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Assessing the role of Institutional factors on the use of Improved Cook stoves in Kenya's Homabay County

Isaiah K. Okuthe

Ministry of Energy and Petroleum, Nairobi, Kenya

ABSTRACT: The aim of the study was to examine the influence of institutional 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 households selected using systematic random sampling from the households in the Division were engaged. For qualitative data, 40 households 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 that, access to credit, participation in extension, participation in cooperative society and membership in social groups were important variables which had positively and significantly influenced adoption of ICS. Whereas, the study found no evidence to show that tenancy status influences adoption of ICS. The overall finding of the study underlined the high importance of institutional support in the areas of extension training, strengthening cooperatives and social groups and improving market and credit condition to enhance adoption of ICS.

KEYWORDS: Institutional factors; Improved cook stoves: Smallholder households.

1 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).

Corresponding Author: Isaiah K. Okuthe

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.

2 MATERIAL AND METHODS

2.1 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 34^0 12' and 34^0 40' east and latitudes 0^0 28' and 0^0 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 Couny is typical of rural areas of Africa where women and children are exposed to household indoor air pollution. In Homabay, rates of acute respiratory infectios, 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 seal 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.

2.2 SOURCES OF DATA

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

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.2.4 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.

2.3 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;

$$n = \frac{NC^2}{C^2 + (N-1)\,e^2}$$

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.

2.4 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.

2.5 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.

2.6 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 Code	Operational definition of the variable
Access to credit	CREDIT	A dummy variable, with value 1, if a person has access to credit and 0 otherwise.
Contact with extension	EXTCON	It is measured as the number of times the farmer has Made contact with extension agent in the last 1year
Access to market	MARKET	A dummy variable, with value 1, if a person has access to market and 0 otherwise.
Participation in cooperative society	COOPS	Is measured as the number of times the farmer has participated in cooperative society activities for the last one year
Participation in barazas	BARAZAS	Is measured as the number of times the farmer has participated in barazas for the last one year.
Participation in field days	FIELDAYS	Is measured as the number of times the farmer has participated in field days for the last one year.
Participation in agricultural shows	AGRICSH	Is measured as the number of times the farmer has participated in agricultural shows for the last one year.
Participation in workshops	AGRICSH	Is measured as the number of times the farmer has participated in agricultural shows for the last one year.
Participation in training	AGRICSH	Is measured as the number of times the farmer has participated in agricultural shows for the last one year.
Land tenure	LANDTN	Land ownership status.
Access to inputs	INPUTS	A dummy variable, with value 1, if a person has access to inputs and 0 otherwise.

Membership in Social groups	AGRICSH	Is measured as farmers' membership in social groups for the last one year.
Contact with non governmental organization	CONNGO	Is measured in terms of frequency of contact with non governmental organization
Contact with government organization	CONTGO	Is measured in terms of frequency of contact with non governmental organization
Contact with community based organization	CONCBO	Is measured in terms of frequency of contact with community based organization

3 RESULT AND DISCUSSION

3.1 ADOPTION OF IMPROVED COOK STOVES.

The study focused on ICS. These 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 3 above, it was noted that only 47.3% of the respondents had fully adopted the practice. It is to be recognized that all the respondents were aware and interested to use manure 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.

3.2 INSTITUTIONAL FACTORS DETERMINING ADOPTION OF INRM TECHNOLOGIES BY SMALL SCALE FARMERS

The farmers were asked to respond to respond to a set of questions on the institutional factors that have influence on the adoption of ICS. The factors included land tenure, access to credit, source of inputs, membership in social groups, access to market and contact with extension.

Land tenure

Land tenure provides farmers with full rights of land ownership and usage thus influencing the decision to participate in natural resource management. Land ownership with title deeds accords the farmers the right to usage (security of tenure) thus creating an incentive to farmers to adopt new, long term and even riskier technologies.

Table 3. Land ownership status by farmers

Monthly income	Adopters (n=105)	Non-adopters (n=115)
Communal	18 (17.1%)	30(26.1%)
Private	84(80%)	85(73.9%)
Rented	3(2.9%)	0(0%)
Total	105(100%)	115(100%)

Table 3 shows that a significant majority (80%) of the adopters owned land privately but the adoption of these technologies was still low. Only a minority (2.9%) rented land. These findings agree with those found by Current *et al.,* (1995) where land ownership did not seem to have a significant effect on the adoption of agro forestry systems in Central America and Caribbean. According to Current *et al.,* (1995) what seemed important was how farmers feel about their property with or without the land ownership.

Access to credit

Adoption of ICS by households is motivated by the income gained from the sale of the produce. Farmers grow crops not for consumption purpose only but to fetch cash income which is allocated for purchasing farm inputs and meet other family needs. But constraints to adoption of ICS are numerous: the cost of ICS, sourcing and its management

Table 4. Access to credit by households

Use of credit	Adopters (n=105)	Non-adopters (n=115)
Yes	19(18.1%)	10(8.7%)
No	86(81.9%)	105(91.3%)
Total	105(100%)	115(100%)

are some of the constraints that hinder the adoption of this technology. Households without cash and no access to credit will find it very difficult to adopt new technologies. Previous authors verified this preposition (Legesse, 1992; Teressa, 1997). It is expected that access to credit will increase the probability of adopting ICS.

According to table 4, eighty six (81.9%) out of 105 adopters had not used credit as compared to nineteen (18.1%).This could have been the reason for the low adoption of the technologies. This showed that there was a significant relationship between access to credit and adoption of ICS. This finding concurs with Ascroft *et al.,* (1993) where only 5% of the progressive householdss obtained loans.

This is disadvantageous to households who operate on a small scale level and are less influential to the credit sector. Poor credit conditions may also be another reason that suppresses the capacity to adopt an innovation. Although credit may appear quite rational to a farmer, social forces outside his control dictate his propensity to adopt the technology. The optimal effective ICS require cash for buying the ICS and fuel. Credit therefore is a strong facilitator in enhancing effective access to ICS.

Access to quality ICS

ICS delivered by an institution will have its own impact on adoption of a given technology and production and productivity of crops. With this understanding data on problems of ICS delivered by organizations and purchased from market were collected and summarized as in Table 5 below.

Table 5. Access to ICS by households

Access to ICS	Adopters (n=105)	Non-adopters (n=115)
Yes	25(23.8%)	10(8.7%)
No	80(76.2%)	105(91.3%)
Total	105(100%)	115(100%)

According to table 5, eighty (76.2%) out of 105 adopters had not used quality ICS as compared to twenty five (23.8%).This could have been the reason for the low adoption of the technology. This showed that there was a significant relationship between access to credit and adoption of ICS. This finding concurs with Ascroft *et al.,* (1993) where only 5% of the progressive farmers obtained inputs from reputable source. This is disadvantageous to farmers who operate on a small scale level and are less influential to the input and credit sector.

Poor ICS sources may also be another reason that suppresses the capacity to adopt an innovation. Although ICS from reputable source may appear quite rational to a household, social forces outside his control dictate his propensity to adopt the technology. The optimal effective ICS adoption requires cook stoves from reputable sources. Cook stove sources therefore are a strong facilitator in enhancing effective access to the technology.

Focus group discussion reported delay and poor quality ICS and expensive stove as problems of accessing them by households. Key informants also reported increasing trend ICS price

Access to market

Markets are common centers both for producers, consumers and traders.

Table 6. Access to market by farmers

Access to market	Adopters (n=105)	Non-adopters (n=115)
Subsistence	77(73.3%)	86(73.9%)
Commercial	28(26.7%)	30(26.1%)
Total	105(100%)	115(100%)

Table 6 shows that a significant majority (73.3%) of the adopters utilized their farm produce for subsistence. Beside the distance taken to travel from home to the nearest market was an average of 10 km. For sample respondents the minimum and maximum distance that a farmer had to travel to access market center were 2 km and 30 km respectively. This means that they could not access the market easily. Only a minority (26.7%) used their produce for commercial purposes. These findings agree with those found by Ascroftt *et al.,* (1993) where only 8% of the less progress farmers had access to the market. The lack of market information represents a significant impediment to market access especially for small holders' produce. It substantially increases transaction costs and reduces market efficiency (Mwale, 1998). These findings also agree with Pearse (1974) who found that market disadvantaged small, less educated and less influential farmers.

Membership in social groups

Usually participation in the community development activities is perceived as willingness of a person to work together. The relationship between membership in social group and adoption is associated with interpersonal networking and exchanges between adaptors and non-adaptors of technology.

In this study membership in social group is hypothesized as involvement of the respondents in any informal and formal organizations as a member. Farmers who are members of any local organization are more likely to be aware of new information and practices. Therefore it was expected that there would be positive and significant relationship between membership in social group and the adoption of ICS.

Table 7. Farmer'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%)
Youth groups	6(5.7%)	4(3.5%)
Women groups	18(17.2%)	16(13.9%)
CBOs	10(9.5%)	7(6.1%)
None	53(50.5%)	83(72.2%)
Total	105(100%)	115(100%)

According to table 7, fifty three (50.5%) out of 105 adopters were not members of any social group as compared to twenty five (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 ICS. According to Blackburn *et al.,* (1982), participation in social groups is important because it indicates the extent of contact, which farmers have with organized groups and other public services and mass media. Groups provide forum for improving dialogue among farmers, thereby providing opportunity for efficient ways of ascertaining consensus on opinion about the relevance of technologies being presented to them (Norman *et al.,* 1989).

Farmers contact with extension

Contact with extension is an input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practices properly. If a farmer has no skill and technical know-how about certain technology, he/she may have less probability of its adoption. The skill acquired through extension helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. The major sources of agricultural information for farmers are extension agents. The frequency of visits or availability of extension services is perhaps the single variable that emerged significantly in most of the research work on technology transfer and adoption (Asfaw *et al.,* 1997; Kedir, 1998). It was hypothesized that frequency and timely contact with extension workers will increase a farmer's probability of adoption technologies.

Table 8. Contact with extension staff

Contact with extension	Adopters (n=105)	Non-adopters (n=115)
Yes	41(39%)	15(13%)
No	64(61%)	100(87%)
Total	105(100%)	115(100%)

The relationship between extension contacts and adoption of ICS was found to be significant. According to table 8, (64%) adopters (87%) non adaptors had not interacted with extension staff. It can be argued that extension measured in terms of use and type of information is important in adoption of ICS. However it was difficult to rate the extension service in this study in terms of its adequacy and usefulness since the scope of the study was limited to only ICS. These findings agree with

those found by Chitere (1985) where it was found out that nearly all the farmers in an area previously occupied by European settlers were knowledgeable about improved farming practices. It was also observed that farmers adopt improved farming practices largely because of early exposure to intensive extension education. Several studies also indicated a positive relationship between contact with agricultural information sources and adoption (World bank, 1993). These also agree with Herribera (1985) who found that the level of expertise manifested by farmers with intensive extension contact was consistently higher than that of other farmer.

Participating in extension events

In this study, participation in training, demonstration, field day, visit by extension staff, visit to extension staff, field days and agricultural shows were considered as the most important extension events. Participation in extension events is an input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practices properly. If a farmer has no skill and technical know-how about certain technology, he/she may have less probability of its adoption. The skill acquired through extension helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. The sample farmers' participation in different extension events in relation to adoption of ICS is discussed in the following pages. To describe the level of farmers' participation in extension events, farmers were asked eight questions on the various activities bringing together the extension agents and farmers. The responses from the farmers are summarized in table 9.

Table 9. Number of times farmers (adopters) participated in extension activities

Activity		No of Times							
		0	1	2	3	4	5	>5	Total
Individual visit by extension staff	f	80	5	8	2	0	1	9	105
	%	76.2	4.8	7.6	1.9	0	1	8.6	100
Group visit by extension staff	f	79	15	4	1	0	3	3	105
	%	75.2	14.3	3.8	1	0	2.9	2.9	100
Farmers visit to extension staff	f	80	19	0	2	1	0	3	105
	%	76.2	18.1	0	1.9	1	0	1.9	100
On farm demonstrations	f	81	16	1	2	0	0	5	105
	%	77.1	15.2	1	1	1.9	0	4.8	100
On station demonstrations	f	93	10	0	0	0	0	2	105
	%	88.6	9.5	0	0	0	0	1.9	100
Farmers own demonstrations	f	94	4	1	1	0	0	5	105
	%	89.5	3.8	1	1	0	0	4.8	100
Field days	f	60	16	9	4	1	0	15	105
	%	85.7	15.2	8.6	3.8	1	0	14.3	100
Agricultural shows	f	90	7	3	0	0	0	5	105
	%	85.7	6.7	2.9	0	0	0	4.8	100
Workshops	f	92	7	1	4	0	0	1	105
	%	87.6	6.7	1	3.8	0	0	1	100

Table 10. Number of times farmers (non adopters) participated in extension activities

Activity		No of Times							
		0	1	2	3	4	5	>5	Total
Individual visit by extension staff	f	90	5	8	2	0	1	9	115
	%	78.3	4.8	7.6	1.9	0	1	8.6	100
Group visit by extension staff	f	89	15	4	1	0	3	3	115
	%	77.4	14.3	3.8	1	0	2.9	2.9	100
Farmers visit to extension staff	f	90	19	0	2	1	0	3	115
	%	78.3	18.1	0	1.9	1	0	1.9	100
On farm demonstrations	f	91	16	1	2	0	0	5	115
	%	79.1	15.2	1	1	1.9	0	4.8	100
On station demonstrations	f	103	10	0	0	0	0	2	115
	%	89.6	9.5	0	0	0	0	1.9	100
Farmers own demonstrations	f	104	4	1	1	0	0	5	115
	%	90.4	3.8	1	1	0	0	4.8	100
Field days	f	70	16	9	4	1	0	15	115
	%	60.9	15.2	8.6	3.8	1	0	14.3	100
Agricultural shows	f	100	7	3	0	0	0	5	115
	%	87	6.7	2.9	0	0	0	4.8	100
Workshops	f	102	7	1	4	0	0	1	115
	%	88.7	6.7	1	3.8	0	0	1	100

Visits made by individual extension agent to farmers

Visits made by extension agent to farmers are an important input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practice properly. If a farmer has no skill and technical knowledge about a certain technology, he/she may have less probability of its adoption. The skill acquired through training by extension agent helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation.

The analyzed data indicates that more than half of the farmers (76.2%) were never visited by individual extension officers in the past one year while 23.9% were visited at different level of frequency (table 18 above). This could have led to the low adoption of ICS by farmers. There existed a significant relationship between visit by individual extension agent and adoption of ICS.

Group visits by extension agents to farmers

Group visits made by extension agents to farmers are an important input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practice properly. If a farmer has no skill and technical knowledge about a certain technology, he/she may have less probability of its adoption.

The skill acquired through training by extension agents helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. Seventy nine out of one hundred and five adopters interviewed (75.2%) were not visited by a group of extension agents while 24.9% had been visited at different level of frequency in the past one year (table18). This could also have led to the low adoption levels.

Visits made to extension officers by farmers

Visits made to extension agents by farmers are an important input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practice properly. If a farmer has no skill and technical knowledge about a certain technology, he/she may have less probability of its adoption.

The skill acquired through training by extension agents helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. Table 18 clearly indicates that, from the total sample farmers 22.9% farmers had visited extension officers at different level of frequency while majority of the farmers interviewed (76.2%) indicated that they not visited extension officers in the past one year.

On farm and on station demonstration

Demonstration means undertaking field trial with farmers with the aim of creating a learning site for the surrounding farm community. Demonstration is an important method of extension to create concrete awareness among farm community. This situation may facilitate the adoption process. It is also a means of diffusing information to neighboring farmers to see and then adopt the practice into their farm.

Table 10 indicates that only 81%% of total sampled farmers interviewed had participated in on farm demonstration and the rest eighty one out of the 24 farmers (23.9%) indicated that they had not attended any on farm trial. On the contrary eleven (10.6%) farmers had attended on station trials once or more than once. Participation in demonstration significantly and positively influenced the adoption of ICS.

Demonstration in this study means accepting new practices and put in the field in the form of trial with close supervision of extension agents and then inviting others to see how he/she perform it. In this finding, farmers who participated in demonstration were all of adopter categories. The probable reason for this difference is that extension agents may select the one who accept technology easily to put in to practice according to the recommendation. When farmers have a chance to participate in practicing demonstrations they may develop know-how more about the fitness of the package with their socio-economic conditions, this enhances them to take further measures, either to use or not the technological packages. Similar results were identified by Edlu (2006).

Attending ASK shows

ASK show is one of the most popular methods of transferring technology. Conducting shows is a good way of convincing other farmers to adopt new technology. In the shows farmers will get an opportunity to observe how the new technology is put in to practice. This situation may facilitate the adoption process. Table 18 clearly indicates that, fifteen farmers (5%) of farmers attended ASK shows at different levels of frequency while majority of the farmers (85.7%) had not attended any agricultural shows in the past year. They explained that most shows are organized far away from their homes. The participation of respondents in ASK shows with varying level of frequency can be observed in Table13.

Field days

Field day is one of the most popular methods of technology transfer. Conducting field days on farmers' field is a good way of convincing other farmers to adopt new technology. In field day neighboring farmers will get an opportunity to observe how the new technology is put into practice in the field. This situation may facilitate the adoption process. Table 13 clearly indicates that from the total sample farmers 42.9% farmers had attended field days at different level of frequency while majority of the farmers (85.7%) had not attended any field day in the past one year. The participation of respondents in the field day with varying level of frequency can be observed in Table 18.

Workshops and seminars

Training is an important input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practice properly. If a farmer has o no skill and technical know-how about certain technology, he/she may have less probability of its adoption. The skill acquired through training helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. Concerning farmer's attending training programmes, out of total 105 adaptors interviewed 12.5% of them had attended workshops and seminars while ninety-two farmers (87.6%) did not attended workshops and seminars related to ICS (table 18).

Mass media exposure

The adoption process of improved technologies depends on access to information and on the willingness and ability of farmers to use information channels available to them. The role of information in decision-making process is to reduce risk and uncertainties to enable farmers to make the right decision on adoption of improved agricultural technologies. Mass media play the greatest role in provision of information in the shortest possible time over large area of coverage. However, as compared to other communication channels, its effect on behavioral change is weak as it is limited to awareness creation than skill development.

But, as far as awareness is pre-requisite for behavioral change, still its role cannot be underestimated. Hence, mass media exposure was expected to positively influence adoption and intensity of adoption of ICS. The survey result on mass media exposure of sample farmers is provided in Table 11 below.

Table 11. Distribution of respondents with respect to radio listening habit

Frequency of contact with radio	Frequency	Percent
Never	43	41
Monthly	2	2
Weekly	29	28
Daily	31	29
Total	105	100

As indicated in Table 11 above in terms of radio listening habit of the farmers in the study area, 41% of them did not listen to radio programs whereas 2%, 28% and 29% of the respondents have monthly, weekly and daily listening habit (Table 19). Surprisingly, majority of radio listeners in the study area do not pay attention to agricultural programs. Lack of attention to agricultural radio program may be attributed to unfamiliarity of the language and also lack of awareness on the importance of the program. It could also be attributed to lack of favorable attitude towards the program. The result of this study is consistent with the findings of Kidane (2001) and Getahun (2004). This could be due to the fact that agricultural radio programs were not given top priority by farmers in the study area rather the priority was for other non-agricultural programs.

Farmers interaction with non-governmental organization, local cooperatives and community based organizations.

Table 12. Farmer's (adopters) contact with other organizations

Organization		Interaction			
		Never	Often	Rarely	Total
Government Organization	f	71	27	7	105
	%	67.6	25.7	6.7	100
NGO	f	72	26	7	105
	%	68.6	24.8	6.7	100
Local cooperative	f	88	5	2	105
	%	93.3	4.8	1.9	100
CBO	f	59	2	18	105
	%	56.2	26.7	17.1	100

Farmer's (non adopters) contact with other organizations

Organization		Interaction			
		Never	Often	Rarely	Total
Government Organization	f	81	27	7	115
	%	70.4	25.7	6.7	100
NGO	f	82	26	7	115
	%	70	24.8	6.7	100
Local cooperative	f	98	5	2	115
	%	82.6	4.8	1.9	100
CBO	f	69	28	18	115
	%	60	26.7	17.1	100

Interaction with government organization

The government plays a great role in providing information and extension service to farmers. A farmer who interacts with government organization has more chance to get information and training in agricultural production. Therefore, interaction with government organization was hypothesized to have positive and significant relationship with adoption of ICS.

As was expected, interaction with government organization had a significant relationship with the adoption of ICS (Table 21). The majority (67.6%) of total adaptors had not interacted with governmental organizations and the rest 32.4% had interacted with government organizations at different level of level of frequency.

The significant relationship between membership and interaction with government organizations and adoption is an indication for the importance of government organizations in supporting agricultural production. Farmers who had interacted with government organizations were found to be better in access to and use of extension information.

Interaction with cooperative

Cooperatives serve as an important source of rural credit and input supply. A farmer who is a member or service cooperative has more chance to get credit. Therefore, the membership in cooperative and interaction with cooperative was hypothesized to have positive and significant relationship with adoption of ICS.

As was expected, the membership of cooperative society and interaction with cooperative society had a significant relationship with the adoption of ICS (Table 12). Ninety eight farmers (93.3%) were found to be non-members of any local cooperative society and had never interacted with any local cooperative society and the rest 6.7% were reported to be members and had interacted with cooperative societies at different level of level of frequency.

The significant relationship between membership and interaction with cooperative society and adoption is an indication for the importance of rural financial institutions in supporting agricultural production. Cooperative members were found to be better in access to and use of credit services.

Interaction with nongovernmental organization

Nongovernmental organizations play a great role in providing information and extension service to farmers. A farmer who interacts with nongovernmental organization has more chance to get information and training in agricultural production. Therefore, interaction with government organization was hypothesized to have positive and significant relationship with adoption of ICS.

As was expected, interaction with nongovernmental organization had a significant relationship with the adoption of ICS (Table 12). The majority (68.6%) of total adaptors had not interacted with nongovernmental organizations and the rest 31.5% had interacted with nongovernmental organizations at different level of level of frequency. The significant relationship between interaction with nongovernmental organizations and adoption is an indication for the importance of nongovernmental organizations in supporting agricultural production. Farmers who had interacted with nongovernmental organizations were found to be better in access to and use of extension information.

Key informants from public institutions identified NGOs such as CARE C-MAD, GIZ and AEP as some of some of the NGOs that have programmes in the division

Interaction with community based organization

Community based organizations play a great role in providing information and extension service to farmers. A farmer who interacts with community based organization has more chance to get information and training in ICS. Therefore, interaction with community based organization was hypothesized to have positive and significant relationship with adoption of ICS.

As was expected, interaction with non-community based organization had a significant relationship with the adoption of ICS (Table 12). The majority (56.2%) of total adaptors had not interacted with community based organizations and the rest 43.8% had interacted with nongovernmental organizations at different level of level of frequency. The significant relationship between interaction with community based organizations and adoption is an indication for the importance of community based organizations in supporting agricultural production. Farmers who had interacted with community based organizations were found to be better in access to and use of extension information.

4 SUMMARY, CONCLUSION AND RECOMMENDATION

4.1 SUMMARY

This study was set to investigate the determinants of the adoption of ICS by small scale farmers' households in Kenya's Ndhiwa division. The study was necessary because the adoption of improved technologies has remained low even after the introduction of improved technologies. The low adoption levels of these technologies affect the overall natural resource management in the area. The study employed cross sectional survey design with an ex-post-facto approach. Data was collected from a sample of 220 farmers from different locations in the area.

Results of data analysis indicated that more than half (56%) of the farmers interviewed were female as compared to (44%) being male. This is an indication that more women are engaged in natural resource management on a day-to-day basis compared to men. However the adoption INRM technology by women was lower than men.

Among the institutional factors frequency of contact with extension agent, attending training, access to market, availability of inputs, access to credit, membership of social group, interaction with non-governmental organization, interaction with government organization, interaction with local cooperative and interaction with community based organization were also found to have positive and significant relationship with adoption of ICS. Thus households need to get information and institutional support like marketing, cooperative society and rural credit institutions. This is paramount to boost the adoption of ICS and improve natural resource management.

4.2 CONCLUSIONS

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

1. Close to 47% of the farmers in the study area had adopted ICS while close to 52% of the farmers had not adopted ICS. This was low given that the technologies have been in existence for more than three years.
2. Farmers mentioned a number of constraints that act as deterrents to adoption of ICS. These include: Cultural beliefs, cultural traditions, social norms, lack of awareness of awareness of ICS information, lack of where to secure quality ICS, high cost of ICS and market. Low level of frequency of extension contacts with farmers was also a common problem, which hindered faster rate of adoption. Others (Amudavi, 1993) have also cited these problems.
3. The most dramatic change that will influence adoption of technologies is the development of institutional strategies that target small-scale farmers so that potential adopters can adopt the ICS to improve natural resource management.
4. As compared to other technologies in agriculture ICS require a little bit more skill to fabricate, install and manage. Therefore sufficient number of training, field day and demonstrations are of paramount importance to equip farmers with the skills. That is why the explanatory variable, education was having a strong relationship with probability and intensity of adoption of ICS in this study. This fact shows that the current extension service delivered to small scale farmers has to change the past trends and special emphasis on skill training on ICS as well as market extension aspects.
5. The findings of this study revealed that the main difference in degree of adoption of ICS was also related to access to credit and inputs and membership in groups. Because of this those sample small scale farmers who did not have access to credit and ICS, had not adopted the technology. So that provision of credit for all and arranging field day visit and

tour program within certain period of time in the production season will be very much important to farmers to adopt new technologies.

6. Being a member of cooperatives and social groups was also positively and significantly related with adoption of ICS. Member of cooperative has got credit and other supply from the cooperative. So strengthening and expansion of cooperatives is one means to enhance adoption of improved technologies in the area.
7. The major constraint of ICS in the study area was the absence of reliable ICS supply. Majority of adopter sample farmers purchased ICS from individual retailers. In line with this the sample farmers complained of ICS quality and lack of ICS.
8. One of the major problems to the development of ICS is poor marketing system. Therefore, much emphasis has to be given to improvement of marketing system particularly through cooperative unions. These cooperative unions should have to create reliable market price by communicating with other cooperatives found outside their localities.

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 farmer's field to understand the farmers' 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-scale households to adopt ICS without necessarily relying on government subsidies should be developed by encouraging them to form small groups with revolving funds.
- Frequency of contact between the farmers and the extension agents was also quite low hence did not seem to improve the adoption of INRM technologies. However there are a number of institutions dealing with agriculture that include GIZ, CARE-Kenya, C-MAD, KARI, AEP, Ministry of agriculture and Diocese of Homabay. These institutions could be encouraged to step up their extension efforts. There should be a linkage between these institutions, extension agents, farmers and researchers.
- Researchers should encourage multistage development of technologies that favor small-scale farmers' households since they form a large proportion of farmers in Kenya today.
- Policy makers should provide small credit to households to help them meet the cost of adoption of ICS. Such credits will go to purchasing of seeds, fertilizer and chemicals which are very expensive.
- Institutional strategies should be developed to favor young and women farmers since they are the majority who engage in natural resource management activities on the ground.
- Farmers should be encouraged to form groups so that they can access credit and bargain for prices of their commodities.
- Producers and extension agents need adequate skills in production management practices starting from seed selection to post harvest technologies suitable at their level. Marketing principles, bargaining skills, business planning, quality management and post harvest handling of agricultural products are some of the interventions needed in the study area.

REFERENCES

[1] Adazu, K, Lindblade, K.A, Rosen, D.H, Odhiambo, F, Ofware, P, Kwach, J, Van Eijk, A.M, Decock, K.M, Amornkul, P, Karanja, D (2005). *Health and demographic surveillance in rural western Kenya: a platform for evaluating interventions to reduce morbidity and mortality from infectious diseases*. American Journal of Tropical Med Hygiene.

[2] Amudavi, M. A., (1993). Influence of Socio-economic factors on adoption of maize related technology. The case of smallholder farmers in Hamisi Division of Vihiga District, Kenya. (Unpublished M. Sc. Thesis). Njoro, Kenya: Egerton University.

[3] Ani, A.O., (2002). Factors inhibiting agricultural production among rural women in Southern Ebony State, Nigeria, (Unpublished PhD. Thesis). University of Maiduguri, Nigeria.

[4] Ary, D., Jacobs, L.C. and Ravavier, A., (1979). *Introduction to research in education*. New York: Holt, Rinehart and Winston Publishers.

[5] Ascroft J., (1973). *The overall evaluation of the special rural development plan*. Geneva. Institute for Social Development.

[6] Asfaw, N., Gungal, K., Mwangi, W., Beyene, S., (1997). Factors affecting adoption of maize production technologies in Ethiopia. *Ethiopian Journal of Agricultural economics.* 2: 52-69.

[7] Bates, L., (2005). Smoke, health and household energy. Volume 1: Participatory methods for design, installation, monitoring and assessment of smoke alleviation. Practical Action.

[8] Bates, L., (2007). Smoke, health and household energy. Volume 1: Researching pathways to scaling up sustainable and effective kitchen smoke alleviation. Practical Action.

[9] Blackburn, D. J., Brinkman G. L., and Driver H. C (1982); Understanding Behaviour and Economic Characteristics in Working with Operations of Small Farms. A case study in Ontario Canada. New York: John Wiley.

[10] Bruce, N, Perez-Padilla, R, Albalak, R., (2000). Indoor air pollution in developing countries: a major environmental and public health challenge. Bull World Health Organization.

[11] Chitere, P.A and Van Doorne, J.H., (1985). Extension education and farmers performance in improved crop farming in Kakamega District . *Agricultural Administration Vol. 18 (2).*

[12] Dhelari, M, Pope, D, Mascarenhas,M, Smith, K.R, Weber, M, Bruce, N., (2008). Indoor air pollution from unprocessed solid fuel use pneumonia risk in children aged under five years: a systematic and meta-analysis. Bull World Health Organization.

[13] Duvel, G.H., (1975). The mediating functions of perception in innovation decision. South African Journal of Agricultural Extension, 4, pg. 25-36.

[14] Food and Agriculture Organization., (1995a). Kenya: Country profile on aqua-statistics. Rome, Italy: FAO. Retrieved from the web on 22/9/2004. http://w.w.w.fao. Orga /a /agl/aglw/ aquastat/countries/ Kenya/index.stm.

[15] Food and Agriculture Organization, (2004). Scaling Soil Nutrient Balance: Enabling meso-level applications for African realities. Rome: FAO.

[16] Fullerton, D.G, Bruce, N, Gordon S.B., (2008). Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. Trans R Soc Trop Med Hyg.

[17] Geist, HJ, Lambin EF., (2001). What Drives Tropical Deforestation? A Meta-Analysis of Proximate and Underlying Causes of Deforestation Based on Sub national Scale Case Study Evidence. LUCC Reprot Series No.4. Louvain-la-Neuve, Belgium: Universlty of Louvain.

[18] Getahum, D., (2004). Assessment of factors affecting adoption wheat technologies and its impact: The case of Hula Woreda, Ethiopia. (Unpublished M.Sc. thesis). Alemaya, Ethiopia: Alemaya University.

[19] Glasgow, R.E, Lichteinstein, E, Marcus A.C.,(2003). Why don't we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. American Journal of Public Health.

[20] Global Alliance for Clean Cook stoves, (2011). Igniting Change: A strategy for Universal Adoption of Clean Cook stoves and Fuels. Washington DC: Global Alliance for Clean Cook stoves.

[21] Government of Kenya., (2002). Homa Bay District Development Plan 2002 – 2008. Nairobi: Government Printers.

[22] Government of Kenya., (2001a). National Agricultural and Livestock Extension Programme. Implementation Framework, Nairobi: MOARD.

[23] Green, L.W, Ottoson J.M, Garcia C, Hiatt, R.A., (2009). Diffusion theory and knowledge dissemination, utilization and integration in public health. Annual Review Public Health.

[24] Hofstad, O, Kohlin, G, Namaalway, F., (2009). How can emissions from wood fuel be reduced. Bogor, Indonesia: Centre for International Forestry Research.

[25] Iheanacho, A.C., (2000). Economics of Millet production under different cropping systems in Borno State of Nigeria. (Unpublished PhD thesis). University of Maiduguri, Nigeria.

[26] Jaetzold, R and Schmidt, H., (1982) Farm Management Handbook of Kenya: Natural Conditions and Farm Management Information. Volume II/A: West Kenya. Ministry of Agriculture, Nairobi, 397 pp.
[27] Kedir, B., (1998). The role of SG2000 Project credit system in the adoption of wheat technologies by smallholder farmers in Ethiopia. The case of Hetosa district. (Unpublished M.Sc. thesis). Morogoro, Tanzania: Sokoine University.
[28] Kidane, G., (2001). Factors influencing the adoption of new wheat and maize varieties in Tigray, Ethiopia. (Unpublished M.Sc thesis). Alemaya, Ethiopia: Alemaya University.
[29] Kohlin G, Sills E.O, Pattanayak S.K, Wilford, C., (2011). Energy, Gender and Development. Policy Research Working Paper, No. WPS 5800. Washington, DC: Social Dimensions of Climate Change division, World Bank.
[30] Legesse, D., (1992). Analysis of factors influencing adoption and the impact of wheat and maize technologies in Aris Nagele, Ethiopia. (Unpublished M.Sc thesis). Alemaya, Ethiopia: Alemaya University.
[31] Legros G, Havet, I, Bruce, N, Bonjour S., (2009). The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa. New York: united Nations Development Program and World Health Organization.
[32] Madon,T, Hofman K.J, Kupfer, L, Glass, R.I., (2007). Public Health. Implementation science. Science
[33] Marenya, P.P., Barret, C.B., Oluoch-Kosura, W.A., Place, F., (2003). Education, non-farm income and farm investment in land scarce western Kenya. A BASIS CRSP Policy Brief No. 14, University of Wisconsin, Madison, WI.
[34] Martin, W.J, Glass R.I, Balbus, J.M, Collins, F.S. Public Health. (2011). A major environmental cause of death. Science.
[35] Mitchell, A,. (2010). Indoor Air Pollution: Technologies to Reduce Emissions Harmful to Health: Report of a Landscape Analysis of Evidence and Experience. Washington DC: USAID-TRACTION.
[36] Mwale, S. M., (1998). Integrating Food and Environmental Security in the Greater Horn of Africa: a preliminary institutional stakeholder Analysis: IUCN and WRI, 67-79.
[37] Nassiuma, D.K., (2000). Survey Sampling: Theory and Methods. Nairobi: Nairobi University Press.
[38] Norman, D., Baker, D., Heinrich G., Joha, C., Maskiara, and Worman, F.,(1989); Farmers groups for technology development, experiences in Botswana, in Chambers; Farmers innovation and agricultural research, London: Intermediate Technology Publication.
[39] Pattanayak, S.K, Pfaff, A., (2009). Behaviour, Environment and Health in developing countries: evaluation and valuation. Annual Review Resource Economics.
[40] Pope, D.P, Mishra, V, Thompson, L, Siddiqui, A.R, Rehfuess, E.A, Weber, M, Bruce, N.G., (2010). Risk of low birth weight and stillbirth associated with indoor air pollution from solid fuel use in developing countries. Epidemiological reviews.
[41] Quisumbing, A.R., Brown, L., Hillary, R., Feldsten, S., Haddad, L., Pena, C., (1995). Women: the key to food security. Food Policy Statement No. 21. International Food Policy Research Institute, Washington, DC.
[42] Rahmeto, N., (2007). Determinants of improved haricot bean production package in Alaba special wored, Southern Ethiopia. (Unpublished M.Sc thesis). Hamaraya University, Hamaraya, Ethiopia.
[43] Ramadhan, V, Carmichael, G., (2008). Global and regional climate change due to black carbon. National Geosciences.
[44] Rehfuess, E.A, Mehta, S, Pruss-Ustun, A., (2006). Assessing household solid fuel use: multiple implications for the millennium development goals. Environment Health Perspective.
[45] Rogers, E.M., Shoemaker, F.F., (1971). Communication of Innovation: Across-cultural Approach, 2nd Edition. New York: The Free Press.
[46] Sagar, A.D, Kartha, S., (2007). Bioenergy and sustainable development. Annual Review Environment Resource.
[47] Shindell, D.T, Kuylenstierna, J.C, Res, F, Ramanathan, V, Rosenthal, E, Terry, S., (2011). Integrated Assessment of Black Carbon and Tropospheric Ozone: Summary for Decision Makers. Nairobi: United Nations Environmental Programme and World Meteorological Organization.
[48] Smaling, E.M.A., Stoorvogel, J.J., Windmeijer, P.N., (1993). Calculating soil nutrient balance in Africa at different scales.II; District scale. Fertilizer Research 35: 237-250.
[49] Smith, K.R, Samet, J.M, Romieu, I, Bruce, N., (2000). Indoor air pollution in developing countries and acute lower respiratory infectory infections in children. Thorax.
[50] Smith-Silvertsen, T, Diaz, E, Pope, D, Lie, R.T, Diaz, A, McCracken, J., (2009). Effect of reducing indoor air pollution on women's respiratory symptoms and lung function: the RESPIRE randomized trial, Guatemala. American Journal of Epidemiology.
[51] Teressa, A., (1997). Factors influencing adoption and intensity of use of fertilizer. The case of Lume district, Central Ethiopia, Quarternally Journal of International Agriculture 36:173-187.
[52] Tesfaye, W., (2006). Analysing factors affecting adoption of rain water harvesting technology in Dugda Bora district, East Shoa, Ethiopia. (Unpublished M.Sc. thesis). Hamaraya, Ethiopia: Hamaraya University.
[53] Van der Bosch, H., De Jager, A., Vlaming, J. (1998). Monitoring nutrient flow and economic performance in African farming systems (NUTMON). III. Monitoring nutrient flows and balancing in three districts in Kenya. Agriculture, Ecosystems and Environment 71: 65-82.

[54] Venkataraman, C, Sagar, A.D, Habib, G, Lam, N, Smith K.R., (2010). The Indian National Initiative for Advanced Biomass Cook stoves: the benefits of clean combustion. Energy Sustainable Development.

[55] Wafula, E.M, Kinyanjui, M.M, Nyabola, L, Tenambergen, E.D., (2000). Effects of improved stoves on prevalence of acute respiratory infection and conjunctivitis among children and women in a rural community in Kenya.East African Medical Journal.

[56] Wasula, S. L., (2000). Influence of Socio-economic factors on adoption of agroforestry related technology. The case of Njoro and Rongai Districts, Kenya. (Unpublished M. Sc. Thesis). Njoro, Kenya: Egerton University.

[57] World Bank., (2011). Household Cook stoves, Environment, Health and Climate Change: A New Look at an Old Problem. Washington DC: World Bank.

[58] World Health Organization., (2009) Global Health Risks: Mortality and Burden of Disease Attributes to Major Risks. Geneva: World Health Organization.

[59] World Bank., (2003). Reaching the rural poor: A renewed strategy for rural development. Washington DC: The World Bank.

[60] World Bank., (1995). Rural women and agricultural extension in the Sahel. Findings, Africa Region, Number 46, August 1995. Washington D.C: the World Bank.
Retrieved from the web on 14/9/2004 at http://www.worldbank.org/afr/findings/English/find 46.htm.