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## Declining wood fuel and implications for household cooking and diets in tigania Sub-county Kenya



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### ABSTRACT

Research on rural energy has in the past focussed on access and environmental effects. Little is however documented on the relationship between declining availability of wood fuel, household cooking and eating patterns, which ultimately impact people's nutritional status. A 2016–2017 cross-sectional survey in Tigania, Meru County in Kenya, targeting 239 respondents, showed that about 81% of the households respond to energy shortages by cooking composite meals instead of single meals, effectively reducing the number of cooking sessions per day. Further, cooking food that takes less time is preferred. Such foods, however, often have low nutritional value. Rich traditional foods that take longer to cook are soaked as an attempt to reduce their energy demand. While cooking composite meals and skipping meals saves energy and time, there are negative health impacts that can, however, be lessened by ensuring that one or two meals per day are balanced diets. Although firewood is the most important and popular energy source, it is becoming scarce. Integrated measures that guarantee a supply of wood fuel at the farm level while at the same building household capacities on energy use efficiency and balanced dieting demand national policy interventions. Ultimately, lasting solutions to declining wood fuel may lie in the adoption of energy-efficient cooking stoves and value addition on available energy options. Expanding income generation options at household levels will also make access to clean energy more possible and ultimately reduce the indignity of poor feeding habits caused by energy shortages within poor rural communities. Future research needs to also focus on increasing the shelf-life of cooked food types where households are too poor to afford refrigeration.

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### Introduction

The use of wood fuel as the principal source of energy for many households worldwide, and particularly in rural communities, since time immemorial is well documented [4, 11, 16, 22, 23]. While almost 100% of the rural populations in

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developing nations depend on wood fuel, about 80% of the urban poor rely on charcoal to meet their domestic energy needs [27, 31]. This over-dependence on wood fuel is a major cause of declining tree cover, loss of biodiversity and aggravated consequences of global warming in response to the declining potential of carbon sequestration [30, 35]. Therefore, a community's efforts to access wood fuel should, as much as possible, not negate efforts towards tree and forest conservation. It is worth noting that conservation of sustainable forest conservation in communities dependent on woodfuel is dependent on concurrent measures to satisfy the social and economic needs of a community, including increasing access to clean and affordable alternative energy [29] and food and nutrition security. It is such integrated approaches that will ultimately contribute towards the achievement of sustainable development goal number seven of affordable clean energy.

The choice to use wood fuel or more efficient alternative sources of energy depends on various factors such as the education and financial capital of the household [26], availability of viable alternative sources [13, 32], the complexity of using the alternative energy [12], the part of the tree available for burning [24] and the capacity of the energy source to meet the cooking needs of a community [2]. These factors, among others, do prevail in rural Kenya and need to be investigated to propose sustainable solutions to extraction and use of wood fuel. Previous work by World Vision in Baringo, Kenya, shows that families sometimes miss or skip meals for not having sufficient firewood to cook with [40]. Our study was conducted in Tigania in Meru County, in Kenya, where wood fuel is a major source of energy for cooking. And despite the area's high agricultural potential, visual observation suggests that dwindling reserves of wood fuel is aggravating the nutritional status of households and hence their overall well-being. High dependence on firewood for cooking and lighting is a major impediment to development through health-related complications such as increased respiratory infections and air pollution. Tigania West constituency has the highest level of firewood use in Meru County at 94% [15]. Significant improvement in health and overall living standards in this region because of access to clean energy has been demonstrated by Murithi [21]. However, access to electricity is dependent on household social-economic status, whereby the high poverty levels in the region will not afford most households this necessity in the foreseeable future. Therefore, current information to inform the formulation of integrated policy initiatives addressing rural energy needs is needed. This observation was the basis for investigating community behaviour concerning wood fuel use in order to provide information to trigger multi-sector and multi-benefit development interventions. These interventions will involve key stakeholders responsible for agricultural extension services, tree and forest conservation, and community health in the context of sustainable community development.

## Methodology

### *Study area characteristics*

This study was done in Thau and Mituntu locations in Tigania West Sub-County in Meru County (0° 30' 0" N, 37° 38' 0" E), Kenya. The climate of this study area is influenced by its closeness to Mount Kenya and Nyambene hill ranges. The rainfall pattern is bi-modal with long rains falling between March and May, and the short rains falling from October to December. The annual rainfall ranges from 1,250mm to 2514mm on the windward eastern and southern slopes of the Nyambene range, and from 380mm to 1000mm on the leeward side. The soils in the upper areas are generally suitable for the production of coffee and tea. The lower altitude areas have less fertile soils that are, however, suitable for the production of cotton and cattle ranching. Agriculture is thus the main economic activity in the study area, with coffee, khat, maize, beans yams and bananas as the most popular crops. Integrating sustainable energy solutions in this agriculture system is critical for enhanced community well-being.

### *Data collection and analysis*

A cross-sectional survey was conducted in 2016-2017 to collect data from a sample of 239 households, which were identified as described by Kothari [18]. Individual respondents were selected using simple random sampling in the two locations. Focus group discussions consisting of up to 10 discussants were used to validate household questionnaire results and build consensus on emerging issues. General trends in household nutritional status were determined from data obtained from local health clinics and through face to face interviews with the County nutritionist. Data generated from the questionnaires were analysed for descriptive statistics, including cross-tabulations. The content analysis approach was used to analyse data from focus group discussions and key informants and integrated in the discussion as narratives.

## Results and discussion

### *Sources of fuelwood at the household level*

Woodlots were the main source of firewood as indicated by 32% of the respondents, followed by bushes (25%) and buying from markets (24%). Other sources of fuel included farmed trees (11%) and harvesting from forests (7%). The future of woodlots is, however, uncertain due to increased demand for land for agriculture and settlement. Gathering of firewood from neighbours' land is also being restricted because of private land tenure regulations as communal use of resources becomes increasingly supplanted by the sanctity of private property. Therefore, strategies to increase own wood fuel and access to alternative energy sources for rural households need to be identified and enhanced [10]. The main source of

**Table 1**  
Type of fuel used for cooking within households in the study area

Type of fuel	Proportion of respondents (%) <sup>1</sup>
Firewood	95.0
Twigs	69.7
Maize stalks	54.8
Maize cobs	53.5
Dry logs	37.8
Charcoal	36.1
Sawdust	10.8
Electricity	2.5
Solar energy	0.8
Biogas	0.4

n = 239

<sup>1</sup> Multiple responses were allowed**Table 2**  
Relationship between the harvesting of trees and practice of afforestation

Tree harvesting behaviour	Annual afforestation frequency (%)					Total
	None	Once a year	Twice a year	> Twice a year	Unspecified	
Harvest trees	3.3	52.3	4.2	0.4	0.0	60.3
Don't harvest trees	6.7	27.6	1.7	0.4	3.3	39.7
Total	10.0	79.9	5.9	0.8	3.3	100.0

n = 239;  $\chi^2 = 22.356$  (P = 0.000170)**Table 3**  
Relationship between motivation for cooking a type of meal and type of meal cooked

Reason for type of meal cooked	Frequency of type of meal cooked (%)			
	Single meals	Composite meals	Others	Total
Save fuel	6.7	56.5	0.4	63.6
Save time	7.1	7.1	0.0	14.2
Other	17.2	4.6	0.4	22.2
Total	31.0	68.2	0.8	100.0

n = 239;  $\chi^2 = 90.987$  (P = 8.124 e<sup>-19</sup>)

cooking fuel (Table 1) was firewood (95 %), followed by twigs (69.7 %) and maize stalks (54.8%). The apparent low usages of biogas, solar energy and electricity are generally attributed to the cost factor, which makes these sources of energy out of reach for most rural households. On the other hand, the use of dry logs and charcoal depended on the availability of trees, whose availability and accessibility have decreased over time. Like other parts of Kenya, charcoal was preferred in urban areas where firewood was difficult to access [40].

In this study, 60.3% of the respondents regularly harvest trees for firewood (Table 2). As the access to trees becomes more restricted, use of charcoal is likely to continue declining, which reinforces the need to shift to environmentally friendly, yet affordable energy alternatives for household use and rural development [5, 17, 36]. This study suggests that already, as a precursor to this shift, 56.9% of respondents engage in afforestation of their land and harvest trees at last once per year. On the other hand, 33% engage in afforestation but do not harvest trees at all. There is a significant relationship between the frequency of afforestation and whether the respondents harvest trees or not. The frequency of afforestation is done mostly once annually (79.9%). Within this group that plants trees once per year, 65.4% of them harvest the trees. The results suggest that those who plant trees have access to the trees for use as fuelwood. Further studies on the frequency of harvesting need to be conducted because high frequencies of harvesting pose a danger to forest-based livelihoods [34].

### Woodfuel, cooking patterns and access to food

When the relationship between daily cooking frequencies and type of meal cooked (single or composite) was analyzed, a high propensity to save fuel by cooking composite meals was established (Table 3). Also, there was a highly significant association between the frequency of the type of meal cooked and the reason for cooking the specific type of meal. Composite meals were a mix of various commodities, for example, maize and beans or potatoes and peas. Overall, those whose objective was to save fuel preferred to cook composite meals (56.5%). Within the 68.2% who cooked composite meals, 82.8% were motivated by a desire to save fuel. The need to save fuel and use more efficient energy sources is critical because the amount of land available for wood fuel production is declining as demand for food production increases [8]. Those who

**Table 4**  
Common foods cooked for persons of different age brackets

Common foods cooked	Proportion of respondents (%) by age group	
	> 5 years	< 5 years
Githeri	81.7	6.2
Ugali and vegetables	80.5	65.6
Tea or porridge (liquids)	74.3	74.7
Rice and vegetables	66.4	69.3
Chapati (flat fried bread)	55.6	39.0
Pulses	53.9	29.5
Unripe bananas	45.6	89.2
Roots or tubers	39.0	46.5
Kithanda	33.6	23.7

n = 239

<sup>1</sup>Multiple responses were allowed

were more concerned about saving time cooked either single meals or composite meals equally (7.1%). On the other hand, 17.2% of respondents cooked single meals for unspecified reasons.

More than 50% of the respondents preferred to cook *githeri* (i.e. maize and bean grains boiled together), *ugali* (i.e. a thick paste of maize meal boiled in water) and vegetables, and tea or porridge regularly (Table 4). Tea and porridge take a little time to prepare and therefore respondents use less firewood to cook them. Githeri is culturally popular besides being a form of composite cooking (maize and beans) that saves energy. It is a traditional dish rich in both proteins and carbohydrates; and once fed on it, one can afford to skip the next meal without debilitating hunger. The study found that more than 80% of the surveyed participants preferred to take tea, porridge and sometimes arrowroots for breakfast. Over 40% preferred to eat ugali and vegetables for lunch. Unripe bananas, porridge, rice and vegetables, and ugali and vegetables were commonly prepared for children aged below 5 years. On the other hand, adults fed more on githeri, ugali and vegetables, tea and porridge. The foods generally fed to children were not rich in protein, but were preferred because they took less time to cook, and hence less energy. The potential to compromise the nutrition of children in this scenario cannot be ignored. Ironically, a study by Chirwa *et al.* [6] found that some rural communities in South Africa preferred to use firewood to prepare meals that took longer to cook while they used electricity for faster cooking foods. This happens where firewood is thought to be sufficiently available and also as a means of reducing the family's expenses on electricity. Ultimately, affordable and accessible high energy content alternatives like bioethanol may need to be considered by policymakers for such rural areas [1]. For Tigania agro-ecosystem, integrating early maturing and multi-benefit tress that easily sprout on coppicing and pollarding can be a possible solution. Also, biogas generation can be encouraged where a household has a zero-grazing unit of 2-3 dairy cows as has been demonstrated in Central Kenya by Wachera and Waswa [38].

#### Household feeding habits and nutritional disorders

Data from the local health clinic showed that kwashiorkor (53.5%) was the most prevalent nutritional disorder in children followed by marasmus (26.1 %) and Ricketts (1.2%). On the other hand, 18.3% of the children suffered from unspecified nutritional disorders. Although no empirical data was available, the apparent lack of vitamin foods in routine diets could be playing some role in the nutrition disorders noted at local health clinics. For instance, the prevalence of kwashiorkor among children seems to be partly due to the carbohydrate-rich but vitamin-deficient foods such as maize-based "cake" (ugali) and porridge that dominate their diet. The role of cooking in nutrient release and the appeal of food cannot also be over-emphasised [3]. From work done in camps for displaced persons, it was noted that while cooking reduces disease incidences, enhances nutrition, and increases food taste, the fuel necessary for cooking the hard-to-cook food (usually maize and beans) is not easily accessible, and the task of obtaining fuel for cooking is placed on women and children [7]. Consequently, women resort to under-cooking meals to save wood fuel, thus increasing the risk of foodborne illnesses. Therefore, the increasing scarcity of wood fuel is likely to lead to families eating less nutritious or even under-cooked meals. These findings are corroborated by those of Sola *et al.* [37] who noted that decreasing wood fuel availability affects nutrition security. However, scale and intensity of nutrition insecurity are also dependent on other factors such as availability of appropriate food, availability of labour for cooking and availability of alternative and affordable small-scale renewable energy sources like biogas and home solar systems [39].

Results from focus group discussions also suggest that lack of balanced diets and cooking fast foods that are less nutritious as a result of diminishing availability of wood fuel were issues of concern to 75% and 62.5% of discussants. According to 37.5% of the discussants, limited wood fuel also resulted in the inability of communities to cater to the nutrition needs of vulnerable categories of the population like children and the elderly. Other viewpoints held by the participants on the consequences of limited wood fuel were reduced cooking rates to one or two meals per day (25%) and eating inadequately cooked meals (12.5%). Foods rich in essential nutrients but which take longer to cook, such as beans, arrowroots, and maize, were avoided or not cooked. The picture that emerges is that of a physically weakened population as a result of eating an inadequate number of meals per day [33] and not accessing and consuming nutritious meals. To mitigate the effects of limited nutrient uptake due to the consumption of fewer meals, policy interventions that facilitate families to ensure the one

or two meals per day have sufficient nutrients to satisfy daily requirements are necessary [20]. The root cause for nutrient insecurity seems to be the limited access to a steady supply of cooking energy, and calls for innovations towards clean and affordable energy alternatives.

#### *Woodfuel use and its impact on the environment*

Various kinds of wood fuel-based cooking stoves are commonly used across households. Among these, the affordable traditional three-stone stove was the most popular as attested to by 61% of the respondents. In addition to cooking purposes, the traditional three-stone fireplace is used for the provision of heat for warming the room and lighting at night in homes that cannot afford other sources of energy. Other types of improved energy-saving cooking stoves in use included *Kunimbili* (2-stick) at 24.9% response, and *Maendeleo* and Kenya ceramic at 8.3% and 1.7% responses respectively. The comparatively low usage rate of these stoves is corroborated by other studies that have attributed the low adoption of improved energy-saving cooking stoves to high purchase costs [14].

During the focus group discussion, 87.5% of the respondents associated the use of wood fuel with decreased rainfall amounts and reduced stream flows. Another 75% suggested that the use of wood fuel promoted illegal deforestation while 37.5% indicated an increase in soil erosion risk due to the use of wood fuel. On the other hand, 37.5% of the respondents said that the declining availability of wood fuel led to increased use of alternative energy sources. The use of wood fuel has also been known to pollute the air and even the food consumed [9, 31]. These results indicate that farm households are aware of the role of climate in supporting vegetation cover and in particular trees. Further, farmers seem to be concerned about the loss of firewood due to deforestation. This community awareness can be leveraged upon in afforestation policies and programmes to increase household tree cover for multiple benefits, including environmental sustainability [25]. As indicated in section 2.1, the rainfall in this agro-ecological zone is also sufficient to quickly support tree establishment and growth. While meeting the energy deficits, the species grown should also provide other benefits like fruits for much-needed nutrition security. In addition, because alternative cleaner sources of energy like wind and solar are currently expensive at the small scale level [28], government support to research on affordable systems needs to be encouraged [19]. In Kenya, some hope lies in the rural electrification programme, whose cost to households should, however, be made affordable through appropriate policy interventions.

#### **Conclusions and Recommendations**

Woodlots were the main sources of wood fuel for most households in Tigania. Declining availability of wood fuel was however attributed to the high demand commensurate with population growth, deforestation and the slow regeneration capacity of prevalent tree species. The dilemma for this study location, where agriculture is the main economic driver, is how to ensure that declining availability of wood fuel, accompanied by associated changing cooking and eating patterns, does not negatively affect household nutrition status. Households adapted to firewood shortage by opting for maize stalks, maize cobs, twigs, and sawdust, which apart from being more polluting, yield less effective energy. The scarcity of wood fuel thus resulted in changes in cooking habits whereby households opted to cook composite meals as opposed to single meals. Households also reduced their cooking frequencies from the conventional three meals per day to two, or sometimes only one meal per day. Foods with shorter cooking times were preferred to those that took longer to cook as an indirect response to firewood scarcity. This compromised the nutritional status of especially the children under five and also the elderly. To mitigate these challenges, a holistic approach that guarantees steady access to wood fuel or more reliable and sustainable alternative sources of energy like solar should be promoted by both the national and County governments. Also, investment in multi-benefit trees that mature early and can easily sprout when harvested is necessary. Energy use efficiency at the household can also be simultaneously enhanced by the use of improved cookstoves as has been demonstrated elsewhere in Kenya. Nonetheless, the affordability of alternative energy sources requires increased income security at the household level. While cooking composite meals and skipping meals saves time and energy, effort should be made to make certain that balanced diets are still achieved. All these interventions working together call for integrated approaches involving key stakeholders in the energy-food and nutrition security-environment nexus.

#### **Declaration of Competing Interest**

The authors declare that they have no conflict of interest. They have received no funding nor inducements to influence the study.

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