What are the Factors Influencing Livelihoods Diversification and Afforestation in the Upper Tana Catchment Area of Kenya?

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ABSTRACT

Kenya is considered to be a low forest country with a forest cover that is lower than the internationally accepted threshold. Deforestation in the country's water towers is estimated at 50,000 hectares annually, with a consequent yearly loss of over USD 19 million. Surprisingly, Kenya's tree cover, which was 1.7% in 2013 is now at 7.2% (KFS,2016). This study assessed the factors influencing afforestation in Upper Tana catchment area (Case study of Embu and Kirinyaga Counties) and the contributions of the Upper Tana Natural Resources Management Project (UTaNRMP) to livelihoods and environmental sustainability.

Quantitative and qualitative research methods were adopted for the study. The representative sample of 421 households were randomly selected and interviewed with the aid of a well-structured questionnaire. Focused group discussions and key informant interviews were also conducted. Data was analyzed using descriptive and inferential statistics, including chi square.

Results revealed that afforestation in the catchment area has improved and the presence of Community Forest Associations (CFAs) has led to increase in forest cover in most of the forests as areas initially degraded have been rehabilitated and there has been enhanced species regeneration for instance the New Njukiri CFA in Embu West, Kirimari Ward, has planted 150,000 tree seedlings, 75% exotic and 25% indigenous tree species in 2 years (2015-2017) with an average survival rate of 75% while the Kangaita Community Forest Users Association has rehabilitated 55 hectares of the Kangaita Forest in Kirinyaga County. The Upper Tana NRM Project has led to improvement in the level of mutual accountability, conservation awareness and learning. Communities have embraced new sources of income like ecotourism, beekeeping and Plantation Establishment and Livelihood Scheme (PELIS) which has helped in increasing forest cover as well as improving food security.

St. Ursula Boarding Primary School, St. Anne Kiriari Secondary School and Ngubiu Boys have received bio digesters and biogas respectively and the Chairman of Upper Rupingazi Water Resources Users Association (WRUA) admitted the community has been given over 600 energy efficient stoves that saves time and do not emit smoke. The study revealed improved income as the average household monthly income was over 20,000Ksh compared to the range of 833-26,667 Kshs per month in 2012. Similarly, the average household meal per day is 3 meals and 81.7% of the households indicated no hunger in the last 1 month. Results also revealed that social and economic factors significantly influenced livelihoods diversification and afforestation in the catchment area.

Overall, the UTaNRMP has contributed significantly to livelihoods diversification, increased level of afforestation, enhanced community-based mutually accountability and learning as well as ensured environmental sustainability. However, there is the need to put in place a sustainable natural resources management framework for enhancing a sustainable balance in afforestation and livelihoods in Kenya.

Keywords*:* Climate change, Agricultural livelihoods, Afforestation, Adaptation, Environmental sustainability.

INTRODUCTION

The sustainability of human beings depends on the proper use of inevitable environmental capital such as soil, water, and vegetation (Keesstra et al., 2016). Forests play an important role in the environment for the provision of necessities of life, and habitat that ensures that benefits are obtained from forest ecosystem goods and services. An estimated 2.4 billion people worldwide benefit from agroforestry systems across one billion hectares and depend on wood energy for cooking and heating.

According to FAO (2018), Forests and trees store carbon, which helps mitigate the impacts of climate change. The total area covered by forests globally is approximately 3866 million ha, almost one-third of the world's land area, of which 95% is natural forest and 5% is planted forest. Tropical forest covers 814 million ha, and 110 million ha is located in Africa, 168 million ha in Asia and the Pacific, and 536 million ha in Latin America. On the contrary, only 25 million ha and 11 million ha of tropical forests are exploited in a sustainable way and conserved with an effective political protection in turn. All the tropical humid forests in Africa suffer from a massive deforestation (Soury, 2007).

Forest are areas of at least 0.5 ha with tree crown cover of more than 10%. They are designated as protected areas which host game parks and forest reserves (FAO 2001b). They make tangible contributions to the national economy by supplying renewable sources of energy in the form of wood fuel and charcoal. According to Aguilai et al., 2012, Afforestation applies to areas that have not been forested for at least 50 years while reforestation applies to land that used to be forested but was turned over to another land use.

Afforestation activities present a specific importance that reduces the negative effects of the torrential rainfall through main components such as the canopy of trees, the vegetation, litter, specific forest soil, loose and powerful high- capacity drainage systems due root development (Miță and Mătreață, 2005).

Currently, there is a global problem because the annual rate of global deforestation is over 13 million hectares, most of which occurs in the developing world. Forest loss in Africa is particularly troubling, two-thirds of the continent's population depends on forest resources for income and food and 90% of Africans use fuel wood and charcoal as sources of energy. Despite, or perhaps because of this dependence on forest resources and non-timber forest products, deforestation in Africa is estimated at about 3.4 million hectares/year (CIFOR, 2005; FAO, 2010). Most forest loss is taking place in countries with relatively large forest area. To date, conversion to small-scale permanent agriculture has been the main contribution to forest loss, but investment in large-scale agriculture could become a major driver of deforestation in the future.

Kenya has approximately 1.42 million hectares of closed canopy forest and it is considered to be a low forest country with a forest cover of 7.2% which is significantly lower than the internationally accepted threshold of 10%. Forests in Kenya can be classified into six broad categories: The High Volcanic Mountains and High Ranges, the Western Plateau, the Dry Northern Mountains, the Southern Hills, the Coastal Forest, and the Riverine Forest. The country's forests are estimated to contribute to 3.6% of Kenya's GDP (NFP, 2014), excluding charcoal and direct subsistence uses. There are currently approximately 165,000 hectares of plantation forestry in Kenya, which are generally poorly managed even though between 2005 and 2010, the Kenya Forestry Research Institute (KEFRI) increased tree seed production by 25% (KSIF, 2016). According to National Forest Policy (2014), Deforestation in Kenya's water towers is estimated at 50,000 hectares annually, with a consequent yearly loss to the economy of over USD 19 million.

The value of Kenya's Forests of being a finite, significant economic resource that should be well managed cannot be overemphasized to achieve Kenya's vision 2030 of effective use of the land to achieve socio-economic and political development and increased forest cover from 7.2% to 10% coverage under a protected area system. Forested catchment supplies 75% of all freshwater for farms, industry and homes while the Upper Tana Catchment Area of Kenya provides water and supplies hydroelectric power to the population.

In 2012, the Upper Tana Natural Resources Management Project an eight-year project started with a rationale based on the link between rural poverty and ecosystem health in a densely populated and environmentally fragile watershed of critical national and global significance. It was noticed that the high

prevalence of rural poverty contributes to environmental degradation which in turn reduces sustainable livelihood opportunities; as well as creates negative environmental externalities which includes forest degradation, human-wildlife conflict, encroachment in water sources and reduced availability and quality of water to downstream users. The project thus recognizes a need to arrest the rapid loss of the life-supporting functions of the Tana River ecosystem due to forest degradation, inappropriate agricultural practices, and overgrazing.

The UTaNRMP aligns with IFAD's goal of empowering rural women and men to achieve higher incomes and improved food security and Kenya's Vision 2030 blueprint which aims at creating a "globally competitive and prosperous country with a high quality of life by 2030" thus transforming Kenya into "a newly–industrializing, middle–income country that would provide a high quality of life to all its citizens in a clean and secure environment.

OBJECTIVES OF THE STUDY

The study aimed at determining the factors influencing afforestation in the study area of Embu and Kirinyaga Counties with specific reference to:

- Assessing whether Improved Efficiency in Energy Use is related to increased Afforestation in the study area
- Examining the level of Awareness on Sustainable Environment Management in the study area
- Assessing whether Improved Community Incomes is related to increased Afforestation in the study area
- Identifying the major factors influencing Afforestation in the study area

CONCEPTUAL FRAMEWORK

The perception of afforestation as well as the factors that affect and determine the participation and engagement in afforestation activities are explained in Fig. 1. The factors stated in Fig 1 include; government policies and strategies, better efficiency in energy use in the household, using improved cooking appliances and increased Green Energy sources, environmental conditions, the effect of diseases and pests on trees and seedlings reduces the survival rate of trees and consequently affects afforestation More so, increased community awareness on environmental management will increase the likelihood of engagement in tree planting, nursery management and other forest related activities. It is also noted that community group awareness and engagement is very important for increased tree cover in a community.

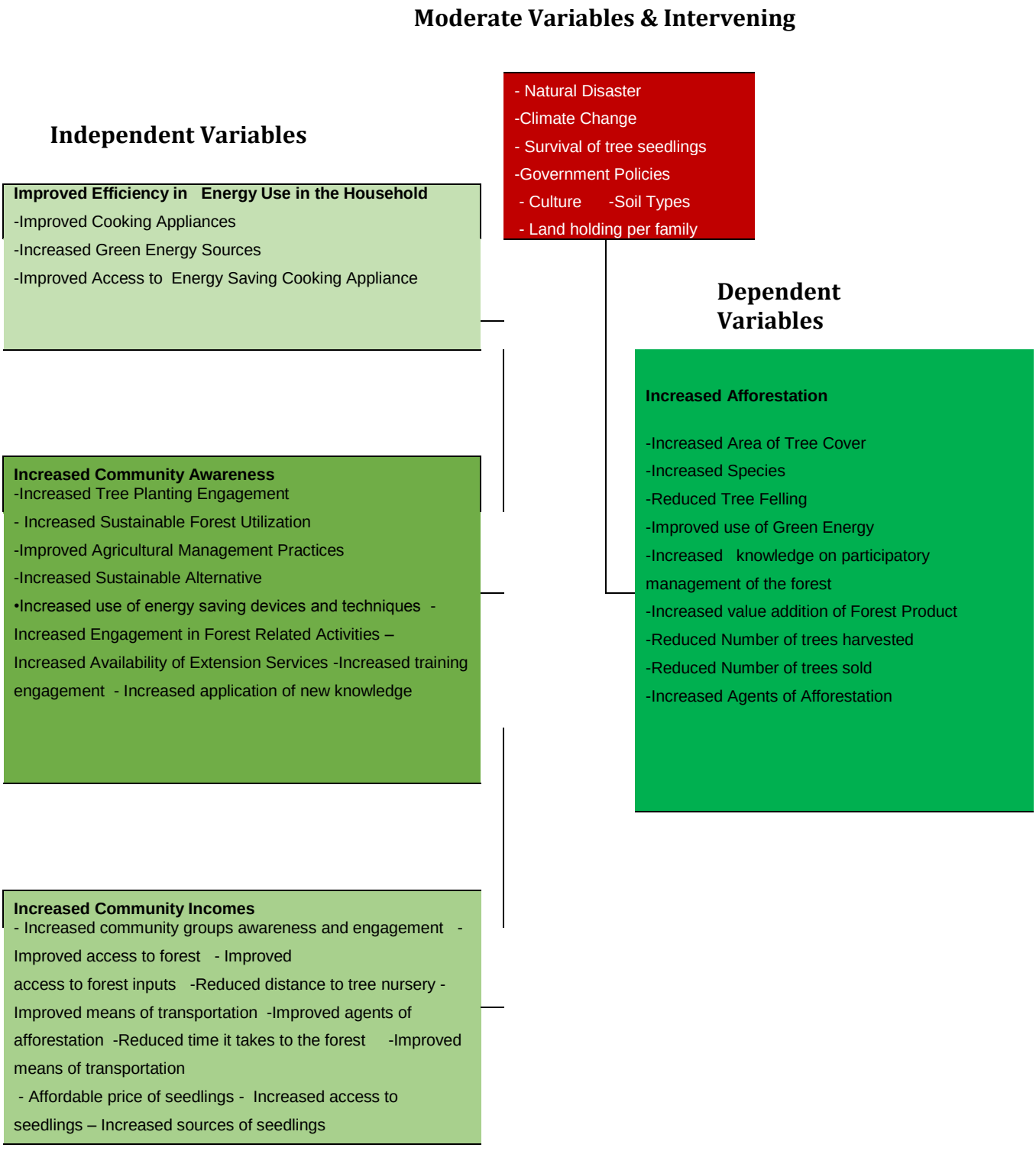


Fig 1: **OPERATIONAL CONCEPT OF DETERMINANTS OF AFFORESTATION**

Source: **Authors Compilation, (2018)**

MATERIALS AND METHODS

This study was carried out in Embu and Kirinyaga counties of the Upper Tana Catchment Area of Kenya which consists of 25% of Kenya's gazetted forests. The catchment area covers an area of 17,420 km2 and includes 24 river basins and the tributaries of four river basins under the former Mt. Kenya East pilot Project (MKEPP) that drain into the Tana River. The River basins crisscross three ecological zones summarized as Tea, Coffee, and Cotton production areas. The catchment area covers the six counties of Murang'a, Nyeri, Kirinyaga, Embu, Tharaka-Nithi and Meru and is home to 5.2 million people. Its temperature is estimated at an average of between 9°C - 28°C and it receives substantial rainfall with average annual precipitation of 1206mm. The wettest season is experienced between March and July while the hottest comes between January and mid- March. The land is largely arable and is well watered by a number of rivers and streams. Agriculture is the main driver of the economy in this catchment with over 70% of the residents being small scale farmers.

Primary and secondary data were used for this survey. The secondary data were collected from journals reports, newsletters, UTaNRMP base-line surveys, interview reports, published research works, internet and books. The primary data was collected through key informant interviews, focus group discussions, individual household respondent interviews, questionnaires and observations and a mixed-method evaluation design, quantitative and qualitative data collection methods was adopted.

Questionnaires were administered through enumerators after the objectives of the survey had been properly explained and they were properly trained on how the questions should be answered. Testing of survey instruments was carried out in the survey areas after which the responses were reviewed and necessary correction were made to the instruments. In the interests of comparability, some baseline questions relevant to the present were kept, although additional ones were added.

Meetings with household respondents and other stakeholders in the study area were facilitated by personnel of the UTaNRMP. The focus group discussions and interviews with members of the Water Resource Users Associations and Community Forest Associations were well guided and structured.

Stratified random sampling was employed to select the households to be interviewed. The target population of the project area (Embu and Kirinyaga) was stratified along the river basins in the area constituting the first stratum. Each river basin (first tier stratum) was then divided into three sub-strata representing the upper, middle and lower sections of the river basin (second tier stratum).

Since population along the river basin is not equally distributed, and taking into consideration that the upper and lower zones of the river basins were normally less densely populated than the middle zones of the river basin, the sample of each river was then divided in the ratio of 1:2:1 for the upper, middle and lower sections respectively (UTaNRMP Impact Assessment Report, 2017).

The sample size per river basin was then determined proportionately depending on the number of FDAs per river basin. This decision was based on the level of activities by the UTaNRMP in the River basins, cost limitation and time limitation of study.

Embu and Kirinyaga counties were used for this research. The River basins in these counties are as follows:

1. **Embu:** Rupingazi, Kabingazi, Mutonga/Thuci, Thura, Rwanjoga, Gangara, Itimbogo, Itabua/Rupingazi.
2. **Kirinyaga:** Kirwara, Kiwe, Rwamuthabmi, Thiba, Nyamindi, Mugaka

River basins used for this study include:

S/No.	County	River Basin
1	Embu	i. Rupingazi
		ii. Thuci
2	Kirinyaga	i. Nyamindi
		ii. Thiba

S/No.	County	River Basins	Length (Km)	Size	Total No. of FDAs	Proportionate Sample size	Adjusted Sample size	Total
1.	EMBU 516,212 183 sq km	Rupingazi	78	354	4	44	60	135
2.		Thuci		152	5	55	75	
1.	KIRINYAGA 537,054 357 sq km	Nyamindi	78	453	10	110	110	286
2.		Thiba	78	715	15	165	176	
TOTAL					36	374	421	421

Conchran's sample size formula (Conchran, 1977) was used to calculate the sample.

Using the formula:

$$n = \frac{Z^2 P (1-P)}{d^2}$$

Where: n= the sample size

Z= Z statistics for level of confidence

P= expected prevalence or proportion

d= precision

$$n = \frac{(1.96)^2 (0.05)(0.05)}{0.5^2}$$

n= 384 For non- response 10% of n will be add to n = (38+384) = 422

Adjusted Sample Size =421

Data Collected was analyzed using Descriptive Statistics, and Chi Square. Descriptive tools such as, simple frequency distribution and measures of central tendency such as mean and percentage were used to analyses data on age, education status, occupation and marital status and data on afforestation variables such as, access to inputs, price of seedlings, sources of seedlings, means of transportation, farm implements ownership. The Chi-square was used to test for the existence of a relationship between two variables. This was used with nominal and ordinal variables such as awareness level of sustainable environment management and River basin of Respondent. SPSS 20 was used to carry out data analysis.

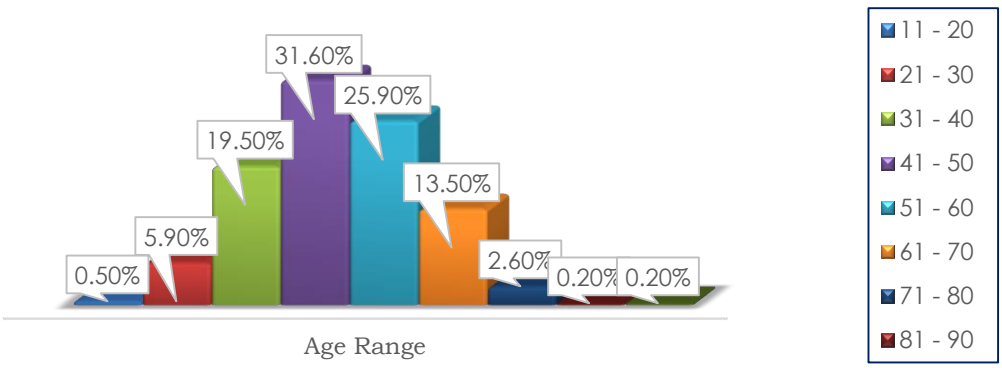
RESULTS AND DISCUSSION

SOCIO-ECONOMIC CHARACTERISTICS AND IMPLICATION

Age Distribution of Respondents

The result in Figure 2 revealed that more than four- fifths (83.4%) of the respondents were between the ages of 11 and 60 years and are considered to be in their economically active years while only few (3%)were aged 71years and above. The average age of the respondents stood at 49.1±12.2 years which implies that the household members are ageing. This could eventually affect their engagement in afforestation activities negatively.

Fig 2: Age distribution of respondents

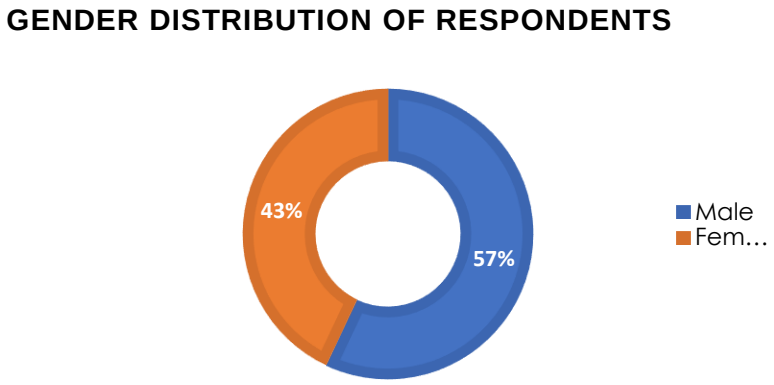


Source: Field Survey, 2018

Gender Distribution of Respondents

Figure 3 shows that over half of the household respondents (57.7%) were males. Based on this result, it can be deduced that out of 10 people engaged in forest related activities in the study area, 7 will be men.

Fig 3: Gender Distribution of Respondents

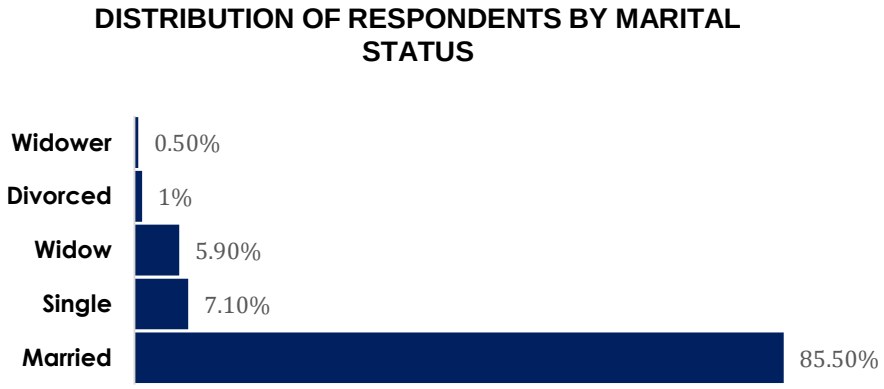


Source: Field Survey, 2018

Distribution of Respondents by Marital Status

With respect to marital status, a greater percentage of the respondents were married (85.5 %), while only about 7.4 % were either single, separated or divorced as shown in Figure 4. In other words, married household constituted the majority in the study area.

Fig 4: Distribution of Respondents by Marital status

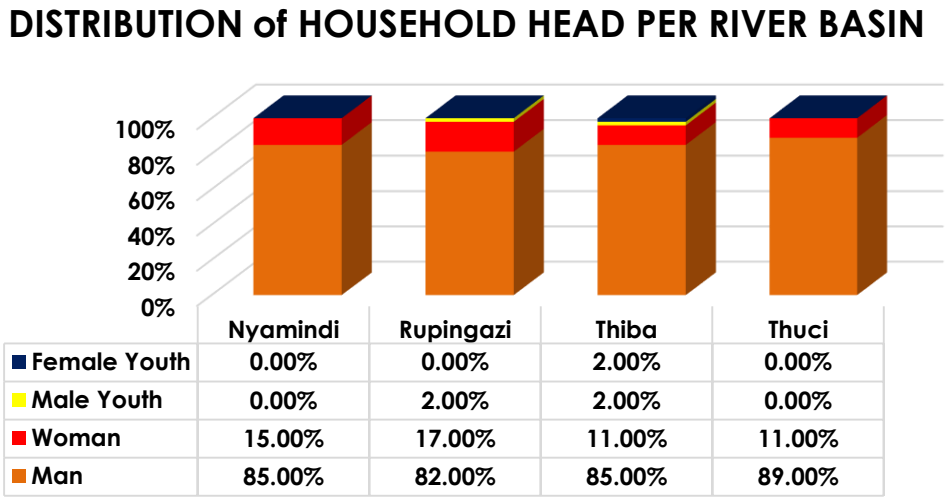


Source: Field Survey, 2018

Distribution of Household Head per River Basin

Majority of households, 89% in Thuci and 85% in Nyamindi as well as Thiba have a man as the head of the household while 17% of the household in Rupingazi are female headed.

Fig 5: Distribution of household head per river basin



Source: Field Survey, 2018

Distribution of Household Members Working per River basin

Table 1 reveals that out of 5 household members in Thiba River basin 3 are not financially contributing to the family thus more cases of inability to afford energy saving jikos, inputs such as tree seedlings, herbicides and pesticides etc and a negative effect on afforestation.

Table 1: DISTRIBUTION OF HOUSEHOLD MEMBERS WORKING PER RIVER BASIN

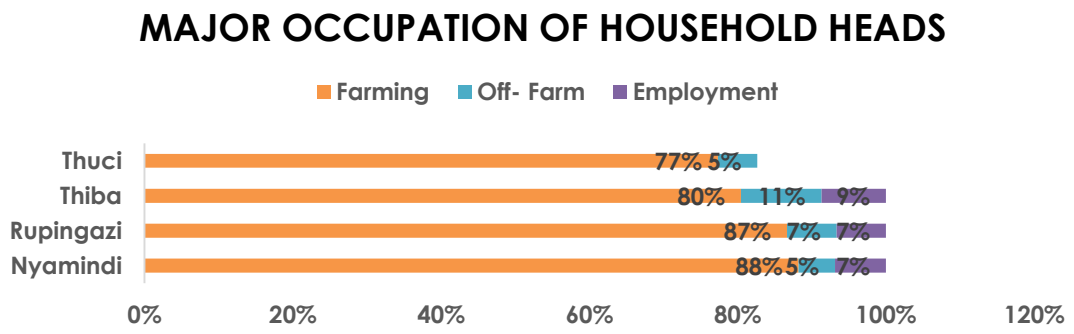
RIVER BASIN	AVERAGE NO OF HOUSEHOLD MEMBERS WORKING	RANGE	AVERAGE NO OF HOUSEHOLD MEMBERS NOT WORKING	RANGE
Nyamindi	2		2	
Rupingazi	3		2	
Thiba	2	**1-11**	3	**0-17**
Thuci	3		3	

Source: Field Survey, 2018

Major Occupation of Household Heads

Figure 6 reveals that the major occupation of household heads in all the River basins is farming. However, Rupingazi has the highest (87%) of household heads engaged in farming and 9% of household heads in Thiba are employed in either government parastatals or private companies.

Fig 6: Major occupation of household heads



Source: Field Survey, 2018

Other Household Socio-Economic Information

Table 2 shows that the average household income in the study area is 20899Ksh monthly thus improved livelihood as the baseline report revealed 26667Ksh as the highest household income in 2012. Also, members are able to afford 3 meals per day even though they own a small portion of land. This survey reveals that most farmers in the survey area are small scale farmers. More so, the larger the size of farm a farmer uses, the higher the production levels are likely to be, and the higher the probability of afforestation.

Table 1: OTHER HOUSEHOLD SOCIO-ECONOMIC INFORMATION

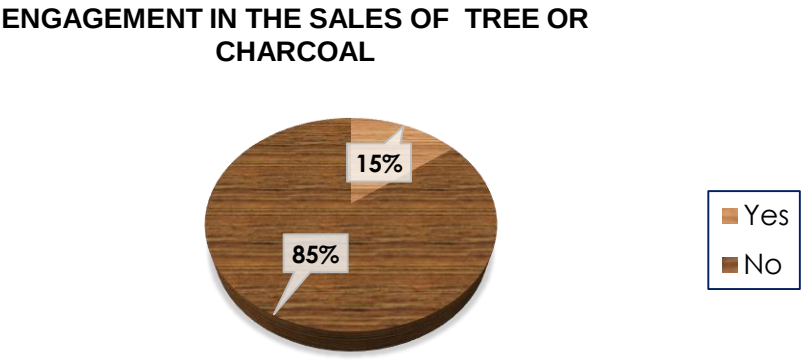
	AVERAGE	RANGE
Household income	20899Ksh	
Meals per Day	**3**	1 - >3
Land Area Owned	**1.65**	0.125 – 22

Source: Field Survey, 2018

Engagement in the Sales of Tree or Charcoal

Figure 7 reveals that only 15% of households in Embu and Kirinyaga Counties are engaged in Charcoal sales thus low level of charcoal use by households in the counties. This indicates reduced cutting of trees for charcoal production in the study area which has a positive effect on afforestation.

Fig 7: Engagement in the sales of tree or charcoal



Source: Field Survey, 2018

RESULTS ON ENERGY USE IN THE HOUSEHOLDS

Cooking Appliances used in Households

Table 3 reveals an average of 69.3% households use three-stone Jiko compared to the Baseline report of 83%. This indicates 16.5% reduction in the use of inefficient energy appliance thus a positive effect on afforestation. In line with this, 20% of households in Thuci use Maendeleo Jiko and 27.7% of households in Thiba use Gas cooker. This should be more encouraged and improved on for improved afforestation. However, 76.6% and 51.6% of households in Rupingazi still use Three-stone Jiko and Normal Charcoal Jiko respectively despite their benefit from energy efficient stoves. This result reveals that there is high prevalence of environmental pollution in Rupingazi which is negative to afforestation.

Table 3: COOKING APPLIANCE USED IN HOUSEHOLD

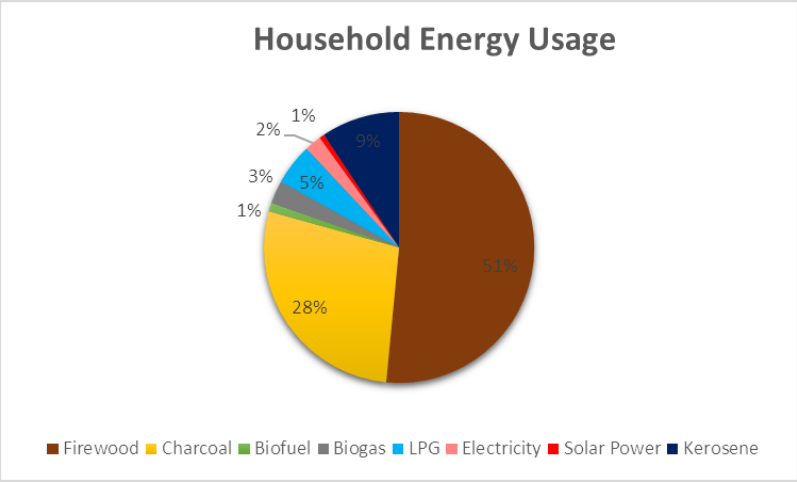
Cooking Appliance	Nyamindi(%)	Rupingazi(%)	Thiba(%)	Thuci(%)
THREE-STONE JIKO	68.6	76.6	55.9	76
NORMAL CHARCOAL JIKO	32.4	51.6	38	46.7
MAENDELEO JIKO	8.8	10	15.2	20
UPESI JIKO	2.9	0	8.2	1.3
JIKO KISASA/KUNI MBILI	18.6	6.7	14.7	5.3
KENYA CERAMIC JIKO	2.9	1.7	2.7	0
ROCKET JIKO	2	3.3	11.4	1.3
UNCLADDED LINER	0	0	0.5	4
KEROSENE STOVE	14.7	6.7	10.3	16
LPG COOKER/MEKO	8.8	8.3	18	18.7
FIRELESS JIKO	1	3.3	2.2	8
PARAFFIN STOVE	10.8	18.3	11.4	14.6
GAS COOKER	14.7	20	27.7	12
ELECTRICITY COOKER	1	0	2.1	2.7

Source: Field Survey, 2018

Household Energy Usage

Figure 8 reveals that 21% of households in Embu and Kirinyaga counties use energy sources other than Firewood and Charcoal. This indicates an improvement in choice of energy sources as 51% household indicated the choice of firewood as a major source of energy in Embu and Kirinyaga compared to the baseline of 77.2% reflecting 33.9% positive change. This implies improved efficient use of energy thus positive effect on afforestation.

Fig 8: Household energy usage

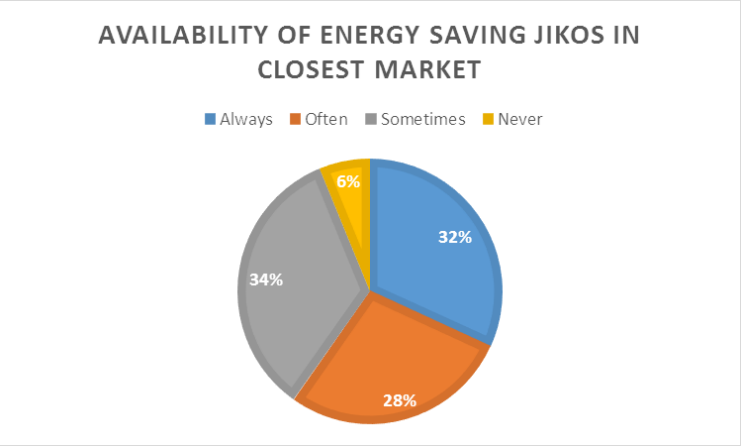


Source: Field Survey, 2018

Availability of Energy Saving Jikos in closest Markets to Households

Figure 9 reveals that over half (52%) of the household members have access to energy saving jikos in the market closest to their houses and only 6% have no access to energy saving jikos. This is positive on Afforestation as increased access to energy efficient stoves could lead to improved afforestation.

Fig 9 Availability of energy-saving jikos in closest market

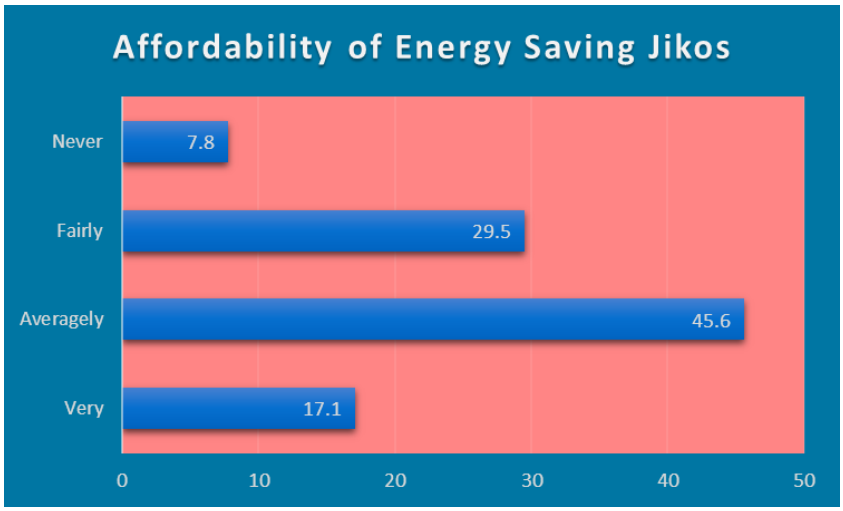


Source: Field Survey, 2018

Affordability of Energy Saving Jikos

Figure 10 reveals that 62.7% of the respondent can averagely and easily afford the energy saving jikos. This implies improved livelihood of respondent thus a positive indicator on increased afforestation as preference of material use changes with time once there is financial capability which could affect afforestation positively

Fig 10: Affordability of energy-saving jikos



Source: Field Survey, 2018

Challenges in the Usage of Energy Saving Jikos

Table 4 reveals that 42% of households in Rupingazi, 38% of households in Nyamindi and Thiba have lack of funds as a major problem in the usage of energy saving jikos even though a minimum of two people are working in a household of 4 in the River basin. 40% of households in Thuci have how level of information on the importance and use of energy saving jikos thus reduced awareness leads to reduced afforestation.

Table 4: CHALLENGES IN THE USAGE OF ENERGY SAVING JIKOS

Challenges in the usage of Energy Saving Jikos	Nyamindi	Rupingazi	Thiba	Thuci
Access to Technology	17%	15%	28%	15%
Lack of Awareness	23%	33%	30%	40%
Inflexible Attitude to New Tech	14%	12%	13%	17%
Lack of Funds	38%	42%	38%	32%
High Cost of Technology	27%	11%	46%	14%
No Technical Know-how	8%	10%	10%	16%
No Tangible Reason	2%	8%	2%	1%

Source: Field Survey, 2018

RESULTS ON AWARENESS OF SUSTAINABLE ENVIRONMENT MANAGEMENT

Level of Awareness on Tree Planting Engagement

Table 5 reveals a significant relationship was established between the Level of awareness of Tree Planting Engagement and the River basin the respondent was situated in, $X^2 = 21.00$ and $p = 0.01$. General level of awareness is gathered to be highest in Nyamindi and seconded by Rupingazi. In the same vein, it was observed that compared to the population size, Thiba had the highest number of respondents unaware of the Tree Planting engagement followed by Rupingazi.

Table 5: LEVEL OF AWARENESS ON TREE PLANTING ENGAGEMENT

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.992[a]	9	.013
Likelihood Ratio	21.535	9	.010
N of Valid Cases	421		

AWARENESS ON TREE PLANTING ENGAGEMENT			Name of River Basin				Total
			Nyamindi	Rupingazi	Thiba	Thuci	
Awareness of Tree Planting Engagement	Very Aware	Count	43	38	94	27	202
		Expected Count	48.9	28.8	88.3	36.0	202.0
		% within Name of River Basin	42.2%	63.3%	51.1%	36.0%	48.0%
	Aware	Count	53	17	80	44	194
		Expected Count	47.0	27.6	84.8	34.6	194.0
		% within Name of River Basin	52.0%	28.3%	43.5%	58.7%	46.1%
	Aware but not interested	Count	4	1	2	3	10
		Expected Count	2.4	1.4	4.4	1.8	10.0
		% within Name of River Basin	3.9%	1.7%	1.1%	4.0%	2.4%
	Not Aware	Count	2	4	8	1	15
		Expected Count	3.6	2.1	6.6	2.7	15.0
		% within Name of River Basin	2.0%	6.7%	4.3%	1.3%	3.6%
Total		Count	102	60	184	75	421
		Expected Count	102.0	60.0	184.0	75.0	421.0
		% within Name of River Basin	100.0%	100.0%	100.0%	100.0%	100.0%

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.223	.013
	Cramer's V	.129	.013
N of Valid Cases		421	

Source: Field Survey, 2018

Awareness of Engagement in Natural Resources Management Training

Table 6 reveals a significant relationship was established between the Level of awareness of Engagement in Natural Resources Management Training and the River basin the respondent was situated in, $X^2 = 27.00$ and $p = 0.01$. Level of awareness on engagement in NRM is gathered to be highest in Thiba and seconded by Thuci. In the same vein, it was observed that Nyamandi had the highest number of respondents unaware of that they should engage in Natural Resources Management Project followed by Rupingazi.

Table 6: AWARENESS OF ENGAGEMENT IN NATURAL RESOURCES MANAGEMENT TRAINING

Awareness of Engagement in Natural Resources Management Training							
			Name of River Basin				Total
			Nyamindi	Rupingazi	Thiba	Thuci	
Awareness of Engagement in Natural Resources Mgt. Training	Very Aware	Count	24	25	62	20	131
		Expected Count	31.7	18.7	57.3	23.3	131.0
		% within Name of River Basin	23.5%	41.7%	33.7%	26.7%	31.1%
	Aware	Count	35	18	85	34	172
		Expected Count	41.7	24.5	75.2	30.6	172.0
		% within Name of River Basin	34.3%	30.0%	46.2%	45.3%	40.9%
	Aware but not interested	Count	17	2	7	7	33
		Expected Count	8.0	4.7	14.4	5.9	33.0
		% within Name of River Basin	16.7%	3.3%	3.8%	9.3%	7.8%
	Not Aware	Count	26	15	30	14	85
		Expected Count	20.6	12.1	37.1	15.1	85.0
		% within Name of River Basin	25.5%	25.0%	16.3%	18.7%	20.2%
Total		Count	102	60	184	75	421
		Expected Count	102.0	60.0	184.0	75.0	421.0
		% within Name of River Basin	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Symmetric Measures			
		Value	Approx. Sig.
Nominal by Nominal	Phi	.261	.001
	Cramer's V	.151	.001
N of Valid Cases		421	

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.654[a]	9	.001
Likelihood Ratio	27.572	9	.001
N of Valid Cases	421		

Source: Field Survey, 2018

Household Members Natural Resources Management Knowledge Acquisition and Usage

Table 7 explains most household members trained use the training utilized for better life and productivity. This is a positive indication as increased use of knowledge gained leads to increased afforestation.

Table 7: HOUSEHOLD MEMBERS NATURAL RESOURCES MANAGEMENT KNOWLEDGE ACQUISITION AND USAGE

HH Members Natural Resources Management Knowledge Acquisition and Usage	Average Number	Range	STD
HH Members Trained	1.7	1-8Persons	0.964
HH Members Utilizing Knowledge gained	1.5	0-6Persons	0.842

Source: Field Survey, 2018

Ranking of Awareness on Sustainable Environment Management

Table 8 reveals 96.5% of the households in the study area are aware of Tree Planting Engagement. This reflects a high level of engagement in tree planting in the study as increased awareness on tree planting should lead to engagement in the act of planting. 77% of households indicated lower level of awareness regarding Legal Harvesting of Forest Product compared to the other environment management choices. This can be attributed to the fact that some household members believe there should be easy access to the forest for harvesting of product since they belong to the community. In all, over three quarter of households in the study area are aware of Sustainable Environment Management which is a higher tendency of improved afforestation.

Table 8: AWARENESS ON SUSTAINABLE ENVIRONMENT MANAGEMENT

SEM	Frequency	Percentage	
Position			
Tree Planting Engagement	406	96.4%	1ST
Reduce Bush Fire	352	83.6%	12th
Livestock Keeping	397	94.3%	2nd
Legal Harvesting of Forest Product	324	77%	17th
Reduced Use of Charcoal	378	89.8%	5th
Use of Energy Saving Jikos	372	88.4%	6th
Engagement in NRM Training	335	79.8%	14th
Application of Knowledge from Training	363	86.3%	8th
Engagement in Forest Related Activities	333	79.1%	15th
Reduce Tree Felling	379	90%	4th
Environment Management Advocacy	313	84.4%	10th

Participation in Conservation Activities	363	86.3%	8th
Flexibility of Traditional Preference	331	78.6%	16th
Reduce Timber Sales/Domestic Use	364	86.5%	7th
Reduce Fuel Wood Sales/Domestic Use	380	90.3%	3rd
No Stealing of Wildlife/Poaching	353	83.9%	11th
Adherence to Forest Restriction	350	83.1%	13th
Use of Irrigation System	358	85.1%	9th

Source: Field Survey, 2018

RESULTS ON THE EFECT OF COMMUNITY INCOMES ON AFFORESTATION

Household Assets Owned

Table 9 explains that majority of the households had phone (Handset mobile) thus better communication with community group members and also extension agents. Mostly all households have a Panga, Jembe, Jembe Fork this implies genuine engagement in farming as it is anticipated that the higher the number of farm implements, the higher the output, the higher the income and hence level of afforestation.

Table 9: HOUSEHOLD ASSETS OWNED

Household Asset Owned	Average Number	Min-Max	Std.
TV	0.8	0-4	0.57
Phone (Handset mobile)	2.3	0-12	1.7
Car	0.1	0-2	0.35
Fridge	0.1	0-2	0.32
Gas Cooker	0.6	0-6	0.69
Computer	0.1	0-3	0.4
Bicycle	0.5	0-3	0.63
Iron	0.5	0-3	0.59
Motor Cycle	0.26	0-2	0.46
Farm Implements Owned			
Panga	3	0-14	1.83
Jembe	1.6	0-22	1.97
Jembe Fork	1.2	0-22	1.47
Sickle	0.3	0-5	0.86
Secateurs	0.4	0-6	0.77
Milking Can	0.6	0-4	0.78
Fishing Gear	0.03	0-4	0.3
Knapsack Sprayer	0.6	0-4	0.62

Source: Field Survey, 2018

RESULTS ON LEVEL OF AFFORESTATION

Tree Planting Engagement

Table 10 explains that majority of households that planted trees in Nyamindi planted 1-20 trees and Thiba households had the highest percentage of 1-20 trees planted. In the same vein, households in Rupingazi planted mainly 1-20 trees but with highest planting (13%) of 201&above and highest level of no engagement in tree planting (13.4%) compared to other River basins. 17.4% of households that planted trees in Thuci planted over 100 trees. This result implies improved tree cover in the survey area.

Table 10: TREE PLANTING ENGAGEMENT

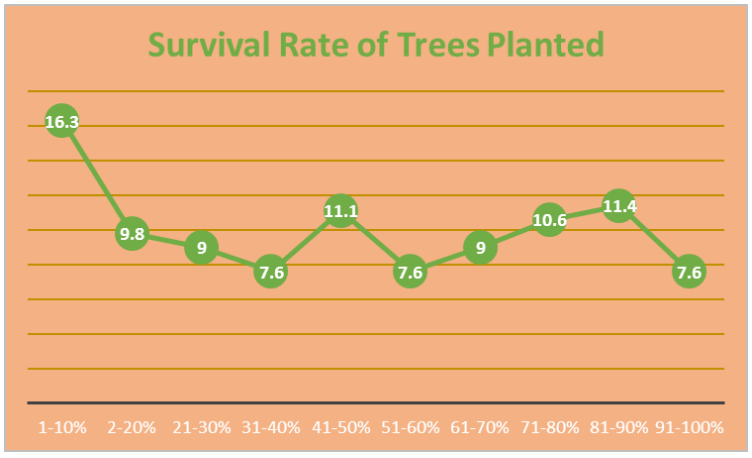
Tree Planting Engagement in each River Basin	Nyamindi	Rupingazi	Thiba	Thuci
1-20	28.4%	33.3%	37%	33.3%
21-50	21.6%	23.4%	21%	25.3%
51-100	22.4%	11.6%	16.3%	12%
101-200	9.8%	5%	6.5%	10.7%
201&above	6.7%	13.3%	5.8%	6.7%
Total Percentage of engagement in Tree Planting per River Basin	88.9%	86.6%	86.6%	88%
Total Percentage of no Engagement in Tree Planting per River Basin	11.1%	13.4%	13.4%	12%
Total Number of Respondents in River basin	102	60	184	75

Source: Field Survey, 2018

Survival Rate of Trees Planted

Fig 11 reveals that about half of the trees planted had over 50% survival rate thus improved afforestation.

Fig 11: Survival rates of trees planted

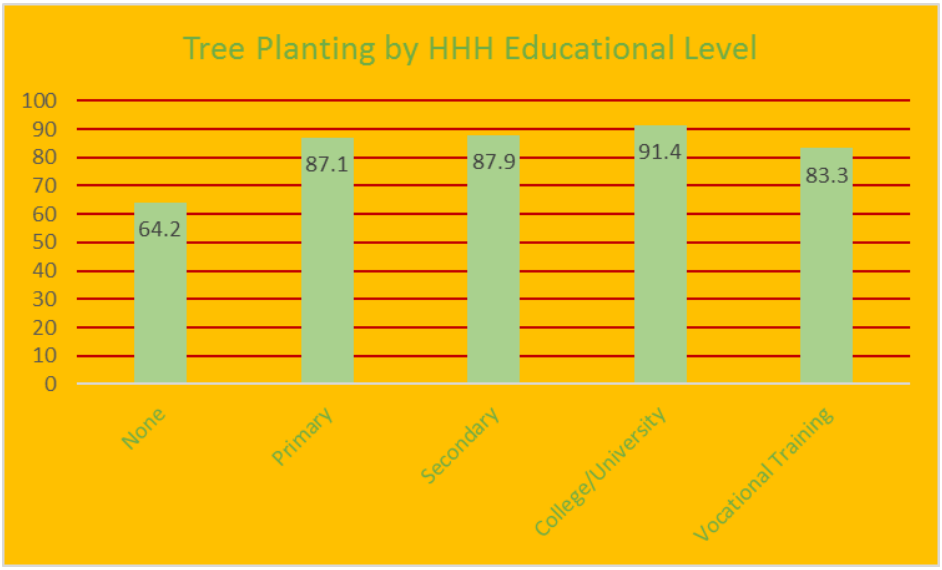


Source: Field Survey, 2018

Tree Planting by Household Head Educational Level

Figure 12 reveals that the higher the level of education of household head the higher the engagement in tree planting as households with household heads that have College/ University education engaged in tree planting more than household heads that had lower level of education. This implies education has a positive effect on afforestation this can be as a result of better understanding of multiplier effects of tree planting.

Fig 12: Tree planting by household head educational level



Source: Field Survey, 2018

Tree Planting by Age

Figure 13 shows that over half of the households' respondents (56.3%) that participated in tree planting were between the ages 11 and 50. 41.1% were between the ages 51-70 and only 2.7% were between 71-10. This implies that households reduce their tree planting activity once they turn 50 years which can affect the level of afforestation negatively since the mean age of the respondents is 49.1.

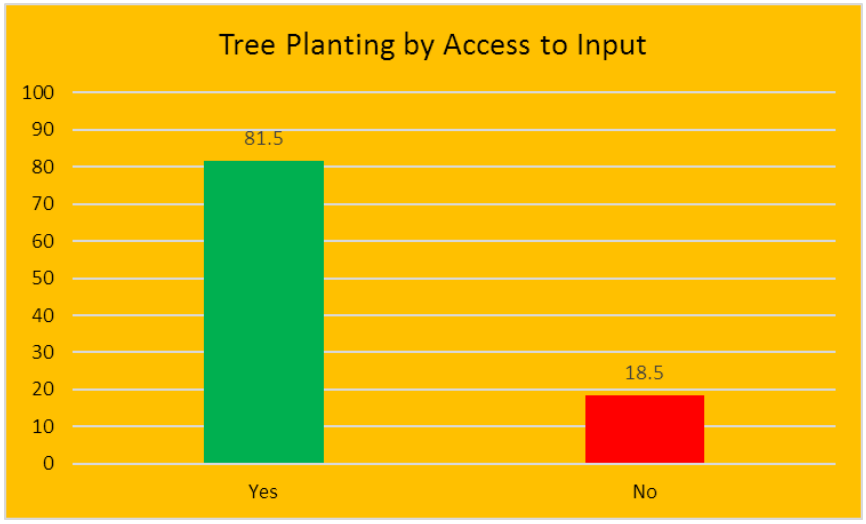
Fig 13: Tree planting by age

Source: Field Survey, 2018

Tree Planting by Access to Input

The figure 14 indicates that 81.5% of households that had access to input such as seeds, seedlings, herbicides and pesticides engaged in tree planting. This result could be an indication that access to input has a positive influence on any form of level of afforestation.

Fig 14: Tree planting by access to Input

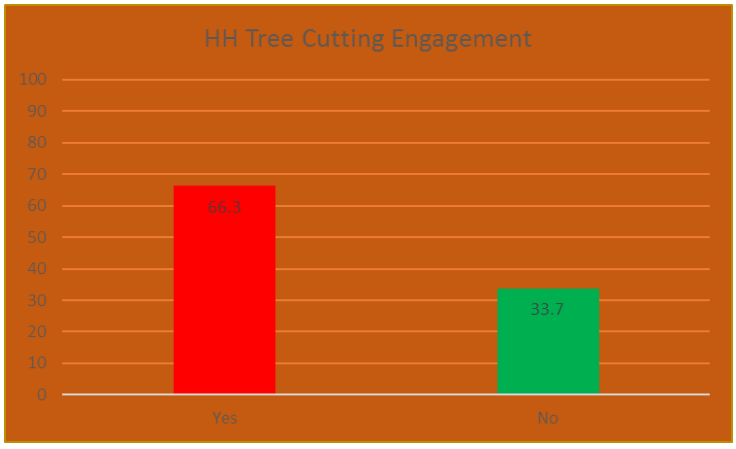


Source: Field Survey, 2018

Tree Cutting Engagement

Figure 15 reveals that less that half (33.7%) of the respondents are not engaged in tree cutting engagement.

Fig 15: Household tree cutting engagement

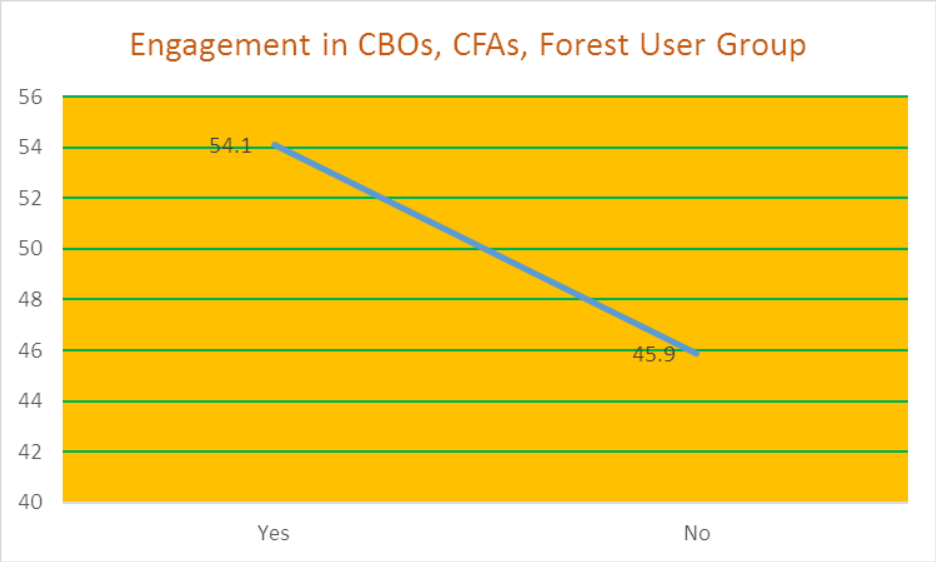


Source: Field Survey, 2018

Engagement in CBOS, CFAS, Forest Users Group

Figure 16 shows that over half (54.1%) of households in the project area had household members engaged in either Community Based Organization, Community Forest Association or Forest Users Group which is a good action for capacity building and improved Afforestation.

Fig 16: Engagement in CBOs, CFAs, Forest user group

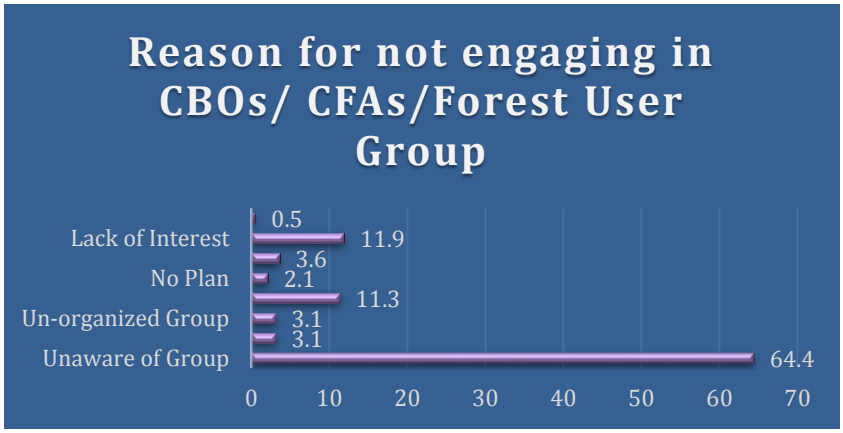


Source: Field Survey, 2018

Reason for not Engaging in CBOs, CFAs or Forest User Groups

Figure 17 reveals unawareness of existing groups as the major reason of no engagement in CBOs CFAs or Forest User Group**.**

Fig 17: Reason for not engaging in CBOs/ CFAs/Forest User Group



Source: Field Survey, 2018

CONCLUSION AND RECOMMENDATION

The major goal of this study is to determine factors influencing afforestation in the study area. The result findings have shown better living standards; majority of the households can afford 3 meals a day. Also households have been able to acquire assets such as phones and farm implements as 2 out of 4 household members are productive and financially contribute to the family thus improved livelihood.

Improved efficiency in energy use has positive effect on Afforestation in the study area as results reveals 16.5% reduction in the use of inefficient energy appliance, 21% use of energy sources other than firewood and charcoal, 88.4% awareness on the use of Energy saving Jikos, about 88% engagement in tree planting, over 33% no involvement in tree cutting activity and only 8.2% engagement in harvesting of above 50 trees yearly.

Furthermore, there is over 80% awareness on engagement in tree planting, reduced bush fire, livestock keeping, reduced use of charcoal, application of environment management training gained, environment management advocacy, participating in conservation activities, no stealing of wild life/poaching, adherence to forest restrictions, reduced fuel wood collection, use of irrigation systems, reduced timber sales and domestic use. The major influencing factors of afforestation in the study area includes; level of education of household heads, age, access to input and engagement in forest management community groups.

In all, there is efficiency in energy use, high level of awareness on sustainable environment management practices, livelihood improvement and increased afforestation in the catchment area.

However, there is still need for household members to be aware of the importance and how to use energy saving jikos so as to improve afforestation, reduce tree felling, manage time effectively, reduce work load and other health related challenges. In the same vein, technical support is needed to increase survival rate of tree seedlings and manage pest infestation on seedlings as well as trees and households need to be introduced to more awareness creation programs on the importance of energy saving jikos that would increase and encourage their interest in using the energy efficient stoves as well as green energy sources.

It is recommended that seedlings should be more accessible for the planting of indigenous species alongside exotic species of trees and more household members between the ages of 11-30 should be trained and encouraged to engage in tree planting. More so, there should be better engagement of household members in Community based organizations, Community Forest Associations or Forest User Groups especially through effective awareness of the presence of the groups in the community and regular NRM oriented entrepreneurship programs, better orderliness, management and improved transparency should be carried out in various groups.

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