Hindrances to Adoption of Biomass Briquettes Technology as a Climate Change Mitigation Measure- Case Study of Maasai-Mau Forest adjacent Community, Kenya

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Abstract: - Climate change impacts on social, economic and political system cannot be understated. This paper outlines hindrances of briquettes uptake, anchored in socio economic factors. Briquettes are eco-friendly biomass green technology that reduces CO_2 emissions a milestone towards climate change mitigation. High demand for wood products to meet the demand for energy supply in the Maasai-Mau region has seen the depletion of the forest cover thus increasing carbon dioxide emission and other greenhouse gases into the atmosphere. The main objective of this study was to assess hindrances to the adoption of briquettes technology as an alternative source of energy on mitigation measure to climate change in the Maasai-Mau region. The study employed an exploratory survey to collect information on demographics of adults in each homestead, sources of energy and economic livelihood. Data results were analyzed through Excel and Statistical Package of Social Sciences. From the results, the hypothesis was tested by Chi-square (χ^2). The null hypothesis of a relatively low level of education hinders the adoption of biomass briquette was accepted, where (χ^2=9.866, DF=6, P=0.13). From the findings, the study concluded that lack of awareness of the briquetting technology and benefits, was the primary hindrance to the adoption of biomass briquettes technology in mitigating climate change in the study area.

Keywords: Adoption of Biomass Briquettes Technology; Alternative sources of energy; Climate Change mitigation.

1. Introduction

Climate Change is majorly caused by increased heat-trapping gases known as greenhouse gases in the atmosphere [2], [7]. According to the Intergovernmental Panel on Climate Change [25], climate change is any interference to natural climate as a result of natural variability or human-induced over time. On the other hand, United Nations Framework Convention on Climate Change [25], defines it as the change of climate that is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable periods. Climate change impacts are felt worldwide. Kenya too is experiencing these impacts like prolonged droughts, unpredictable weather patterns, and floods during the short rains, decreased yields of the staple foods and water shortage.

In the Maasai-Mau region, impacts of climate change have led to the residents, whose main economic activities include livestock keeping and farming, to encroach into the forests in search of food, feeds for their livestock and clearing of forest resource for charcoal production. This encroachment has led to a reduction of forest cover and increased human-wildlife conflict, as the region is home to the Maasai-Mara game reserve and the Mau Forest [14], [19]. One of the mitigation measures of climate change in the region is the adoption of biomass briquettes as alternative source of energy, which reduces dependency on forest wood as the main source of energy. According to [28], briquette production in Africa facilitates reduction of environmental degradation as the main source of biomass energy [10]. Although adoption of biomass briquette is one of the best climate change mitigation measures, residents face various hindrances affecting 100% uptake of this source of energy as alternative energy to charcoal, firewood, liquefied petroleum gas among other sources [11], [6].

The continued use of wood fuel has led to forest destruction that generates global calamities such as climate change and global warming. Kenya's energy use is not different from that of the world, where wood fuel accounts for 70% of the source of energy, petroleum products 21% and electricity and other sources 9% [23]. This shows how the current 6% forest cover is under the enormous pressure of degradation in the coming years [11]. According to research studies done by [2], Kenya produces 1.61 million tons of charcoal, and

the value is increasing at an alarming rate. According to UN-Habitat, 2013, 680 tons of charcoal is produced per day, of which 112 tons are consumed in Nairobi; 70tons are thrown away as charcoal dust. A study by [16], showed that the annual per capita of charcoal consumption in Kenya is 150kgs translating to 2.4 million tons, while the supply falls short with a difference of 11% from 1980 to 2000 period. Due to the impacts associated with dependency on wood fuel, this study sort to understand the hindrances the residents of Maasai-Mau region, Narok County, Kenya face when adopting the biomass briquettes technology. Even with the available studies done on the benefits of biomass briquettes to wood fuel like charcoal and firewood, the rate of adopting their usage at household level is minimal.

1.1. What is Biomass Briquette and briquette making process

A biomass briquette is a compressed solid unit that goes through the briquette making process [24]. The solid unit, is used as alternative fuel for charcoal, firewood, electricity and petroleum product usages in the households [9]. The briquette making process has five basic processes namely: combustion, anaerobic digestion, fermentation, gasification and pyrolysis the end product is biomass which can be converted into electricity or heat [26]. The named processes involve three important stages for a briquettes to be made, that is; milling stage where the raw material are cut into smaller particles, carbonation stage where the collected biomass is converted to char through slow burning in low oxygen, then the char is mixed with binders and fed into the briquetting machine before they are dried and transported for usage [12].

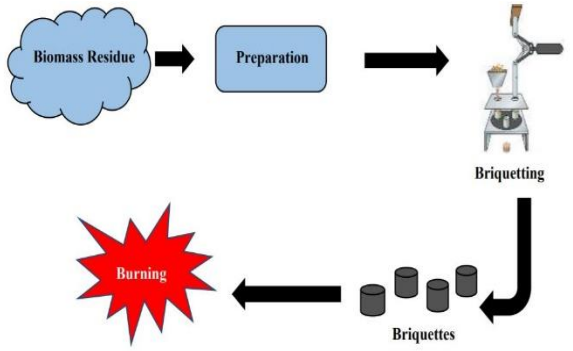

Fig. 1 Biomass briquette making process (adapted from [3])

The source of material for the biomass briquettes is the agricultural residues and the municipal waste residue [5], but the experts recommend use of agricultural residues to avoid the use of materials that may pose health risk to the human health. To get a compact biomass briquette solid, the right ratio of briquette making material to binders should be applied. There are various binders recommended by [1] to be used namely;

molasses, potato peelings, clay soil, corn flour and paper pulp. A review by [9] found out that for high calorific value and minimal ash content, the right agricultural residue to binders should be 70:30 and the moisture content of the final compacted solid should be 11% to minimize the drying period and ensure efficient burning or high calorific value [3], [18].

1.2. Benefits of adoption of Biomass Briquettes to the households

There are many biomass wastes available in Kenya that includes coffee husks, maize stalks, rice husks, maize cobs, sisal fibers among others. The biomass waste can be turned into briquettes so as to provide an alternative, sustainable energy and curb forest degradation [12]. The briquettes burn with less smoke and have been proven to burn up to 98% efficiency if the stove is energy-saving one and up to 76% if the stove is not an improved stove [26]. This is a higher efficiency as compared to charcoal and firewood that have an efficiency range of between 60-68%. They produce a low ash content because they only burn by 5% less of their original weight [23]. Moreover, they are odorless as they contain a minimum evaporative gaseous substance. They leave no soot on pots and reduce household air pollution with carbon monoxide and fine particulate [27]. The briquettes are cheaper when cooking traditional meals like dry maize and beans, where it costs Ksh 3 (equivalent of 0.028 USD) to prepare a meal for a family of three as opposed to the usual cost of the smallest locally available charcoal tin at Ksh 26-50 (0.24-0.46 USD) [24]. According to a study conducted by [8], the biomass briquettes burns with 75% efficiency and that 3 kgs of briquettes replaces 1 liter of diesel usage in the commercial industries. This translates to reduced emissions of greenhouse gases, thus contributing positively to climate change mitigation.

1.3. Challenges of Biomass Briquette Adoption in Africa

Briquette making projects from Africa has been in single trials that later failed to take off due to lack of funding, stakeholder involvement, and lack of aggressive awareness campaigns on the continent [4]. Other reasons for failure include high machine maintenance, poor planning of the projects, and lack of trained experts to drive community briquette adoption [17]. According to [15], several briquettes doing projects have been implemented in Kenya with sawdust and coffee husks as the primary raw materials. The projects failed to

take off due to early donor withdrawal leaving the projects with no funds to sustain themselves. The few projects that have taken off has seen local forest covers being conserved, with 80% non-dependency on wood fuel noted [17].

1.4. Adoption of Biomass Briquette Technology in Mitigating Climate Change

Climate change mitigation is an important step towards meeting the future generation's energy demand [11]. [13]. Biomass briquettes adoption, as other clean energy sources, has several benefits. Biomass briquettes adoption reduces greenhouse gas emissions and reduces air pollution that is associated with other energy sources like coal, charcoal, and use of fossil fuel in the industries. A study that was done by [12], found out that there was a reduction of 14% of emissions in 33 European countries that adopted biogas energy in the period 1990 to 2010. This initiative had a positive result in Turkey's forest cover. Biomass briquettes being one of the clean sources of energy, like biogas, are projected to have a similar impact if adopted.

2. Methodology

A mixed method research design was conducted and information on demographics of adults in each homestead, sources of energy and economic livelihood collected. The use of a stratified sampling technique was used to stratify the area into six residential blocks as per administrative sub-locations and major villages. Cluster and simple random sampling were used to select the ward used in the study. Urban and suburban areas were grouped to form a cluster. For urban and sub-urban cluster, purposive random sampling was employed to collect information from it as per the study carried out by [2], states that urban centers are the highest consumer of wood-fuel energy. Also, purposive random sampling techniques were used to collect data from key informants found within the study area.

3. Results Findings

Table 1 below shows the hindrance to the adoption of biomass briquette technology in the Maasai-Mau region, Narok County, Kenya. From the table, six statements were sampled and the respondents' perceptions were determined by the magnitude of the response with 4 being the highest hindrance, 3 for moderate hindrance, 2 for slight hindrance and 1 for least hindrance. From a total weight of 374.33, lack of briquette making skills with 76.92% and 20.51%, for highest hindrance and moderate hindrance respectively. From a total weight of 369.03,

lack of awareness with 82.05% and 10.26% for highest and moderate hindrance respectively. Education level was the third-rated with a total weight of 330.77, where 61.54% of the respondents agreed that it was the highest hindrance. The respondents agreed that poverty, briquette availability and stereotype to briquette making materials were not the highest hindrances with analysis of the respondents magnitude of their response highest hindrance, moderate hindrance, slight hindrance and least hindrance as per the total weight of 317.93 (43.59%), 307.69 (38.46%) and 276.93 (23.08%) respectively. From the table 76.92% with a total weight of 374.33 (n=30), ascertained that briquette making skills was the highest hindrance proliferating the rate of biomass briquette adoption further.

These findings agree with a study done by [11] that reveals that level of awareness affected the uptake of briquette making technology in Ruiru in Kiambu County, Kenya, with 70% of the respondents saying they were not aware of the briquette usage, benefits and briquette making technics, thus hindrering the adoption of this clean source of enrgy as an alternative to wood fuels like charcoal and firewood in that county. Also, a study by [17], agrees that most consumers, 78%, lacked knowledge of briquette making and were confused between a briquette and charcoal. Further, Sub-Saharan African is biomass dependent with approximately 75% of the population rely on charcoal and wood fuel as sources of energy in households. The choking carbon pollution endangers mothers and children that are exposed to higher carbon levels [14], [21].

Table 1: Sources of hindrances to adoption of biomass briquette technology in Maasai-Mau region

Hindrance to adoption										
	4		3		2		1			T.W
	n	%	n	%	n	%	n	%	%	
Lack of briquette making skills	30	76.92	8	20.51	1	2.56	0	0.00	100	374.33
Lack of awareness	32	82.05	4	10.26	1	2.56	2	5.13	100	369.03
Education level	24	61.54	8	20.51	2	5.13	5	12.82	100	330.77
Poverty	17	43.59	13	33.33	8	20.51	1	2.56	100	317.93
Briquette availability	15	38.46	14	35.90	8	20.51	2	5.13	100	307.69
Stereotype to	9	23.08	17	43.59	8	20.51	5	12.82	100	276.93

briquette making materials										

Ho: Relatively low education is the primary hindrance to the adoption of biomass briquettes as alternative energy in Maasai-Mau region

The below descriptive statistics were used to investigate the *Ho* that relatively low education is the primary hindrance to the adoption of biomass briquettes as alternative energy in the Maasai-Mau region. From table 2 below, a cross-tabulation of education level and briquette usage in Maasai-Mau region, Narok County, Kenya was tested on the SPSS and the result represented as per table 2 below.

	How often do you use briquette in								Total	
	Daily		Once a week		Once a month		More than three months			
	n	%	n	%	n	%	n	%	n	%
Tertiary/ University	11	33.3	9	27.3	9	27.3	4	12.1	33	100
Secondary	7	21.9	6	18.8	12	37.5	7	21.9	32	100
Primary	13	37.1	12	34.3	3	8.6	7	20	35	100

From the descriptive statistics above, the study found out that only 33.3% (n=11) of the educated respondents used the biomass briquette in their households daily as opposed to 37.1% (n=13) of the respondents considered to have relatively low level of education. Among the educated respondents who use the biomass briquettes at least once a week as per the study were 27.3% (n=9) as opposed to 34.3% (n=12) of the respondents considered to have relatively low level of education.

Table 2: The chi-squared results

Chi-Square Tests

	Value	Degrees of freedom	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.866[a]	6	.130
Likelihood Ratio	10.830	6	.094
Linear-by-Linear Association	.082	1	.775

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.76.

After performing the chi-square test; table 2 above, it was revealed that the p-value was 0.13. The table 2 shows a chi-square test at DF 6 and the critical chi-square χ^2 9.866=0.13 at 0.05 level of significance. Since the p-value 0.13 is greater than the significance level 0.05, there is strong statistical evidence to accept the null hypothesis. Thus, we can conclude with some confidence (95%) that relatively low level of education hinders the adoption of biomass briquette as alternative energy in the Maasai-Mau region.

4. Conclusion

According to the World Health Organization, use of wood fuel (charcoal and firewood) constitutes to the global environmental health risks [5], [21] that accounts of over 4 million annual deaths related to use of types of fuel that cause indoor pollution [20]. Poor indoor air is the cause of several household related illness such as legionnaires' disease [16]. In Kenya, wood fuel pollution from charcoal and firewood directly impact 77% of the pollution of which 15,600 people die annually due to the indoor related diseases in Kenya. The pollution mostly affect the women and children in the rural areas [22]. Adoption of the biomass briquette will have positive impact in reducing the emissions of greenhouse gases. According to inter-governmental panel on climate change (IPCC) tropical forests store 50% of the total carbon in the atmosphere [25]. This implies that if the current state of wood fuel dependency continues, these greenhouse gases will be released into the atmosphere worsening the climate change impacts like prolonged dry seasons, droughts and floods. Adopting of biomass briquettes will conserve the natural carbon sinks like the natural forests thus contributing towards the climate change mitigation.

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Conflict of interest

This paper doesn't ascertain conflict of interest from any party.

Reference

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