# Adoptions of Improved Biomass Cook Stoves by Households: an Example from Homabay County

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## Abstract

*The aim of the study was to examine the influence of socio cultural factors on the adoption of improved cook stoves in Homabay County, Kenya. The economic, social, ecological and environmental roles and benefits of forests are obvious and need no emphasis. Inefficient use of fuel wood is considered one of the main causes of deforestation. Use of more efficient improved cook stoves is proposed as one of the measures that can reduce demand for fuel wood and charcoal and help in lowering the annoying deforestation rate in many developing countries. During the 2000s several programs aiming at testing and disseminating energy saving technologies were implemented in Kenya. One of these technologies was improved cook stove (ICSs), which was intended to increase the efficiency of using energy from biomass sources. The global focus on ICS and clean fuels has increased because of their potential for delivering the triple dividends: household health, local environment quality and regional climate benefits. However, ICS and clean fuel dissemination programs have been met with low rates of adoption. This study was carried out to examine the adoption rate and the factors affecting adoption of improved cook stoves in Homabay County. The study is based on primary data collected through personal interviews with husbands and wives in 220 randomly selected households. In Kenya all the household domestic tasks, particularly food preparation and related activities, are considered women's responsibilities and all the decisions related to them are taken by women. An ex-post-facto survey design which utilized both qualitative and quantitative methods of data collection was used in the study. For quantitative data collection, a sample of 220 small scale farmers selected using systematic random sampling from the small scale farmers in the Division were engaged. For qualitative data, 40 small scale farmers and 37 Key Informants selected using purposive sampling from the division were used. The results showed that the device's adoption rate is low. Results of the study indicated that households' education status, gender, cosmopoliteness, leadership status, cultural beliefs and social norms were important variables which had positively and significantly influenced adoption of improved cook stoves. The overall finding of the study underlined the high importance in strengthening social groups to enhance adoption of improved cook stoves. The study will be significant to planners, policy makers, researchers, extension and farmers to build the case for interventions on improved cook stoves.*

**Keywords:** Adoption; Improved cook stoves: Smallholder households

## *Introduction*

Nearly half of the global population relies on solid fuel, such as biomass, coal, or dung, for their cooking needs (Legros *et al*., 2009; Rehfuess *et al*., 2006). Unprocessed biomass (e.g. charcoal, wood, crop waste) remains a major household fuel source for most residents of low income countries particularly the poor (Bruce *et al*., 2000). During cooking, inadequate ventilation and incomplete combustion through the use of rudimentary stoves or open fire pits are common resulting in acute and chronic exposure to air pollutants (particulate matter, carbon monoxide, nitrous oxides, carcinogens and others) (Fullerton *et al*., 2008; Smith *et al*., 2000). Exposure to household air pollution has been linked to a range of negative health outcomes in children and adult, including pneumonia, tuberculosis, chronic obstructive pulmonary disease, lung cancer low birth weight and premature mortality (Bruce *et al*., 2000; Dherani *et al*., 2008; Pope *et al*., 2010).

Indoor air pollution (IAP) emitted by burning solid fuel indoors in poorly ventilated conditions is possible for 2 million premature deaths per year, or 3.3% of the global burden of disease, particularly women and children (World Health Organization (WHO), 2009).

The adverse health outcomes are chiefly caused by inhalation of fine soot particles ≤ 2.5μm in aerodynamic diameter (Smith et al., 2009). In addition to adverse health effects, negative social impacts often result from using traditional stoves. For example, inefficient stoves require more time to cook and gather fuel, a burden usually borne by women and children, which diverts their time from education and income producing activities.

Local environmental impacts arise from damages arise from damages to ambient air and local forest ecosystems. Due to the fact that only a fraction of the IAP is deposited indoors, biomass burning contributes to ambient air pollution (Shindell *et al*., 2011). Additionally, the unsustainable harvest of fuel wood degrades local forests (Hofstad et al., 2009; Kohli et al., 2011), sometimes even damaging wildlife habitat and watershed functions and contributing to deforestation (Geist and Lambin, 2001).

Cooking with unsustainably harvested biomass can affect climate because inefficient fuel combustion releases products of incomplete combustion with a higher global warming potential than carbon dioxide, such as methane and carbon monoxide (Sargar and Kartha, 2007). Biomass and fossil fuel cook stoves also emit 22% and 7% of global carbon (BC) emissions, respectively, which is the second strongest contributor to current global warming (Ramadhan and Carmichael, 2008). Unlike globally distributed greenhouse gases, such as carbon dioxide, the shorter 8 to 10 day atmospheric lifetime of BC results in localized impacts (Smith *et al*., 2009).

Improved cook stoves (ICSs) were developed initially to address these adverse health and livelihood impacts. Since ICSs improves cooing efficiency compared with traditional cook stoves, ICSs can reduce the amount of fuel required, fuel gathering time and cooking time, all of which have the potential to improve health and increase household income. In addition, these efficiencies can benefit the local environment and global climate because of reduction in fuelwood harvesting and particulate and particulate emissions. Despite clear scientific evidence on efficacy of these innovations, initial efforts to promote these technologies have run into challenges surrounding diffusion, dissemination and implementation.

Initially, failed attempts to foster untested technologies on reluctant households and consumers turned the focus of research to identifying the drivers of demand. The demand-side of thinking has been bolstered by a small yet growing body of field evidence suggesting that potential consumers often do not invest in or maintain use of environmental health technologies (e.g., piped water, water filters, private latrines, insecticide treated bed nets, improved stoves), because they do not know about or value the benefits of the technology. In addition, consumers are unwilling to finance or unable to pay the prevailing prices for the technologies (Pattanayak and Pfaff, 2009). More generally, implementation and diffusion challenges may be due to ICSs that are unsuitable for local customs, ineffective financing, poor distribution channels, or insufficient social marketing (Mitchell, 2010).

Several coinciding "game changers" may now make the large-scale deployment of ICSs more feasible: the development of a new generation of ICSs, significant experience in implementing small-scale credit operations, and new financing instruments and sources, especially those linked to climate change mitigation (World Bank, 2011). The influence of the game changers is further strengthened by general trends in low-income countries such as the rising cost of fuel wood (because of increasing scarcity and forest sector reforms). Collectively, these forces have led to increased attention on ICSs and related technologies, culminating in the recent formation of the Global Alliance for Clean Cook stoves (GACC, 2011), which aims to have 100 million homes adopt clean cook stoves by 2020. Additionally, countries such as India have launched a new National Biomass Cook stoves Initiative in 2009 to provide 160 million ICSs to households currently using solid biomass fuel (Venkataraman et al., 2010).

To mitigate adverse health and livelihood impacts in Western Kenya, a partnership was established between Ministry of Agriculture and German Society for International Cooperation (GIZ). GIZ is a nongovernmental organization that provides training, outreach and mobilization for community based groups. Use of ICSs was designed to improve health, conserve fuel wood and reduce emissions. The use of improved cook stoves is also appealing because it may translate in saving time and money used for gathering or purchasing fuel.

The cook stove technology promoted and distributed by Ministry of Agriculture and GIZ was *Maendeleo/Upesi jiko.* The functional unit of *Maendeleo jiko* is a simple ceramic liner. Using clay found in nearby river banks, these units were produced locally by skilled laborers in the Keyo and Masogo pottery groups, which are located in the cities of Kisumu and Ahero, respectively.

Pottery skills are developed similarly to a trade organization with informal apprentices, journal and masters. The ceramic liners installed into simple, earthen, base that is constructed semi-permanently within a kitchen. The ceramic liner dimensions are guided by the Kenya Bureau of Standards (KS 1814:2005)[20], which aims to ensure that the correct shape and size are retained so that energy saving efficiency is maintained in the design.

Practical Action, non-governmental organization that has promoted improved cook stoves for low income countries (including Kenya), calculated the yearly savings of Kshs 7,400 could be obtained by improving the efficiency of fuel use with maendeleo jiko (Bates, 2005) However, the health impact of *maendeleo jiko* or similar cook stoves in rural Africa has not been fully established (Wafula *et al*.,; Bates, 2007). The relative cost of Ksh 150 is a primary advantage of the liners, although additional material and labor costs for the installation of the liner into a base typically Ksks 150 to Kshs 200 to the cost.

This study provides a useful insight into whether and how external assistance can be used more effectively to enable smallholder households to secure their basic needs, promote self-reliance and adopt sustainable appropriate technologies as a means of breaking the cycle of natural resource degradation to ensure environmental sustainability and eradicate disease, poverty and hunger in these households.

The findings from the study may also be used by researchers, planners, and policy makers to build the case for more focused planning for interventions on technology within the development sector and also contribute to knowledge in the area of environment and natural resource management.

## *Research Methodology*

### The Study Area

The study was carried out in Homabay County. It is one of the ten counties in Western Kenya, located in the southwestern part of Kenya along Lake Victoria. It is located between longitude 340 12' and 340 40' east and latitudes 00 28' and 00 40' south (G.O.K, 2001). Homabay is inhabited mainly by the Luo community. The County has an annual population growth of approximately 2.7%. The County has a mean density of 270 persons per square kilometer but the distribution within the County is influenced by the availability of road infrastructure and climate (G.O.K, 2001). The female/male sex ratio is 100/110 with the youth and labor force comprising 23% and 47.8%, while the dependency ratio is 100:110. The County is typical of rural areas of Africa where women and children are exposed to household indoor air pollution. In Homabay, rates of acute respiratory infections, malnutrition, infant and child mortality and malaria transmission is endemic (Adazu et al., 2005). Access to health interventions in Homabay County is inadequate due to poverty and limited transportation and communication infrastructure. At least half of the households rely on fuel wood for cooking and superficial sources of drinking water (Centres for Disease Control and Prevention, 2007). In this polygamous society of Luo ethnicity, families live in multigenerational compounds. The County is further sub divided into 8 constituencies. According to Jaetzold and Schmidt (1982), the County lies in lower midland (lm3) agro-ecological zone. It is situated at an altitude of 1200-1400m above sea level. The mean rainfall is about 1300mm received in a bimodal pattern. The County has three types of soils; black cotton soil (vertisol), silt loam, clay loam (luvisoils) with drainage being poor in some of the soils (Jaetzold and Schmidt, 1982).

Agriculture is the lifeline of the County's economy employing over 50% of the residents. Smallholder farming is the dominant land use practice accounting for about 86.8% of land cultivated in the division (G.O.K, 2001). The cultivation of food crops is dominated by maize, sorghum and bean production (G.O.K, 2001).

The high use of firewood and charcoal contributes to deteriorating tree and vegetation cover exposing the soil to severe degradation especially on hill tops, a trend that threatens future livelihood activities. Agronomic and soil science research in recent years has shown that soil nutrient mining, monocroping and continuous cropping is widespread in Homabay County undermining the ability of many agrarian households to produce enough food supplies for subsistence (Smaling et al., 1993; Van der Bosch et al., 1998; FAO, 2004). For instance, Smaling et al. (1993) report average annual net mining of 42 Kg nitrogen/ha, 3Kg phosphorus/ha, and 29 Kg potassium/ha from the soils in this region.

**Sources of Data**

The study used both qualitative and quantitative data collection techniques. The data collection tools included;

**Questionnaires**

Questionnaires were administered to the first sub-category (220 households selected for the study. Questionnaires were considered ideal because of the ease of administration and scoring of the instrument besides the results being readily analyzed (Ary, Jacobs & Razarieh, 1979; FAO, 1995a). The items on the questionnaire were developed on the basis of the objectives of the study.

The questionnaire captured data on the socio-demographic characteristics of the respondents, the degree of adoption of ICS, socio-economic determinants of the adoption of ICSs, socio-cultural determinants of the adoption of ICSs and the institutional determinants of the adoption of ICSs.

**In-depth Interviews**

Semi-structured interview schedule guidelines with relevant questions were developed for the 18 key informants. The semi-structured interview schedule was considered appropriate for extension officers from the Ministry of Agriculture and opinion leaders because they have varied literacy levels. Some of them were not able to interpret and react to a questionnaire. Thus the semi-structured interview schedule was used to obtain in-depth information from the extension officers and opinion leaders regarding their opinion on the determinants of the adoption of ICSs in Homabay County.

**Focus Group Discussion.**

Focus group discussion (FGD) guideline was developed for the 40 households. A total of four FGDs were held. FGDs were important in obtaining information that could not be easily obtained through face-to-face interview or questionnaire. For this method, the researcher brought together forty small scale farmers in four groups, to discuss the topic. Atopic guide to aid discussion was prepared beforehand and a range of aspects of the topic will be explored. Brainstorming techniques were used to explore the topic.

**Observations**

To get a greater picture of ICSs, a checklist was developed for observations to be made. Data was collected by the researcher so that a detailed understanding of the values and beliefs held by the members of the population can be understood. Observations were done to gather evidence about how value judgments made by extension staff and farmers impact on decision making. Observation were recorded as field notes and analyzed for content.

**Sample Size and Sampling Procedure**

The sampling frame was a list of household in Homabay County. The sample size was obtained using the coefficient of variation (Nassiuma, 2000). This is because for most surveys or experiment, a coefficient variation of at most 30% is usually acceptable. The study took a coefficient variation of 21% and a standard error of 0.02. The formula given by Nassiuma (2000) is;

$$n = \frac{NC2}{C2 + (N-1)\,e2}$$

Where n =sample
N = population
C= covariance
e = standard error

The eight constituencies was the criterion for stratified simple random sampling. All the households in the eight constituencies were used to enable random selection of households to be included in the study. A systematic random sampling procedure was used to select the number of households in each stratum. Purposive sampling technique was applied to identify individuals to participate in the focus group discussion and Key informants to be interviewed. A total of 40 households were purposively selected to participate in the four FGDs.

From each constituency, three categories of target group, viz the households, Ministry of Agriculture Officers and opinion leaders were targeted. Among the Ministry of Agriculture target category, one District Agricultural Officer from District/Constituency yielding a total of eight Ministry of Agriculture officers. From the third category of opinion leaders (1 District Commissioner) were selected yielding eight opinion leaders.

They supplemented the information from the small scale farmers. The entire sampling matrix yielded a total sample size of 276 for the study.

**Data Analysis**

All the data collected from the study area as in the questionnaires, FGDs, in depth interviews and observation reports were analyzed in an ongoing process. Quantitative data was processed, coded and analyzed using computer statistical packages (S.P.S.S version 13). The results were presented by use of descriptive statistics, namely percentages and frequencies. Qualitative data will be transcribed and subsequently themes and sub-themes derived. The themes and subthemes were then presented as they emerged.

**Ethical Consideration**

The study was conducted in accordance with the standard research ethics. Informed consent was sought prior to data collection. Anonymity and confidentiality was also upheld. An appointment for administration of questionnaires to the respondents was prepared with the assistance of the village headmen. The principal researcher guided and supervised the fieldwork during data collection. The instruments were then administered to household heads to collect the required data in face-to-face interview and their responses recorded accordingly.

**Definition of variables**

Dependent Variable: The dependent variable in this study was adoption index which indicated the degree of adoption of ICS. Degree of adoption in this case was a continuous dependent variable. The degree of adoption refers to farmers' level of use of ICS.

Independent (explanatory) variable: The independent variables of importance in this study are those variables, which are thought to have influence on the degree of adoption ICS. These include households' personal and demographic variables, and socio-cultural variables.

These explanatory variables are defined as follows:

**Table 1: Summary of Explanatory Variables**

| Variable | Variable | **Operational definition of the variable** |
|---|---|---|
| Farmers age | AGE | rational number |
| Farming Experience | FAREXP | A continuous variable measured by years of experience |
| Membership in Social groups | AGRICSH | Is measured as farmers' membership in social group for the last one year. |
| Cosmopoliteness | COSMOP | Is measured in terms of frequency of visits outside his Social system |
| Cultural beliefs | BELIEF | A dummy variable, with value 1, if belief influence Adoption And 0 Otherwise |
| Cultural traditions | TRADIN | A dummy variable, with value 1,if traditions influence adoption and 0 otherwise |
| Leadership status | LEADER | A dummy variable, with value 1, if a person has leadership experience and 0 otherwise |
| Farmers' onINRM technologies | PERCEP | Aperception continuous variable, perceived relative advantage and disadvantage of the technology attributes are measured by score |

## Result and Discussion

**Adoption of Improved Cook stoves**

The study focused on ICS. This was the use of Maendeleo/Upesi jiko for emissions reduction and conserving fuel wood. To determine the level of adoption of ICSs, household representatives were asked to respond to a set of questions on degree of adoption of ICSs. The questions were based on the type of stoves used for cooking. The results obtained indicated that out of the 220 respondents, 105 households (47.7%) had adopted ICSs. On the other hand the remaining 115 (52.3%) had not adopted ICSs. Table 2 presents results of how farmers adopted ICSs.

**Table 2: Adoption of ICSs**

| Technology | Frequency | Percentage |
|---|---|---|
| ICS | 105 | 47.3 |

From the Table 2 above, it was noted that only (47.7%) of the respondents had adopted the practice. It is to be recognized that all the respondents were aware and interested to use ICS but not all did. The respondents indicated that even though they were interested in ICS, the technology was not always available and when it became available, it was limited in quantity and consequently, it would not be within the reach of most poor rural households.

The use of ICS was also known to all (100%) of the respondents while only a few (47.3%) of the respondent respondents eventually adopted the technology. It was noted here that the non significant adoption of this technology could be attributed to non ready availability of the ICSs and lack of affordability on the part of the respondents due to high cost. During group discussion most respondents expressed that none of them had used ICSs. Respondents' interest in adopting new practices may be constrained by inadequate information about that particular innovation, which may in part be caused by inability of the extension personnel to reach the farmers. It has been reported that most rural households stick to old practices as result of economic inability on the part of the farmers to afford the cost of innovations, risk involved, ignorance of existence of innovations and their attitude (Wasula, 2000). Non adoption of some of these technologies could be as a result of high prices, relative scarcity, and poor presentation of the technologies to farmers, unavailability of the technologies and inability of extension agents to facilitate their adoption (Wasula, 2000).

During focus group discussion participants pointed out that, use of ICSs is impossible due to it was expensive and hence low adoption of this. Key informants from the sampled institutions cited the rising cost of the rising cost of ICS as a major budgetary constraint. "Everything is going up in price, even firewood and ICSs are very expensive these days". Similarly, key informants from the sampled institutions cited additional cost for use of ICSs in their houses.

FGD results also indicated that people are aware of the technologies like ICSs but such technologies are priced out of their reach. Even in relatively better off regions only a few participants said they use ICSs. A woman FGD participant from one cluster said "we long to use ICSs but we cannot afford". In some cases FGD participants expressed awareness of the ICSs but cited lack of information on whether such technologies are affordable or easily accessible.

**Socio-cultural determinants**

In order to understand the sample households, it is very important to describe their demographic characteristics. The households were selected from the eight constituencies in Homa Bay County. The household respondents were asked to respond to respond to a set of questions on the socio-cultural factors that have influence on the adoption of ICSs. The factors included: age, and level of education, size of household, income, and farm size and off-farm income.

**Age distribution of farmers**

The role of age in explaining technology adoption is somewhat controversial. It is usually considered in adoption studies with the assumption that older people have more experience that helps them to adopt new technologies. On the other side, because of risk averting nature of older age people are more conservative than the youngest one to adopt new technology. The risk of adopting ICSs arises from the high cost of production. Due to this fact age was thought to have a negative relationship with the adoption of ICSs.

The respondents were asked to indicate the category of their age. Forty five out of one hundred and five adopters (42.9%) interviewed indicated that they were between the ages of 31-40 years. Table 3 presents the frequencies and percentages of age group of the household representatives interviewed.

**Table 3: Age Distribution of the Respondents**

| Age group | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| Below 20 years | 4(3.8%) | 2(1.7%) |
| 21-30 | 20(19%) | 30(26%) |
| 31-40 | 45(42.9) | 55(48%) |
| 41-50 28(26.6) | 20(17.4%) | |
| Above 50 years | 8(7.6%) | 8(7%) |
| Total | 105(100%) | 115(100%) |

As shown in Table 3 above, forty five out of one hundred and five adopters (42.9%) interviewed indicated that they were between the ages of 31-40 years. This is a prime age when the farmers are very active and ready to risk by adopting technologies delivered to them. Farmers who are within age group 18-43 years tend to be more active in practical, "hands-on" activity as compared to older farmers. The results reveal that older farmers are less likely to adopt INRM technologies in question.

Moreover, younger farmers may incur lower switching costs in implementing new practices since they only have limited experience and the learning and adjusting costs involved in adopting technologies may be lower for them. This study therefore found out that household heads who are young were better adopters than household heads. Rodgers (1983) argued that younger and educated farmers are more inclined to adopt new practices. This was supported by Wasula (2000), who found that the age of a household had significantly influenced the adoption of contour vegetative strips. This raises an important extension policy issue. Extension systems must differentiate their clientele based on critical characteristics such as age.

**Level of education of farmers**

Education is very important for the households to understand and interpret the information coming to them from any direction. A better educated person can easily understand and interpret the information transferred to them by development agent. Households were asked to indicate the highest level of education they attained. Table 4 presents the frequencies and percentages of the level of education of the households.

**Table 4: Level of Education of the Households**

| **Age group** | **Adopters (n=105)** | **Non-adopters (n=115)** |
|---|---|---|
| None | 5 (4.8%) | 10(8.7%) |
| Lower Primary | 26(25%) | 33(28.7%) |
| Upper Primary | 45(43%) | 53(46.1%) |
| *Total* | *105(100%)* | *115(100%)* |

Forty-five out of one hundred and five adopters interviewed (43%) had at least upper primary level of education and 26 farmers (25%) had lower primary school level of education. Those with secondary level of education and above were 37 (27%). Technologies are knowledge intensive and require considerable management input (Barret et al., 2002). Formal schooling may enhance or at least signify latent managerial ability and greater cognitive capacity. This is in agreement with Amudavi (1993), Chitere and Dourve (1985), and Wasula (2000) who in their respective studies found that education is a significant factor in facilitating awareness and adoption of technologies.

Education enables one to access information needed to make a decision to use an innovation and practice a new technology. High level of education enhances the understanding of instruction given and also improves the households' level of participation in development activities. The implication is that extension systems and development projects in this region should seek not only to provide technical options to households, but also to attempt to make up for low levels of educational attainment, perhaps through emphasis on management training and skill building.

**Gross Monthly Farm Income of Farmers**

Farm income is the main source of capital to purchase farm inputs and other household consumable goods. Farm income refers to the total annual earnings of the family from sale of agricultural produce after meeting daily family requirements. In this study farm income was estimated based on the sales of crop produce, livestock and livestock products. The major cash income for sample households in the study area was from sale of crops.More than half of the adopters (91%) indicated that they get less than Kshs 6,000 as gross income. Nine out of one hundred and five (9%) indicated that their gross monthly income was between Kshs 6,000 and 10,000. Table 5 presents the levels of gross monthly income of households.

**Table 5: Approximate Level of Gross Monthly Farm Incomes of the Households**

| Monthly farm income | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| <3,000 | 46 (44%) | 53(46%) |
| 3,001-6,000 | 50(47%) | 50(43%) |
| 6,001-10,000 | 7(7%) | 10(9%) |
| *Total* | *105(100%)* | *115(100%)* |

Household farm income can be used as a proxy to working capital because it determines the available capital for investment in the adoption of technologies and it is a means through which the effect of poverty can be assessed. According to World Bank (2000), poverty is the main cause of environmental degradation. One way of measuring the household's poverty is through income.

Household income has a big bearing on the socio-economic status of farmers. Households from higher economic status have access to resources and institutions controlling resources necessary for the effective adoption of technology (World Bank, 1983). This is consistent with the findings of Wasula (2003), who found that farm income had a significant relationship with the adoption of soil conservation measures.

**Farm Size**

Land is the main asset of farmers in the study area. Households in the study area use both their own land and also rent farm for crop production. More than half of the adopters (65.7%) indicated that they owned less than 2 hectares. Fourteen out of one hundred and five (13.3%) indicated that owned between 3 and 5 hectares. Table 6 presents the average size of land owned by households.

**Table 6: Approximate Land Owned by the Households**

| Land in HA | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| 4-5 | 6 (5.7%) | 4(3.5%) |
| 3-4 | 8(7.6%) | 7(6.1%) |
| 2-3 | 22(21%) | 20(17.4%) |
| *>1* | *42(40%)* | *58(50.4%)* |
| *Total* | *105(100%)* | *115(100%)* |

The probability of adopting ICSs was positively and statistically influenced by the total farm size operated by a farmer. The policy lesson for research and extension is that technology development must emphasize not only sufficient divisibility but also that new methods prove remunerative even at small scale operation.

**Family Size**

Family size in the study is considered as the number of individuals who reside in the farmers' household. Large family size assumed is assumed as an indicator of labor availability in the family. Based on this fact this variable was hypothesized to have positive and significant relationship with adoption of technologies.

Sixty six (62.9%) out of one hundred and five adopters indicated that they had more than six members in their families. Thirty nine out of one hundred and five (39.1%) indicated that they had less six members in their households. Table 7 presents the average size of the households

**Table 7: Number of members in farmers' households**

| No in Household | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| >10 | 20(19%) | 16(13.9%) |
| 8-10 | 22(21%) | 20(17.4%) |
| 6-8 | 24(22.0%) | 20(17.4%) |
| 2-4 | 15(14.3%) | 26(22.6%) |
| >2 | 6(5.7%) | 11(9.6%) |
| *Total* | *105(100%)* | *115(100%)* |

The number of members per family was significant and positively associated with adoption of ICSs. This would seem to reflect the important role that availability of family labor (number of adults in the household) plays in the adoption of these practices. Family labor assumes great importance given that low incomes constraints financial liquidity for hiring wage laborers, and given possible moral hazard problems associated with non-family labor calling for considerable supervision. Given that the bulk of labor for most farm operations in this region is provided by the family rather than hired, lack of adequate family labor accompanied by inability to hire labor can seriously constraint adoption of technologies.

**Off-Farm Income**

In most part of rural Kenya, off-farm employment is viewed as transitory situation, and only considered necessary as income source for low earning farm community. In this study area, grain trading, vegetable trading, teaching and daily labour were found to be some of the off-farm activities in which sample households were participating. Hence those households who have got an engagement in off-farm employment are understood to raise their annual income. Therefore, in this study, it was hypothesized that there is appositive correlation between participation in off-farm activities and the adoption of ICS.

**Table 8: Approximate Level of Monthly Off-Farm Incomes of the Households**

| Monthly off-farm income | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| | | |
| <1,000 | 46 (44%) | 53(46%) |
| 2,001-4,000 | 50(47%) | 50(43%) |
| 5,001-8,000 | 7(7%) | 10(9%) |
| *Total* | *105(100%)* | *115(100%)* |

As illustrated in table 8, more than half of the adopters (91%) indicated that they get less than Kshs 5,000 as gross off-farm income. Nine out of one hundred and five (9%) indicated that their gross monthly income was between Kshs 5,000 and 8,000. Participation in off-farm activities had significant relationship with adoption of ICS.

Household's off-farm income can be used as a proxy to working capital because it determines the available capital for investment in the adoption of technologies and it is a means through which the effect of poverty can be assessed. According to World Bank (2003), poverty is the main cause of environmental degradation. One way of measuring the household's poverty is through income. Household income has a big bearing on the socio-economic status of farmers. Farmers from higher economic status have access to resources and institutions controlling resources necessary for the effective adoption of technology (World Bank, 2003). This is consistent with the findings of Wasula (2000), who found that farm income had a significant relationship with the adoption of soil conservation measures.

Off-farm income from informal and formal non-agricultural employment proved quite important in fostering adoption of technologies. Majority of the farmer did not have off-farm income hence the low adoption. Cash is essential in the hiring of labor for the purchase, construction and maintenance ICSs.

At existing productivity levels and production scales, the high-population-density small farm system of Western Kenya might not be generating sufficient investible surplus to remain self-sustaining in the absence off non-farm income to invest in sustainable agricultural intensification, including improved technologies (Marenya et al., 2003).

**Households Experience in Farming and ICSs**

More than half of the adopters (91%) indicated that they had 6 years ICSs and farming experience. Nine out of one hundred and five (9%) indicated that their ICS and farming experience was between 6 and 10. Table 9 presents the levels of experience of households.

**Table 9: Approximate ICSs and farming experience of farmers**

| Farming experience | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| <3 | 46 (44%) | 53(46%) |
| 3-6 | 50(47%) | 50(43%) |
| 6-10 | 7(7%) | 10(9%) |
| *Total* | *105(100%)* | *115(100%)* |

Experience of the household is likely to have a range of influences on adoption. Experience will improve households' skill at production. A more experienced household may have a lower level of uncertainty about the innovation's performance.

Households with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology considered. Therefore, it was hypothesized that households experience has a positive influence on adoption of ICSs.

As depicted in Table 14 the results of this study is in contrast to the assumption, where experience was expected to have positive relationship to the adoption of ICSs. The result shows that there is no relationship between farming experience with adoption of ICSs. The result is in line with the findings of Rahimeto (2007) and Chilot (1994). Ani (1998) and Iheanacho (2000) also indicated that experience of households to a large extent affects their managerial know-how and decision making. Besides, it influences the households' understanding of climatic and weather conditions as well as socio-economic policies and factors affecting them.

**Cultural Beliefs**

**Table 10: Cultural Beliefs**

| Cultural beliefs | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| No | 17(16.2%) | 10(8.7%) |
| Yes | 88(83.8%) | 105(91.3%) |
| *Total* | *105(100%)* | *115(100%)* |

According to table 10, eighty eight (83.8%) out of 105 adopters indicated that cultural beliefs influenced the adoption of ICSs as compared to seventeen (16.2%). This could have been the reason for the low adoption of these technologies. This showed that there was a significant relationship between cultural beliefs and the adoption of ICSs. Traditional culture and beliefs play a powerful role in influencing people's decision making and actions. This agrees with the findings of Ani (2002) that cultural beliefs were significantly related to the adoption of new recommended farm practices.

The general perception is that due to cultural beliefs, women may have little decision making authority in technology use (Ani, 2002). Among the challenges faced by women are permission to attend training, household responsibilities, particularly young children; lack of tools; and poor health. Understanding and addressing these issues is essential if women are to be included in any type of outreach or developmental program. Field observations and confirmation through key informants revealed that this is true even in the present day and age.

During FGD farmers pointed out that, beliefs, cultural attitudes and social norms such s trees and land belong to the men were deterrent to adoption to the adoption of ICSs by women. Findings from the key informant interviews also indicated that land and trees belong to men hence women had no incentive to adopt technologies leading to low adoption of technologies.

**Cultural Traditions and Social Norms**

**Table 11: Cultural Traditions and Social Norms**

| **Traditions & social norms** | **Adopters (n=105)** | **Non-adopters (n=115)** |
|---|---|---|
| Yes | 90(85.7%) | 105(91.3%) |
| No | 15(14.3%) | 10(8.7%) |
| *Total* | *105(100%)* | *115(100%)* |

According to table 11, ninety (85.7%) out of 105 adopters indicated that cultural traditions and social norms influenced the adoption of ICSs as compared to fifteen (14.3%).This could also have been the reason for the low adoption of these technologies. This showed that there was a significant relationship between cultural beliefs and the adoption of ICSs. This agrees with the findings of Ani (2002) that cultural traditions and social norms were significantly related to the adoption of new recommended practices.

The general perception is that due to cultural traditions and social norms, women may have little decision making authority in farming and ownership of key resources (Ani, 2002). Field observations and confirmation through key informants revealed that this is true even in the present day and age.

**Cosmo politeness**

Cosmo politeness is the degree of orientation of the respondents towards outside social system to which he or she belongs. It can be measured by frequencies of visits to outside his or her area of residence for several reasons. Cosmopolite ness as independent variable is expected to have positive relationship with the adoption of innovation (Rodgers and Shoemaker, 1971). It provides more chance of exposure to external information and environment.

**Table 12: Distribution of Respondents on the Basis of their Visit to Near by Town**

| Frequency of visit to Nearby town | | Visit | | | |
|---|---|---|---|---|---|
| | | Never | Often | Rarely | Total |
| Adopters | f | 60 | 30 | 15 | 105 |
| | % | 57.6 | 28.6 | 14.3 | 100 |
| Non adopters | f | 71 | 27 | 7 | 105 |
| | % | 67.6 | 25.7 | 6.7 | 100 |

It can be seen from Table 12 that 57.6% of the adaptors never visited the nearby town while 28.6% and 15% of the total adaptors visited the nearby town often and rarely respectively. The main purpose of visiting the nearby town as expressed by them was to purchase household goods, farm inputs and sale farm produce. Some of them were visiting the nearby town to visit friends and relatives, to get banking services, for medical treatment, and for entertainment purposes. The data revealed that there was a significant relationship between cosmopoliteness and adoption of ICSs.

FGD result indicate that culture, socio-economic environment and level of income are the major factors influencing gender roles and decision making in the household as well as access to resources in Homabay County. In this region traditional attitude still persist; women bear the burden of water and fuel collection and other household labor. Cultural tradition still hold strong and income levels are relatively low, women bear the burden of household labor while men are not expected to play any role. Culture dictates that household tasks such as cooking, cleaning and caring for the young while men engage in activities such as farming, casual jobs and construction. This therefore slows down the pace rate of adoption of ICSs by women households.

### *Membership in Social Groups*

In this study membership in social group was hypothesized as involvement of the respondents in any informal and formal organizations as a member. Households who are members of any local organization are more likely to be aware of new information and technologies (Wasula, 2000). Therefore it was expected that there would be positive and significant relationship between membership in social group and the adoption of ICSs.

**Table 13: Household's Membership in Social Groups**

| Social group | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| Input supply | 10(9.5%) | 2(1.7%) |
| Marketing | 6(5.7%) | 2(1.7%) |
| Co-operatives | 2(1.9%) | 1(0.9%) |
| Women groups | 18(17.2%) | 16(13.9%) |
| CBOs | 10(9.5%) | 7(6.1%) |
| *Total* | *105(100%)* | *115(100%)* |

According to table 13, fifty three (50.5%) out of 105 adopters were not members of any social group as compared to 49.5%.This could have been the reason for the low adoption of the technologies. This showed that there was a significant relationship between membership in social group and adoption of ICSs. According to Blackburn et al., (1982), participation in social groups is important because it indicates the extent of contact, which households have with organized groups and other public services and mass media.

Groups provide forum for improving dialogue among households, thereby providing opportunity for efficient ways of ascertaining consensus on opinion about the relevance of technologies being presented to them (Norman et al., 1989).

Usually participation in the community development activities is perceived as willingness of a person to work together (Wasula, 2000). The relationship between membership in social group and adoption is associated with interpersonal networking and exchanges between adaptors and non-adaptors of technology (Wasula, 2000). This enhances the ability of group members to adopt technologies.

### Leadership Status

Usually participation in the community development activities is perceived as a willingness of a person to work together. The relationship between leadership and adoption is associated with interpersonal networking and exchanges between adopters and non adopters of technology. In this study leadership is hypothesized as involvement of the respondents in any informal and formal organizations as a member and leader. Households who have some position in any local organizations are more likely to be aware of new information and practices. Therefore, it was expected that there would be positive and significant relationship between leadership and the adoption of ICSs.

**Table 14: The Relationship between Leadership Status of Respondents and Adoption of ICSs**

| Social group | Adopters (n=105) | Non-adopters (n=115) |
|---|---|---|
| Input supply | 10(9.5%) | 2(1.7%) |
| Marketing | 6(5.7%) | 2(1.7%) |
| Co-operatives | 2(1.9%) | 1(0.9%) |
| Women groups | 18(17.2%) | 16(13.9%) |
| CBOs | 10(9.5%) | 7(6.1%) |
| *Total* | *105(100%)* | *115(100%)* |

As indicated in Table 14, from the total adopters 33.3% participated in different leadership status at different local organizations and the rest 66.7% did not participate in leadership. From the non adopters group 17.4% participated in leadership while 82.6% did not. This revealed that there is significant relationship between adoption and leadership influence on the adoption of ICSs. This study is in line with the findings of Tesfaye (2006) where he detected the relationship between leadership and adoption of rain water harvesting technology.

**Farmers' Perception**

Households' perception on use of technology is generally attached with the advantage of technology components. Farmers examine the advantages from the point of view of compatibility to their current situation, with labor demand, profitability, and other social necessities to adopt a technology. If people's perception is positive towards the advantage of technology it will enhances decision in favor of adoption of technology.

According to Duvel (1975) perception is a key dimension in behavioral change process. Perception about the relative advantage of different package practices was assumed to have positive effect on adoption of ICSs.

The more accurately a person perceives his current poor production efficiency, the more likely he is to alter his behavior and thereby improve his production efficiency. For example, the need for technical assistance, early maturity, and yields advantage, income and employment generation is assumed to be incentives for adopting technologies. On the other hand incompatibility like availability of inputs, initial cost of labor, and market problem are negative attributes related to technologies. The farmers' response on perception of implementing ICSs is presented in Table 26.

In the present investigation, the respondents were asked to give response regarding how they perceived advantages of ICSs. This figure gives positive perception towards ICSs by adopters.

**Table 15: Total Perception Score on Advantages of ICSs**

| Adoption category | N | Mean |
|---|---|---|
| *ICS* | 105 | *74.4* |

As can be seen in Table 15 above, the mean perception scores on advantages of ICS was 74.4%. This shows that adaptors in this region had positive perception towards ICSs. Perception towards technology has a positive significant influence on the extent of adoption. Positive perception increases the probability of the extent the household is willing to adopt a technology. The reason for perception here is that technology characteristic within potential users' context model in which the characteristics of the technology underlying farmers' agro-ecological, socio-economic and institutional context plays a central role in the extent of adoption decision process. Households who perceive the technology as beneficial to them would adopt it more than those whose perception is negative or indifferent. The results are in agreement with, Rahimeto (2007) who reported similar result in their study on adoption of improved technology.

## *Households' Perception Score for Disadvantage of ICSs*

Total perception score for relative disadvantage of ICSs for whole respondents was negative. The result of scores achieved on relative disadvantage of ICSs is shown in Table 16 below.

**Table 16: Total perception score on disadvantages of ICS**

| Adoption category | N | Mean |
|---|---|---|
| *ICS* | *105* | *48.8* |

As can be seen from Table 16, the mean perception scores on disadvantages of ICSs were 48.8. This indicates that adopters have low scores on relative disadvantage which means that they did not perceive the package as highly disadvantageous. The result of this study is in agreement with research conducted by Adesina and Zinnah (1993) who gave due attention to technology specific factors in addition to the farm and farmer specific variables in the adoption decision process. The research was employed to analyze the determinants of adoption decisions of improved mangrove swamp rice varieties in Sierra Leonne. In the analysis, the authors reported that none of the farm and farmer specific factors was significant in explaining the adoption decision of the improved varieties. Rather, farmer perceptions of the technology specific traits of these have been the major factors conditioning adoption behavior.

## *Summary, Conclusion and Recommendation*

**Summary**

This study was set to investigate the socio cultural determinants of the adoption of ICSs by households in Kenya's Homabay County. The study was necessary because the more than half of the county's population relies on solid fuel, such as biomass for their cooking needs.

Unprocessed biomass (e.g. charcoal, wood, crop waste) remains a major household fuel source for most residents of low income countries particularly the poor. During cooking, inadequate ventilation and incomplete combustion through the use of rudimentary stoves or open fire pits are common resulting in acute and chronic exposure to air pollutants (particulate matter, carbon monoxide, nitrous oxides, carcinogens and others). Exposure to household air pollution has been linked to a range of negative health outcomes in children and adult, including pneumonia, tuberculosis, chronic obstructive pulmonary disease, and lung cancer low birth weight and premature mortality.

The variations in adoption of the package practices among households were assessed from the point of view of various factors which influence households' adoption behavior. These influencing factors are categorized as demographic and socio-cultural factors. Most of the variables assumed to influence the adoption behavior were significantly associated with the adoption and degree of adoption of ICSs. Majority of the respondents were in the ages between 31 – 40 years. On the education level most respondents were found to be literate. Adoption of ICS remained low. Among the personal and demographic factors the study confirmed that education status and size of household were significantly related to the degree of adoption of ICSs. In the case of socio-cultural variables household income, farm size, family size, off-farm income, cosmopoliteness, leadership status, household's perception on use of technology, cultural beliefs, social norms and experience were found to be significantly related with adoption of ICSs.

### *Conclusions*

In view of the data analysis and results shown in chapter four it can be concluded as follows:

**1.** Close to 48% of the households in the study area had adopted ICSs while close to 52% of the households had not adopted ICS. This was low given that the technologies have been in existence for more than three years.
**2.** The study further concludes that there were more youthful respondents. Since age influenced adoption of ICS, strategies should be developed so as to target more youth groups for increased technology adoption and development.
**3.** Farmers education level does influence the use of ICS and therefore it is related to the adoption of ICS, a finding which concurs with studies cite earlier. It requires that households are educated on new technologies.
**4.** Regarding adoption of the ICS in relation to selected variables, a number of factors showed varying relationship. For instance tenancy status seemed not to influence household's adoption of ICS while level of education, income, farm size, family size, off-farm income, and membership of social groups, cultural traditions, beliefs and social norms seemed to influence the household's adoption of ICS in the study area.
**5.** Respondents mentioned a number of constraints that act as deterrents to adoption of ICSs. These include: Cultural beliefs, cultural traditions, social norms and lack of awareness of awareness of ICS technology information.
**6.** The most dramatic change that will influence adoption of ICS is the development of institutional strategies that target smallholder households so that potential adopters can adopt the technologies to improve their quality of life.

### *Recommendations*

- The following recommendations have been suggested from the findings and conclusions of the study.
- Extension agents should consider improving their level of participation in joint activities. They should also consider improving the number of visits to field to understand the households' conditions better.
- Plenty of extension effort is needed in dissemination of ICS technologies information. This effort could be in terms of field days, farm visits, agricultural shows, holding demonstrations that focus on new technologies.
- Ways and means of encouraging small holder households to adopt ICS without necessarily relying on government subsidies should be developed by encouraging them to form small groups with revolving funds.
- Researchers should encourage multistage development of technologies that favor small holder households since they form a large proportion of households in Kenya today.
- Institutional strategies should be developed to favor young households since they are the majority on the ground.

- Households should be encouraged to form groups so that they can access credit and bargain for prices of their commodities.
- Households should be sensitized on socio-cultural aspects that hinder adoption of technologies in the County.

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