SOCIO-ECONOMIC ANALYSIS OF LAND USE FACTORS CAUSING DEGRADATION AND DEFORESTATION OF MIOMBO WOODLANDS IN KILOSA DISTRICT, TANZANIA

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ABSTRACT

Despite the threatening effects of deforestation, the dimension of this phenomenon at the micro-agent level is not well known. This study was conducted in Kilosa District, Tanzania to assess the socio-economic impact of agriculture, charcoal making and pitsawing on degradation and deforestation of Miombo woodlands. Data were collected through a socio-economic survey using questionnaire, participantory research appraisal, and literature survey. A total of 164 households (6.5%) were randomly sampled in 6 villages for interview. Data were analyzed through descriptive statistics and multiple regressions. Results indicate that agricultural and charcoal making activities are statistically significant causes of deforestation in Miombo woodlands. Practically, charcoal making and pitsawing are regarded as selective logging but leads to degradation of Miombo woodlands as they are carried out extensively. Timber harvesting by pitsawing for example contributes the highest to household average annual income of Tanzanian Shillings (Tshs) 510,290 (US$ 425) followed by charcoal making Tshs 175,675 (US$ 146) and agriculture which account for an average of Tshs 80,290 (US$ 67). On average, total annual income per household amounts to Tshs 255,420. The study further found that population growth; poverty, market and policy failures are some of the major underlying causes of deforestation. The area cleared per household per year was 0.08ha of which, agriculture contributed 0.04ha, equivalent to 50% of total deforestation; while charcoal making contributes 0.03ha (37.5%). It is recommended that deliberate efforts be taken by the government: to improve people's economy hand in hand with conservation activities, develop alternative energy sources and ensure a proper definition of property rights and security of land tenure. Besides, extension education regarding tree planting and environmental conservation is of paramount significance.

Keywords: Deforestation - miombo woodlands – charcoal – agriculture - pitsawing

INTRODUCTION

Background

Tanzania is endowed with vast forest resources. About 38% (38.8 million ha) of the 86.6 million ha of mainland Tanzania is covered by forests and woodlands of which, almost two thirds consists of woodlands on public lands, which lack proper management (URT, 1998). Miombo woodlands are type of African woodlands dominated by species of *Brachystegia,* either alone or together with *Julbernardia* or *Isoberlinia* (White, 1983).

Contrary to popular belief, savannas, and not forests are the most widespread vegetation in tropical Africa (White, 1983). The savanna areas are where most of Africa's population lives. In the southern hemisphere, of all the savannas, miombo woodlands are by far the most common. Human activities are therefore important in the dynamics of miombo ecosystems (Morris, 1970). Resources of Miombo Woodlands are central to the livelihood systems of millions of rural and urban dwellers (Lawton, 1982).

Despite their significance, miombo woodlands have suffered and continue to suffer great destruction. Shaba (1993) has reported that about half a million hectares of miombo woodlands are cleared annually in seven countries of the miombo region. Agricultural activities especially shifting cultivation significantly cause deforestation of miombo woodlands (Chidumayo, 1990). Charcoal making and pitsawing are regarded as selective logging as well as species specific; these also lead to forest degradation (Grainger, 1993). However, the effects of these land uses differ since the woodlands themselves differ markedly in time and space; and most of them occur under communal forms of utilization.

Therefore the study is aimed at conducting a socio-economic analysis of selected land uses namely agriculture, charcoal making and pitsawing with respect to management and utilization of miombo woodlands in order to explain their impact on degradation and deforestation in the miombo woodlands and also to find ways to improve utilization and conservation.

Problem and Objectives of the Study

Despite the threatening nature of deforestation and forest degradation, the dimension of these phenomena at the micro-agent level is not well known and it varies from place to place (Ahlback, 1992). It's not clear as to how much each socio-economic activity contributes to deforestation. It is only mentioned that human economic activities and land uses contribute towards deforestation of miombo woodlands (Chidumayo, 1990; and FAO, 1991).

Therefore, there is a need to further study these phenomena in order to understand them more clearly. The purpose of this study was to investigate agriculture, charcoal making and pitsawing as major land uses in Miombo woodlands in order to find out their contribution in the degradation and deforestation of miombo woodlands, focusing on Kilosa District as a case study.

The main objective of this study is to assess the socio-economic impact of agriculture, charcoal making and pitsawing on degradation and deforestation of miombo woodlands. The specific objectives of the study are as follows:

- To determine the socio-economic importance of the three landuses (agriculture, pitsawing and charcoal making) in the study area.
- To assess the significance of each land use factor in causing degradation and deforestation.
- To estimate the rate of degradation and/or deforestation caused by each land use factor.
- To analyze what are the driving forces behind agriculture, charcoal making and pitsawing as direct agents of degradation and deforestation in the study area.

MATERIALS AND METHODS

Description of study area

The study was conducted in Kilosa district, in Morogoro region. The selection of this study area was backed by two main reasons. Firstly, the dominant vegetation type in Kilosa District is Miombo woodlands, and secondly the study area has greatly suffered from deforestation due to land use problems mainly agriculture, charcoal making and pitsawing (among others).

Location and size

Kilosa District is located in the North-western part of Morogoro Region. It lies between Latitudes 6^0S and 8^0S, and Longitudes $36^0$30'E and 38^0E. It is bordered in the North by Tanga Region and in the East by Morogoro District. In the South it is bordered by Kilombero District and part of Iringa Region. And in the West by Dodoma Region. The total area of the District is 14,567.9 km^2 or about 20% of the land area of Morogoro Region.

Climate and topography

Most of the areas are 500 metres above sea level (m.a.s.l.), the major landforms however, lie between 200m.a.s.l. and 700 m.a.s.l. They comprise of almost flat lowland plain which covers the whole of eastern part, called the Mkata Plains.The district experiences the average of 8 months of rainfall (October – May) with the highest levels between February and March. The rainfall distribution is bimodal, with short rains (October – January), followed by long rains (Mid-February – May). Mean annual rainfall ranges between 1000 – 1400mm in Southern flood plain, while further North (Gairo Division) has a mean annual rainfall of 800-1100 mm. Temperature in Kilosa town is about 25 degrees centigrade.

Soils and vegetation

The soil range from dark-reddish-brown to red sand loam in most parts, and sand clays in the valleys. The vegetation is complex but the miombo woodlands and savanna grasses dominates.

Economic activities

The main economic activity is peasant farming, producing both food and cash crops. Crops produced include: maize, rice, beans, cassava, sweet potatoes and coconuts. Others are simsim, sunflower, cowpeas and sisal, to mention a few..

Social Services

The district is endowed with quite a number of social services. Educational institutions include: primary, secondary, and vocational schools. Both private and public health centres and hospitals are available. These services increase the pressure on miombo woodlands for various products such as charcoal, timber and firewood.

Main Hypotheses of the Study

Charcoal making, pitsawing and agriculture, are profoundly undertaken in Kilosa District (which is a study area), as the main socio-economic activities. In light of this, it was hypothesized in this study that deforestation in the study area is significantly due to agriculture, pitsawing and charcoal making. Based on a dichotomous form of deforestation theory, in which the cause can either be significant or insignificant, these hypotheses were statistically tested at 1% level of significance using a multiple regression analysis.

Sources of data

Data mainly concerned with agricultural activities, pitsawing and charcoal making, as well as socio-economic and land use were collected from various sources. The primary sources of data were as follows: miombo woodlands, village leaders, sample households, pitsawyers and charcoal makers. Others are District Forest Officials and Institutions. Secondary sources included publications, reports obtained from local authorities and government offices.

Primary Data collection

Primary data for the study was obtained using questionnaire survey, informal survey and direct observation. This was aimed at acquisition of both qualitative and quantitative data.

Questionnaire Survey

Questionnaire survey was used for collection of data from households. The questionnaires were pre-tested and revised accordingly prior to the actual data collection. A Sample of 6.5 percent of all households was randomly drawn (Table 1). Based on Boyd *et al.* (1981), in socio-economic studies, a sample should at least constitute 5% of the total population to be a representative of that population.

Table 1 Sampling units in the study area

Division	Ward	Village	# HH	S/Size	%
Gairo	Chakwale	Ndogoni**	406	22	5.4
Magole	Magibike	Magubuke*	468	29	6.2
		Maguha**	557	40	7.2
Kimamba	Rudewa	Gongoni*	301	29	9.9
	Chanzuru	Ilonga*	649	35	5.4
		Mbwande*	146	8	5.5
Total/Average			2527	164	6.5

N.B: * refers to areas with relatively low-stocked miombo woodlands ($10m^3$/ha).
** refers to areas with relatively high-stocked miombo woodlands ($45m^3$/ha).

Informal surveys

The discussion with key informants such as local leaders and forest officials was conducted in order to gather necessary information on agriculture, pitsawing, and charcoal making. Interviews were conducted to both individuals and groups. This was employed to encourage a collective response and identify differences of opinions as well as areas of consensus within the group. Group interviews were conducted to find out the role of agriculture, charcoal making and pitsawing in deforestation.

Direct observation

Transects were made into the miombo woodlands at an interval of 150 metres apart and 2.5km long into the woodlands; and physical assessment of the extent of deforestation was undertaken. The parameters under observation included: newly cleared farms, farm holdings; number, size and species of trees cut for charcoal and timber; number, size and efficiency of charcoal kilns; effect of fire due to kilns; number and size of sawing pits as well as destruction due to falling trees. This method supplemented information obtained from social surveys.

Measurements and calculations of deforestation and degradation rates

Agriculture: Only data on newly cleared areas for agriculture were recorded (in acres) using questionnaire. Participant observation involving actual measurements of the areas cleared for farming was undertaken to crosscheck data obtained through questionnaire survey. Participant observation on this aspect was timely as it was the time where respondents were preparing their farms. The collected data in acres were then converted into hectares using the relationship 1ha = 2.54 acres. Deforestation rate (ha per household per year) = deforestation per year (in acres) divided by 2.54 divide by total number of households in the surveyed area.

***Pitsawing*:** The procedure used to calculate degradation / deforestation by pitsawing, was as follows: (i) Volume of timber is computed (in ft^3) using the formula: volume = width (ft) x thickness (ft) x length (ft); since sawn timber is usually measured in feet (ft). (ii) Volume computed in (i) above is then divided by 35.315 to obtain volume in m^3. It was found during the study that on average, 1 piece of sawn timber (2"x6" or 1"x12") =0.026$m.^3$ (iii) Total deforestation (m^3) per year due to timber = total number of sawn timber per year x 0.026.

(iv) 3 m^3 of logs produce 1m^3 of sawn timber. Therefore, total volume of logs per year equivalent to timber produced = (total number of sawn timber $year^{-1}$ x 0.026 x 3) m^3. (v) Deforestation (ha per household $year^{-1}$) due to pit sawing =total volume of logs pit sawn per year divide by stocking rate / total number of households in the surveyed area. According to Temu (1979), the relatively low-stocked miombo woodlands =$10m^3ha^{-1}$ while the relatively high-stocked miombo woodlands = $45m^3$ ha^{-1}. *(N.B. It should be clearly noted that, total deforestation due to pitsawing is essentially the sum of spots or patches of degraded /deforested areas due to pitsawing activities).*

Charcoal making: The rate of deforestation /degradation due to charcoal making was calculated using the following method: According to Ishengoma (1982), 1 bag of

charcoal = 28.4 kg of round wood and 6-8m^3 of wood produces one tone of charcoal. It is also assumed that 1 year = 12 months. Therefore, according to the above facts, volume per month round wood equivalent to produce charcoal (m^3 $month^{-1}$) = bags/month x28.4kg/bag x7/1000 (m^3 kg^{-1}). Estimated volume of round wood per year = volume/month x months/year. Deforestation rate (ha per household per year) = estimated volume per year divide by stocking rate / total number of households in the surveyed area.

[It should be explicitly noted that, for the sake of simplicity of deforestation rates' computations, all deforestation rates were calculated per household per year. Nevertheless, knowing the total number of households in the study area, total deforestation (caused by each landuse) can easily be computed]

In the study area, it was found that practically the charcoal makers and pitsawyers undertake their activities in different areas; and there was no any observed incidence in which charcoal was made out of residues from pitsawing.

Secondary Data Collection

The secondary data were obtained by compilation from secondary sources, mainly: publications, reports obtained from local authorities, government offices and personal communication with relevant people. This formed an overview and identified gaps in information.

Data analysis

Statistical analysis

The Statistical Package for Social Sciences (SPSS) was employed for data analysis. Two types of statistical analysis were done, namely descriptive statistics and inferential statistics.

Descriptive statistics

This involved percentages, frequency counts, means, and standard deviations of variables including: age, marital status, sex, education level, household size and annual income.

Inferential statistics

This involved regression analysis. Multiple linear regression analysis was used to explain the impact of charcoal making, pitsawing and agriculture on deforestation. The analysis assessed the following: Whether the variables (i.e. dependent and independent) are related

Measurements of the the strength of the relationship.

The following assumptions were made with regard to this regression analysis:

The relationship between the dependent variable and each independent variable is linear. The variance of the distribution of the dependent variable is constant for all values of the independent variable.

For each value of the independent variable, the distribution of dependent variable is normal. The error term should be normally distributed and uncorrelated with dependent and independent variables. The basic statistical model for multiple regression was as follows:

$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + E_i$

Where:

Y = The observed value of the dependent variable (deforestation)

B_0 = Population parameter for Y intercept

B_1' B_2, B_3 = Independent variable coefficients

X_1, X_2, X_3 = Independent variables (socio-economic factors)

E_i = Random disturbance error.

The explanatory power/goodness of fit of the regression was assessed by its coefficient of determination (R^2). The test of significance was done at 1% level of significance (using a two tailed t-test) by testing hypotheses:

Null hypothesis: Ho: $B_1 = B_2 = B_3 = 0$ (i.e. there is no relationship between deforestation and socio-economic factors). Alternative hypothesis: at least one of the coefficients (B's) is not equal to zero (i.e. There is a relationship between deforestation and socio-economic factors). Null hypothesis (Ho) was rejected when $p < 0.01$.

Dependent variable was deforestation, while charcoal making, agriculture and pit sawing were independent variables. Deforestation was measured in ha of forest cleared, charcoal making in bags produced, agriculture in ha of a newly cleared land, and pitsawing was measured in cubic metres of pitsawn timber produced. The alternative multiple regression model included education level, household size, age, employment and marital status as independent variables and deforestation as a dependent variable, was also developed to further explain deforestation process in the study area.

Choice of Regression model adopted

Both linear and non-linear regression models have weaknesses. The weaknesses of the linear regression models seem to be relatively fewer and easier to handle than those of non-linear regression models; that is why the former model was adopted in the present study. Furthermore, the method of Maximum Livelihood (ML) was not used in this study due to its mathematical complexity and biasness of its u_i

Linear regression model

Standard linear regression models assume that errors in dependent variable are uncorrelated with the independent variable. It implies therefore that when this assumption doesn't hold true then, the linear regression using Ordinary Least Square (OLS) no longer provides optimal model estimates. To avoid this, Two-stage Least-square regression was employed; and all independent variables used in the regression models were checked for the 'multicollinearity' effect. Essentially all the independent variables were less collinear (with correlation coefficient < 1).

Non-linear regression model

The non-linear regression models posses the following difficulties (weaknesses):

It is difficult to have a specified function that accurately describes the relationship between dependent and independent variables.

It involves the use of iterative algorithms, which entails relatively more statistics than linear regression models.

Sometimes, one algorithm performs better than the other, on a particular problem.

Appropriate starting values for the parameters are necessary, and some models require constraints to converge.

Models that require exponentiation of or by large data value can cause overflows or underflows.

The method of Maximum Livelihood (ML)

This method possess some stronger theoretical properties than OLS. Nevertheless, it has the following weaknesses:

Its mean's standard deviation ($\sigma^2 = \Sigma\hat{u}_i^2/n$) is biased as compared to standard deviation of OLS [$\sigma^2 = \Sigma\hat{u}_i^2/(n-2)$].

Has slight mathematical complexity

The OLS with the added assumption of u_i provides all the necessary tools for both estimation and hypothesis testing of the linear regression models (Gujarati, 1995).

RESULTS AND DISCUSSION

Preliminary ranking of agriculture, charcoal making and pitsawing to deforestation and degradation of miombo woodlands.

Results from four villages out of the six villages surveyed (equivalent to 66%) showed that agriculture is the most destructive activity to miombo woodlands. Responds from one village showed that

destruction of miombo woodlands is mostly due to charcoal making, while in the other village they cited pitsawing as the most destructive activity to miombo woodlands. Villages, which cited agriculture as the most destructive activity, are: Magubike, Gongoni, Mbwade and Ilonga; while charcoal making and Pitsawing were pointed to be the most destructive activities by Ndogomi and Maguha villages respectively.

Agriculture

The subsistence agriculture is the most common economic activity in the study area. The average farm holding per household is 3 acres. The minimum and maximum farm holdings per household are 1 and 8 acres respectively. About 60% of the farm holdings are at the average distance of 6 km from their homesteads; 10% of the farm holdings are at the distance of 1km; while 30% of the farm holdings are a distance of 3 km from the homestead One observation is that there is no a clear distinction between peasants, pitsawyers and charcoal makers in that one person may be found doing all the three economic activities. It was found during the study, that 102 respondents were peasants, 45 respondents were charcoal makers while 26 respondents were pitsawyers. Nine (9) people were found to be engaged in both charcoal making and pitsawing activities.

Economic importance of agriculture in the study area

As shown in Table 2, agriculture contributes on average, a total income of Tshs 80,290 per annum per household. The average minimum and maximum income per annum per household being Tshs 10,800 and 600,000 respectively. The low income accrued from agriculture is due to number of factors including poor agronomic practices (such as lack of fertilizer application and fallowing) and low capital. Farmers in the study area hardly use fertilizer and manure to enrich their farm holdings (only about 13.5% of all respondents) primarily due to lack of capital.

Moreover, due to low capital, majority of the peasants have small sized farms which, together with poor agronomic practices lead to low/poor productivity and hence relatively low income. On average, the total annual household income in the study area, was found to be Tshs. 255,420.

Table 2 Summary of household annual income for agriculture, charcoal and timber

Item	Income (Tshs/hh/year			
	N	Minimum	Maximum	Mean
Charcoal	45	36,000	1,152,000	175,675.6
Sawn timber	26	90,000	1,800,000	510,292.3
Agriculture	102	10,800	600,000	80,293.9

Agriculture as the cause of deforestation

Relatively many farmers in the study area do expand their farms annually in search of fertile land by clearing miombo woodlands. In the study area, agriculture causes a deforestation of 0.04ha per household per year equivalent to 50% of total deforestation in the area (Table 3). Data on area cleared annually for farming was collected in acres and then converted into hactres (ha) using the relationship 1ha=2.54acres.The average annual deforestation per household = total annual deforestation / total number of households in the surveyed area.

Table 3 Deforestation rates in Kilosa District due to charcoal, pitsawing and agriculture.

Landuse	Ha per household year	Total deforestation (%)
Agriculture	0.04	50.0
Charcoal	0.03	37.5
Pitsawing	0.01	12.5
Total	0.08	100.0

Source: Own survey data 1999.

The previous study by the District Natural Resources Office in 1999 (in the study area) reveals similar observation that, a considerable amount of wood is harvested annually due to charcoal and timber (Table 4); the study does not however compare the quantities harvested by the two landuses viz. charcoal making and timber production.

Table 4 Quantity of wood products harvested for six years period in Kilosa District.

Year	Quantity harvested		
	Charcoal (tons)	Timber (m^3)	Firewood (m^3)
1992	2084	1750.0	511
1993	2500	1663.8	5187
1994	3000	920.9	5087
1995	2690	1900.0	5036
1996	2812	1690.0	2525
Total	10,274	7,924.7	18,346

Source: District Natural Resources Office, 1999

Pitsawing

Pit sawing is another economic activity undertaken in the area. According to the District Forest Officer, pitsawing business is mostly done illegally due to two main reasons. First, it is relatively expensive for a normal pitsawyer to acquire license because payments for the license should be done to both District Council (50% of total cost) and the Forestry and Beekeeping Division (100% of total cost), implying that one has to pay 150% of the normal cost. Second, licensing procedure (on the side of pit sawyers) is loaded with bureaucracy such that it takes time before some one completes the procedures leading to the acquisition of license.

Pitsawing in the study area contributes about 12.5% of total deforestation /degradation in miombo woodlands, equivalent to 0.01ha per household per year. (Table 9). The study found out that majority of the pit sawyers are residents while the minority are immigrants, mainly from Dodoma and Iringa who are employed by local people. On average, total gross annual income per household as indicated in table 12, amounts to Tshs 510,290; which is by far, higher than that from agriculture. The minimum and maximum household annual income accrued from pitsawing is Tshs 90,000 and 1,800,000 respectively. Tree species highly affected by pit sawing include: *Pterocarpus angolensis, Brachystegia spisformis, Brachystegia microphyla, Afzelia quanzesis, Burkea africana, Terminalia cericea, Newtonia spp and Dalbergia melanoxylon.* Most of sawn timber is sold locally for construction purposes and furniture making. Some however is consumed outside the district. The average price per piece of sawn timber at the local market ranges from 1500 –2500 Tshs.

Charcoal making

Based on total sample of households surveyed, of the three economic activities (agriculture, charcoal making and pitsawing),

charcoal making contributes 37.5% of the deforestation / degradation of miombo woodlands in the study area. The study has shown that the annual deforestation per household due to charcoal making amounts to 0.03 ha.

According to Ishengoma (1982) 1 bag of charcoal = 28.4 kg of round wood and 6-8m^3 of wood produces one tone of charcoal. It is also assumed that 1 year = 12 months. Therefore, according to the above facts, volume per month round wood equivalent to produce charcoal (m^3 $month^{-1}$) = bags/month x 28.4kg / bag x7/1000 (m^3 kg^{-1}). Estimated volume of round wood per year = volume/month x months/year. Deforestation rate (ha per year) = estimated volume per year / stocking rate. Hence the average annual deforestation per household per year = deforestation (ha per year)/ a total number households in the surveyed area.

Like pitsawyers and for similar reasons, majority of charcoal makers are undertaking their activities illegally. Charcoal is mostly sold locally (local consumption) except in few areas, which are located along Morogoro-Dodoma road where it can be transported and sold a long, distance from the area of production especially in urban centers. The price per bag of charcoal (about 28kg) varies between 1000-1500Tshs and charcoal contributes (as shown in Table12) on average, a gross income of 175,675Tshs/annum/household; which is higher than that from agriculture and less than that accrued from pitsawing. The minimum and maximum income /annum/household accrued from charcoal amounts to Tshs 36,000 and 1,152,000 respectively.

In summary, the average annual income (gross) per household from charcoal, pitsawing and agriculture (in Tshs) are 175,675; 510,290 and 80,290 respectively. It is vivid from the data that, in the study area, agriculture contributes least while pitsawing contributes most to the household's annual income; charcoal making has a modest contribution to the household annual income. The implication is that many people are engaged in pitsawing and charcoal making as the major income generating activities while agriculture is practiced (primarily in already existing farm-holdings) mainly for subsistence. Since pitsawing requires relatively higher capital investment than charcoal making, a relatively greater number of people go for the later activity, thereby rendering it highly destructive to miombo woodlands in the study area. Tree species highly preferred and therefore affected by charcoal making include: *Brachystegia spp, Acacia spp, Combretum spp, Terminalia spp, Dalbergia melanoxylon and Anacardium occidentale.*

Most of people are engaged in charcoal making activities owing to the fact that unlike pitsawing, it does not require high capital investment and it has many customers. Charcoal makers just like pit sawyers, have species preference in their activities; since the quality and hence the price of charcoal is greatly dependant on tree species used to make it.

Land and tree tenure system

The villages in Kilosa District are mainly of peasant farmers. Majority of people acquired land through inheritance within clans. Some farmers however, acquired their lands through clearing the forest and woodlands. Customary land laws guide these lands. There are some people who came from outside to dwell in the area. These got land through the village government or buying from local people; some borrow land from neighbours and payment is either done in terms of cash or kind. The price being negotiable and ranges from Tshs 7,500-15,000 per year.

Inferential statistical results

Multiple regression analysis was undertaken in which case two multiple regression

models were developed. The first (basic) model was carried out to determine the contributory effects of charcoal making, pitsawing and agriculture (independent variables) to degradation and deforestation of miombo wood lands (dependent variable) while the second (alternative) model further explained other socio-economic factors thought to influence degradation and deforestation in the study area. These factors include age of respondents, household size, employment, income level, education and marital status.

Factors contributing to deforestation in the study area

Table 5 gives the results of regression analysis for charcoal making, pitsawing and agriculture as factors contributing to degradation and deforestation in the study area.

Table 5 regression analysis results for factors contributing to deforestation and degradation of miombo woodlands.

Variable	N	B	SE B	Beta	T	P
(Constant)		-1.053	1.472		-0.716	0.481
Agriculture	102	2.19E-02	0.002	0.692	14.444	0.000 S
Charcoal	45	0.315	0.027	0.602	11.562	0.000 S
Pitsawing	26	0.496	0.715	0.037	0.693	0.495Ns
$R^2 = 0.951$						

Source: Own survey data 1999

Key: S = significant at 1% level of significance; Ns = not significant at 1% level of significance; R^2 = coefficient of determination;
SE = standard error; and N = sample size

Table 5 suggests that generally in the study area, charcoal making; and agriculture, significantly contribute to deforestation of miombo woodlands.

Factors contributing to deforestation and degradation

From table 5, the significance test shows that agriculture and charcoal making (with deforestation rates of 0.7% and 0.6% of total deforestation in the study area, respectively) were statistically significant at 1% level of significance, while pitsawing (with deforestation rate of 0.04%) was not. The results also reveal that agriculture has the highest contributory effect to the deforestation of miombo woodlands followed by charcoal making. Pitsawing as the direct agent of degradation has the least contributory effect; this is partly because few households (only males) are involved in pitsawing activities and the activity is highly species specific. Besides, the activity requires relatively high capital investment. Both males and females undertake charcoal-making activity; the activity affects trees of almost all diameter classes; charcoal making activities require relatively low capital investment for acquisition of necessary equipment (and also low operational costs) and as such, many people are able to undertake it. These are some of the reasons as to why charcoal making has high contributory effect to degradation and deforestation of miombo woodlands. Agriculture as a land use constitutes only 9.5% of the District land area. There is not much cultivation in mountainous areas. Cultivation is practiced around the villages mainly for subsistence. The small-scale farming is more widespread and characterized by mixed cropping, while the large-scale farming is limited to plains and mainly characterized by monoculture of sisal and maize.

It can be clearly seen that agriculture is mainly done in the existing farms. However, farming involves clearance of the whole canopy cover of a given area; that's why it has significant contributory effect to the deforestation of miombo woodlands. All the independent variables were found to be positively correlated to deforestation, hence signifying their positive contributions to deforestation. The coefficient of determination (R^2=0.951) indicates that about 95% of variations in deforestation, can be explained by charcoal making, pitsawing and agriculture. Therefore, the model has stronger explanatory power; it is also statistically significant at 1% level of significance.

Incentives for better management of miombo wood lands

When interviewed as to what should be done to facilitate the better management of miombo wood lands, villagers enumerated various incentives to be rendered some of which include: Provision of extension education on the management of miombo wood- lands; Provision of loans to people (in groups) so as to enable them engage in other non-forest related income generating projects; Empowerment of villagers to their surrounding forests/wood lands and Introduction of cash crops in the study area and provision of reliable markets. Others include, Launching of village micro-projects. Provision of adequate fertile land to the villagers Village environmental committees should be started.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the present study, various conclusions can be made. Pitsawing has the highest contributory effects to the annual household income, followed by charcoal making while agriculture ranks the last; their contributions are Tshs: 510,290; 175,675 and 80,290 respectively. Agriculture is revealed to have the most contributory effect towards the deforestation of miombo woodlands followed by charcoal making, while pitsawing has insignificant contributory effects to the deforestation of miombo woodlands. The total deforestation of miombo woodlands in the study area is 0.08 ha per household per year, which is quite significant. Contribution of agriculture and charcoal making, to this deforestation, is 0.04 ha, (equivalent to 50% of the total deforestation) and 0.03 ha (equivalent to 37.5% of the total deforestation) respectively. Pitsawing insignificantly contributes 0.01ha (equivalent to 12.5% of the total deforestation).

Both charcoal making and pitsawing activities are species-specific hence causing biodiversity disturbances and species extinction. The main species highly affected include: *Pterocarpus angolensis; Brachystegia spisformis; Brachystegia microphyla; Afzelia quanzesis; Burkea africana; Terminalia cericea; Newtonia spp; and Dalbergia melanoxylon.* The driving forces behind agriculture, charcoal making and pitsawing as direct agents of deforestation are mainly low income level and lack of employment

People in Kilosa District depend heavily on miombo woodlands for among other things, charcoal and pitsawn timber; despite the deliberate efforts made by district forest office to prevent deforestation of miombo woodlands in the district. Therefore the management strategies should also include the needs of the people in the study area. The charcoal making and pitsawing activities lead to forest degradation. In the study area however, these activities are so extensive that they cause deforestation.

Recommendations

It is recommended that the government render deliberate efforts: to improve people's economy hand in hand with conservation activities. Improved wood and charcoal stoves should be introduced in the

study area so as to reduce the consumption of woodfuel, thereby conserving the miombo woodlands. The government should see to it that the prevailing conflicts between peasants and pastoralists are fully addressed by explicitly allocating the areas to be occupied by the latter group. Licensing procedures and costs should be thoroughly reviewed to enable pertinent people acquire license for charcoal making and pit sawing activities. This will facilitate the controlling of such activities and hence reducing deforestation of miombo woodlands.

The forest staff members in the study area should be well equipped with especially means of transport to enable them move and work from one village to another. Moreover, political leaders should give them moral support.

Farm forestry and agro-forestry activities should be initiated and /or promoted in the study area as they are potential alternatives for creating medium and long term supply of forestry and agricultural products and services.

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