

# Impact of Fuelwood Consumption by Three Tea Factories on Environment and on-Farm Tree Production in Kangema Sub-County, Murang'a County, Kenya

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**Abstract:** *The tropical forest loss is increasing by 2,101 km<sup>2</sup> per year. The factors causing the increasing tropical forest loss include agro-industrial development and exploitation of fuelwood by many countries. The role of human involvement in the deforestation situation in Africa cannot be understated. Studies carried out in Kenya show that most of the Tea factories rely on fuelwood for their energy requirements. This forces them to heavily contribute to the felling down of trees in the quest of meeting energy demands. The study sought to determine the impact of fuelwood demand by three tea factories on environment and On-farm tree production in Kangema Sub-county. The objective that guided the study was to determine the effects of fuelwood consumption by the three tea factories on the environment and on-farm tree production. The study employed a descriptive research design. The study target population was the Tea farmers in Kangema Sub-county. The study had a sample size of two hundred and ninety farmers and six key informants. Increased consumption of on-farm trees had serious effects on the environment. Exploitation of on-farm tree production and the approximate portion of land with trees showed that there was a significance correlation thus the null hypothesis was rejected. The study recommended that tea factories should be regulated and forced by way of the statute to diversify their energy sources. The tea factories should equally be forced by the county governments to grow trees as a replacement measure in the harvested areas. This would positively impact on the tree replacement rates by the tea factories. Sensitization by the statutory environmental organs on the need to practice On-farm tree production to attain the requisite ten percent tree cover should also be done.*

**Keywords:** fuelwood, on-farm trees, tree-cover, consumption rate

## 1. Introduction

The tropical forest loss is increasing by 2,101 km<sup>2</sup> per year. The factors contributing to the increasing tropical forest loss are agro-industrial development, development of cattle ranches in many parts of the growing economies. A classic example is Indonesia which has lost 50% of its natural forest cover in the past thirty years. The loss has been mainly fuelled by consumption of fuelwood [1].

The role of human development in the deforestation situation in Africa cannot be understated. A survey carried out in thirty-five African countries over the past eighteen years, from 1992 to 2010 showed that 3.4% of the forest cover had been lost. The trees had been consumed in the production of fuelwood and parts of the forests had been consumed by the excision of forests for agricultural activities. This had the effect of reducing life expectancy in the continent of Africa owing to the elimination of carbon sinks. Access to economic opportunities which are provided by the natural forests has also been lost [2].

The tea processing factories consume both thermal and electric energy in the process. Thermal energy used in the withering and drying processes is produced by burning coal, firewood or fuel oil in heaters. A study by Asian Institute of Technology indicated that tea industry is one of the energy-intensive food processing sectors consuming both electrical and thermal energy [3]. Most of the thermal energy requirement is derived from firewood, lignite, coal and fuel

oil and ultimately they contribute to direct emission of carbon dioxide (CO<sub>2</sub>) in Asia (India, Vietnam and Sri Lanka). The report also rates that the extensive damage of deforestation created by the use of fuelwood is also to be reckoned with [3].

The deforestation trends in Kenya have been alarming. With the advent of independence, the country's tree cover stood at 10% and it has been reduced to 5.7%. The reduction can be attributed to rapid population growth and the over-exploitation of forests for commercial activity. The invasion of forests lands by speculators seeking land for habitation has equally been a documented factor leading to the loss of forest cover. This has exposed the country to high risk of degradation of our national heritage in which the forest covers provide [4].

Deforestation has been confirmed to increase global warming. This can be attributed to reduced carbon sequestration. The heat traps provided by the trees are rendered unavailable owing to the cutting down of trees and depletion of the forest cover. This exposes flora and fauna to more unstable climatic conditions owing to the imbalance perpetuated by the depletion of forest cover. It brings along with it the challenge of global warming and it puts the populations at risk [5].

Wood fuel use has increased in recent years in the developed world, and more attention is being given to finding sustainable wood fuel for use in the developing world [6]. In

Africa, one of the key drivers of deforestation and landscape degradation is the demand for cheap energy [7].

Studies carried out in Kenya show that most of the tea factories rely on fuelwood for their energy requirements. This forces them to heavily contribute to the felling down of trees in the quest of meeting energy demands. It occasions the prevailing forest cover undue negative exposure owing to the fact that the tree replacement rates cannot match the energy requirements of the tea factories. This causes most of the tea factories to overly exploit the forests around their catchment areas and expose the local communities fail to achieve the requisite tree cover requirement [8]. According to national environmental management authority study on fuelwood production statistics in Kenya revealed that 84% of the total fuelwoods are sourced from small-scale farmlands [8].

Tea factories in Kenya majorly consume fuelwood in the tea processing activity. The consumption of fuelwood has had profound effects with regard to environmental degradation owing to the massive tree felling occasioned by the tea factories. This has had far-reaching ramifications on the expected tree cover requirement. It has had negative implications on the overall forestry industry attributed to the massive consumption of trees in the fuel generation [9].

The consumption of fuel derived from trees has been a factor which has challenged and exposed the forestry and conservation sector to enormous risk. This is attributed to the rapid degradation of the forest cover occasioned by the felling of trees for charcoal and firewood [10].

The underlying causes of environmental problems in the Tea industry in Kenya are mainly overutilization of primary resource base such as forest products and water, inadequate use of appropriate technologies, weak enforcement of environmental laws and insufficient support towards technology change [11].

## 2. Methodology

### Target Population

The 1200 registered small-scale Tea growers of Kiruri Tea electoral zone constituted the target population. The unit of analysis was the household while the unit of observation was the household head. The study included 6 key Informants who included the area Chief, Agricultural Extension Officer, area Environment Officer and Section Heads for the three tea factories.

### Sample Size

A sample size of 291 respondents was obtained from the target population. Simple random sampling method was used to determine respondents from the registered tea farmers in the four villages within the study area. This was done per village till the sample size was achieved.

### Instruments of the Study

This study utilized semi-structured interview schedule and personal observations as the leading instruments. An observation record sheet was used for quick recording. In its structure, it contained the household number and

observations made such as; the presence of remnants of logging, stacked wood for sale, bare ground as a result of tree harvesting and visible eroded ground. The interview schedule involved pre-coded questions in producing quantitative data. It was pre-tested in one of the villages outside the four that were studied and the necessary amendments made. The interviewer engaged a face-to-face contact; explained the purpose of the study and the information needed. This created a congenial atmosphere for the purpose of data collection. The study instruments reliability was confirmed by use of the test and retest method in the pilot study. This assured the researcher the ability of the respondents to understand the language used in the tools and it was also a measure of confirming the adequacy of the tools as regards to the coverage of the thrust of the study.

### Data Collection Procedure

Interviews were conducted with individual farmers in the sample and the key informants. Three section heads from the three factories were interviewed to evaluate their knowledge on the 10% tree cover policy as a measure of encouraging On-farm tree production, the role of tea factories in afforestation, the rate of fuelwood consumption and possible impacts of the continued harvesting of trees for the fuelwood. A five-year fuelwood consumption data (2009-2013) by the three tea factories were analyzed to verify the tree harvesting trend from farms. The area administrative Chief, Agricultural Extension Officer, and District Environment Officer were interviewed on their perception on the fuelwood use by the factories and the tree harvesting trend in Kiruri area Vis-a-Vis the 10% national tree cover requirement.

## 3. Results and Discussion

### Effects of Fuelwood Consumption by the Tea Factories

The study sought to establish effects of fuelwood consumption by the three tea factories on the environment and on-farm tree production.

### Effects of Cutting Down Trees on Farms

Responses on the impact of cutting down all trees in the farms were as captured in table 2.

**Table 2: Impact of Cutting Down all Trees in Farms**

Response	Frequency	Percentage (%)
Soil degradation	108	37
Lack of fuelwood	136	47
Accelerated desertification	46	16
Total	290	100

The respondents had varying views on the impact of cutting down all trees on their farms. They were of the view that it would lead to exposure to environmental degradation 37% (n=108) whereby the land would be left bare leading to massive soil erosion owing to the fact that the soil would not have tree roots to hold it together. They were also of the view that very strong winds would affect the area leading to wind erosion and losses in the event of destruction by wind. This is because the trees act as very good safeguards against a strong wind.

The respondents were of the view that cutting down all trees would expose them to the challenge of accessing fuel in a sustainable manner 47% (n=136). This was motivated by the fact that they rely on trees to provide them with firewood for fuel purposes and in the absence of trees to harvest firewood they would suffer immensely. This denotes the importance that they are attached to the trees as a source of fuel. The cutting down of trees would also impoverish the respondents due to the fact that they rely on the trees as a source of income. Failure to access income from timber and fuelwood would certainly ruin the respondents economically.

Higher incidences of accelerated desertification 16% (n=46) were also brought forth by the respondents as the perceived challenges that would be occasioned by the cutting down of all trees. They were of the view that there would be reduced rainfall exposing the area to lower precipitation thus inhibiting capacity to sustain vegetation. Increased cases of frost and alternate high and cold temperatures were also some of the perceived outcomes that could come along with the cutting down of all trees. The respondents equally confirmed having had experienced the pain of frost in the year 2012 which can be related to the cutting down of trees. The frost came along with enormous losses in the Tea plantations and other agricultural activities.

The responses were reflective of the ability of the respondents to identify trees as important and effective in assuring them their economic and environmental needs. This equally brings to the fore the capacity of the respondents to attach a high premium to trees in their daily livelihoods. It was thus proof of having them informed on the importance of trees in terms of making the world a better living place.

#### Reduction of Fuelwood for Domestic Use

The responses were captured for the respondents who experienced fuelwood shortage as a result of the increased demand by tea factories as shown in table 3.

**Table 3: Fuelwood Shortage**

Fuelwood shortage	Frequency	Percentage (%)
Yes	170	59
No	120	41
Total	290	100

Table 3 shows that 59% (n=170) of the respondents experienced firewood shortage. The firewood shortage was attributed to the long periods that the trees took to mature, thus bringing about deficits in the firewood supply owing to the disparity between consumption and the maturity rates. The respondents equally attributed firewood shortage to the prevailing weather condition in the study area. They were of the opinion that the area was predominantly wet leading to high moisture content and longer drying periods for the firewood lots. This occasions them the challenge of going for intermittent periods without firewood as they waited for it to dry.

The respondents were also of the opinion that the temptation to sell firewood to the tea factories was a handicap which exposed them to the shortage. The situation of deriving the benefits accruing from the sales and having the farmers left without firewood for use was a common scenario in the

study area. The respondents admitted to having had occasion to sell and deplete all their stocks leading to a shortage in their households. This was a confirmation that the ready markets provided by the tea factories for fuelwood posed a risk of exposing the local community to firewood shortage.

Drying of fuelwood identifies with research carried out by [12] which argued that the most effective and quicker way to dry fuelwood is through splitting the wood into smaller pieces and then stacking them in piles while ensuring that air passes through them. It is also essential to ensure that the fuelwood does not get wet or damp whilst it is being stored because if it does most likely the wood will begin to rot. In order to prevent the wood from getting wet, it is important that they be stacked on a surface above the ground, under a roof while ensuring proper drainage of water. In case wood gets wet during the storage, re-drying is important before it is used in the boiler.

#### Over-Exploitation of Trees Attributed to Increased Fuelwood Demand

The responses on whether the respondent had sold fuelwood to tea factories were as shown in table 4.

**Table 4: Over-exploitation of trees attributed to high fuelwood demand**

Over-exploitation of trees due to high Fuelwood demand	Frequency	Percentage
Yes	188	65
No	102	35
Total	290	100

A significant percentage of respondents 65% (n=188) confirmed that they had occasionally over-harvested their farm trees as a result of economic pressure which was complemented by high fuelwood demand by tea factories. They also confirmed that similar situation had applied to their neighbors. The situation of harvesting immature trees was also confirmed. This was a pointer to the situation of high demand for fuelwood by the tea factories which was not being effectively met by the local community.

The chief confirmed that local farmers had not put in place effective measures to ensure that the tea factories had sustainable provision of wood fuel. He alluded this to be a factor which led to the over depletion of the available trees. The sub-county environment officer was equally of the opinion that the measures put in place by the farmers to ensure sustainable provision of fuelwood to the factories were below average. Farmers would not effectively guarantee tea factories a sustainable fuelwood supply. Similar sentiments were shared by the agricultural extension officer about the underlying factors which led to over-exploitation of trees by the farmers selling fuelwood to the tea factories.

The practices carried out by tea factories in Kangema mirrored previous works [13] whose finding revealed that most of the energy requirements by most tea factories in the country are actually met by use of wood fuel which are a necessary source of power to the boilers. Through carbon cycle forests have a huge potential to lower carbon emissions by fuel wood but this is subject to proper

management of forest. The Intergovernmental panel on climate change concluded that 'a sustainable forest management strategy is responsible for providing guidelines for maintaining and increasing forest carbon stock. In the same spirit it is expected to balance the sustained annual yield for timber as well as energy from the forest. This will perhaps generate the biggest sustained mitigation benefit to the country. The emissions mitigation strategy for which tea factories depends on require that the wood used to run factory boilers be supplied in a sustainable manner [13]. The easiest way by which such sustainable supplies can be achieved is by tea factories increasing the size of fuelwood plantations so that they can fully supply themselves with wood requirements and equally manage those plantations in a sustainable manner.

The tea factory managers from the sampled factories alluded to not having an explicit programme to ensure sustainable provision of fuelwood by the local communities. They were of the opinion that the tea factories engaged the farmers on commercial agreements driven by the premise of a willing buyer and willing seller devoid of the situation in the individual farmer's portions of land. This brought to the fore the precarious situation that the farmers were put in by the tea factories with regards to having the financial motivation overriding and superseding environmental concerns at the advent of tree harvesting from the farms.

The Kenya Tea Development Agency issued out a circular to the factory unit managers on 28<sup>th</sup> April 2014 discouraging them from the use of indigenous trees for fuelwood in line with the company's policy as regards the conservation of indigenous trees. On the other hand, though, the circular brought out information about the practice of exploitation of indigenous trees for fuelwood, the practice was still prevalent. A joint audit carried out by RA-Cert and Africert established that the practice was still ongoing in many KTDA factories in contravention of the national ideals of the natural ecosystem conservation and the KTDA's own environmental policy. The circular gave out a strong warning to all the managers against the practice regardless of the fact that supplies of fuelwood to the factories were the function of contracted suppliers.

The researcher had the occasion of visiting fuelwood storage lots for the sampled tea factories. He had the opportunity of coming across fuelwood from indigenous trees. In the course of data collection, he also came across cut trees stumps of indigenous trees in farms harvested by suppliers contracted by the tea factories. This was evidence of the event of harvesting indigenous trees by the tea factories.

The study findings concur with [15] which found out that in Sub-Saharan Africa, about 81% of the households also depend on fuelwood for cooking. It is projected that even though biomass fuels are likely to increase in developing countries such as India and China among others, in Sub-Saharan Africa use of fuelwood is relatively higher and is expected to increase further in future.

In Kenya, 80% of the population is dependent on firewood and fuelwood for cooking and other energy needs [13]. KIPPRA suggested that renewable technology is the way

forward to Kenya's energy security but the energy production from renewable sources has been limited to small-scale consumption and household cooking in the country [16]. An analysis of fuel types in Kenya observed that the most popular household fuel in terms of usage presently is kerosene at 80 percent, followed by charcoal which stands at 60 percent, fuelwood at 55 percent, electricity and LPG at thirty-one and twenty-one percent respectively [17].

#### Perceived effect of fuelwood demand on the environment

Responses on the impact of fuelwood demand on the environment are as shown in table 5.

**Table 5:** Perceived Impact of Fuelwood Demand on Environment

Impact of fuelwood demand on the environment	Frequency	Percentage (%)
Yes	244	84
No	46	16
Total	290	100

Table 5 shows that 84% (n=244) of the respondents appreciated the fact that fuelwood demand impacted on the environment. This depicted an enhanced level of Awareness of the impact of the vagaries associated with cutting down trees for the purpose of fuelwood on the environment. It was a pointer to the situation of the respondents having had experienced firsthand of the challenges brought forth by fuelwood demand on the environment. It also showed that the respondents had experienced the pain of watching the depletion of natural ecosystems occasioned by increased fuelwood demand.

The respondents went further to enumerate some of the effects of increased fuelwood demand on the environment which they cited as the situation of increased frost. They attributed it to the felling down of trees occasioning reduced forest cover exposing the environment to lower temperatures and chilly weather from the mountainous ranges unlike before when the trees acted as safeguards from the frost. They held the view that the felling down of trees exposed the local community to the pain of aggravated losses occasioned by strong winds undeterred by lack of windbreaks.

The respondents were of the opinion that felling of trees for fuelwood had impacted negatively on the water catchment areas. This had occasioned the lowering down of water volumes in the rivers, streams, wells and springs. They were of the opinion that the situation had heavily compromised the availability of water to the local populations. It had impacted negatively on the persons living downstream in terms of their capacities to access to natural water sources in abundance like before.

Deforestation of the formerly heavily forested areas had equally exposed the residents to incidences of increased soil erosion. The respondents attested to having had incidences of soil being washed downhill owing to impaired holding by the roots from the cut-down trees. They were of the view that the prevailing situation heavily impaired and compromised the capacity of available farmlands to be

productive owing to the event of having the rich top soils eroded. This heavily reduced the productivity of the farms occasioning the community diminished returns from their production.

The cases of smoke pollution owing to the use of fuelwood for Tea processing also came out from the respondents. They were of the view that increased fuelwood use caused accelerated smoke pollution leading to the depletion of the ozone layer and increased carbon deposits in the air. This was a factor which contributed to profound global warming occasioning the larger communities the risk of suffering from the resulting ramifications. The consequences of the climate change have had an immense negative toll on the populations like the incidences of reduced rainfall, increased temperatures and similar changes in weather patterns.

The respondents' position mirrored previous works by [14] who argued that increasing forest cover by area and density through afforestation, reforestation and forest restoration will increase the absorption of carbon dioxide from the atmosphere thereby increasing the carbon stock. Establishing wood plantations in areas that do not fall under forest fields is ideal. However, it is unlikely that every tea factory will become self-sufficient in terms of fuelwood needs thus effort should be put in place in order to support the local small farm holders to develop woodlots in a sustainable manner and encourage them to sell wood to their local factory.

The fuelwood demand by tea factories has been confirmed to accelerate the rate of deforestation thus causing a negative impact on on-farm tree growing and consequently affecting the attainment of the 10% tree cover. Exploitation of on-farm trees was correlated against the approximate portion of land held by the farmers to ascertain the extent of the effects of fuelwood consumption by the tea factories. A Pearson's correlation index of  $r = 0.016$  and a  $p$ -value of 0.792 were obtained thereby meaning that the increased demand for on-farm trees by factories to facilitate tea processing had a positive correlation with the reduced tree cover on the portions of land held.

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## Author Profile



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