

Firewood Utilization and Its Impacts on Vegetation and Land Degradation Around Mopipi Village in Central District of Botswana

ABSTRACT Firewood is a principal source of energy, and because of its over-use and unsustainable production, it has become a scarce resource in most rural settlements of Botswana. A questionnaire was used to assess the number of people using firewood in order to determine rate of firewood utilization, distance traveled from the village to the collection areas. Households of 8 people were chosen and 79 households were interviewed. A sample of 383 households was provided with the questionnaire that investigated the use of firewood and the socio-economic situation. Transects of 14 km radiating from the village were established and six sampling points at different distances were located. Three 50m x 10m quadrats were demarcated at each sampling point. Firewood biomass was determined by measuring the basal area at ankle height and adjusted by using regression curves formulae. Biomass of live trees was dominated by *Colophospermum mopane* woodlands, but its standing dead wood was only available at further distances. Most households gathered firewood by head-loads within a range of 4-6 km from the village. Trade-offs was clearly involved when people collected less preferred species at near distances. Consumption rate per household was estimated at 10 kg per day per household. Reasonable biomass of live trees occurred near the village, concurring with household claims that they do not chop live trees. It is therefore likely that bush and pole fencing of farmlands, kraals and shelters are the cause of deforestation in the area, not the use of firewood alone. The Government should promote and encourage use of affordable alternatives for energy in rural areas to bridge the gap between the demand and what the forest can sustainably supply.

KEYWORDS: Firewood; Households; Woody Biomass; Consumption Rate; Preferred Species; Non-preferred Species; Botswana

INTRODUCTION

Fuel wood continues to play a significant role as an energy source for many households, especially in rural areas of Botswana [1,2] and it is used across a very wide spectrum of activities including domestic cooking and heating [3,4,5,6,7]. In Botswana, it is the principal

energy source used for cooking in forty-six percent of the households nationally; and in seventy-seven percent of households located in rural areas [1,2]. This represents a decline from around ninety percent in 1981 [8,9], but still significant enough to attract policy attention.

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Firewood is used not only by households but also by other sectors such as education, health and manufacturing industries. In Botswana, as in many other developing countries; the households sector is the main consumer of firewood [3,6,10,11]. Many rural households depend primarily on woody biomass for their daily energy needs [2,11]. As biomass production is generally not sustainable, its repeated collection is causing deforestation, thus hampering the ecosystem viability [12,13,7,14].

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Firewood in Botswana accounts for a lower percent of total energy consumption as compared to some other African countries such as Nigeria (80%), Uganda (92%), Rwanda (90%), Burundi, Malawi and Somalia >ninety percent [15]. In order to survive, however, rural households have to depend on many kinds of available fuel biomass and have to adopt several mechanisms for obtaining energy. Several other authors have reported a change in economic behavior of households to adapt to firewood scarcity [16,6,10].

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Despite the fact that firewood is the most important source of primary energy in Botswana, there is a wide gap in knowledge of firewood availability around most of the settlements. Little has been done to come up with the inventory of firewood in rural areas. Attempts to relate woody biomass amounts with Landsat TM imagery [17,18,19] and 1:50,000 aerial photographs [20], while revealing broad scale trends, have generally failed to provide the required level of detail for planning purposes [21].

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The acceptability or preference of the woody biomass resource to the community as a source of firewood is a critical factor that is vital to an understanding of future rural energy demands [22,23,3]. [24] found that the most preferred firewood species were *Combretum apiculatum* and *Combretum imberbe* which later got depleted, such that households had to switch to *Dichrostachys cinerea* and *Acacia erubescens*, which were also becoming scarce. The distance traveled and time-taken to collect firewood are two factors that have frequently been used in socio-economic studies as an index of scarcity. Field-work undertaken in Mochudi village by [25] shows that firewood was taken from a mean distance of 4.4km, 20km and

71 44km, for head-loads, donkey-carts and small trucks, respectively. Some trees are associated
72 with taboos, or spirits and therefore not used, while others produce toxic and/or unpleasant
73 smoke.

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75 Mopipi village was chosen for study because the area has received a significant decline in the
76 density and amount of vegetation normally used for firewood over the past 20 years in the
77 vicinity of the village [26]. Firewood usage has been declining over the years while LPG and
78 electricity consumption has been on the rise [10]. This is mainly attributed to the rising level
79 of affluence as well as the increased access to electricity. [10] pointed that local energy
80 resources considered to be in abundance in Botswana include coal (200 billion tonnes),
81 sunshine (3200hrs at 21MJ/m²), biogas (2.5 million cattle, 3kg dung/livestock unit/day) and
82 firewood (200 tonnes/annum). Botswana's domestic energy-related resources present
83 immense opportunities for addressing her energy insecurities and increasing access to energy
84 services. The most significant input is the technology required to leverage the energy latent in
85 these resources.

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87 The use of firewood touches on biodiversity conservation and gender in that without a system
88 that allows local community management of forests and the overall suite of range resources,
89 depletion is likely to occur as more resourced citizen harvest at rates higher than those at
90 which nature can replenish the wood resources. As with wildlife, the capacity of government
91 to monitor wood resources is limited and without the management of firewood quotas being
92 devolved to local communities and the requisite local capacity developed, it is the poor who
93 stand to lose.

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95 **Objectives of the Study**

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97 This study aims at quantifying available firewood and consumption rates around Mopipi
98 village with the aim of fulfilling the following objectives: (1) determine firewood inventory
99 in order to quantify available firewood for the community, and (2) determine the
100 consumption rates of the available firewood, and (3) determine the impacts of firewood
101 harvesting on land degradation.

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MATERIAL AND METHODS

Description of the Study Site

The survey was carried out in Mopipi Village in a semi-arid environment of Boteti of the Central District in Botswana (Fig. 1). Soil type is comprised mainly arenosols away from the river and fluvisols adjacent to the Boteti river [27].

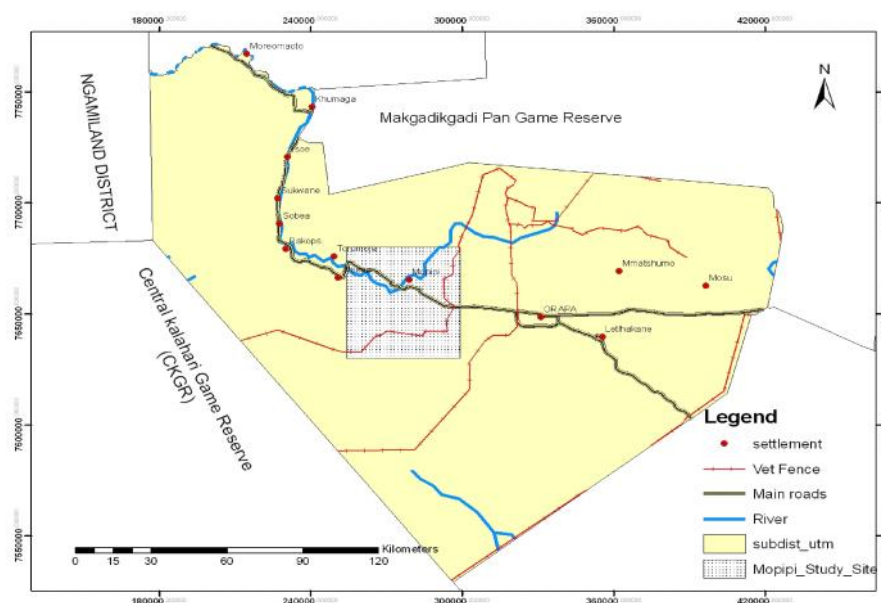


Fig. 1. Map of Boteti sub-district showing Mopipi village

These semi-arid soils are considered problematic because their physio-chemical properties limit the uses for agricultural purposes. They generally have low organic matter content and an unstable structure. The main problems associated with these soils are high levels of salinity and sodicity, poor drainage around pans, soil erosion and low soil fertility [27]. The saline soils, brackish groundwater and forage for cattle need certain mineral supplementation.

The climate is semi-arid and the rains are concentrated in the summer season (October to April), average around 350 mm/yr. The rate of evapotranspiration for the area is 1860 mm per year. The temperatures range between 25-30°C, but higher temperatures (up to 40°C) have been recorded, especially in the summer months of drought years. Winter temperatures are 15-20°C during the day, but at night occasional frosts occur.

The Boteti area is quite diverse in terms of vegetation physiognomy, ranging from woodlands, forests to grassed pans [28]. The area is historically a drainage system for the

Boteti River which disintegrates into smaller streams that individually drain into the grassed pans and extending into plains or woodlands/and forests. Common species in the area include *Acacia erioloba*, *A. tortilis* and *Colophospermum mopane* as taller trees. *Colophospermum mopane* woodland dominates much of the area to the south and north of Mopipi village. The shrub layer is sparse in both vegetation types, but includes *Grewia flava*, *Rhigosum brevispinosum* and *Rhus* spp. The study area is also dominated by plains, as it is part of the Makgadikgadi basin, which was once a mega lake which dried up over the millennia to leave several pronounced shorelines, for example, the Gidikwe Ridge [29]. The herbaceous cover, density and richness tend to increase with distance away from the village or the river. The Makgadikgadi depression is mainly covered by grasslands with halophytic species, of which *Odysea paucinervis* is dominant. *Panicum coloratum* var. *Makgadikgadiensis* and *Cenchrus ciliaris* also form a major part of the grass association.

The study site is located on tribal land and falls under the responsibility of the Ngwato Land Board. Tribal land in Botswana is communal owned, hence its use is also communal except where individuals or groups of people have been granted exclusive rights to use a particular piece of land. Most livestock are kept at cattle posts, located away from villages to avoid conflict with other land uses such as crop production.

The Boteti sub-district has an estimated population of approximately 57376 [30]. The population has increased significantly from 1991 to 2001 with an increase of 35.5 percent which gives an annual growth rate of 3.5 percent which is significantly higher than the national growth rate. The population pressure in the area is further exacerbated by the fencing of communal rangeland for wildlife and foot and mouth disease control. The village of Mopipi has an estimated population of 3,912 [30]. Overgrazing by livestock is a prominent driver of degradation in the area [27]. The degradation is marked by large livestock population, disappearance of most desirable forage species, and declines in the water table.

Measurement of Woody Biomass

There is a broad range of methodologies cited in the literature for field estimation of woody biomass. In timber surveys the 'diameter at breast height' or '*dbh*' is commonly used [31] and featured prominently in [17]'s study, with the diameter at knee height [15] and the diameter at ankle height [21] also used. The latter appears to show the most promise, although canopy cover (measured along two perpendicular axes) [18,19,32] has also been used.

The survey of firewood focused on the amount (kg/ha) of both live and dead wood and the consumption rates in relation to the distance (maximum of 14 km) from the village of Mopipi in order to quantify firewood availability. Both the preferred and non-preferred firewood tree species were quantified for both availability and consumption rates. The inventory of all the firewood trees was conducted because some studies have shown that when the preferred firewood trees diminish households tend to switch to the non-preferred species [23,2], suggesting that all tree species are potential firewood. Transects were deliberately located in the areas where the local people had stated they went to collect firewood. Direct measurements of the firewood tree species in the field were conducted to estimate its availability. Firewood availability across a radius of 14 km was quantified using [21] regression curves formulae. Four transects of 14 km radiating from the village were established and sampling located at 4 kms, 6 kms, 8 kms, 10 kms, 14 kms from the village.

Transects were demarcated in the direction of the tracks/dirt roads to allow easy access to sample locations. At every sample location three 50m x 10m quadrats were demarcated using measuring tapes and survey poles. Quadrats of large sizes are discouraged because they have problems of double counting and losing orientation within the quadrat, particularly within dense vegetation [31,33,34]. Rectangular quadrats were chosen because the longer the quadrats, the more different communities of vegetation can be captured as compared to square or circle quadrats. The quadrats were demarcated in such a way that their length cut across transects. The distances between the quadrats were 100m. In every quadrat individual woody plants rooted within the quadrat were identified; their stem diameters were measured at ankle height (*dah*) using callipers. Canopy diameters of woody plants were measured twice at a right angle to each other because the cross section of plant canopy is usually not circular and then the two diameters were averaged to determine the estimate of the diameter. The *dah* was selected over the common diameter at breast height (*dbh*) because woody plants in the study area are dominated by shrubs or low tree savanna, with most of the shrubs multi-stemmed.

A questionnaire was used to assess the number of people using firewood, the distance from the village to the firewood collection area, the mass of firewood used measured through daily consumption per selected household. Both preferred and non-preferred woody species were recorded. Households of 8 people were selected. A sample size of 383 households was provided with the questionnaire and 79 were interviewed in a formal structured survey that investigated the use of firewood as well as socio-economic situation.

The data from direct measurements were analyzed using Microsoft Excel and ArcGIS software. The measured stem diameters were converted to woody biomass using the model developed by [34]. Regression analysis was then undertaken to determine the interrelationships between woody biomass and distance. The collected data were compiled and further analyzed with SPSS 1.0

RESULTS

Biomass of Live Tree

Field survey of the area revealed that vegetation composition varied considerably often over short distances. Table 1 illustrates the distribution of biomass (kg/ha) of live trees at different distances away from the village. Total biomass of live trees increased linearly with distance from 13,986 kg per ha at 4 km to 34,477 kg per ha at 10 km from the village and somehow declined at 12 and 14 km. Biomass was highest at 10 km location and lowest at 4 km. *Colophospermum mopane* contributed the most biomass of live trees at most distances with a mean of 11,630 kg per ha. Other plant species that contributed significantly to live woody biomass include *Terminalia sericea*, *Acacia mellifera*, *Terminalia prunioides* and *Mundulea sericea*. However, *M. sericea* was not present at beyond 4 km from the village. The average biomass for all species across all distances (4-14kms) was 22,595.9 kg per ha.

Table 1: Biomass (kg/ha) of live trees species at different distance away from the village

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<i>Plant species</i>	<i>Distance from the village (km)</i>						<i>Mean</i>
	<i>4</i>	<i>6</i>	<i>8</i>	<i>10</i>	<i>12</i>	<i>14</i>	
<i>Acacia tortilis</i>	213.3	6.7	13.3	120	1642.2	486.7	413.7
<i>A.mellifera</i>	203.3	93.3	3577.8	320	2704.4	-	1149.8
<i>Dichrostachys cinerea</i>	503.3	393.3	103.3	783.3	163.3	113.3	343.3
<i>Colophospermum mopane</i>	9411	10183	2889	23517	11749	12027	11629.3
<i>Terminalia prunoides</i>	360	1103.3	20	1103.3	4406.7	-	1165.6
<i>T. sericea</i>	273.3	2183	807	3086.7	380	3676.7	1734.5
<i>Combretum apiculatum</i>	-	-	-	233.3	390	-	103.9
<i>Grewia spp.</i>	1517	493.3	155.3	530	1177.7	383.3	709.4
<i>Boscia albitrunca</i>	-	720	-	-	-	-	120
<i>Mudulia sericea</i>	-	-	2478	660	657.7	1720	919.2
<i>Miscellaneous plants</i>	1505	4160	11118	4123	3398	1540	4307.3
Total	13986	19337	21161	34477	26669	19947	22595.9

Though *M. sericea* significantly contributed to the amount of the total live biomass, it is however, a multi-stemmed and small shrub usually not suitable for good fuelwood collection but, however, it is highly browsable to both game and livestock [35] and its canopy is well distributed within the browse line. Biomass of *A. tortilis*, *A. mellifera* *D. cinerea* and *Grewia spp*, was reasonably high at 4 km as compared to 6 and 8 km distances from the village. The latter species usually occur as a result of land disturbance (overgrazing, cultivation etc), hence their relative dominance at lower distances from the village.

Biomass of Standing Dead Wood

Table 2 shows how standing dead wood distribution varies with increasing distance from the village. In general, the amount of standing dead fuelwood showed the same trend as that of live trees (increasing linearly with distance from the village). The amount of standing dead trees declined at 14 km from the village and was 430 kg per ha. *Terminalia sericea* contributed the most amount of the standing dead wood. Other plant species that made significant amount included *Combretum apiculatum* and *Terminalia prunioides*. Standing dead wood occurring at 4 km from the village included that of *A. tortilis*, *A. mellifera*, and *D. cinerea* amounting to 160 kg/ha while other plant species had no dead wood available. It should be noted here that the latter species are spinescent invader plants (making these species difficult to fetch as fuelwood or to browse) and regarded as bush encroachers. The standing dead wood of *C. mopane* was non-existent or very low at 4 and 6 km from the village. Reasonable amounts (that is, 447 kg/ha) of standing dead wood of all tree species occurred at 8 km from the village and dead wood increased from 1,486 to 1,897 kg per ha at 10 and 12 km respectively from the village, but declined to 431 kg per ha at 14 km distance due to a change in vegetation structure and composition.

Table 2: Biomass (kg/ha) of dead trees at distance away from the village

<i>Plant species</i>	<i>Distance from the village (km)</i>						<i>Total</i>
	<i>4</i>	<i>6</i>	<i>8</i>	<i>10</i>	<i>12</i>	<i>14</i>	
<i>Dichrostachys cinerea</i>	100	-	6.7	160	-	40	45.1
<i>Acacia tortilis</i>	40	-	-	71	76	-	37.2
<i>A.mellifera</i>	20	6.7	113.3	-	164.4	-	50.8
<i>Colophospermum mopane</i>	-	5.1	6.7	-	17.8	-	4.9
<i>Terminalia prunoides</i>	-	33.3	95.6	143.3	224.4	60	92.7
<i>T. sericea</i>	-	-	51.3	920	-	333.3	217.4
<i>Combretum apiculatum</i>	-	-	-	42.2	615.5	-	109.6
<i>Grewia</i> spp.	-	4.4	-	148.9	26.7	33.3	35.6
<i>Boscia albitrunca</i>	-	-	-	-	20	-	3.3
<i>Miscellaneous plants</i>	-	-	173.4	-	748.9	-	153.7
Total	160	49.5	447	1485.5	1897	430.6	744.4

Utilization of Firewood

From the households interviewed, firewood is the main source of energy in Mopipi Village. All households collect firewood for themselves and almost all for their needs, particularly cooking. In certain cases, households bought in additional firewood to their own collection from traders, at a reported price of P 175.00 (\$10.03 - USA) per van – with [25] estimating such loads to weigh 300kg. Households rarely collect firewood for other people, except for funerals or social gatherings. In Mopipi village, the use of firewood as the primary energy source for cooking meals is ninety-five percent. A high percentage of people gather firewood on foot (55.7%) and most people claim to chop only dead trees whilst 44.3 percent buy their firewood or use donkey-cart or their vans. None claimed to cut live trees for firewood. The frequency of collection of firewood depends on a number of factors, including:

- a) The mode of gathering - frequent collectors all carry firewood by head
- b) Household size
- c) Season of the year – more collection in winter
- d) The intensity of use of other energy sources

In many parts of Botswana, there are preferred tree species that households would normally collect for their energy needs. This preference may be guided by some traditional norms but largely by the efficiency of burning of that particular wood species. For example, in northern and eastern Botswana, *C. mopane* and *Combretum imberbe* are regarded as the best and therefore most preferred. Preference for tree species used by respondents in Mopipi village is shown in Table 3.

Table 3: Households response to preferred tree species for firewood

<i>Tree species</i>	<i>Respondent (%)</i>
<i>Colophospermum mopane</i>	88.6
<i>Terminalia prunioides</i>	63.3
<i>Acacia mellifera</i>	24.3
<i>Acacia tortilis</i>	6.1
<i>Acacia erioloba</i>	1.3

More than seventy-five percent of households indicated some problems associated with firewood collection. These included distance from the village and the interference caused by

rainfall during time of gathering etc. Seventy-five percent of the households interviewed encountered problems with firewood availability and rendering firewood an unreliable resource for household energy. A list of problems households encountered regarding firewood supply/availability are shown in Table 4. People could give more answers than one, except ofcourse if they encountered none. About forty-five percent of the households indicated gas (LPG) as the most preferred alternative source of energy should these problems persist. They reasoned that it is relatively easy to use and is readily available. Apparently they do not have any ideas of using other alternative energy sources.

Table 4: Problems encountered in firewood supply

<i>Problem encountered</i>	<i>Respondents (%)</i>
Shortage	24
Expensive	27.8
Distance to collection sites	36.7
Time spent collecting	2.5
Too much labour	10.1
None	24.6

Daily Consumption of Firewood

Due to problems encountered in the daily measurement of firewood consumption, an adjusted average of use was set at 10 kg usage per day. Problems encountered included, new stocks of firewood being piled on the stock that was to be measured, the loss of substantial firewood stocks due to sales or other multifaceted reasons that often had to do with family relationships.

DISCUSSION

Firewood is used in Mopipi village as a source of energy and was used by all those households interviewed. Most of the community relies on firewood as all households

consider it to be the main source of energy for cooking, warming bath water and various other family activities such as social ceremonies and funerals. These data concur with those reported in India [36], in Sub-Sahara-Africa [3,37,2,14], in Kenya [4], in Badladesh [6] and Nigeria [11]. As the use of supplementary energy sources, in particular paraffin, LPG and electricity requires cash, they are likely to be used only by relatively ‘better off’ households.

There has been mounting scarcity of firewood within accessible areas of the village. Most firewood is collected from communal land predominantly lying in an easterly direction from Mopipi village. Most households who frequently gather firewood on foot collect it within a range of 4-6 km from the village. This figure fits well with [25] estimate of 4.4 km for head-load firewood collection around Mochudi in south eastern Botswana – where the average head-load weight was estimated as 18kgs, with this load lasting 3 days and taking 2.5 hours to collect.

In general, in Mopipi village, as in other parts of the country, collection of firewood is mainly the responsibility of women and children. But if donkey-carts or vans are used, men are often involved. With depletion of wood resources in areas closest to homesteads, more time is spent in firewood collection thus depriving children of study-time and women of other productive time such as commercial activities, adult education, or participating in village governance structures [7]. Collection of firewood is typically an individual household activity for their benefit. Households rarely collect firewood for other people except for social gatherings such as weddings or funerals. The majority of households collect firewood at least once per week. The frequency depends on the mode of transport used, for example, gather firewood by head or use of donkey-cart or vans. The season of the year and size of the household also contributes to the frequency of firewood gathering [2].

Colophospermum mopane contributed the most biomass of live tree species but its standing dead wood was estimated to be less than that of less abundant species such as *T. sericea* or *D. cinerea*. *Colophospermum mopane* is a preferred firewood species, but it is only available as standing deadwood far from the village. Trade-offs are clearly involved with people collecting less preferred species such as *T. sericea*, available at closer distances, rather than trek further for higher quality firewood. *Terminalia prunioides*, *A. mellifera* and *D. cinerea* are also popular firewood species, although the spinescence of the latter two makes them

difficult to collect – which is unfortunate as they are encroaching upon the heavily grazed rangeland around the village.

Detailed studies such as that undertaken in Niger [38], have highlighted the merits of traditional methods of harvesting the natural woodlands and the need to build upon management systems that are familiar to the local population and so easily implemented. For firewood purposes it would be beneficial if the transformation of bushes around the village into trees could be encouraged. It may be considered by district authorities to set aside an area close to the village as a wood-lot of indigenous or well performing exotic species in which the plantation is managed by the community.

The biomass of live trees was reasonably high at distances near the village concurring with households claims made during the survey that they tend not to harvest live trees but only harvest dry wood. Government Projects in the arable sector in the 1980s that encouraged the clearance of relatively ‘pristine’ areas of savanna by offering distumping and ploughing subsidies were greatly criticized for the widespread clearance of land they effected [39]. Apparently, many of these effective subsidies have recently been introduced under newly named projects as the Botswana Government’s drive to increase food production in the rural areas. As such, they contribute significantly to the loss of firewood near villages and also to environmental degradation [5,40,41]. One of the most significant impacts of unsustainable use of natural resources is deforestation [5,37,41,7,2]. Deforestation leads to an increase in greenhouse gas emissions and a consequent acceleration of climate change impacts [2].

Bushes are also cleared for use as livestock kraals, poles for fencing arable lands and for building homesteads, although such clearance tends to be localized and relatively insignificant compared to that cleared to take advantage of the various subsidies now available in the arable sector. [42] estimated that nationally 1.7×10^5 tonnes/year was used in the fencing of kraals and 0.34×10^5 tonnes/year in construction of buildings. Unlike firewood consumption of these poles are taken from live trees, with stem diameters in the range of 8cm which are required to provide the necessary support for construction.

Bush and pole fencing for arable lands in order to keep livestock out of the crops is still a common practice in the rural areas of Botswana, with wire fencing expensive by comparison. The amount of wood required to bush and pole fence an area of 4.6 hectares has been

estimated at 30 tonnes, with 6 tonnes required annually for renewal [43]. Clearance for arable cultivation can therefore generate firewood in the short term, although by depleting the woody biomass resource, it is likely to be detrimental to firewood supplies. This is especially so where land clearance is followed by soil and nutrient loss, via wind and water erosion. Significantly studies in the Sahel in the early 1990s concluded that, *'it has been a grave error to think that firewood has come from the exploitation of the natural savanna when, in the great majority of cases, it comes from deadwood in areas cleared for agriculture'* (Catinot and Bonkungo 1985 from [38]).

CONCLUSION

Farms, houses and cattle post all need fencing and wooden poles. It is likely this is the cause of deforestation in the area, not the use of firewood alone. Unless alternative, more sustainable solutions are found it can be expected that the future will bring: ever-increasing firewood harvesting distances; a continued rise in prices of firewood; increased cutting of live trees; probable introduction of more lorries in fully privatised operations for transporting firewood to the schools, hospitals and other private sectors as distances to the source areas increase and access become more difficult. In Mopipi village, poor households will undoubtedly remain in an effective poverty trap as alternative energy supplies remain out of their financial reach and the hardship of collecting natural firewood from increasing distances from the village increase. Policy makers in Botswana pay little attention to the ways in which wood fuels are produced and used. Most governments fail to recognize wood-fuels as the main source of energy for the majority in their countries leaving it to the informal sector

RECOMMENDATIONS

The Government of Botswana should promote and encourage popular use of affordable alternatives for energy in rural areas to bridge the gap between the demand and what the forest can sustainably supply. In the long-term, Botswana demand for firewood must be augmented by using alternative energy resources such as electricity, biogas (LPG), cow-dung, coal and solar energy, or establish firewood plantations manned by the community and also use of wood-efficient stoves which is believed to be effective in reducing the rate of consumption of fuel wood and thus saving women and children the time spent in collecting fuel wood. Reliance on fuels wood entrenches gender disparities as time spent, especially by women, on collecting fire wood could be spent on other productive activities and education.

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