Consumers' Perception on Adoption of Improved Cookstoves: A Case of Kilimanjaro Region, Tanzania

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Abstract

This study was conducted in Kilimanjaro Region to examine consumers' perceptions on adoption of Improved Cookstove (ICS) involving 294 households. The results recorded low prominence of positive perceptions among respondents on ICS relative to traditional stoves. Despite several positive attributes of ICS, the study observed that the majority of non-adopters considered positive attributes to be less important in making a decision to adopt the technology, while negative attributes were considered important in guiding decisions not to reject adoption of ICS. Consistently, the study recorded high association between high adoption levels and the relative advantages and adoption of ICS while the non-adopters weighed on the negative attributes to make their decision. This suggests that promoters of ICS should focus on end users, launching awareness campaigns to understand and address factors perceived by end users to be disadvantages of using ICS. The ICS designers and promoters should capture values of end users and incorporate them in their designs when developing technologies and innovations to foster higher adoption rates.

Key words: Perception, adoption, innovation, improved cookstove, prominence, ICS Introduction

Introduction

Recently, the literature has increased attention on adoption of clean energy technologies due to its relevance in ensuring environmental sustainability (Rehfuess *et al.,* 2006). However, to date, it is estimated that 1.3 billion people have no access to electricity while 2.6 billion people rely on unsustainable utilization of traditional biomass (World Energy Outlook, 2013). Most people in developing countries, including Tanzania have no access to electricity due to poor economic conditions leading to overdependence on utilization of traditional biomass which contaminate the enviroment (Maes and Verbist, 2012; Jan *et al.,* 2012). Since 1980s, use of improved cookstove has been promoted as a feasible clean energy source in

Tanzania (Kassenga, 1997). Regardless of continuing efforts over a long time to improve the supply of better energy sources in Tanzania, 96% of the population still use solid fuel such as firewood for cooking (Global Alliance for Clean Cookstoves, 2014).

Other stakeholders including the government and private sector actors have similarly joined hands to promote use of improved biomass cookstoves which are more efficient than traditional cooking stoves. Nonetheless, the trend of improved cookstove (ICS) adoption is still low. For example, the percentage of population using improved cookstoves in Tanzania stands at 1% compared to 73.2% and 53.5% in China and Brazil, respectively (Global Alliance for Clean Cookstoves, 2014). This implies that the majority of Tanzanians still use traditional cooking stoves, which have been reported to be a source of indoor air pollution and various health risks (Saatkamp *et al*, 2000).

Available studies on adoption of efficient and clean cooking technologies explored some variables related to demographic characteristics (e.g. age, household size, religion and number of children) and socio-economic characteristics (e.g. income, education, price of the fuel, price of the stove and occupation) (Adrianzen, 2011; Gebreegziabher and Van Kooten, 2011; Jan, Khan, and Hayat, 2012; Jan, 2011; Muneer and Mohamed, 2003; Pine *et al.*, 2011; Silk *et al.*, 2012). These studies were conducted in India, Latin America and Africa (Lewis and Pattanayak, 2012). Only a few studies focusing on ICS have been conducted in Tanzania. A study by Rwiza (2009) focused on innovation and sustainability aspects of improved cookstove while the study by Holmes (2010) determined the rate of fuelwood consumption by ICS compared to traditional cookstove and barriers to ICS acceptance. However, these studies lacked a comprehensive analysis on how users perceive the technology.

Initiatives to replace inefficient cooking stoves would be successful through a better understanding of consumers' perception towards ICS, which will assist in identifying views of promoters and consumers towards ICS (Ramirez *et al*, 2012) hence creating room for improving the stoves to meet users' needs. In view of the above, this study was conducted to assess consumers' perception regarding various aspects of ICS in Kilimanjaro region, and whether the perception is associated with adoption of ICS. Specifically, the study addressed the following research questions; (i) how do consumers rate the ICS in comparison with traditional stove? This research question is designed to verify the notion commonly promoted by those who promote such stoves where ICS are considered to be more efficient in using energy sources (fuelwood and charcoal) than traditional stoves. The second question relates to how

consumers rate the importance of positive and negative attributes of the stove, which inevitably guide their decision to adopt an ICS or not.

Theoretical framework

Although there are various theories explaining adoption and diffusion of innovation such as that of Rogers (1995, 2003); such theories have been criticized for being complex and hard to be applied in a single study. While previous theories focused on adoption of innovation, little attention has been done regarding change of behaviour among individual users. For example, there are several factors influencing energy use and conservation; firstly, individuals need to be aware of the need for and possible ways to reduce household energy use; second they need to be motivated to conserve energy and thirdly, they should be able to adopt relevant behaviours leading to energy saving (Steg, 2008). In addition, the adoption of energy conservation technologies can be achieved through changing energy related behaviour and/or adoption of energy efficient technologies (Abrahamse, 2007; Rutherford *et al.*, 2007).

In view of the arguments by Steg (2008); Abrahamse (2007); Rutherford *et al.* (2007), it is logical to conclude that behaviour change becomes a central point towards successful energy conservation projects. Behaviour is regarded as a function of an extensive number of dynamically interdependent personal and environmental factors, which depend on the situation (Düvel, 1997); and can potentially become functional in various combinations. The Düvel model of behaviour analysis and change (1991) divided the behaviour determinants into independent and intervening variable indicates that intervening variables, perception being one of them, are the only determinants of behaviour change. The model indicates that the causes of poor or non- adoption of innovation are either because to an individual is unwilling or is unable to adopt an innovation. It has been conceptualised by Düvel (1997) that unfavourable perception is the cause of unwillingness to adopt a practice or innovation. According to Düvel (2007, 1997, 1991) household perception about a technology will influence adoption if the adopting unit perceives the technology to be relatively advantageous or more prominent and compatible with the lifestyle of the adopting unit. The prospective users' perception captures more effectively the key attributes of the innovation, which is then translated into their relative ranking of the technology.

According to Düvel (1997) the relative advantage of the technology can influence perception through awareness or concern of disadvantage or lack of awareness regarding the advantages related to the technology. In this view, if the potential adopters are aware of the disadvantage of ICS they are less likely

to adopt the technology. Unfavourable perception regarding ICS can also be influenced by lack of awareness regarding the advantages associated with ICS. Meanwhile, the prominence (relative advantage) of a technology captures the way ICS is perceived in comparison to the alternative technology it is expecting to replace. Unfavourable perception can be caused by insufficient relative advantage of the technology, which is defined as a degree to which an ICS is perceived as being not better than an idea it supersedes (Msuya and Düvel, 2007). In this case, if the traditional cooking stove is perceived to be more advantageous than the improved one, the probability of adopting the ICS will be low and vice versa.

In this view, an innovation is expected to receive a high rate of adoption if it is compatible with the lifestyle of the adoption unit. The compatibility of an innovation relates to how the innovation fits within the socio - cultural and economic situations of the community or society. As stated earlier, having unfavourable perception regarding the compatibility of an ICS to the individual specific situation (cultural, economic situation) will lead to the likelihood of the technology not being adopted.

Application of Düvel's model by previous scholars has shown that there is a direct link between perception and adoption behaviour (Annor-Frempong and Düvel, 2009; Düvel and Botha, 1999; Düvel, 2007; Düvel., 1997; Msuya and Düvel, 2007). Regardless of the revealed link between perception and adoption behaviour, many authors have examined the adoption of agricultural related technologies without paying enough attention to the perceptions of intended beneficiaries. This study set out to test Düvel's model in a different type of technology to establish if there is any association between perception and adoption behaviour. Assessing consumers' perception of an innovation is important since public perception significantly influence and shape peoples' behaviour (Ramirez *et al.*, 2012). Perception being a behavioural variable can be intervened and changed hence the need to understand the interaction between the two variables (perception and adoption). Such understanding is expected to help project implementers and subsequently increase adoption of ICS.

Methodology

The study was conducted in Kilimanjaro Region since it is among the fuel wood deficit regions in Tanzania (Mwihava, 2002) and had benefited from various interventions designed to promote and disseminate improved cookstoves. Several stakeholders such as Local Government Authorities, religious institutions, microfinance institutions (e.g. Village Community Bank

(VICOBA)) and non-governmental organizations have been promoting sustainable utilization of biomass and alternative energy sources.

Rombo and Hai Districts were purposively selected based on criteria of having ICS interventions. Following the same criteria, three villages were also purposively selected from each district. In Rombo District, the villages of Shimbikati, Manda Juu, and Mamsera Juu were selected while Foo, Nkuu Sinde and Nshara villages were selected from Hai District.

The study adopted a cross sectional research design. A simple random sampling technique was used to select 294 households for primary data collection. Based on the nature of the data to be collected, all adult members within a household above 18 years who were available at the households during the field survey were encouraged to participate because they are more likely to influence decisions involving technology adoption. This choice of respondents was driven by the interest of the study to capture the opinion of the household than individual respondents.

Qualitative data were collected through Focus Group Discussions (FGDs) and interviews with key informants, which were guided by a check list of questions. The FGDs were conducted in each village, formulating groups of 8 - 10 people such that there was representation by age and sex from among village members. The FGDs were useful to initiate discussions on the subject and hence provided an in-depth explanation to answer "why" questions in relation to ICS adoption In addition, interviews with key informant were conducted with purposively selected individuals within each village to capture some in-depth information in relation to adoption of ICS.

Perception was measured based on relative advantages (advantages and disadvantages of ICS) and prominence. Prominence captures the way innovation is perceived to be more advantageous or attractive than conventional practice or alternative. Measurement of relative advantages was based on five statements of semantic scale (1= very unimportant to 5= very important) while eight statements of the same scale were used to capture perceptions regarding the disadvantages of the ICS technology. The objective of measuring relative advantages was to establish which ICS attributes were considered important or less important in making decision to adopt the technology. A lower score on the scale implied less importance of the attribute in the decision to adopt the technology, while a higher score implied the factor was more important in decision making the decision to adopt.

Meanwhile the prominence of ICS was captured by asking respondents to compare the overall relative advantage of the ICS relative to traditional stoves. The reference stove was the improved stove with a chimney which technically has demonstrated high performance in all attributes (Ringia and Massawe, 2009). For this study, respondents were asked to rate three stoves (traditional open stove, ICS with chimney and ICS without chimney) based on a scale of 1-5 (1 = very poor to 5 = very good). The comparison was based on total benefits of ICS as perceived by respondents including its efficiency in cooking, fuel consumption and other items. Based on the respondents own assessement and self rating of the stoves the respondents were categorized into three groups (1-3) implying low to high prominence According to Düvel (1991, 1997 and 2007) the low prominence or insufficient prominence implied unfavourable perception that the innovation was perceived as being not better than the idea it superseded and vice versa for the high prominence.

In the analysis of perceived prominence (relative advantages) of the technologies a total score from the positive and negative attributes was computed separately for statements representing advantages and disadvantages. Perception was measured based on five statement that reflected advantages of the technology. The expected maximum score was 15 while the minimum score was 5. For statements reflecting the disadvantages of the technology, a scale similar scale of one to three (less important, neutral and important) was represented the options for each of the eight statements. The maximum score was therefore 24 and the minimum was 8. Descriptive analysis was performed separately for positive and negative attributes.

A cross tabulation with chi- square test was used to establish if there was any association between adoption and respondent's perception towards advantages, disadvantages and prominence of ICS. To assess the strength of association between the variables, Cramer's V value was used, which according to Healey (2005), should range between 0.00 – 0.1 (weak), 0.11 – 0.3 (moderate), above 0.3 (high) association. Qualitative information from FGDs were analysed by organizing responses from the discussion into themes such as benefit of ICS, Weakness of ICS, comparative attributes between the ICS and traditional stove, end users attached values on ICS, which were predetermined based on key research questions. Then interpretation was made by researcher and subsequently used in the discussion.

Results and Discussion

Consumers prominence on ICS

The consumer's prominence was examined to ascertain if there is any association with the adoption of ICS. The findings as presented in Table 1

show that 58.8% of the respondents expressed low prominence of ICS, implying that majority of respondents do not perceive ICS to be better than traditional stove. Furthermore, the prominence levels recorded for each respondent represented significant association with corresponding adoption of ICS at $p< 0.001$ with Crame's $V = 0.745$, and $\chi^2= 162.97$. The findings further show that, none of the respondents expressing low prominence adopted ICS. The adopters of ICS ranked the improved stove to represent medium or high prominence. Several reasons were identified by respondents from different FGDs to explain why the ICS was perceived to be of low prominence. The first argument was based on the design of the stove, since they used the same biomass fuel as traditional stove. Hence, the consumers did not feel that the ICS were different from traditional stoves. One of the focus group discussant from Foo Village in Hai district had this to say;

> *"The ICS is not much different from traditional stoves regarding the type of fuel it used. If the concern is to address the problem of fuelwood scarcity why doesn't the government promote clean cooking fuels such as gas? There is a need to subsidize gas since it is now largely available in our country. To us ICS is not different from using traditional stoves."*

The above response implies that as long as the ICS is using the same fuel as traditional stoves, it is not perceived to be more prominent than traditional stove in terms of saving energy. Hence, there is need for promoters of ICS to launch an awareness campaign to elaborate regarding the specific advantages of ICS relative to traditional cookstoves. The awareness campaign will help to capture broader benefits of the ICS such as; reduction of indoor air pollution and less fuel consumption.

Table 1: Association between prominence and adoption of ICS

	Adoption Rate (Frequency & Percentage)						Model Statistics		
	Adopters		Non adopters		Total		Chi square	P-value	Crame's V Value
Prominence	Frequency	%	Frequency	%	Frequency	%			
Low	0	0.0	173	58.8	173	58.8			
Medium	39	13.3	36	12.2	75	25.5	162.97	0.001	0.745
High	38	12.9	8	2.7	46	15.6			
Total	**77**	**26.2**	**217**	**73.8**	**294**	**100**			

In addition to the type of fuel used by ICS, low prominence was associated with the perceived technical problems reported by respondents. According to

the interview with key informant, stoves that were adopted were either not working properly or in some households they had been completely abandoned. This trend creates negative perception among non – adopters, hence resulting in loss of interest to install the stoves. One of the key informants from Shimbikati village argued as follows;

> *The stoves with chimney which had been promoted have several technical limitations; those who adopted them are now complaining since most of the stoves are no longer working. Now, they have to pay money for the stove to be broken/dismantled.*

Consumers therefore perceive ICS to have less or moderate advantages compared to traditional stoves. The consumer's assessment of the stove's performance is based on how much the stove is able to deliver the same functions offered by traditional stoves and the extent to which the stove can make cooking easier and more comfortable.

Results from the consumers' prominence rating of ICS contradicts experts' views, who argue that technical assessment have proved the ICS to have an outstanding performance. Features of the improved stove, which are considered by experts to be value addition qualities, include having a small opening for fuelwood input. However, such attributes have been perceived as a limitation by women who are often busy. They believe that inputting more fuelwood pieces into a stove will speed up cooking time. This may suggest that promoters of ICS need to understand the values of end users and incorporate them when developing technologies. These results clearly show that what are regarded as key benefits by ICS promoters are not considered to be important by end users. Hence they do not perceive ICS to have any added value relative to traditional stoves, which explains the low adoption rate of ICS. A FGDs member from Shimbikati village argued that:

> *How can we say this is a good technology? It is adding more stress to the users. Why don't we continue using traditional stoves which are less stressing?*

Consumers' perception towards the prominence of ICS does not mean that the stove's proven qualities by experts are not true; rather we can discuss this in the light of failure of the stove to serve consumers' needs hence failing to demonstrate outstanding performance relative to traditional stoves. Qualitative information shows that the stove qualities have been damaged by the early adopters whose stoves could not perform well. Judgement on what advantages the ICS have compared to traditional stoves can be related to what Rogers

(2003) call consequences after adoption of an innovation. Once an innovation is diffused within a social system, the system can influence the innovation's diffusion through its performances. The first people to adopt the stove are regarded as innovators who will share the benefits through different communication channels.

Perception towards advantages of ICS

The study assessed the perception of respondents towards the advantages of ICS and how people rate the importance of various attributes to guide their decision to adopt. The results show that all the advantages had a positive relationship with the decision to adopt an ICS. The strengths of relationships ranged from 0.4 to 0.7 Cramer's V values and the level of significance was at $p < 0.001$, which are considered to be very high (Healey, 2005). The results showed further that three advantages were considered by the majority of respondents to be more important in influencing adoption of ICS. The variable, clean cooking environment was rated important by 54.8% of the respondents. Likewise the attributes of reducing cooking time and reduction of smoke in the kitchen were also rated to be important by 54.8% and 55.5% of the respondents respectively. In addition to these three attributes, which were rated above 50%, which is considered high, the strongest attribute rated by adopters to be associated with adoption was reduction in fuel wood consumption with Cramer's V values of 0.73 which was significantly different from zero at $p < 0.001$. The nature of the attributes is more easily judged by the household already using ICS than the non adopters. It is important to note that the non adopters were neutral for almost all the attributes.

Perception towards disadvantages on ICS

The study underscores the importance of disadvantages guided decision to adopt an ICS. As presented in Table 4, there were significant associations ($p \leq 0.001$) between ICS perceived disadvantages and adoption of ICS. The strengths of association ranged between 0.36 to 0.94 Cramer's V values and significant at $p \leq 0.001$) which, according to Healey (2005) is a very strong association. The results from most of variables show that non-adopters rated most of the negative attributes to be very important in guiding their decision making. For example, the technical limitation of ICS ($V = 0.94$, $\chi^2 = 262$, $p \leq 0.001$) size of firewood ($V = 0.57$, $\chi^2 = 96.78$, $P \leq 0.001$), cost of ICS ($V = 0.493$, $\chi^2 = 71.4$, $p \leq 0.001$) and cooking time ($V = 0.473$, $\chi^2 = 65.77$, $p \leq 0.001$) were only considered to be important attributes by non - adopters.

Meanwhile the adopters were either neutral or they considered the same factors to be less important in decision making. Although adopters rated the remaining variables as important, the comparison of adoption rated (%) between the two

groups shows that a higher proportion of non adopters were represented under each of the negative attributes. For example, 39.5% of the 42.2% of the respondents who rated low or declining supply of fuelwood as important for the decision making to adopt ISC were non- adopters.

Table 2: Perception on ICS advantages as bases for adoption

Attributes	Adopters		Non adopters		Total		Chi square	P- Value	Cramer's V- value
	Frequency	%	Frequency	%	Frequency	%			
Reduce fuel consumption									
Less Important	8	2.7	84	28.6	92	31.3			
Neutral	1	0.3	108	36.7	109	37.1	156.53	0.001	0.73
Important	68	23.1	25	8.5	93	31.6			
Reduce cost of fuel wood									
Less Important	32	10.9	98	33.5	130	44.2			
Neutral	15	5.1	119	40.5	130	44.2	100.302	0.001	0.584
Important	30	10.2	0	0	30	10.2			
Reduce cooking time-									
Less Important	0	0	5	1.7	5	1.7			
Neutral	4	1.4	124	42.2	128	43.5	47.09	0.001	0.479
Important	73	24.8	88	29.9	161	54.8			
Clean kitchen environment									
Less Important	0	0	56	19	56	19			
Neutral	8	2.7	69	23.5	77	26.2	52.95	0.001	0.40
Important	69	23.5	92	31.3	161	54.8			
Reduce smoke and indoor pollution									
Less Important	19	6.6	27	9.2	46	15.8			
Neutral	9	3.1	75	25.7	84	28.8	67.55	0.001	0.48
Important	48	16.4	114	39	162	55.5			

Table 3: Perception towards disadvantages between adopters and non adopters

Negative Attributes	Adopters		Non adopters		Total		Chi square	P- Value	Cramer's V-value
	n	%	n	%	n	%			
Fixed cooking pot holder									
Less Important	45	15.3	90	30.6	135	45.9	48.6	0.001	0.407
Neutral	13	4.4	1	0.3	14	4.8			
Important	19	6.5	126	42.9	145	49.3			
Not user friendly									
Less Important	17	2.7	115	39.1	132	44.9	179.01	0.001	0.78
Neutral	52	17.7	0	0	52	17.7			
Important	8	2.7	102	34.7	110	37.4			
Longer Cooking time with ICS									
Less Important	53	18	99	33.7	152	51.7	65.77	0.001	0.473
Neutral	24	8.2	16	5.4	40	13.6			
Important	0	0	102	34.7	102	34.7			
ICS is not flexible for multiple uses									
Less Important	56	19	134	45.6	190	64.6	38.84	0.001	0.36
Neutral	11	3.7	1	0.3	12	1.1			
Important	10	3.4	82	27.9	92	31.3			
ICS has technical limitations									
Less Important	64	21.8	7	2.4	71	24.4	262	0.001	0.94
Neutral	13	4.4	0	0	13	4.4			
Important	0	0	210	71.4	210	71.4			
ICS are expensive									
Less Important	48	16.3	157	53.4	205	69.7	71.4	0.001	0.493
Neutral	29	9.9	8	2.7	37	12.6			
Important	0	0	52	17.7	52	17.7			
ICS require specific size of firewood									
Less Important	62	21.1	99	33.7	161	54.8	96.78	0.001	0.57
Neutral	15	5.1	0	0	15	5.1			
Important	0	0	118	40.1	118	40.1			
Unavailability of fuelwood									
Less Important	51	17.3	101	34.4	152	51.7	79.98	0.001	0.522
Neutral	18	6.1	0	0	18	6.1			
Important	8	2.7	116	39.5	124	42.2			

Generally, the results imply that adoption is significantly associated with the consumer's perception towards ICS attributes. Looking at the perception towards positive and negative attributes of ICS it is logical to say that low adoption was attributed to negative perception of ICS since non adopters considered the negative attributes to be more important in decision making. The negative attributes identified by consumers are more related to the stove's design as pointed by respondents during the study. This implies that there is a conflicting perception between stove designer and consumers. When stove designers consider the attributes to be important in increasing stove efficiency, the consumers consider them as obstacles to adoption, which reflects a basic problem of top down technology development.

Such differences between designers and consumers can be explained based on low technical knowledge by consumers regarding how to use ICS which may lead to non adherence by adopters to follow recommended technical use, which resulted into failure to maximize the recommended ICS efficiency, subsequently affecting their perception of ICS (Massawe *et al.,* 2015), hence ranking the technology low in terms of prominence. In addition, the negative perceptions for the stove are related to poor construction by stove technicians hence failure to meet the consumers' needs.

Although technology adoption depends on users perceptions regarding negative and positive attributes, negative attributes have a more powerful association with the decision to adopt than positive attributes. Even when a technology has very few negative attributes, users attached more weight to them, hence affecting the overall relative advantage of the proposed technology.

Conclusion

The perception of people towards ICS is associated with adoption of the technology, which implies that efforts to change the current and prospective consumers' negative perception towards ICS attributes will increase the ICS adoption. The overall consumer perception of ICS influenced their rating of the stoves' relative advantageous (prominence), which was considered to be low, implying that the stoves are not regarded to be better compared to traditional stoves. This outcome is influence by a number of perceived negative attributes listed and rated by the respondents to be important factors for their decision to adopt. The existence of negative attributes which were often related to the stoves' technical design lead to failure of the stove to function properly, hence failing to meet the users' needs.

Some of the adopted stoves are not functioning well or completely abandoned, amplifying the negative perception among prospective users towards ICS. Subsequently, the situation reduces the probability of adoption by the larger community. Low adoption levels imply that the stove is not commonly used by households for cooking, hence questioning the achievement of programmes that promote such stoves. Often, the broad goal of such organizations has been to increase efficiency of energy use, while also improving human health and addressing climate change related problems.

Based on these finding, it is recommended that stove promoters should provide support to communities such that technical problems associated with the ICS are addressed during technology upgrading processes. There is also a need for stove promoters to establish feedback mechanisms from and to users, in order to ensure effective communication between consumers, promoters and ICS technicians. The communication will be useful in facilitating the integration of consumers complains in subsequent improved ICS designs, which will help to adapt the stove to suit household cooking needs. Furthermore, there is need to promote more awareness to change the perception of people towards attributes of ICS in the study area, hence ICS promoters, technicians and village leaders should take the lead in promoting benefits of ICS while also clarifying on negative aspects which may simply be misconstrued based on hearsay, which has spread and taken roots among prospective users.

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