Household Social Economic Status and Adoption of Improved Cook Stoves: the Case of Kilimanjaro Region Tanzania

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Abstract: *Low adoption rate of improved cooking stove (ICS) has been a challenge in most developing countries where biomass is a major cooking energy. Low adoption rates have been attributed to several factors but little attention has been given to the role of household Social Economic Status (SES) in the adoption of ICS. This study was conducted in Hai and Rombo Districts in Kilimanjaro Region to investigate the role of household Social Economic Status (SES) in the adoption of ICS. The study employed the Asset Index as a proxy indicator for household SES. Descriptive statistics establish the share of ownership of various assets and housing conditions between adopters and non-adopters while binary logistic regression model was employed to test the influence of SES on the adoption of ICS. The descriptive statistical results have shown that some assets and housing conditions were common for both ICS adopters and non-adopters while differences was observed on ownership of assets such as cars, generators, TV and some quality housing conditions. The binary logistic regression results show that households with higher SES were leading in ownership of ICS. The study concludes that although ICS is a fuel saving technology with multiple benefits including social, environmental, health and economic benefits, such benefits were not sufficient for the poor households to adopt the stoves. There were other needs that households want to meet including the acquisition of several other valuable assets. Therefore, the study recommends continuing with awareness campaigns to emphasise on the economic, social and environmental values of ICS while at the same time designing a strategy to increase the adoption of ICS for the households of low SES.*

Keywords: *Biomass, Improved Cooking Stove (ICS), adoption, assets, Socio Economic Status (SES)*

1. Introduction

Worldwide, the use of traditional wood fuel has continued to serve almost 3 billion people in meeting their daily cooking and heating needs. The majority of these people are living in developing countries including China and Sub Saharan Africa (Vaccari et al., 2012). This trend is expected to continue for several years due to the current world energy crises and poverty levels of the people living in developing countries (Maes and Verbist, 2012). The problem is compounded by the fact that the energy sector in these countries is characterised by uneven distribution of modern energy supplies coupled with inefficient end-use technologies which are the source of indoor air pollution and contribute to serious health effects (Jan *et al.*, 2012, Fullerton *et al.*, 2008, Karekezi and Kithyoma, 2003, Saatkamp, *et al.*, 2000). Inefficient burning of solid fuels represents unsustainable use of wood resource. This trend ultimately aggravates deforestation in areas where wood resources are already scarce.

Tanzania is a country endowed with various energy resources including biomass, hydropower, natural gas, wind, nuclear, solar, and thermal energy (Research and Analysis working Group, 2012). Despite these various energy resources, 96 % of the population rely on biomass in the form of firewood and charcoal as the main source of energy for cooking and heating (Global Alliance for Clean Cook stoves, 2014). The annual deforestation rate in Tanzania stands at 372,816 ha for forests and 248,871ha for woodlands (MNRT, 2015).

Heavy reliance on wood based biomass and the use of inefficient wood energy conversion technologies are reported to be among the leading causes of deforestation and poor indoor air quality in Tanzania (Lusambo, 2009; Lyimo, 2005). The available data show that around 46 million people are affected by household air pollution (HAP) in Tanzania (Global Alliance for Clean Cook stoves, 2014). The use of improved cooking stove is reported to have reduced exposure to high emission among the highest per capita consumers of wood fuel (Bailis, et al 2015).

In the light of the foregoing observations, efforts have been made by various actors to address the energy related challenges facing developing countries, Tanzania inclusive. Several solutions to the problem has been proposed; and Maes and Verbist (2012) categorized the solutions into two broader policy options; the first option is to climb the energy ladder by switching from solid fuels to fossil fuels; and the second option is to increase the sustainability of the traditional biomass system. Sustainability of the traditional biomass systems therefore calls for fuel-efficient inventions that would allow for the production of more energy from less fuel and with less emission (Larson and Rosen, 2002). Given the nature of the energy sector in developing countries and limited possibilities of switching from biomass, an increase in the efficiency of traditional wood burning stoves becomes an easy biomass sustainability option (Arnold *et al.*, 2006). Improved cook stoves is one of the interventions promoted by various stakeholders in addressing biomass sustainability (Chirwa et al., 2010). According to Rehfuess et al. (2014) the term improved stove simply refers to stove models which are optimized for fuel efficiency or are designed to minimize emissions. The ICS have multiple social, economic, health and environmental benefits. For example, while South Asian and East African emissions from wood fuels are estimated to stand at 1.0–1.2 Gt CO2e yr−1 (1.9–2.3% of global emissions) the adoption of 100 million improved stoves is reported to reduce the emission by 11-17% ((Bailis, et al. 2015).

Despite the apparent benefits and the accompanying intervention efforts, the adoption rate of improved cooking stoves is still low in most of the Least Developed Countries (LDCs). Literature indicates that in developing countries, the overall adoption of ICS stands at 25% while in Sub-Saharan Africa (SSA) only 7% of the people use improved cooking stoves (Legros *et al.*, 2009). Furthermore only 30% of the population in East Africa use the improved stoves (EAC,2007), while the overall use of ICS in Tanzania stands at 1% (Global Alliance for Clean Cook stoves, 2014). The question is why the adoption rate is not increasing? This low adoption rate of improved cooking stove in developing countries poses a challenge on switching to more sustainable energy option (Takama et al., 2012). One of the Tanzania energy policy statements for the household sector is "Encourage efficient end-use technologies and good household practices" (URT, 2003). This policy statement is in tandem with various local efforts of addressing inefficient utilization of biomass resources at various levels. The promotion of improved cooking stoves is one of the possible long term solutions of addressing this challenge, although it's up take has been very low. It is in this context that the present study was designed to examine the possible factors that constrain the adoption of improved cook stoves.

2. Conceptual Gap of the Study

Literature identifies several factors that influence the adoption of ICS. A study by Pine et al., (2011) in Mexico identified factors such as irritation in the eyes and household size as influential in the adoption of ICS. Furthermore, womens' age and remoteness of the village have a positive impact on the adoption of improved stove, whereas decreased cooking frequencies and the time spent on wood collection are the motivation behind the adoption of improved stoves in Ethiopia (Gebreegziabher and van kooten, 2011). In Sudan, adoption of the improved cook stoves was associated with relative advantages as housewife's exposure to messages about ICS and education level as well as the average educational level of the female household's members were found to have a significant effect on the adoption of ICS (Muneer and Mohamed, 2003). In another study conducted in Northern Peruvia, economic status of the adult women in the household, and active involvement in communal activities were identified as the factors which increased the likelihood of adopting improved stove whereas factors such as the gender of the household head, age and education level were not significantly contributing to ICS adoption (Adrianzén, 2011)9,14]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}. Another study in Pakistan revealed that the respondents' qualification, the total number of working members in the household, income, and biomass collection were found to have some effects on the adoption of ICS (Jan et al., 2012). In Burkina Faso, a major deterrent to the adoption is the upfront investment costs which seem to have been much more important than access to information, taste preferences, or woman's role in the household (Bensch, 2015).

Studies that emphasize on income as a socio economic indicator that determines the adoption of improved cook stove is based on the theory of moving up the energy ladder. The theory of energy ladder associates household's income with a shift to cleaner cooking energy technologies and fuels (Masera et al., 2005, 2000). The hypothesis is that the household switches to more modern energy and appliances as the household income increases. Likewise, it assumes that an increase in the household income leads to attaining higher socio economic status and thus expanding the household choices on goods and services. However, this theory raises the basic question as to whether the increased income in the household guarantees that it's spent on purchasing modern fuels or appliances rather than on other goods and services? Although the monetary approach has been extensively used to measure household socio economic status and adoption of technologies, the approach has several methodological limitations in terms of its capacity of capturing permanent incomes of the household. Apart from the limitations associated with the monetary approach in measuring household socio economic status, this study argues that a high level of income may not necessarily lead to the adoption of ICS. According to Kolenikov and Angeles (2004), Socio Economic Status is a multifaceted concept that is supposed to capture many of the aspects of the relative position and achievements of an individual or a household in the society. The dimension may include education and occupation of family members, their access to goods and services, quality of services and ownership of durable assets. Given the limitations of income and expenditure data, it is important to use other proxy indicators in measuring household's SES. Therefore, this study used assets and housing conditions information to establish the indices of socio economic status.

SES or actor social status characteristics refers to the prominence of the actors' relative position within a population of actors (Wejnert, 2002). Social economic position differentiate persons of different social classes based on resources and prestige measures which stand for diverse components of economic and social wellbeing (Morris et al., 2000). SES is considered a key indicator for the adoption of improved cook stoves. The focus on SES adds value in identifying which category of SES within a wider community is likely to adopt the ICS. SES is useful in monitoring and evaluating improved stoves dissemination projects in identifying which socio economic group in a given community with low adoption that may require more targeted intervention (Howard et al., 2003).

3. Research Methodology

3.1 Study Area

The study was conducted in the Kilimanjaro Region, Tanzania. The region is located in the north eastern part of Tanzania Mainland. It lies between latitudes 20 251 and 40151 south of the Equator. Longitudinally the region is between $36^{0}25^{1}30^{11}$ and $38^{0}10^{1}\ 45^{11}$ east of the Greenwich. The region shares a common border with Kenya in the north, and to the south east it shares border with the Tanga region; and finally to the south and west the region shares borders with the Arusha region. The region has seven administrative councils, that is, six districts councils namely, Hai, Rombo, Same, Mwanga, Moshi Rural and Siha and one municipality (Moshi Urban). The region was selected since it is one of the most fuel deficient regions in Tanzania; other regions include

Mwanza, Singida, Arusha and Kagera (Mwihava, 2002). Secondly, the region was chosen because it is among the regions which have been subject to several interventions on the promotion and dissemination of improved cook stoves. Tanzania Traditional Energy Development Organization (TaTEDO) is one of the Non-Governmental Organizations that has worked with stakeholders to disseminate various prototypes of improved stoves in the region.

3.2 Sampling Procedure and Data Collection

Rombo and Hai Districts were randomly selected among the districts which have had extensive ICS interventions. In each district, three villages were selected for in-depth study. The selection criteria for the villages included prior information from TaTEDO on availability of ICS intervention and the adoption of stoves by households. Furthermore, the number of installed stoves was a criterion in the selection of villages; both villages with high and low number of stoves were included in the study. In the Rombo District, the selected villages were Shimbikati, Manda Juu and Mamsera Juu, and in the Hai District the villages included Foo, Nkuu Sinde, and Nshara. Shimbikati and Foo were among the villages with a high number of installed stoves (more than 100) while the rest of the villages had less than 50 stoves installed by the year 2011.

Simple random sampling technique was used to select households in each village to be included in the interview. The household sampling frames were constructed from the village's registers. In cases where the village registers were not available Village Executive Officers (VEO) and Village Chairpersons (VC) with the support from Sub Village Chairpersons provided the information necessary to construct the sampling frame.

The study applied both qualitative and quantitative methods for data collection. A total of 294 structured questionnaires were administered to the households to collect information regarding types and number of various assets owned and some socio–demographic information. Furthermore, information on housing conditions were collected based on the construction materials used for floor, walls, roofing and connection to the electricity grid. Three Focus Group Discussions (FGDs) were organized in each village, and each session included one combined and two separate female and male focus groups. Key informant interview (KIs) was conducted to provide insight about knowledge and experience in relation to improved cook stoves.

3.3 Conceptualization of Household SES Based on Assets and Housing Conditions

The value of assets and quality of housing vary from one social context to the other. The community's opinion on valuable assets is important in ascertaining different socio economic classes based on asset index scores. The classes present how the community judges the prestige of an individual household based on assets ownership. This gives light on assessing the position of ICS within various assets owned by households. In this regard, two categories of assets were established namely; basic and luxurious assets (Figure 1). The basic asset category is divided into two categories of essential assets (house, land, agricultural implements) and live assets (all animals owned by a household). Basic assets are those owned by the majority in a community, implying that ownership of this type of asset will not connote any prestigious position. In addition, the essential assets category of basic assets includes such assets as house, land and agricultural implement (axe, hoe, bush knife); whereas live assets include all animals (livestock) which were owned by the households; and these included cattle, goats, sheep, pigs, chicken and ducks. On the other hand, the luxurious assets are the ones perceived to connote a certain level of prestige whereby the household owning this type of assets is perceived to be of high social or prestigious class. The luxurious assets include assets such as a car, mobile phone, radio, bicycle, TV set, generator and motorcycle.

On housing conditions, households are categorised in relation to building materials and electrification status. On building materials component, households are categorized based on materials used for floor, wall and roofing. Households living in houses with concrete floor and wall, iron roof and installed electricity are associated with a higher socio economic status and expected to be leading in the adoption of ICS. Therefore, the likelihood of adopting ICS increases as the household moves from the lowest continuum of assets (basic assets) and housing conditions to more luxurious assets and high housing quality conditions.

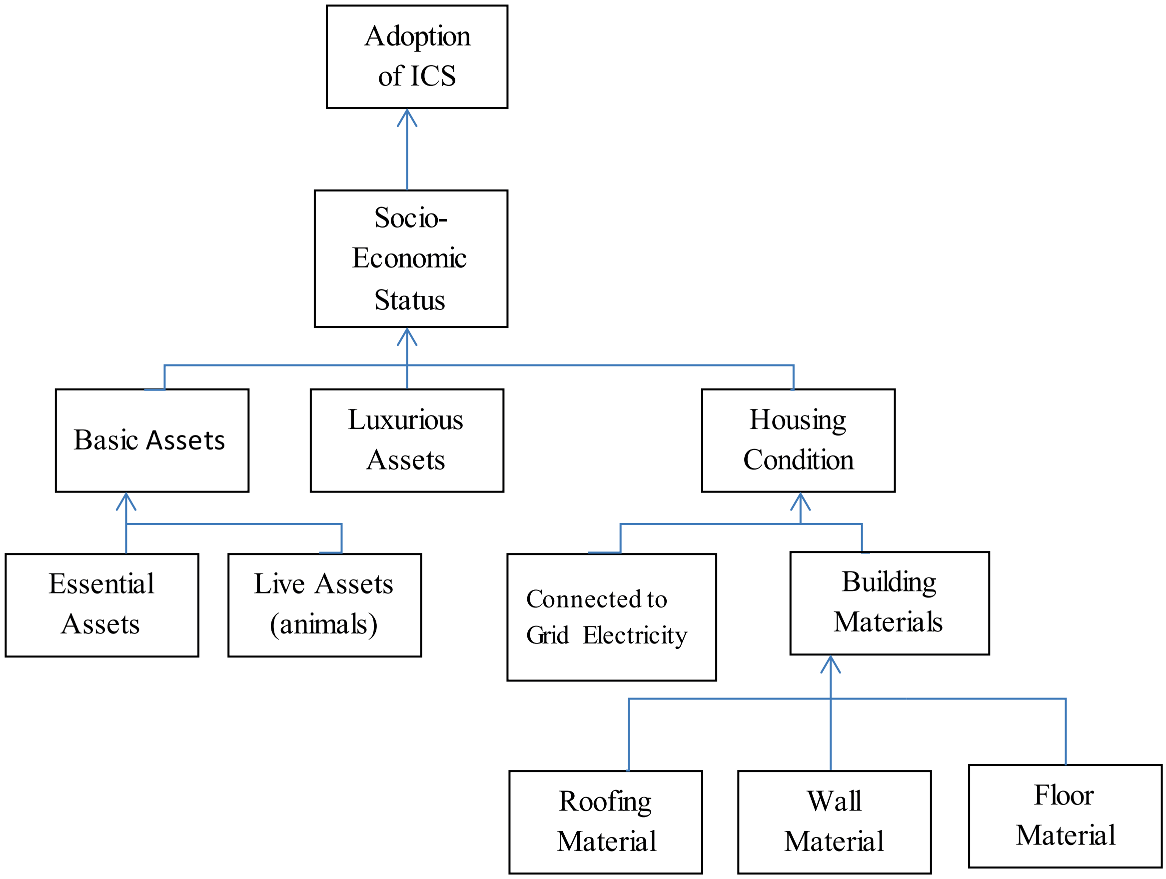

***Figure 1:** Categories of household according to assets and housing conditions*

3.4 Measurement of SES and Adoption

The adoption of improved stove was measured as a binary variable carrying a value of 1 for adopters and 0 for non-adopters. The definition of improved cooking stove used in this study refers to the biomass cooking stove with or without chimney, either fixed or not fixed in the kitchen. The measurement of SES involved the choice of non-monetary approach following the limitations of capturing the income data from the respondents. The use of non-monetary approaches such as SES has been useful where the income and expenditure data are unavailable or are hard to collect (Kolenikov and Angeles, 2009, 2004). Socio Economic status can be measured by different dimensions; and these may involve the use of single indicators such as education and Occupation Status Score (OSS), the Household Prestige Score, and, the household's access to goods and services. It may include more complex measures such as asset incidences as the measure of household welfare (Chuma and Molineux, 2009; Filmer and Pritchett, 1998; Kolenikov and Angeles, 2004; Prakongsai, 2006). The study chose the asset index as a proxy indicator for SES.

Asset indices were created using Principle Components Analysis (PCA) based on the type of assets owned by a household and some housing conditions. The PCA estimate weights of various items (tangible assets and housing conditions) selected for creating the index. PCA as a data reduction approach involved a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principle components or factors. Then the scoring factor of the first principle component among the assets variables are normalized by their standard deviation and are used as asset weights in the index. In this study, a total of 24 variables (assets and housing conditions items) were included in the calculation of households' social economic index. The index scores were calculated by the use of a formula proposed by Filmer and Pritchett (1998 cited by Mwageni et al., 2005).

$$A_j = \frac{f_1 x(a_{ji} - a_1)}{s_1} + \cdots + \frac{f_N x(f_N x(a_{jN} - a_n)}{s_N}$$

As shown in equation X, the index includes not only the ownership of asset but also the value in terms of number of asset owned by households. Where:

Aj = Index developed
f_1 = scoring factor for the asset
x = the variable
a_1 = mean of the asset
a_{ji} = the value for the asset or service
S_1 = standard deviation
N = Total number of asset included in the procedure
j = 1… j households
n = 1… n household assets

Generally, a variable with a positive factor score is associated with higher SES; and conversely a variable with a negative factor score is associated with lower SES (Vyas and Kumaranayake, 2006). As show in Figure 2, the calculated socio economic indices ranged from -15.46 to 10.88 with 72.4% of households scoring negative indices. The skewness value was -0.12 indicating that majority of the households were clustering on the left at low levels (low SES).

The indices could be used as continuous independent variables in the regression model in examining if there is significant influence of SES in the adoption of ICS; however; as argued by Vyas and Kumaranayake, 2006) the estimated coefficient would be hard to interpret. This leads to the categorization of households into three socio economic quantiles based on overall household index scores. The first category represents the poorest group whose house-

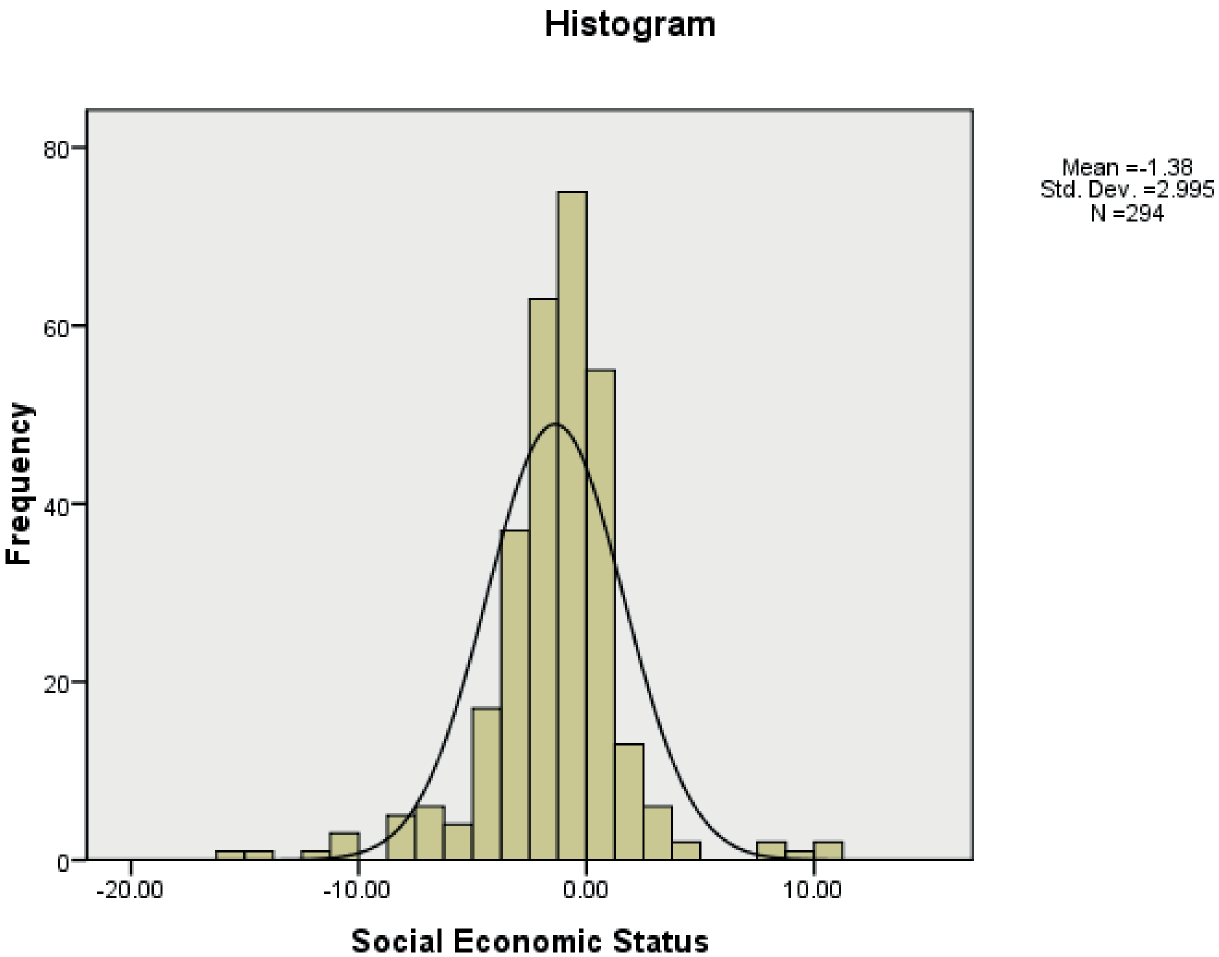

Figure 2: *Distribution of households based on assets index scores*

holds have scored the minimum index to the mean (-15.46 to -1.38), the second category representing the middle group is from the mean of -0.022 and the last category is all household with positive index scores (least poor).

3.5 Data Analysis

The analysis involved both qualitative and quantitative techniques. The qualitative information collected from Focus Group Discussion (FGDs) and key informant interviews (KII) were subjected to word to word analysis to compare the narrations in relation to the theme of the study. Mostly the qualitative information from FGDs and KIIs were used to supplement the discussion from quantitative findings. The descriptive analysis establishes the share of ownership of various assets and housing conditions between adopters and non-adopters. The influence of SES on the adoption of ICS was estimated by fitting the binary logistic regression model as follows:

$$\ln [P_i / (1-P_i)] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots\ldots + \beta_k X_{ki} + e$$

Where the subscript *i* means the ith observation in the sample.
P is the probability that a household adopts the ICS; and (1-P) is the probability that a household does not adopt an ICS

β_0 = intercept term
$\beta_1, \beta_2, \ldots, \beta_k$ = coefficients of the independent variables X1, X2, …, Xk.
e_i = error term

The three classified social economic groups serve as two dummy variables in the model as binary predictors. The poor households function as a baseline (reference) group to test the likelihood of the ICS adoption. Apart from SES, the model involved other predictor variables as control; and these were household size, age of the household head and location in terms of the district where the village is located.

4. Results and Discussion

4.1 Distribution of Assets Between Adopters and Non-Adopters

Ownership of assets is one of the indicators of wealth in most of the rural populations in developing countries. As indicated in Table 1, the results show that common assets such as land, house, radio, agricultural implements (hoes, bush knives), mobile phones, cattle, local chicken and goats did not show differences in terms of share of ownership between adopters and non-adopters. These are among the key assets owned by the majority of the household regardless of the wealth category of the household. The trend was different in other assets like car, motorcycle, generator, TV, and pigs where the adopters showed to lead in ownership.

4.2 Distribution of Housing Condition Characteristics Between Adopters and Non-Adopters

Regardless of the high percentage of household owning houses, this was not included as an indicator for SES status. The quality of the house was among the attributes of SES within the study area. The quality assessment includes general characteristics such as the type of floor, roof and wall materials used for construction and access to the grid electricity. As indicated in assets ownership in Table 1, over 99.3% of all the respondents owned houses. About 96.6% of all the houses had iron sheet roof. The information from FGDs indicated that one among several priorities to most of the households is to own an iron roof house. Further articulated in the FGDs that, someone owning a house with no iron roof was considered as a lazy person. The study observed that 67% of all houses had earth floor while in this category the non-adopters were the majority. The shares of adopters are leading in various housing quality attributes including having houses with concrete wall (96.1%), concrete floor (70.3%) and access to the electricity grid (64.9%). Overall, 71.4% of all houses had walls of cement blocks walls and 96% of all adopters' houses had this quality attribute in comparison to 53.0% of all non-adopters. Likewise, the share of adopters having houses with concrete floor was 70.3% against 12.9% of non-adopters. The last quality indicator was the connection to the electricity grid. The houses with electric power are ranked as of good quality in comparison to houses with no connection to the electricity grid regardless

Table 1: *Share of assets ownership between adopters and non-adopters*

Type of assets	**Non Adopters (n= 217)**		**Adopters (n=77)**		
	Own	**Not own**	**Own**	**Not own**	**Overall % of asset ownership**
Essential assets					
Land	99.0	2.0	99.0	1.0	98.3
Living house	99.0	1.0	99.0	1.0	99.3
Wheelbarrow	13.8	86.2	19.5	80.6	15.3
Agricultural Implements	91.7	8.3	90.9	9.1	91.5
Luxurious assets					
Car	1.4	98.6	11.7	88.3	2.7
Motorcycle	1.4	97.7	6.5	96.2	2.7
Bicycle	13.4	86.6	23.3	76.7	16
TV	18.0	82.0	49.3	50.8	26.2
Generator	0.9	98.6	3.8	97.4	1.7
Radio	76.5	23.4	88.2	11.8	76.9
Mobile Phone(s)	83.5	16.5	96.2	3.8	86.7
Live assets					
Cattle	72.8	27.2	71.4	28.6	72.4
Goat	52.6	47.4	62.2	37.8	55.1
Pig	9.2	88.5	32.5	74.1	15.3
Chicken	74.7	25.3	74.1	26.0	74.4
Overall % of households adopted ICS					**26.2**

of other quality variables. As indicated in Table 2, 40.5% of all households had access to electricity with 64.9% of all ICS adopters' houses leading in this category.

4.3 Influence of Socio Economic Status (SES) on Adoption of ICS

As shown in Table 3, household SES plays a significant role in understanding adoption rates. The analysis suggests that a household with a higher SES (least poor) is more likely to adopt ICS. The model was statistically significant χ^2 (6, n=294) = 13.76 p < 0.001 indicating that it was able to distinguish between respondents who had and those who did not have ICS. The model as a whole was able to explain between 48% (Cox and Snell R square) and 71% (Nagelkerke R squared) of variance in adoption status and correctly classified 74.9% of cases. The remaining cases cannot be explained and thus call for other explanatory factors not tested in the model.

As shown in the findings, only one variable made a unique statistically significant contribution to the model (i.e. household socio economic status). The likelihood of the household to adopt ICS is more than 7 times higher amongst households with higher SES (Table 3). This implies that the least poor households were 7 times more likely to report having adopted ICS than the poor households. The similar finding was reported by Silk et al., (2012) in Kenya where it was found that the improved cook stoves known as *Upesi jiko* were installed in households in the highest socio economic quintiles. Comparing asset ownership and housing conditions the findings shows that the share of household that adopted ICS are leading on ownership of assets such

Table 2: *Share of housing conditions attributes between adopters and non-adopters*

Category	Non- adopters		Adopters		All
	own	Not own	own	Not own	
Floor material					
Earth floor	68.7	31.3	62.2	37.8	67
Concrete Floor	12.9	87.1	70.3	29.8	27.9
Wooden floor	7.9	92.0	7.6	92.4	7.8
Roof material					
Thatch	34.1	95.8	3.8	11.8	4.1
Iron sheet roof	95.8	4.2	94.7	5.3	96.6
Wall			0.0	0.0	
Poles	13.4	86.6	23.3	76.7	16
Wooden	12.9	87.1	7.6	91.6	11.5
Block/Concrete	53.0	46.9	96.1	3.9	71.4
Connection to grid electricity	31.8	68.1	64.9	37.8	40.5

as a car, TV, motorcycle, generator and TV and are connected to grid electricity. This implies that the decision to purchase ICS for households in lower socio economic group will be competing with many other priorities than just the benefits of the ICS. As reported by Mobarak, et al. (2012) in a cook stove study in Bangladesh, women gave priority to other basic needs than non-traditional stoves. One of the key informants mentioned similar arguments for weighing other needs, when asked why the ICS are not largely adopted by households.

> *… it is not that we don't know the importance of ICS especially one with chimney but where will I put my face in the public when people find me investing money to construct such an executive stove while I don't have even a good house to live ….and my kitchen is of the low quality…….* (Male key informant- Foo village).

This explanation of non-adoption appears in the arguments given by female participants in the focus group discussion, when asked about their opinion on why the majority does not adopt improved cook stoves

> *…. We sometimes don't encourage our husbands to support the construction of ICS with chimney … It is shame to advise him to go for this executive stove while the kitchen room is not of that good quality …*
> (Female FGD participants - Nkuu Village)

These statements and the findings from the asset distribution pattern, imply that households in lower SES struggle to meet other basic needs before setting a priority to install/buy ICS.

Despite the influence of higher SES in the adoption of ICS (Table 3), other factors found to be associated with non-adoption are the households' perception and knowledge about ICS qualities. For example, to make the ICS with chimney energy efficient the stove is having fixed and tight cooking pot holder and one small opening for filling the fuelwood. This design is perceived as one among the decisive factors for non-adoption by women who are often busy. While stove designers consider the attributes to be important in increasing stove efficiency the women who mostly involved in cooking activity in the household consider the technical attributes as obstacles to adoption (Massawe, et al, 2014). Likewise, the low level of knowledge and awareness about the merits of the ICS were among the reasons for non-adoption of ICS (Massawe et al., 2015).

The implication of this finding is that regardless of the high level of fuel wood scarcity and the stress

Table 3: *Binary Logistic regression results for the influence of SES on ICS adoption*

Socio demographic characteristics							95.0% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Age of Household head	.014	.009	2.615	1	.106	1.014	.997	1.031
Household size	.063	.072	.759	1	.384	1.065	.924	1.228
Education level of household head(1)	-.344	.292	1.389	1	.239	.709	.400	1.256
Least poor Vs poor (1)	.900	.334	7.257	1	.007	2.460	1.278	4.734
Middle group Vs poor (1)	.051	.364	.019	1	.889	1.052	.515	2.149
Location (District)	-.085	.303	.079	1	.779	.918	.507	1.663
Constant	-2.090	.745	7.874	1	.005	.124		

people are going through in searching for or buying fuel wood for household energy needs, there are other prioritized needs to meet before adopting ICS. For poor households, cooking with ICS is not as important as having a house with a quality wall, floor and roof materials, and connection to electricity together with the ownership of some basic assets. The adoption of ICS will only be a priority to the poorer segment of the community if they have already met the basic needs for assets and have knowledge and a positive perception towards ICS.

5. Conclusion

The use of asset index approach in the establishment of SES has shown to be useful in determining which household socio economic group is likely to adopt an improved stove. The study concludes that although improved stoves have multiple social, economic, environmental and health benefits, target users have a different perspective on the technology. For the household to climb the energy ladder the adoption of ICS is subject to the living conditions of the adopter and determined by the type and nature of assets owned. The household's decision to adopt ICS becomes less important regardless of the level of income, if the household have not met the basic needs of life. Ownership of essential and live assets together with ownership of houses with quality walls, floors and roof materials may not be good indicators of the prospects of adoption of ICS. Likewise, the households owning luxurious assets such as a car, mobile phones, TV set, generators, motorcycle and the like and with houses connected to the electricity grid shows a significant difference in the adoption rate. This study provides insights into the ICS as an asset more likely for adoption by households with a minimum level of ownership of valuable assets and owners of high standard houses.

The adoption of ICS by the well-off households with high SES point to the conclusion that ICS is not perceived as just an efficient cooking stove saving wood resources and household money rather it is a symbol of an asset for households with high socio economic status within a community. Given the broader goals of ICS dissemination programmes, the results are very useful for program implementers and policy makers. For a wider uptake of the ICS focus should be on designing a specific strategy to increase the adoption of ICS by targeting the more well-off households and in particular female heads of households to draw attention to the health benefits of adopting improved cook stoves. Emphasising the multiple benefits (health, environmental, social and economic benefits) of ICS may not contribute to increase the adoption rate of the poorer household categories as these households give priorities to other needs and wants. Increasing adoption rates require designing a complimentary strategy such as subsidies or cheaper stoves to facilitate adoption.

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