaffa Zone. Among 28 kebeles in Adiyo Woreda, Boka and Mera Kebeles were selected using purposive sampling. Sample size between the users and non-users of ICS, was determined using proportionality principle and more proportion of sample was given to those ICS user households. Then, 298 sample households were selected using systematic random sampling technique. The household surveys, focus group discussion, personal observations and key-informants interview were used for primary data collection. Data were analyzed using descriptive and inferential statistical techniques. Logistic regression was employed to assess determinants that were affecting dissemination of ICS among rural households. The inferential statistics like chi-square and t-test were employed to see the statistical significances and associations of variables. Logistic regression results revealed that ICS use has a statistically significant and negative relationship with gender, family size and the price of the stove while, positive relationship with educational status, annual income, distance to forest, availability of promotion, availability of credit service, awareness on government policy.

Keywords: Dissemination; Biomass energy source; Improved cook stove; Traditional Cooking stove; Utilization

Introduction

Ethiopia is one of the developing countries with more than 80% of the country's population is engaged in the small-scale agricultural sector and live in rural areas, traditional energy sources along with traditional cooking stoves represent the principal sources of energy in the country. The government of Ethiopia and NGO has made a great effort in introducing the new technology (improved cook stove) to the rural users. The Ethiopia energy policy promotes ICS as an appropriate technology to reduce emissions from deforestation and forest degradation as well as to improve the livelihood of rural people. As the result of this in 1970s, the Ethiopian Rural Energy Development and Promotion Centre (EREDPC), has been engaged in the business of improving household cooking efficiency, resulting in three improved cook stoves, namely: "Laketch" charcoal stove, "Mirt" fuel wood stove, and the "Gonzie" multi-purpose wood stove used for baking, cooking and boiling [1]. However, the dissemination rate of the technology by the local people is very low so far.

Since Adiyo Woreda is one of the rural areas in Ethiopia, it also shares similar problem. According to Adiyo Woreda Water, Mine and Energy Office [2] more than 97% of the Woreda households use traditional stove. Most available studies related to dissemination of ICS, such as [3] and [4] have generally focused on urban area, such that the rural sector is under-represented. Therefore, focusing on rural households is useful, from the viewpoint of protecting forest cover. Still up to now, the distribution of the ICS is very low therefore; existing literatures have not explored factors for this low adoption of ICS technology. To this end, this study was used logistic regression model to access determinants that affecting the dissemination of ICS Therefore, this study has filled these knowledge gaps and added onto the existing knowledge, particularly by developing conceptual framework for assessing factors affecting adoption of ICS technology based on adoption theories. Therefore, this work is aimed to explore challenges in disseminating ICS technology.

Materials and Methods

Study site

This study was carried out in two selected kebeles, namely Boka and Mera Kebeles of Adiyo Woreda, in Kaffa Zone. Adiyo Woreda is one of the ten Woredas of Kaffa Zone. The study area lies between 7°8' to 7°26'N latitude and 36°15' to 36°50'E longitude. It shares boundaries with Oromia region of Jimma Zone in the North and North east, TelloWoreda in the South, GimboWoreda in the West, Decha Woreda in the Southwest and Konta special Woreda in the South East [2]. According to [2] Adiyo Woreda covers a total area of about 94,992.3 km^2 which comprised 9.45% of the Zone.

In order to facilitate the socio economic development of the Woreda, it was structured in to 27 rural and 01 urban kebeles. The highest political decision body is the Woreda council, which has 81 (seats) council members. All political, economic, social as well as governance duties are carried out by the Woreda cabinet members and

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council of the Woreda. Adiyo Woreda is a predominantly highland area with undulating landscape, mountains and rivers, forests, wide vegetation cover and wildlife. As AWADO [5], about one third of Adiyo and the surrounding area is covered by forest comprising a rich mixture of species. Adiyo Woreda has the mean annual rainfall ranging between 1400 and 2000 mm and average annual temperature varying from 12°C to 26°C. It has three traditional agro-ecological zones such as cold zone (Dega) 2500-3000 meters above sea level (masl), semi cold zone (Woina Dega) 1500-2500 masl, and hot zone (Kolla) 500-1500 masl. Thus, cold zone, semi-cold and hot zones comprised for 56%, 38% and 6% of the Woreda respectively (Figure 1) [2].

Research design

A mixed approach of both qualitative and quantitative methods was used in the analysis of the study. Therefore, qualitative as well as quantitative data were collected in the form of opinions, semi-structured interviews, focus group discussion and observation. For this reason, it was necessary to use a mixed methods approach coding the data in two ways: qualitative and quantitative.

Sampling techniques

Multi stage sampling technique was used to this study. In the first stage, Purposive sampling was used to select AdiyoWoreda among 10 rural Woredas and 1 City administration that were found in Kaffa Zone because of two reasons. The first one is the existence of wide forest resource coverage along with deep problem of deforestation as compared to other Woredas in the zone [2] and the second one was the researcher's deep work experience in the study area. In the second stage, for the selection of sample Kebeles among 28 kebeles that exist in the study area, purposive sampling was also used based on the distribution of ICS services made by the Woreda energy office. To this end, ICS distribution has been made only in 8 kebeles while, in the remaining of 20 kebeles there was no distribution. According to the report of Adiyo Woreda Water Energy and Mine Office [6], the priority given for those 8 kebeles was because they are residing near to the Buta forest, which is included under Biosphere reserved region. From those of 8 accessed kebeles, two of them with the highest number of stove distribution were selected using purposive sampling because the number of distributed stoves is few in all 8 kebeles as compared to the number of households in those kebeles [6]. In addition to this, researcher's main aim was to investigate the contribution of ICS utilization on rural livelihood improvement and forest resources. To do so, representative sample was taken from the population. Moreover, this method allowed the researcher to examine factors that determine the utilization of ICS technology.

The sampling frame was included all the households in these two kebeles including both household groups that are user and non-user of the improved cooking stoves. The total number of the households in these two kebeles was 1,162 and the sample size was determined using Yamane T [7] formula as follows:

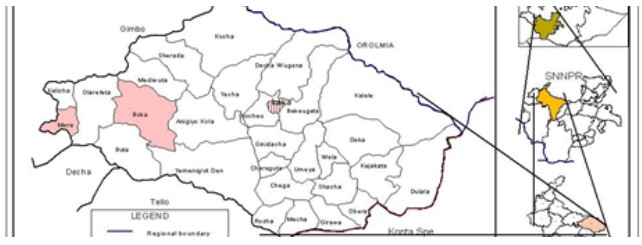

Figure 1: Location map of Addiyo Woreda.

$$n=\frac{N}{1+N(e)_2}$$

This formula was employed to calculate the sample sizes at 95% confidence level and P =0.5. Where n is the sample size, N is the population size, and e is the level of precision. When this formula is applied to the above sample, we get

$$n=\frac{1162}{1+1162*(0.05)2}=\frac{1162}{1+2.905}=\frac{1162}{3.905}=298$$

Therefore, the researcher believed that a total of 298-sample size was a representative of the population. The sample size for each kebele was determined using the proportionality principle. Moreover, the sample size between the two strata (users and non-users of ICS) was further determined by giving more proportion of sample (60% of proportionate sample size) to those ICS user households. This was because of their being few in number and the study is mainly focused to investigate the contribution of improved cook stove on rural livelihood improvement and forest resource coverage in depth. Then the sample households were selected using systematic random sampling technique (Table 1).

According to the report of AWWEMO [6], the stove distribution in the study area covers only 1,000 households. Therefore, distribution limitation is one of the problems and hence, the study was also investigated the challenges in adopting improved cook stoves in the study area. Accordingly, the population for this study was both households who received and did not received improved cook stoves. Moreover, both male and female households were included to the study.

Sample household respondents were selected through simple random sampling technique using the sampling frame of the list of the households obtained from the Woreda Water and Mineral Office for the users of ICS and the list from the Woreda Finance and Economic development Office for non-users of the ICS. Tools and Techniques for Data Collection Large and representative household sample survey was collected in order to obtain the information that was needed to conduct the research. To carry out this, different tools were used for this study. Data was collected from different sources through structured questionnaires, interview, personal observation and focus group discussion.

Methods of data analysis

The survey generated both qualitative and quantitative data was summarized, categorized and coded some qualitative responses into numeric values and then entered in to statistical program (StataIc11) and Microsoft window (2007). Information obtained from unstructured interviews and informal interviews with key informants and with focus group discussion in the study area was narrative and qualitative in nature and used to support the coded qualitative and quantitative data. Descriptive statistics; sum, mean, standard deviation, cross tabulation and percentages was presented in tables, graphs to enable easy interpretation and quick visual comparisons of variables within the study area. Moreover, logistic regression model was employed to identify determinants of ICS utilization among rural households. T-test and chi-squire test were also used to explore the relation between independent variables with dependent.

Results and Discussion

Econometric analysis and results

The probability of improved cook stove utilization is dependent

Kebeles	Clusters of Samples		Total No. of HH	proportionate sample	60% of Proportionate sample (from users cluster)	40% of Proportionate sample (from the non-user cluster)
	No. of user households	No. of non-user households				
Boka	209	621	830	213	128	85
Mera	175	157	332	85	51	34
Total	384	778	1162	298	179	119

Table 1: Sample size determination.

variable, which begins by adding independent variables in to categorical and continuous variable lists in StataIC 11 version and coded on the data set for 0 and 1 for dummy variables. The study ensures that independent variables are categorical and continuous those were declared in this analysis. The binary logistic model results revealed that the probability of improved cook stove utilization was determined by the interaction of different demographic, socio-economic, environmental, technological and institutional factors.

Binary logistic regression analysis for adoption of ICS

In the binary logistic model analysis, the study emphasized on considering the combined effect of variables between users and non-users in the study area. All variables associated with adoption of ICS in binary logistic regression were referred to the p-values, with the value of $p<0.01$ and $p<0.05$. Therefore, those variables, which were identified as statistically significant in relation to dependent variable and which have no multi-co linearity effect, were entered in to the model and the outputs (the estimates) of the logistic model were predicted using logistic Stata command to obtain the output with odds ratio described below in (Table 2).

Among the 10 variables included in the model, the Wald χ^2 test results for 9 of these indicated that they were found to be statistically significant and had significant probability on decision of adopting ICS (Table 2). The result of the logistic regression analysis indicated that education level (grade 5-8), household annual income, distance to the forest, the perceived price of the stove, availability of promotion, availability of credit service were statistically significant at 1% significance level.

Gender, family size, Education level [(grade 1-4), (grade 9-12) and (certificate and above)] and awareness on government policy were also statistically significant at 5% significance level. However, understanding level of IAP was found to be insignificant at 5% significance level. Moreover, except gender, family size and price that had a negative correlation, the rest were found to have a positive correlation with adoption of ICS.

Even though, the understanding level of IAPP was insignificant at less than 5% significance level, the positive coefficient indicates that households who have a clear understanding about IAPP are most likely to adopt ICS than those who do not have. However, in this study; understanding about indoor air pollution was insignificant to influence household decision on adoption of ICS. This was similar to [8], found that concisely, the respondents were generally well aware of IAP and its harmful effects but attributed this pollution more to fuel than to stove. That means, changing fuel was their solution to prevent IAP not changing stove.

The results from the model reveal that characteristics of households could be a good source of knowledge on the reasons why households may or may not adopt this technology. Many programs aimed at promoting a given technology have tended to focus more on the technical aspects of the technology disseminated. However, the results of this study show that both the technical aspects of the technology and the socio-economic characteristics of the target beneficiaries are crucial in the popularization of ICS technology.

Interpretation of odds ratios

Gender of household head: The gender relationships regarding male-female of household head has a significant negative relationship with adoption of ICS at 5% significance level. Table 2 shows that the odds ratio associated with gender of household is [OR = 0.251, 95% C.I: (0.068, 0.916)]. This implies that, keeping all independent variables constant, the odds ratio of 0.251 is in disfavor of adopting ICS increases as households headed by male than female in the study population. This suggests that households headed by female were more likely to adopt ICS than male. This might be because, cooking related activity is culturally considered as women responsibility, so that they need to adopt ICS in order to minimize the opportunity cost which they incur from traditional cooking stove. The finding of this study is similar to a study conducted in rural Bangladesh by [9] that women who bear disproportionate cooking costs have stronger preference for ICS but they lack the authority to make the purchase. However, the finding of this study is opposing the finding of [10] in their study of ICS adoption in urban Ethiopian households, find that gender of the head of household did not matter to the adoption of the ICS.

Educational status of household head: Educational statuses such as (1-4th), (5-8th), (9-12th) and certificate and above level have a significant positive relationship with ICS adoption at 5%, 1%, 5% and 5% significance level respectively. Table 2 shows that, educational level variable was categorized under 5 categories and educational status with category of "no formal education" was taken as a reference. The odds ratio associated with educational statuses of household head such as (1-4th), (5-8th), (9-12th) and certificate and above educational level were [OR= 5.832, 95% C.I: (0.907, 37.485)]; [OR=7.072, 95% C.I: (1.955, 25.586)]; [OR=8.440, 95% C.I: (0.678, 104.986] and [OR=9.128, 95% C.I: (1.577, 52.823)] respectively. Thus, it was interpreted as, holding all variables constant in the model, the odds ratio of 5.83, 7.03, 8.44 and 9.13 were in favor of adopting ICS increases as household heads educational status to (1-4th), (5-8th), (9-12th) and certificate and above than those who have no formal education, respectively. This might be justified as; the educated person can have better awareness and understanding about new technologies than the non-educated ones. The more educated household heads were expected to be less conservative, more exposed to sources of information and therefore more informed, knowledgeable and environmentally alert about the effects of utilization of ICS on the environment. They should accept cleaner energy sources such as ICS that is more environmentally friendly and more readily than their less educated counterparts. In addition to this, high levels of literacy can facilitate effective flow of information for qualitative decision-making regarding a new technology. The result is in conformity with the findings of some other adoption studies [11], which show a positive correlation between education and the probability of adoption. It was also in line with the study conducted in Ethiopia by [12] that household with higher socio-economic status as

Explanatory variables	Odds Ratio	Robust Std. Err.	Z	p>z	[95.0% Confidence Interval]	
					Lower	Upper
Gender	0.251	0.166	-2.09	0.036**	0.068	0.916
Family size	0.751	0.105	-2.05	0.040**	0.571	0.988
Educational status of HHH						
Education (1-4th grade)	5.832	5.536	1.86	0.036**	0.907	37.485
Education (5-8th grade)	7.072	4.64	2.98	0.003*	1.955	25.586
Education (9-10th grade)	8.44	10.855	1.66	0.047**	0.678	104.986
Education (certificate and above)	9.128	8.176	2.47	0.014**	1.577	52.823
Annual income	1.179	0.055	3.56	0.000*	1.077	1.292
Distance to the forest	1.94	0.291	4.41	0.000*	1.445	2.604
Price of ICS						
Perceived as medium	0.087	0.072	-2.94	0.003*	0.017	0.444
Perceived as expensive	0.043	0.031	-4.44	0.000*	0.011	0.173
Availability of promotion	6.391	4.067	2.91	0.004*	1.835	22.257
Availability of credit service	6.453	4.56	2.64	0.008*	1.615	25.783
Awareness on Government policy	3.977	2.355	2.33	0.020**	1.246	12.694
Awareness on IAP problems	1.523	0.962	0.67	0.505	0.442	5.252
Note: * and ** indicate significance at 1% and 5% probability level respectively						
Number of observations=298						
Pseudo R- Square=0.779						
-2 Log likelihood value=-44.198						
% of correct prediction for ICS users=96.05 (170 households out of 177)						
% of correct prediction for ICS non- users=92.56 (112 households out of 121)						
% of total correct prediction=94.63 (282 households out of 298)						

Table 2: Binomial logistic regression (reporting odds ratio) of ICS adoption.

in terms of level of education are expected to consume more energy, a decrease in the importance of biomass fuels and an increase in modern forms of energy.

Annual income of household: Increasing household income proved to be a key factor in positively influencing a household's decision to adopt ICS. As it was hypothesized in section 3.8, annual income has a significant positive relationship with adoption of ICS at 1% level of significance. In Table 2, the logistic regression result showed that the odds ratio associated with annual income of household head was [OR=1.179, 95% C.I: (1.077, 1.292)]. Thus, this can be interpreted as keeping all other independent variables constant in the model; the odds ratio of 1.179 is in favor of adopting ICS as annual income of household increases by one unit (Birr). This implies that, household heads that have more annual income were more likely to adopt ICS than those who have less amount of annual income. Accordingly, when income increase by one birr from average value of (12,723.15 Birr), the probability of adopting ICS increases by marginal factor of 0.024 (Appendix 1). This might be because, most probable effect of income of household on adoption of ICS is the financial ability to purchase the new technology, which is the most important factor determining whether a household adopts or not.

Distance to fuel source: As it was hypothesized in section 3.8, distance has positive relationship with ICS adoption at 1% significance level. The result of Logistic model revealed the odds ratio associated with the distance to the forest was [OR=1.940, 95% C.I= (1.445, 2.604)]. This can be interpreted as keeping all variables constant in the model; an odds ratio of 1.940 is in favor of adopting ICS as distance to fuel source increase in one unit (kilometer). This implies that household who lives at farther distance from the fuel source was more likely willing to use ICS. Accordingly, when distance to fuel source increases by one kilometer from an average value of 3.56, the probability of adopting ICS increases by marginal factor of 0.095 (Appendix 1). The possible reason for the present results might be the far distance to the fuel source, possibly captures aspects on fuel insecurity, unavailability and inaccessibility of fuels by households. In addition, households may perceive distance as additional cost wastage of time. The result was consistent with that of [13], who also found a positive coefficient between ICS adoption and the distance.

Family size: In the study area, the average household comprised of 4 members and it was significantly influenced the household's decision to adopt ICS. As it was hypothesized in section 3.8, family size in Table 2 had a negative relationship with adoption of ICS at 5% significance level. The odds ratio associated with the variable family size was [OR=0.75, 95% C.I: (0.57, 0.99)]. This can be interpreted as keeping all other independent variables constant in the model; an odds ratio of 0.75 is disfavor of adopting ICS as family size increases by one unit (one-person) in the number of family size. This suggests a larger family sized household had a smaller probability of adopting ICS technology than a smaller one. Accordingly, when family size increases by one person from an average value of 4.36, the probability of adopting ICS decreases by marginal factor of 0.041 (Appendix 1). This might be a large size family has more labor force that can collect fuel wood and meet the energy demand of the household than smaller sized family that can be forced to use ICS in order to save the fuel. The finding of this study is similar to the study conducted by [11] that large sized household head may not be willing to adopt a new technology. Rather, they would negatively influence the decision to adopt improved cook stove.

Availability of promotion about ICS: As it was hypothesized in

section 3.8, the existence of promotion about ICS has a significant positive relationship with ICS adoption at 1% significance level. Table 2 shows that the odds ratio associated with the availability of promotion in the study area was [OR=6.391, 95% C.I: (1.835, 22.257)]. Thus, it was interpreted as; holding all other independent variables in the model constant, an odds ratio of 6.391 is infavour of adopting ICS as households who have gotten promotion about ICS than that of households who have not gotten the promotion. This implies that household heads that got necessary promotion about ICS adoption were more likely to adopt ICS than who did not get it. The finding of this study was in line with the dominant theory of innovation-diffusion model by [14] that asserts the availability and promotion of new technology to potential users about an innovation is the key factor in determining adoption decisions.

The perceived price of ICS by household head: As it was hypothesized in section 3.8, the perception of household head on the price of ICS has a significant negative relationship with ICS adoption at 1% significance level. Table 2 shows that the perceived price of ICS was categorized under 3 categories and the price of ICS category of "cheap" was taken as a reference. Logistic model revealed that the odds ratio associated with the perceived price of ICS by household head as medium and expensive were [OR=0.087, 95% C.I: (0.017, 0.044)] and [OR=0.043, 95% C.I: (0.011, 0.173)] respectively. Thus, this can be interpreted as keeping all other independent variables constant in the model, an odds ratio of 0.087 and 0.043 were disfavor of adopting ICS when the household head perceived the price of ICS as medium and expensive, respectively than cheap. This implies that when household heads perceive the price of ICS as expensive and unfair, it was less likely to adopt ICS than who perceive the price of ICS as cheap and fair. The finding of this study is similar to the study conducted by [15] that used survey data from rural and urban Guatemala and examine the effects of startup cost of adoption of improved cook stove. Their analysis shows that the prices of a stove have a negative effect on the adoption of ICS stove; the effect is more pronounced in rural than in urban areas.

Credit service: Table 3 compares the availability of credit service between non-users and user households that were offered the credit service. The chi-square statistic of 81.3 indicates that the adoption of the ICS has statistically significant different at the 1% level of significance. Over 76% of the user households who have been offered the credit service was adopted ICS similarly 77% of non-user households who did not receive the credit service was not adopted ICS. From this, it is possible to conclude that the credit service is therefore incentivized households to adopt ICS.

Pearson $chi^2(1)$-81.2729 Pr= 0.000

As expected, access to credit service in this study has appositive relationship with adoption of ICS at 5% level of significance. Logistic result in Table 2 revealed the odds ratio associated with credit service in the model was [OR=6.453, 95% C.I: (1.615, 25.783)]. This can be interpreted as holding all other independent variables constant in the model; an odds ratio of 6.453 is in-favor of adopting ICS when household's head who have gotten credit service from government than household who have not gotten credit service. This implies that household heads who had access to credit service were more likely to adopt ICS than who do not have access to credit service. The finding of this study is similar to the study conducted in Ethiopia by [16] that for many households in the developing world, the high cost of improved stoves and limited access to credit is among the factors that impede adoption of improved stoves.

Availability of credit service	Clusters of households						
	non-users			users			Total
	frequency	column %	row %	frequency	column %	row %	
No	91	76.47	68.42	42	23.46	31.58	133
Yes	28	23.53	16.97	137	76.54	83.03	165
Total	119	100		179	100		298

Table 3: Comparison between users and non-users based on credit service.

Awareness on government policy: The awareness level of household on the government energy policy has a positive relationship with adoption of ICS at 1% level of significance. Logistic result in Table 2 revealed that the odds ratio associated with awareness of household head on government policy was [OR=3.977, 95% C.I :(1.246, 12.694)]. This can be interpreted as holding all other independent variables constant in the model; an odds ratio of 3.977 is in-favor of adopting ICS as households who have awareness on government energy policy than who have no awareness on government policy. This implies that household who had awareness on Ethiopian National Energy policy makes his family to benefit from the policy that promotes the use of ICS. This was similar to the observation of [11] that understanding government policy promotes the use of ICS.

Conclusion

The result of the study revealed that among 28 kebeles in Adiyo Woreda only 8 of them were accessed with ICS while, the remaining 20 kebeles were not accessed by ICS distribution. Besides this, only 1000 households were using ICS from 27,570 households that were found in the Woreda. This also indicates that adoption of ICS were under a big challenge. Logistic regression results revealed that adoption of ICS has a statistically significant and negative relationship with gender, family size and the price of the stove while, statistically significant and positive relationship with educational status, annual income, distance from home to forest, availability of promotion, credit service, awareness on government policy. However, it did not have statistically significant relationship with understanding about IAP.

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