International Journal of Biochemistry, Bioinformatics and Biotechnology Studies
Vol.7, No.1, pp.1-15, 2022
Print ISSN: 2397-7728(Print)
Online ISSN: 2397-7736(Online)

Gender Aspects Influencing Adoption of Bioenergy Conservation Technologies, the Case Lower Eastern Kenya

[1]Emily Mumbua Kitheka* ; [2]Nellie Caroline Oduor, [4]Timothy W. Namaswa, [5]Josephine K. Musyoki, [6]Joseph Githiomi (PhD)
Kenya Foretry Research Institute (KEFRI)

[3]Jane W. Mutinda (PhD)
Kenyatta University (KU), Kenya.

Citation: Emily Mumbua Kitheka; Nellie Caroline Oduor; Jane W. Mutinda; Timothy W. Namaswa; Josephine K. Musyoki; Joseph Githiomi(2022) Gender Aspects Influencing Adoption of Bioenergy Conservation Technologies, the Case Lower Eastern Kenya, *International Journal of Biochemistry, Bioinformatics and Biotechnology Studies*, 7, (1)1-15

ABSTRACT: *This paper examines the influence of gender in adoption of biomass energy conservation in Eastern Kenya. The region suffers deforestation, environmental degradation and threatened species as result of overexploitation of tree resources for woodfuel production. The government of Kenya and development partners has developed and promoted energy conservation technologies in the region for increased access to sustainable energy resources in rural areas geared towards achievement of sustainable development goals (SDGs) relating to increased access to clean and affordable energy, the eradication of poverty and environmental sustainability, climate action as well as gender equality and the empowerment of women. Despite these efforts, adoption and continued use of improved bioenergy technologies has been low. The objective of the study was to determine gender aspects influencing adoption of biomass energy conservation technologies at household and community levels. The study was carried out in selected sub-counties of Kitui County using a survey design. Structured questionnaire and thematic guidelinesfor group discussions were used to collect data from 192 respondents. SPSS and Excel were used for data analysis. Results revealed that, at 0.05% level of significance, adoption of improved technologies were positively correlated to income and awareness levels. Inadequate awareness on benefits of improved bioenergy technologies among men, biased resource ownership, cultural roles and responsibilities, lack of inclusive decision making and over dependence on men and subsistence farming for financial support by women were indicated as key factors influencing adoption of improved technologies. The study concludes that though women are culturally responsible for provision of food and cooking energy, high poverty among women, and lack of awareness on the socio-economic benefits among men affects adoption of improved bioenergy technologies. The study recommends financial empowerment of women, inclusive decision making and mainstreaming gender at all levels of project implementation for increased adoption of new technologies.*

KEY WORDS: gender, bioenergy, improved technologies, adoption

INTRODUCTION

Increasing interest in renewable energy resources including biomass energy as source of energy for over a third of world's population has increased their role in sustainable

development and interests in climate change issues. In developing countries, biomass energy is predominantly used in form of fuelwood, charcoal, bio-fuel and agricultural wastes or briquettes, and accounts for nearly 80% of the total renewable energy supply worldwide (FAO, 2010). Globally, the demand for biomass energy for cooking and heating has been on the rise due to increasing population, rapid urbanization and increasing demands in the commercial and institutional sectors. Unsustainable energy production and consumption has been attributed to changing environment, with 20 to 30% of global greenhouse gas (GHG) emissions attributed to the energy production and utilization and about 7% of deforestation in the world also associated to biomass energy extraction and processing (WHO/UNDP, 2016). Increased use of biomass energy is also associated with increased respiratory diseases and according to world health organization (WHO), over 4.3 million people worldwide in 2012 suffered from respiratory and cardiovascular diseases related to use of solid fuels in poorly ventilated housing units (WHO/UNDP, 2012), majority of whom are women, children and the elderly.

In Sub-Saharan Africa (SSA) over 90% of households depend on biomass energy including woodfuel, agricultural and forest residues that currently accounts for over 90% of primary energy requirements with most of them using applications with less than 10% conversion efficiency (Röder et al., 2022). In Kenya, wood based energy provides 70% of the national energy needs with about 90% of Kenyan's rural households depending on fuel wood as basic source of energy while it is estimated that 83% of Kenyan urban households depend on charcoal for cooking (MoE, 2012). Wood fuel energy is also an important source of energy for small and medium commercial enterprises (SMEs) (Githiomi & Oduor, 2007) and institutions such as schools, prison, and hospitals. Majority of this fuel comes from unsustainable sources such as dry forests and woodlands, with forestry sector accounting for 87% of supply of biomass (WBA, 2017). With increasing demand both for domestic and commercial purpose, accessibility of this indispensable resources is reducing as distances travelled, time taken to fetch and costs of purchasing continue going high (FAO 2006; Namaswa *et al*., 2016a). In Kenya, government agencies and development partners have devoted resources to development of improved modern bioenergy production and utilization technologies, however the uptake has been low due to a number of factors chief among the cost of the technologies, cultural preferences and lack knowledge and skills.

According to the International Development Research Centre (IDRC, 2006), sustainable management of natural resources, including energy, requires the participation of all stakeholders both women and men. While its recognised that men and women both

require energy inputs in their productive and reproductive activities, the burden of household energy supplies and services still remains largely the responsibility of women. This task takes away time which would have been used for other important socio-economic activities (WRI, 2007) hence the need to support in promotion of energy use efficiency and wood fuel conservation. In sustainable natural resource management, gender inequalities in areas such resource ownership, land tenure systems, access to resources, education, accessibility to extension services have contributed to lower agricultural productivity, lower adoption of new and improved technologies and higher poverty levels especially among the women (WEO, 2002; FAO, 2006). The issue of resource ownership, land and tree tenure systems which favors' men in terms of access and control of resources leaves women disadvantaged in terms of making decisions concerning technology adoption within the households (Mugure *et al* 2013). With limited land rights and incomes, women have restricted access to credit facilities and little incentive to invest in better management and conservation practices (FAO, 2006), hence the low adoption of biomass energy conservation technologies. For instance, in Kiambu County in Kenya, though 93% of households received improved cookstoves from developmental programmes, only 50% of them make use of them but only 14% of 50% have fully adopted them as main cookstoves (Kong'ani *et al*., 2016). It is therefore important to identify gender-sensitive strategies to respond to the energy and environmental degradation crisis as well as address adoption of efficient biomass technologies in the country. This is because women are more dependent on natural resources for their livelihoods; implying that they are greatly affected by impacts of energy scarcity and environmental degradation (UN- women Watch, 2009). Therefore, there is need for information on gender aspects on bioenergy to help government and developmental partners develop and implement programs meant to minimize impacts of unsustainable production and utilization of bioenergy resources on the environment and the people, especially the collectors who are mainly women and children.

In this regard, this paper sought to assess gender aspects influencing adoption of biomass energy conservation technologies in four selected sub-counties in Kitui County. The specific objectives of the study were to establish the socio-economic and demographic characteristics of the respondents in the study area, to investigate how gender related aspects influence decisions on acquisition, establishment, installation ,adoption and continued use of biomass energy conservation technologies at household and community level in the county.

METHODS AND MATERIALS

Study Area

The study was undertaken in four selected sub-counties of Kitui County namely: - Kitui Central, Chuluni, Matinyani and Mutonguni (Figure 1). The County total area is 30,496.4 km2 (KNBS, 2015) and has two rainy seasons with low and erratic rains ranging from 250mm to 1050 mm per annum with 40-percent reliability. The 2099 Kenya Population and Housing Census report puts the population of the County at 1,136,709 persons (KNBS, 2020). Kitui County is located in the Arid and semi-arid lands (ASALs) of SouthEastern Kenya.

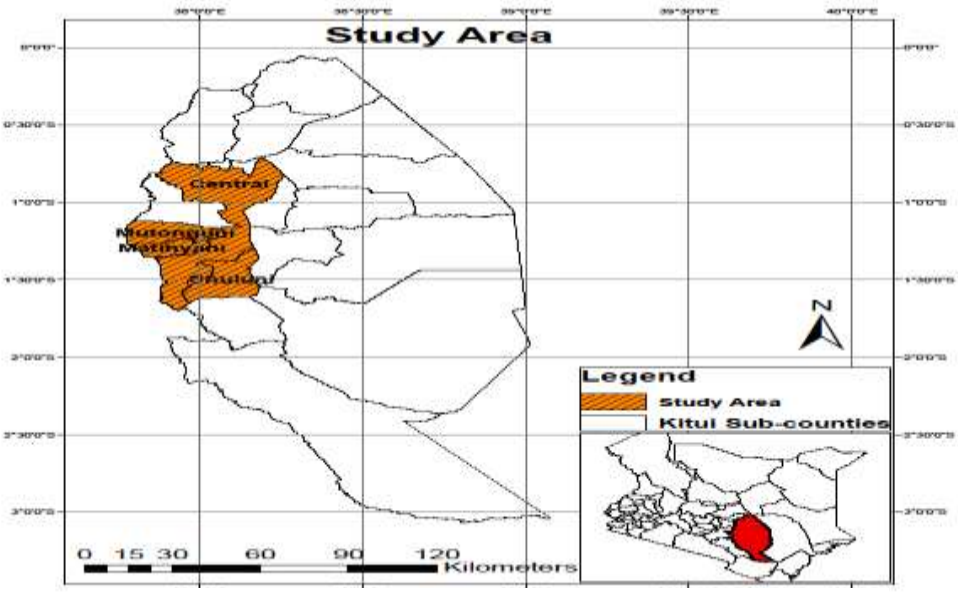

Figure 1: Map of the study site

Subsistence mixed agriculture and horticulture is the backbone of the County and is carried out mainly in the central part of the County. In the lowlands, livestock and charcoal production supplement crop farming as source of income especially during prolonged droughts. The study areas falls in the central parts of the County which is characterized by moderate rainfall (700mm to 1050mm) and high population densities at 55 persons/Km^2 higher than the county mean density of 33 persons/Km^2. The area has potential for tree growing, crop production, dairy and horticultural farming (GOK, 2021). Due to population pressure, the central area is also characterized by small land sizes thus putting a lot of pressure on available forest /tree resources. Overexploitation of wood resources to meet domestic and commercial energy demands has contributed to

wood fuel scarcity, threatened species, environmental degradation and prolonged droughts resulting to food insecurity (GOK, 2013).

Sampling and data collection

Multistage stratification method was used to stratify the study area into Sub-counties, and lastly wards as the sampling units. Semi structured questionnaires were administered to 192 respondents randomly selected from the selected wards and thematic guidelines for community group discussions.

Data analysis

SPSS and MS Excel statistical packages were used to analyze data for descriptive and inferential data statistics.

RESULTS AND DISCUSSIONS

Head of households and lack of participatory decision making.

The study revealed that 61.2% and 39.1% of households were headed by men and women respectively (Figure 2). The women headed households included single women parents and windows who were mainly elderly women. As head of households, men were noted to be the main decision makers on all development matters in the men headed households including adoption of any new technology in the households.

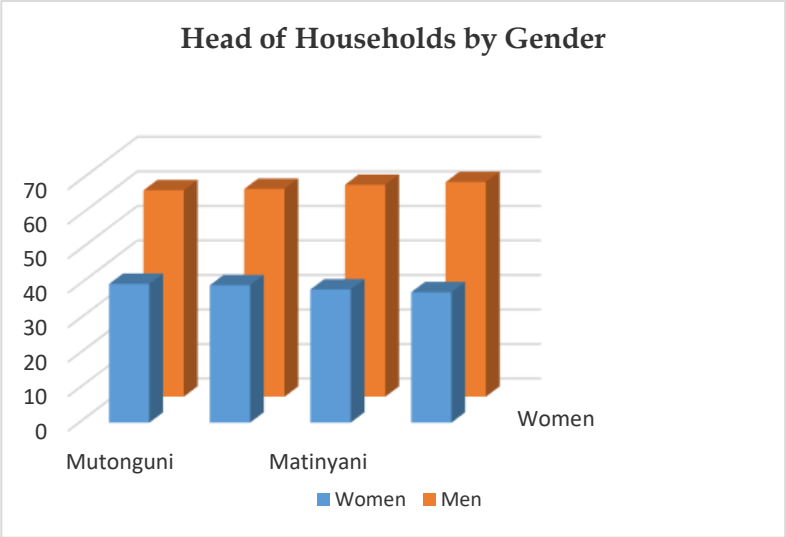

Figure 2: Decision making in the households

Decision making at family and community level is very important factor especially in an African setup. On who should make decisions in the households, results indicated that 59.25% of respondents (Figure 3) indicated that, men as head of household ought to be the main decision maker on all matters in the households concerning technology adoption including those touching on energy issues which falls under the women domain. This has affected adoption of technologies such as establishment of woodlots for woodfuel production, as men dictate on choice of planting sites and species for tree planting Men's preference for multipurpose trees for timber, poles and posts other than the preferred trees for woodfuel production means fuel wood will only be obtained after the trees have been harvested for those other purposes. In earlier studies in the community (Muok *et al*, 2002), tree planting as an activity was noted to be a preserve of men and are the main decision makers on species choice and planting site and women will only provide labour to plant and maintain the trees through watering, weeding and protetion. Wome will only plant trees with consultation or authority from men even in absentia or if windowed.In a study on land and resource ownweship and its impacts on adoption of agroforesytuy ytechnolgies by(Mugure et al 2013), women are disadvantaged in taking up proven agroforestry technolgies due to socio-cultural and economic factors despite the providing for most of the labour required in agricultural and food production systems . This has affected rate of establishment of woodlots by the women as a technology for energy provision and conservation through increased resource production.

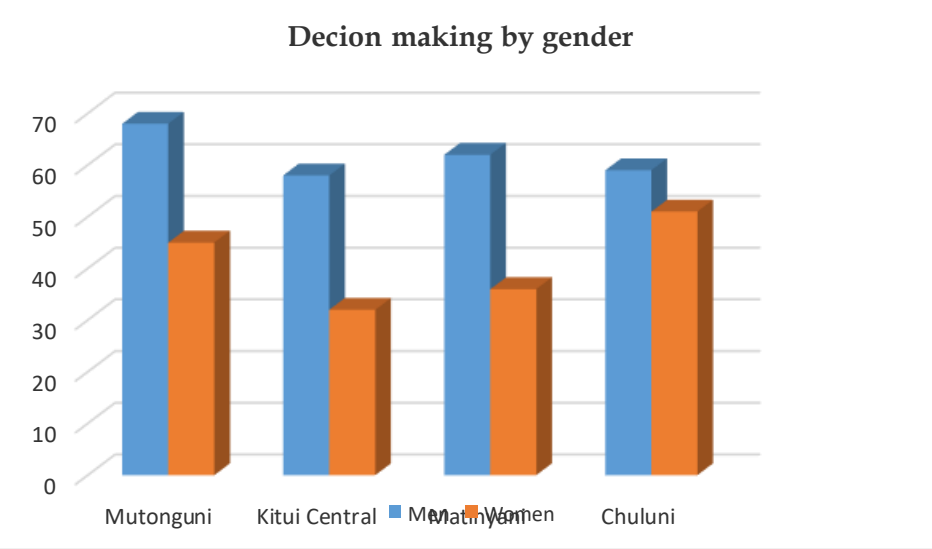

Figure.3: Decision making by gender on energy conservation technologies (%).

Over half of the respondents (59.25 %) indicated in Figure 2, men were indicated as suitable to make decisions concerning adoption of new technologies in the households. Culturally, men as head of households are bestowed the role of decision makers and this gives them opportunity to make decisions, however sometimes arbitrary without consulting other family members including women. Recent studies in Kitui County (Giathi *et al* 2017, Ndengwa *et al* 2015) have indicated that men and women actively participate in activies related to woodfuel production especially charcaol production and firewood collection. Women are indeed highly present among charcoal producers, accounting for more than 60% of the respondents surveyed. However, while women and men are participating in especailly wood preparation, setting of kilns, monitoring and harvesting of charcoal, men tend to produce more quality charcoal and sale at higher prices than women. Lack of inclusive decision making denies women the opportunity to make decisions on adoption of new modern efficient technologies which affects their productive and reproductive roles. Adoption of technolgies such improved charcaol kilns which have finacncial implications and tree planting for wood fuel production depends on final decision by men.. Women cannot make any decision on their own and have to seek consent from the husbands majority of whom are absent from home most of the time due outmigration to urban centres in search of alternative livelihoods. Lack of inclusive decision making processes in most households due to cultural aspects leaves women disadvantaged in terms of making decisions concerning technology adoption within their households and this affects adoption and continued use of any new technologies. A situational analysis of Kenyan women by UNICEF (Mutavi *et al*,. 2013) presents women as marginalized in the area of property ownership, decision making and management in agriculture compared to men and this affects any decision on adoption of technologies on farm that would improve their productivity.

Sources of incomes and decision making at household levels

From the results and group discussions, the improved technologies were indicated as more costly compared to the traditional ones. The financial aspects related to procurement and installation or establishment of the technologies such as establishment of woodlots and procurement of improved cookstoves could be the main reason men were indicated as the main decision makers as culturally men head households and are financiers of most development activities at household level. Men with higher disposable incomes and more stable sources of incomes (62%) than women (Figure 4) had greater opportunities to procure or invest on energy conservation technologies than women that relied more on subsistence farming as source of income. However, lack of awareness on

the socio-economic and environmental benefits of improved bioenergy technologies among men, meant few men are willing to financially invest on the technologies.

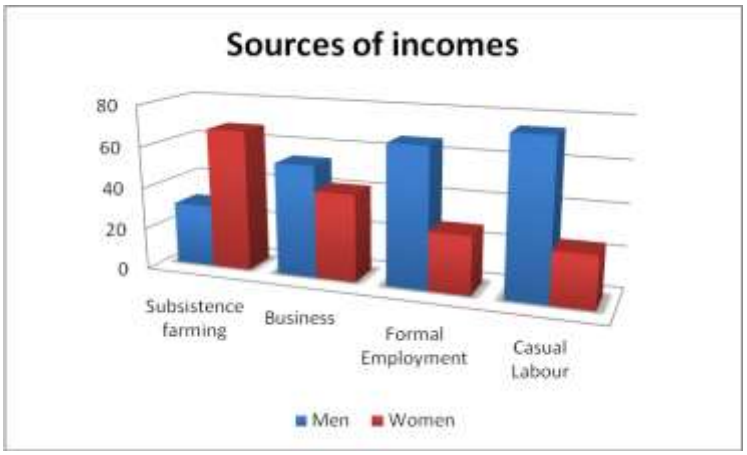

Figure 4: Sources of incomes for Men and women

With few alternative income generating activities, women are thus financially constrained. With changing climatic conditions, reliability of rains for farming has become lower, thus crop failure has become frequent. This, coupled with small land sizes and large families per household within the study area (GoK, 2011), most of the food crop produced goes towards feeding the families and cannot afford to spend monies outside the family's basic needs. Over dependence on subsistence farming by women and lack of credit facilities to boost their farm production capacities, explains why most women lack financial resources to invest in acquiring new technologies such as improved energy technologies thus low adoption of the technologies.

In reference to costs of improved technologies which was higher than the traditional technologies, education levels of the women and energy conservation technologies adopted , there is a significant correlation between income sources/levels and energy conservation methods, p=0.000 as indicated (Table 1)

Table 1: Correlation analysis between income sources, education level and adoption of technologies

		Source of income	Education level	Energy conservation methods
Source of income	Pearson Correlation	1	.070	.433**
	Sig. (2-tailed)		.338	.000
	N	441	188	231
Education level	Pearson Correlation	.070	1	-.009
	Sig. (2-tailed)	.338		.915
	N	188	189	159
Energy conservation methods	Pearson Correlation	.433**	-.009	1
	Sig. (2-tailed)	.000	.915	
	N	231	159	249

****. Correlation is significant at the 0.01 level (2-tailed).**

From the results, women and men with higher levels of income had higher levels of adopting improved energy conservation technologies. This means with improved income sources within households and more alternative sources of income among the women, adoption levels and continued use of the energy conservation technologies will increase.

Influence of information and skills

Lack of expertise and information was indicated by 36.1% of the respondents as one of the factors influencing adoption of improved energy conservation technologies (**Table2).**

Table 2: Socio-Economic, Technical and Environmental Constraints to Adoption of Energy Conservation Technologies (%)

Constraints	Cultural preferences	Lack of Finance	Lack of credit facilitie	Availability of alternative fuels	Trees for fuel still on farms	Lack of expertise	Lack of follow-up	No of sharing of information
Mutonguni	55.5	59.3	51.8	32.5	32.6	39.5	55.1	33.5
Kitui Central	41.5	57.8	45.3	33.3	27.5	33.3	45.1	46.7
Chuluni	60.5	65.6	40.9	35.8	43.9	32.6	88.3	40.9
Matinyani	56.4	63.5	35.8	38.2	33.4	42.5	67.5	38.8
Means	**53.5**	**61.55**	**43.5**	**35.1**	**34.1**	**36.1**	**56.5**	**39.1**

Though, generally, literacy levels in the study area are lower than the national averages which according to World Bank report of 2014 places Kenya's adult literacy levels at 79% , while 62%of the respondents had completed primary education as their highest level of education while those with secondary and tertiary were at 31% and 2% respectively.. However, women formed majority of those having lower education or no education at all as indicated in (Table 3).

Table 3: Education levels of the respondents by gender (%

Study areas	None			Primary			Secondary			Tertiary		
	F	M		F	M		F	M		F	M	
Mutonguni	3.5	1.4	4.9	26.0	22.5	58.5	10	18	28	0	0	0
Kitui Central	3.2	1.3	4.5	35.5	33.3	68.7	14	20.4	34.4	1	1	2
Matinyani	3.6	2.0	5.6	33.0	32.3	69.3	15	20.2	35.2	0	1	1
Chyuluni	2.7	2.0	4.7	22.3	22.0	54.4	10	17	27	0	1	1
Total Mean			4.925			62.475			31.15			2.0

Though men had a higher literacy levels with secondary education level in all the study sites with 18%, 34.4%, 35.2% and 27% in Mutonguni, Kitui Central Matinyani and Chyuluni respectively, their participation in the study as respondents was noted to below at (15%) and women at (85%) due to outmigration from home in search of alternative livelihoods mainly in major urban areas.. Absence home denies those opportunities participate in information and dissemination activities like trainings where most of the technologies are disseminated thus have to rely on second hand information. Hence, the lack of necessary information on benefits of improved bioenergy technologies, thus the men are less willing to investment on technologies they know very little about.

On the other hand, though women are available, their low literacy levels compared to men as women formed majority (75%) of those with little or no education at all., affects their active participation in information dissemination such as trainings and use of extension materials. It also affects their knowledge level and understanding of the technologies, the benefits accrued from using them in their production and on their health. In a related study according to Kiptot, *et al* (2014), it was reported that only 15% of extension agents disseminating information on agricultural technologies are women while only 5% of the women receive extension services in Africa. Men with higher literacy level, are in a better position to participate in the information dissemination activities, however their continued absence from home and villages most of the times, leaves a gap for information in most households. With lack of information and skills, women are unlikely to adopt technologies they know and understand little about and this affects adoption and continued use of biomass energy conservation technologies even when issued free through developmental programmes.Biases in land tenure systems and resource ownership land ownership, tree and land tenure systems are among factors noted to hinder technology adoption in the study area. From the results, while most of the land is private and public owned at 72.4% and 25.7%, respectively (Figure 5), Over 80% of the private land is registered in men's name except where land was jointly bought by both man and the wife or woman inherited from parents

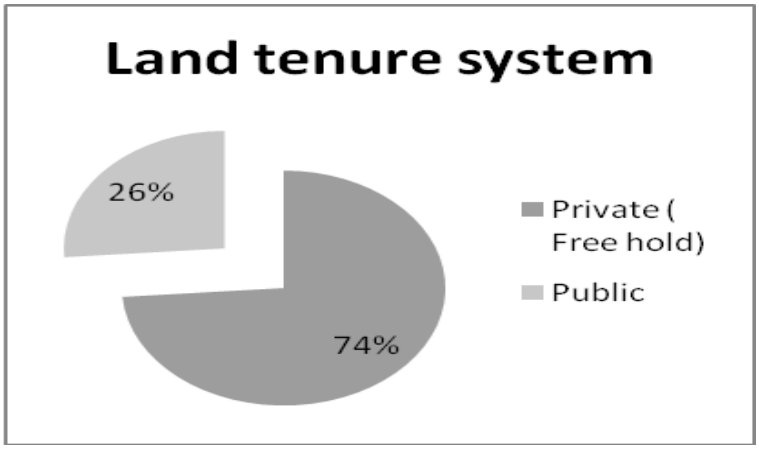

Figure 5: Land tenure system in the study area.

While the current Kenya constitution (2010) allows women to inherit and own family land, silent cultural laws favors men in the registration of family land. Under the Kenyan law, the private or freehold gives the holder of the title deed unconditional ownership of the land without any limitations regarding use or occupation (Kanyinga *et al.,* 2008). Though women have "free access" to land, most of the land is registered under men's names and is absolutely under their control. This gives them absolute authority to make decisions concerning any development on the farm, especially long term investment decision like tree planting or installation of energy conservation technology like a masonry kiln.

Men and women are more likely to make sound environmental decisions when they have secure ownership of resources and know they can benefit. It is important to note that land ownership and decision making are preserve of men and affects any decision on any permanent development on the land. The issue of land / resource ownership affects adoption of any new technology on the farm even though beneficial to the whole family. In a study undertaken western Kenya, it was noted that men will invest in forestry technologies which meet their social economic needs other than for the whole family. For example plant fast growing eucalyptus trees species for sale to pulp and paper, poles and posts or timber industry. However, despite the contribution women make in tending the trees, accessibility by women to the tree resources especially for energy purposes is only limited to by-products of "men's" trees i.e. small branches and twigs after the tree has matured and harvested for other purposes (Kiptot *et al.,* 2011). The issue of land and adoption of new technologies becomes even more complicated and a major hindrance to adoption of technologies when land belongs to extended families. These discourages

activities like establishment of woodlots as trees are considered a long term investment hence no members of the family or community are willing to invest on land or put up permanent development or installations on land which might be re-allocated to other family member's later on subdivision and thus loss of their investment.

Implications to Research and Practice

There is need to understand that gender is a developmnental issue and that the role of men and women are determined by legislation, religious norms, economic status of the people , cultural norms of the commuity and the types of production activities in the society. Empowered men and women are in better position to contribute positively to productivity of the entire society and for good prospects of the future generation. Rigid gender norms and outdated cultural values, may affect negatively full participation of the marginalized gender in development issues. This may bring long-lasting connsequences especially to women leading to depression, lack of confidence, poor performance which may affect research or project results. Research in developmnt studies shows that diversity including gender can enhance the scientific quality and social relevance of the reserch work. Therefore, there is need for concerted efforts to eradicate outdated cultural practices and norms which discrimate against the marginalized gender in the community. There is also need to create awareness and mainstream gender equality on all research and developmnt sectors.

CONCLUSIONS

The study concludes that adoption of biomass energy conservation technologies that have the potential for improved livelihoods and environmental conservation can be upscaled; however gender related constraints affecting women, which hinder adoption and continued use of available technologies, need to be addressed. These includes; financial constraints among women due to overdependence on subsistence agriculture in the face of changing climatimatical conditons, lack of alternative source of incomes, low illiteracy levels compared to men, lack of inclusive decision making at family and community levels and biases in land tenure and resource ownership systems which favor men especially in the cultural setups. Addressing gender related challenges affecting women and men, translates to increased adoption and use of the energy conservation technologies.The study therefore recommends; Government institutions and development partners to mainstream gender aspects and awareness in community development matters to ensure participation of all members of the community. This will ensure both men and

women participate in development related matters such as community trainings that will empower them to acquire knowledge and skills related to new technolgies.It will also enable them participate in decisions making on matters touching on activities and technologies which directly influence their lives. In order to uplift poor rural women, there is need also to provide alternative income generating activities which are climate change resilient, so that women can stop relying on subsistence farming as source of livelihood for increased adoption of new technologies..

Future Research

The following areas in Gender and developmnt are potential reserch gaps to be addressed ;- Gender issues influencing success and failure of developmental projects in Kenya.; The role of ICT in brigding the gender gap in information dissemination for rural developmnt,; The role of men and women in development of gender friendly policies and legislative frameworks that influence their participation in development activities.

References

Benson Mburu Kamau, James Biu Kung'u, John Njagi Muriuki, (2015). *Climate change adaptation strategies by small-scale farmers in Yatta District, Kenya*. African Journal of Environmental Science and Technology Vol. 9(9), pp. 712-722, September, 2015

Evelyne Kiptot, Steven Franzel and Ann Degrande (2014 Gender, agro forestry and food security in Africa. Science Direct

FAO (Yianna Lambrou and Grazia Piana, 2006). E*nergy and Gender issues in rural sustainable development*, Rome, Italy. (pp 46)

FAO, (2010). Forestry Paper 162. *What wood fuel can do to mitigate climate change?* (pp 98)

Githiomi J.K Oduor N. (2012). *Strategies for Sustainable Wood fuel Production in Kenya*. International Journal of Applied Science and Technology Vol. 2 No.10; (pp18-25)

GoK (2014). *Kitui County integrated development plan 2018- 2022). County Government of Kitui*. (pp 2-18)

IEA (2014). *Africa Energy outlook: A focus on Energy Prospecting in Sub-Saharan Africa* (pp 20-76)

IDRC (2006) *Social and Gender Analysis in Natural Resource Management (Learning Studies and Lessons from Asia*) -Edited by Ronnie Vernooy

KNBS (2015). *Kitui County Statistical Abstract* (pp76)

KNBS, (2020). *2019 Kenya Population and Housing Census report*. Government printer, Nairobi, Kenya.

Kong'ani, L., Ang'u, C., & Muthama, J. N. (2019). *Adoption of improved cookstoves in the peri-urban areas of Nairobi: Case of Magina area, Kiambu County, Kenya*. Journal of Sustainability, Environment and Peace. 1(1), 19-24.

Kiptot E. and S. Franzel. (2012). *Gender and agro forestry in Africa; A review of women's participation*. Springer Science, Nairobi Kenya. 82 (1) pp 35-58

Mugure, A., Oino, P. G., & Sorre, B. M. (2013b). *Land Ownership and its Impact on Adoption of Agroforestry Practices among Rural Households in Kenya*: A Case of Busia County. International Journal of Innovation and Applied Studies, 4, 552-559.

Muok, B.O, Kamene J, Kemmonchi, Ali. A. (1997). *Socio-economic and resource survey of Kitui district. SOFEM Project report.* KEFRI. (pp 128)

Namaswa, W. T., Mbego, J., Muisu, F., & Mandila B. (2016a). *Firewood Accessibility among Rural and Urban Households in Trans-Nzoia and West-Pokot Counties, Kenya*. Int. Res. J. Environment Sci. 5(5), 1-11

Röder, M., Chong, K., & Thornley, P. (2022). *The future of residue-based bioenergy for industrial use in Sub-Saharan Africa. Biomass and Bioenergy*, 159: 106385

UN Women watch (2009). *Gender Equality and Empowerment of Women* (Fact sheet)

WHO, (2014). *Health statistics, WHO Report*. (pp 180)

WHO/UNDP. (2009) Energy access situation in developing Countries - Review focusing on least developed countries and sub-Saharan Africa (14-16) Washington D.C

World Bio energy Association (WBA) (2016). Clean and Efficient bioenergy cook stoves. Accessed through - www.worldbioenergy.org

World Bio-energy Association. (WBA) 2017. *Global bio energy statistics.* http://worldbioenergy.org/uploads/WBA.pd