
Potential of Agroforestry in Sustainable Fuelwood Supply in Kenya

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Abstract: Sub Saharan African (SSA) region rely heavily on fuelwood for their energy needs and will potentially increase in the foreseeable future due to increased population growth in the region. The continued utilization of fuelwood in the region subject to inefficient technology of energy conversion is projected to put more increasing pressure on forest cover and resources. The decline in forest resources is a precursor to exploration of other resources that may provide energy to human, in which agroforestry comes in mind. Therefore, the aim of this discussion paper was to review the status of fuelwood consumption patterns in Kenya, while highlighting the status and sustainability of fuelwood sector in the country. One of the approaches to deal with fuelwood problem is to enhance adoption of agroforestry, with an aim of reducing the harvest of wood and non-wood products in forests through sustainable planting of trees in the farms. However, the main constraints identified in adopting agroforestry for sustainable forest management were: Lack of suitable laws, legislation and policy framework, unavailability of planting material, inadequacy of research and extension services, long gestation time, access to credit, and finally land tenure and security. In order to expand the adoption of agroforestry for sustainable forest resource use, there is a need for logical approach aimed in promoting a multi-purpose agroforestry system under local farming systems where there is still large land capable of sustaining the practice.

Keywords: Agroforestry, Fuelwood, Livelihood, Kenya, Sustainable Land Use

1. Introduction

Globally, energy demand is continuously increasing due to population growth and the need for more energy for domestic and industrial uses [1, 2]. Reliably, International Energy Agency (IEA) and other energy sources have forecasted that the demand for energy will increase by approximately 50-65% by the year turn of the year 2040 [3, 4]. Despite varied sources of energy, fuel wood accounts for 44.2-58.7% of all global energy consumed globally [5, 6], which benefit at least 1.7-2.1 billion peoples' energy need for lighting, heating and cooking activities [7]. In 2018-2020, fuelwood consumption was approximately 45 million m³ per year [8] and was expected to increase to 70 million m³ by the year 2030 [9].

In the developing countries, fuelwood provide the most dominant form of energy to the populations residing in these regions [10]. The proportion of population who depend in firewood and charcoal for energy for cooking and heating in Africa is between 80-90% (Burundi 91%, Rwanda 90%,

Central African Republic 90%, Mozambique 89%, Burkina Faso 87%, Madagascar 85%, Niger 85% and Malawi 81%) [10, 11]. These statistics make Sub Saharan African (SSA) region to be the highest regional per capita fuelwood consumers (average is approximately 0.69 m³/year). The global average fuelwood consumption stands at 0.27 m³/year. While it is clear that there is a difference in fuelwood consumption between urban and rural areas in these regions [12], majority of the rural dwellers still use fuel wood probably because of the availability, cultural preferences, economic factors, perceived absence of alternative sources of energy and poverty [10, 13].

In Kenya, the contribution of fuel wood to total energy demand, which is approximated at 68% of biomass energy [14, 15] but is higher than 80% of rural household energy consumption [16, 17]. In previous reports, Kenya consumes 34.3 million tons of biomass for fuel wood [18, 19]. Majority of the rural dwellers still elect to use fuelwood due to low cost of obtaining the energy source, ease of availability,

perceived lack of alternative energy sources [15]. The dwindling energy sources make several households to waste precious time in fuelwood collection. In next two to five decades, the pattern of fuelwood consumption is unlikely to change unless there are cheaper alternative sources of energy found in the region. As long as there will be continued dependence of the forest as a source of fuelwood, then there will be significant decline in forest cover and resources or complete depletion of the forest resources.

There is increasing focus of fuelwood production from agroforestry. Agroforestry can also provide multiple economic and socio-economic benefits for smallholders, limit deforestation, as well as improve health and nutrition of rural dwellers. However, studies on the role of agroforestry on the fuelwood use in Kenya remain peripheral. Therefore, the aim of this discussion paper was to review the status of the fuelwood consumption patterns in Kenya, and to discuss the status and sustainability of the fuelwood sector in Kenya. The review also looks at the main constraints identified in adopting agroforestry for sustainable forest management.

2. The Status and Sustainability of the Fuelwood Sector in Kenya

Energy drives the economic agenda of Kenya. In households, fuel wood provides energy for domestic chores such as for cooking, lighting and heating, while nationally fuel wood helps in the creation of employment and generation of income [20]. There is however less known information about energy demand and consumption in Kenya. Although there are several energy sources in Kenya, ranging from electricity, biofuels, fossil fuels and biomass energy [21], the demand has been increasing in recent years to sustain the growing economy. Among these energy source, electricity is still elusive in rural areas due to the high cost involved in supply [22]. In the meantime, fossil fuels are becoming more expensive for large scale consumption and coal remains limited to regions where coal mines deposits are large enough and there is no machinery to do the mining [23]. Therefore, it is logical that wood biomass energy sources are more relevant to the rural communities in Kenya.

In Kenya, biomass energy surpasses any other energy source for cooking and/or heating [24], more particularly in the rural areas [25]. Wood biomass is obtained from tree parts such as twigs, tops, and unmerchantable stems [26]. Firewood is also used by schools, tea, textile, food and chemical processing industries among others and use firewood as a source of energy [27]. Charcoal is consumed mainly in the urban areas due to its relative cleanness where it generates less smoke compared to firewood [28]. Charcoal consumption has also increased over the last two decades in urban areas compared to firewood [29]. The preference of charcoal as a means of energy source stem from its role in employment including firewood collectors and harvesters, transporters, wholesalers as well as retailers [30].

The firewood supply comes from collection of dead woods in the forests as well as non-forest areas while charcoal is generated from live trees either from the natural or planted stands. When burning wood for charcoal it takes place in rudimentary earth kilns, there is often low conversion efficiency ranging between 8 and 20% which leads to energy wastage during conversion of wood to charcoal [31]. As a result of these, there is a massive landscape effect of charcoal production which may also escalate the process of land degradation from cutting down of trees. Many researchers have therefore advocated for improvement in the efficiency of charcoal production from firewood as a practical solution to improve forest resource utilization.

3. Approaches to Address Fuelwood in Agroforestry

In Kenya, there is high population growth rate which necessitate large amounts of fuelwood use by households especially in rural [32]. Indeed, the value of fuelwood, especially firewood and charcoal, has been growing since the 1980s [33], and drylands regions continue to be the major source of charcoal supply.

In Kenya, there is increasing adoption of agroforestry [34], which may significantly increase firewood and charcoal and thus reduce the urge to harvest wood from natural forests. Nevertheless, adoption rates of agroforestry practices for charcoal production in Kenya is largely anecdotal [13]. There are several fuelwood programmes were scaled down in the 1990s [33]. Adoption of trees during agroforestry will provide fuelwood resources to address energy crises. Thus, agroforestry may provide the desired benefits and integrating them into traditional agriculture. Agroforestry in the country has increasingly found a central place in this fuelwood energy consumption. There is however scanty information on the estimates of fuelwood from agroforestry in the country. Some unverified assumptions by the Kenya Forest Service estimate that the share of agroforestry to fuelwood in Kenya is between 10-20%.

There is increasing adoption of agroforestry in Kenya to improve energy needs despite many challenges [35, 36]. There are however, several identifiable bottleneck that hinder the advancement of agroforestry for fuelwood in Kenya [37]. These range from inadequate legislation, regulations, and policies, unavailability of planting material, long gestation time, access to market and value chains, access to credit and land tenure as discussed in this sub-section.

3.1. Lack of Suitable Laws, Legislation and Policy Framework

In Kenya, poor legislation, and policies coupled with poor forest governance have contributed significantly to the poor development of the commercial aspect of the forestry [38]. There are no strong legislation, policies and governance structure in Kenya to bring in the required institutional capacity, public-private partnerships, transparency and

accountability, institutional financing mechanisms to enable the sector boast of better agroforestry development.

The Kenya forest sector is driven by Kenyan governments, donor agencies, Non-State Actors (NSAs), conservation groups and public [38] with an earlier focus on timber production [39] which resulted in formulation of a policy on timber harvesting (Timber Act, CAP 386 of 1972) as well as Forest Act CAP 385. Later there were proviso for conservation and management of forests, which was achieved through the Kenya Forest Act (2005). The Forests Conservation and Management Act (FCMA) No. 34 of 2016 provided for sustainable management, including coherent utilization of forest resources and for connected purposes replaced the Forest Act (2005) and allowed the locals to succinctly participate in management of forests [40]. There is also the Forestry Policy (2015) with wide measures to solve challenges faced by the forest sector (<http://www.kenyaforestservice.org/documents/Forest%20Policy>). The Government of Kenya has incorporated issues related to commercial forestry and to some extent agroforestry in the policy framework. However, in each of these policies, the issue of agroforestry is not coming out strongly as expected.

Agroforestry has been practiced in Kenya for some times [34], but there is a general lack of suitable policies, legal frameworks which facilitate the adoption of agroforestry to enhance firewood production in Kenya. There are also very punitive government measures by the Kenyan governments to ban harvest and trade of timber, including in the public and community land [41]. Thus, the potential of agroforestry to enhance the supply of firewood has not been fully exploited.

3.2. Unavailability of Planting Material

In Kenya, investment in trees germplasm lags behind the investment in traditional agricultural crops [42]. Although the country has hybrid and appropriate varieties of tree species is currently being researched [43], there have been challenges among farmers in obtaining superior germplasm as planting materials [44]. When one considers crop agriculture such as fruit and vegetables farming, the outcome has been a large pool of genetic variation, are not regulated and they are always low on productivity. In some cases, large crop plantation establishments were encouraged by the government. Several recommendations have argued for mechanisms to certify planting material of tree species. There is also a consensus that there is lack of institutional mechanism to register tree nurseries.

3.3. Inadequacy of Research and Extension Services

A major challenge in promotion of agroforestry adoption is inadequate research and extension or insufficient knowledge, of tree-growing practices. Furthermore, there are numerous important trees species that can be grown in different agro-ecological zones in Kenya to enhance agroforestry. There is need to use the outcome of research

to offset the obstacles brought about lack of extension services in the sector. There are several research initiatives in Kenya with some funding to enhance the development of agroforestry systems. In Kenya, research and extension service are often under-resourced and therefore does not achieve the desired outcomes. Besides, agroforestry there is need for apt management to overcome problem related to the availability of seed, fertilizer, and other inputs. Large degree of success has been reported in the private sector concerning this aspect.

3.4. Access to Market and Value Chains

Although demands for fuelwood has been on the rise in Kenya, there is limited information on exact demand and potential supply in Kenya. Whenever one wants to grow trees, harvest and market the wood products, it has been established that there is lack of information on market leading to uncertainty in profits. Indeed, the marketing avenues and segments for agroforestry wood products in Kenya has remained largely unorganized. Also, it is clear that agroforestry products and its linkage to the markets is yet to be developed, due to their low priority among farmers practicing agroforestry. Good marketing infrastructure with respect to market segments, pricing, channels and information should be introduced to mainstream agroforestry.

3.5. Access to Credit

According to available estimates, the overall demand to fully finance the forest sector is approximately US \$40–70 billion per year and almost \$120-145 billion in SSA [45]. These financing need estimates include all the elements and thematic areas of forest management, commercialization of the sector, development and conservation [46, 47]. Many of the estimates are based in collected information from forestry stakeholders' reports. In Kenya, funding of forest sector is done through public and private means, of which the combined total funding from either the public or private sector is estimated to be less than 10% of the total financial requirement for the sector [48]. Domestic public financing is the major source of financing for forestry in Kenya and most of the countries in the SSA. Public funding from government budgetary allocations remains the main way financial resource are generated for managing forests. Unfortunately, Kenya cannot raise enough finance though this method to finance forest sector development to enable it enhance the fuel wood supply. There is a growing consensus that to scale up forestry sector, add value, and run profitable forest management programmes, private financing may be important in forestry sector.

Forests in Kenya are largely government owned but can also be individually owned with some few communal forests. In government owned or gazetted forests, the local community members have been urged to form community forest associations (CFAs) to manage the forests, secure partnership for leveraged growth, or opportunities to

sustainably use forest resource [14]. As a result, there has been increasingly proliferation of community forest associations (CFAs) among forest adjustment communities to secure forest management agreements with the forest administration [49]. There has been incorporation of the small-holder farmers and land owners to enhance forest utilization and management through several initiatives. Nevertheless, the exact figures are not available despite the fact that a large proportion of wood and non-wood product such as timber and poles can be obtained from agroforestry. Also, the extended logging bans that was put in place by the Kenyan government accelerated rapid growth of small-scale plantations which met the increasing demand for forest resources needed by the population.

In absence of public funding from the government, there are several informal financings for forest-based often carried out at household levels. The inability of the rural household to secure funding for agroforestry is due to weak financial institution for such undertaking and inability of the formal financial systems to provide loans to these farmers. Therefore, funding packages for rural energy programs, in line with agroforestry, should include comprehensive planning approaches.

3.6. Land Tenure and Security

Secure land rights are necessary if farmers are to invest in agriculture and related activities. Without secure land rights, farmers might fear their land will be taken away by more powerful actors once its quality has been improved. It contributes to a sense of stability that can positively influence societal relations, encouraging the sharing of benefits among individuals and groups. In recent years, there have been move towards adopting land policy for access and use of land in Kenya [50]. Even where there is adequate land tenure, pressure on land resource in Kenya is increasing due to natural factors vis-à-vis human factors, notably: (1) growing demand for food in terms of both quantity (kj of energy) and quality (proportion of animal protein in the diet); (2) competition for productive land for biofuel, urban expansion and other non-productive uses; and (3) decrease or lack of growth in productivity due to decline in soil health indicated by lower nutrient status and organic matter, and other degradation processes [51]. Pressures also arise from natural factors such as climate variability, extreme weather events and wildfire; these add to the challenge of matching management practices to environmental conditions for optimal yields and for sustainable use of the land resource [52]. Anthropogenic climate change is projected to exacerbate variations in year-to-year yields and income from agroforestry, threatening the resilience of agro-ecosystems.

Having tenure security means possessing land rights and may influence the extent to which the populations are willing to invest in production and land management. It adds to stability on land matters that positively encourage sharing of benefits among individuals and groups. In recent years, there have been move towards adopting land policy for access and

use of land in Kenya [50]. Even where there is adequate land tenure, pressure on land resource in Kenya is increasing due to natural factors vis-à-vis human factors, notably: (1) increasing demand for forest products in terms of quantity (kj of energy) and quality and; (2) increasing competition of land for biofuel, agriculture, and urbanization [51]. There is also increasing concerns from natural factors such as climate variability and extreme weather events [52].

4. Conclusions

In Kenya, there is increasing demand for energy source which is currently supplied by electricity, biofuels, fossil fuels and biomass energy. Wood biomass energy sources are more relevant to the rural communities in Kenya where the demand for fuelwood constitute 68% of the total biomass energy demand. Supply of fuel wood in Kenya comes from collection of dead woods in the forests as well as non-forest areas while charcoal is generated from live trees either from the natural or planted stands. Collecting fuel wood from the natural forest is increasingly difficult due to the government move to protect forest including fencing, there is option of employing agroforestry to meet the shortfall. Although adoption of agroforestry in the country is on the rise, there is however, unrecognized role of agroforestry in enhancing fuelwood supply. The challenges that hinder the advancement of agroforestry for fuelwood in Kenya are currently being recognized as: inadequate legislation, regulations, and policies, unavailability of planting material, long gestation time, access to market and value chains, access to credit and land tenure.

5. Recommendations

There is a huge gap in understanding projected future consumption and demands for energy sources in Kenya; strength of agroforestry across different agro-ecological zones. There is therefore a need for consideration of options to encourage farmers to adopt agroforestry leading to increased supply of fuelwood.

There is need of policy involvements to change and improve the land tenure systems. Resolving land tenure will ultimately lead to increased adoption and uptake of agroforestry. Similar to the development witnessed in the cropland agriculture, agroforestry should be given more attention by the Kenyan governments, civil society groups, and private sector to enable it to realize its full potential of enhancing fuelwood and reducing pressure on the natural forests sectors and resources.

There is need to explore ways of enhancing an integrated and sustainable fuelwood production and management including improving the efficiency of resources that make charcoal. There is need to invest more resource to improve the tools and equipment that enable the conversion of biomass to charcoals. There is need to increase the effort to adopt more energy saving stoves that burn less charcoal and firewood.

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