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TREE SPECIES DIVERSITY UNDER PASTORAL AND FARMING SYSTEMS IN KILOSA DISTRICT, TANZANIA

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ABSTRACT

Loss of tree diversity through improper land use practices such as overgrazing and poor farming practices in tropical areas and other natural ecosystems is one of today's most worrying environmental problems. This study was conducted to assess the impact of farming and pastoralism on tree species diversity in two forests each owned and managed by pastoral and farming communities in Kilosa District. Household survey solicited information on perceptions of local communities on drivers that influenced tree stocking and diversity of their forests. A forest inventory was conducted involving twenty circular in each system plots laid along two transects. In each plot, trees and shrubs with DBH > 5 cm were measured for DBH and height. A total of 48 different species were recorded out of which 75%were tree species and 25% shrubs species. The forest under pastoral system had a Shannon - Wiener Index (H') of 3.13 as opposed to farming system with an index of 2.05. Average stocking for the forest under pastoral system was 235 stem ha-1, whereas that of farming system was 209 stem ha-1. Basal areas of 13m2ha-1 and 6m2 ha-1 were recorded for forests under pastoral and farming systems respectively. Standing volume showed the same tendency where 216m3ha-1 was recorded from the forest under pastoral system as opposed to 100.12 m3ha-1 from the other forest. The high loss of species diversity and stocks particularly in the forest under farming system were attributed to anthropogenic disturbances including cutting trees for farm expansion, charcoal making and house construction. Although the assessment on the community perception on the loss of tree diversity in the area showed conflicting interests between the two societies each blaming activities of each community as major causes of forest degradation. This calls for more enforcement of rules and regulations and tree planting in degraded areas predominantly in the farming communities. The study further revealed that the existing tensions over land resource ownership between the two communities of farmers and pastoralists may be contributing factors of unsustainable use of tree species and other forest resources. It is recommended that interventions should be done to settle conflicts over land resource ownership and management between the two villages as well control proliferation and dominance of Acacia nilotica as a way to improve pasture and improve species diversity in the area.

Key words: Tree stocking - rules and regulations - anthropogenic disturbances

INTRODUCTION

An ecosystem with many trees species has a better chance of including individuals that might be able to adapt to changes in the environment. Species diversity identifies and characterizes the biological community and the functional conditions of a habitat as well as the overall ecosystem function**.** Loss of tree diversity through improper land use practices such as overgrazing and poor farming practices in tropical areas and other natural ecosystems is one of today's most worrying environmental problems (Mahunnah & Mshigeni, 1996). According to Dale and Slembe (2005) under anthropological disturbances**,** species that are restricted to undisturbed, primary forests will be replaced by species adapted to disturbed, secondary forests. Poor land uses in tropical countries has a major impact on global biodiversity (Simberloff, 1986; Whitmore & Sayer, 1992).

It is projected that most of the tropical forest will have been destroyed or severely damaged within the next 25 years because of increasing poor land use practices in the tropics and sub – tropics (Abdallah & Sauer, 2007). In Tanzania for instance, the most important factor driving tree diversity fragmentation including anthropogenic activities such as cultivation and conversion of natural vegetation to other uses (Luoga *et al.,* 2000). In places where pastoralism and farming are undertaken at subsistence level, and there is nothing done to protect tree diversity, species loses is obvious. But, in literatures pastoral and farming activities are considered to have varied impact on tree species diversity (Lawton, 1982; Silayo *et al.,* 2006). Studies by Homer-Dixon (1999); Hesse and MacGregor (2006) have found that pastoral communities do not favour forest conservation measures that allow human used to forests, as compared to farming communities, which are not rooted in conservationists' priorities result in marred ecosystems suffering from local extinction of tree species.

Other conservationists postulate that cattle overgrazing cause vegetation degradation and deforestation, water pollution (from erosion and manure), desertification and loss of biodiversity (Chidumayo, 1990). It is believed that grazing in tropical forests reduces forest litter which could be detrimental during seasonal fires hence facilitating survival of seedlings. However other findings (Nduwamungu *et al.,* 2004) have revealed that some pastoralists set fire in the forest and woodland as a way of inducing growth of fresh grass and eradicating tsetseflies hence degradation of trees diversity. In addition to defoliating plants, animals physically damage plants by cutting, bruising, breaking and debarking them. In some cases it is believed that the effect of farming systems especially shifting cultivation has remarkable effects on tree species diversity in tropical forests (Shaba, 1993; Luoga *et al.,* 2000; Darlong, 2002). This is probably due to the fact that farming involves clearing of forest cover, continuous seedling removal and depletion of soil nutrients (Silayo *et al.,* 2006).

Pastoralism and farming are practiced in various places in Tanzania such as Kilosa. However the influence of these practices to the forest tree resources at a local scale is not well captured/understood. The aim of this study therefore was to assess and compare at local scale the influence of pastoral and farming systems on tree species diversity in Kilosa District. The district is well known for conflicts between farming and livestock keeping communities who often contest for land resource use and management priorities.

Pastoralists on one hand claim that farming expands and grab more land resulting into clearance of trees and other types of vegetation important for sustainable grazing and diversity of fodder. Farmers on the other hand criticize pastoralists as being trespassers to their farmlands hence severely damaging their crops while affecting soil productivity.

METHODOLOGY

Description of the study area

The study was done in Kilosa district which is located in the North-western part of Morogoro Region. It lies between Latitudes 6°S and 8°S, and Longitudes 36°30'E and 38°E. 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. The district covers approximately 1,426,450 hectares corresponding to about 20% of the land area of the region (Brehony et al. 2003).

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 1,000 – 1,400mm in Southern flood plain, while further North (Gairo Division) has a mean annual rainfall of 800-1100 mm. The mean annual temperatures in Kilosa is about 25 degrees centigrade.

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 (Lusambo *et al.*, 2007).

Selection of study villages

Two villages; Mabwegere and Mfuru were selected for this study. The criteria for selecting these villages was the existence of pastoral and farming communities with constant land use interactions. Mabwegele is dominated by pastoral communities while Mfuru is dominated by farmers who are mainly crop producers. According to 2002 national census Mabwegere had a population of 2,146 and Mfuru had 1,807 people (NBS, 2002).

Mabwegere in one hand is commonly inhabited by Maasai and scattered Barbeig people who keep cattle, sheet, donkey, goats among other livestock kept in free range system. On the other hand Mfuru is a farming-society village commonly inhabited by Kaguru, Waluguru, and Sukuma although there are few individuals from other ethnic groups around Tanzania which together depend on agriculture and forest products for subsistence and economic gains. The farming system in the villages is a small-scale peasantry practiced on small patches with riverine characterizes and in lowland farming in the general land forest. They practice shifting cultivation, a common farming system by many communities living adjacent to uncontrolled forests in Tanzania and especially where soils nutrients are poor. The common crops are maize, sorgum, millet, cassava, beans, groundnuts, banana, sunflower, simsim, sugarcane, sweet potatoes, watermelon, sweet potatoes and sesame which are mainly for food and trade. The two villages are connected by forests/woodlands from which people depend heavily for grazing, fuelwood, medicines and rituals. Charcoal production is also the cash generating activity in the area.

Data collection methods

Socio-economic data

Socio-economic data were collected using various approaches including administration of questionnaires to household heads and discussions with key informants. Information collected included perceptions of local communities on drivers that influenced tree stocking and diversity of their forests. A total of 70 households were interviewed in both villages.

Forest Inventory

Sampling designs

Systematic sampling design to ensure full coverage of the population, maximization the precision of estimates as well as obtaining additional information on soils, vegetation and topography. Four transects spaced at 0.5km were laid down in each forest type (in pastoral and farming systems) from which 48 sample plots; 24 plots in each land-use system were laid out for data collection. The sample plots were 200m apart.

Sample plots

We used circular sample plots were used to avoid 'edge' effect for data collection. Each sample plot was sub divided into four nested plots where measurements were taken within:

(i) 2m radius, all/regenerants were counted and recorded;

(ii) 5m radius, all trees and shrubs with Dbh ≥ 5 < 10 cm

(iii) 10m radius, all trees and shrubs with Dbh ≥ 10 < 20cm;

(iv) 15m radius, all trees and shrubs with Dbh > 20 cm;

Data analysis

Stand Parameters

We performed statistical analysis of the data was performed to calculate stand parameters; stems (N), basal area (G) and volume per hectare (V). The total number of stems was computed based on the individual counts while the basal area and volume were computed based on the diameter at breast height (Dbh) measure per individuals. Since the study area falls within the Miombo ecosystem, the volume of individual tree was calculated using a general Miombo tree species' equation by Malimbwi *et al.* (1994) (equation 1).

$$V_i = 0.0001 * d_i^{2.032} * h_i^{0.66} \qquad 1.$$

Where;

V_i = the volume of the i^{th} tree (m^3); d_i = the diameter at breast height (1.3m) for the i^{th} tree (m) and h_i = the total height of the i^{th} tree (m).

Species diversity

Shannon - Wiener Index of Diversity *H';* was used to calculate species diversity we used. This is the most widely used index as it is not affected by the sample size (Kent and Coker, 1992 cited in Zahabu, 2000)..

The shannon - Wiener index of diversity 'H' was calculated as shown in equation 2.

$$H' = \sum_{i=1} P_i \log_a * P_i \quad \ldots 2.$$

Where;

H' is the Shannon index of diversity; Σ is the enumeration symbol, while P_i is the proportion of individuals or the abundance of species i^{th} in the sample.

Index of dominance (C) was calculated using the formula (Krebs, 1989) equation 3.

$$C = \sum \left(\frac{n_i}{N} \right)^2 \qquad 3.$$

Where, n_i is the number of individuals of species i^{th} in the sample while N is the total number of individuals (all species in the sample)

Social economic data analysis

Descriptive statistics were used to analyse the data with the Statistical Package for Social Sciences (SPSS) employed as a tool to code and facilitate the analysis.

RESULTS AND DISCUSSION

Socio-economic aspects

Respondent characteristics

Characteristics of the surveyed population show that in pastoral community males represented 90% of respondents as compared to the farmers (65%). Most of the pastoralists were 45 years or older and were the ones who made important decisions with respect to village resources such as pasture, water and tree resources (forests and woodlands). While in farming community the middle aged group (19-45 years) was relatively highly represented (70%). The family size was generally higher in pastoral as compared to the farming community. Bigger family sizes in pastoral families are important as it 'means' high labour source.

The pastoral community owns land in communal system while in farming communities some portions are privately owned while some is owned communally as well. The study found both communities own their land in designated villages although in farming community individual acquire land within their villages by opening up new areas these being forests and woodlands or inherit from their parents. While the decision on resource in pastoral community is vested over the elders, in farming communities the middle aged group were the key players in most issue related to trees and forests in particular.

Tree species composition

A total of 544 and 103 tree and shrub individuals distributed in 48 species were identified from pastoral and farming communities inhabited areas (here referred to as forests) respectively. The canopy tree layer was dominant at 65% and 35% as compared with shrub layer with 5 and 15% in pastoral and farmers' area forests respectively. The relatively higher percentage observed for shrubs in the farmers areas might be due disturbances from agricultural activities which opens the forest for pioneers and shade intolerant species. Browsing and grazing may have also affected the occurrence of shrubs in big numbers in pastoral areas.

Species diversity

The results on the species diversity index showed that the Shannon - Wiener index (H') was 3.13 and 2.05 while the dominance indices were 0.18 and 0.25 for forests under pastoral community and the farming community forests respectively. This observation indicates that the diversity in both areas in relatively high. According to Barbour *et al*. (1987 cited in Zoungrana and Temu, 1996) the higher the value the greater the diversity while in cases where values of Shannon's Wiener Index is greater than two then, the situation can be categorized as of being medium to high diversity.

However, the small diversity observed in forests under farming communities reflects degradation due to diverse anthropological activities including charcoal making and shifting cultivation, which is commonly practices by local communities in the area. This is because when we performed the species important value index we found that those tree and shrubs species earlier mentioned by Malimbwi *et al*. (2004) as charcoal and or timber preferred like *Brachystegia* species, *Combretum* species, *Acacia gerradii, Afzelia quanzesis, pterocupus angolensis* and *Burkea Africana* ranked the least. Species like *Acacia polyacantha* subsp. c*ampylacantha* was the most dominant in farmers land probably due to its two major characteristics which were reported in Zahabu (2000) and . That, the species is pioneer and not suitable for charcoal making as its charcoal easily breaks down into small pieces during transportation. Its charcoal also sparks during initial stages of burning which threatens the life of users (Silayo *et al.,* 2006)

Forest standing crop and regeneration potential

Wood stocking per ha

We found 235 and 209 stems per ha in forests under pastoral communities and farming community forests respectively. The dominant tree species in pastoral land forests were acacia species although *Acacia nilotica* appear dominant with 155 stems per ha. Occurrence and spread of these species have resulted into disappearance of some herbaceous species and has lowered the quality and quantity of pastures. *Acacia nilotica* is believed to have high level of allelopathic effect and can establish prolifically in opened areas. However, the distribution of number of stems by diameter class in both forests show a reversed J-shaped trend (Figure 1.) as expected in natural forest with active regeneration and recruitment. *Gravillea robusta* was the only intercropped timber tree found in farmers land although in small numbers due to overexploitation.

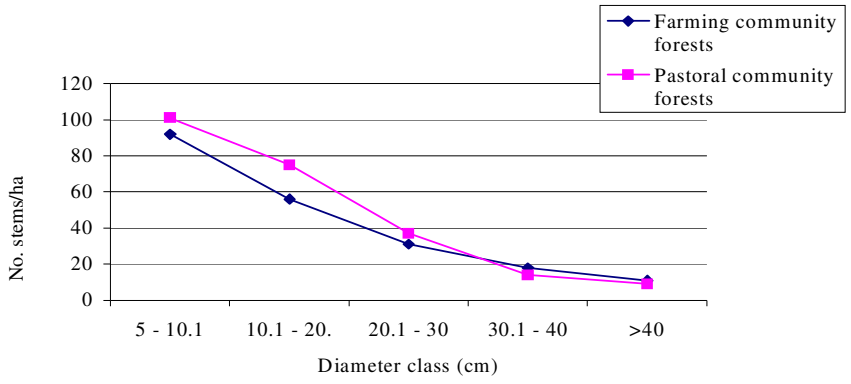

Figure 1. Distribution of stems per ha in the farming community and the pastoral community forests of the selected villages, Kilosa, Tanzania.

Stand basal area and wood volume per hectare

The mean basal areas per ha were 13m²ha^{-1} and 6m²ha^{-1} for forests under pastoral communities and farming communities respectively. The mean volumes were 216m^3 and 100.12m^3 per ha in that order of forest types. The volume values were found higher at lower diameter classes (i.e. Dbh <30.1cm) with subsequent decrease at higher diameter classes indicating an overexploitation of bigger diameter trees. Temu (1980) reported that the average limit of 60m^3 per ha for Miombo woodlands

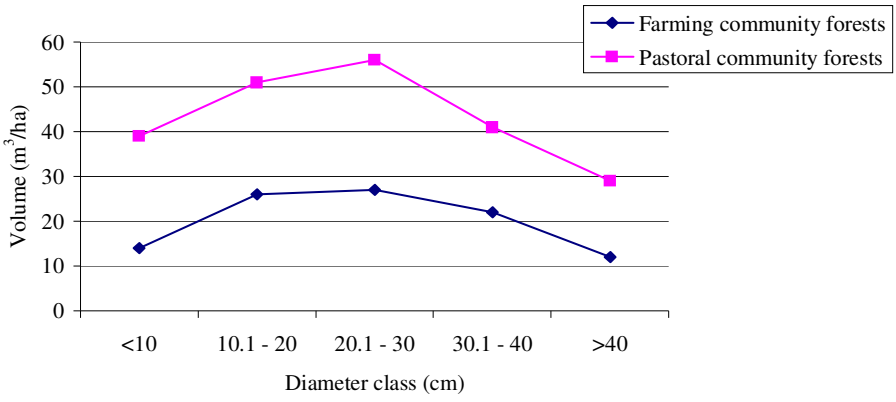

Figure 2. Distribution of wood volume by diameter class for forests under farming and pastoral communities in the selected villages of Kilosa District, Tanzania.

Communities' perception on degradation of the tree vegetation

The study revealed that both communities have different perceptions on the main causes of tree vegetation and environmental degradation in general. Table 1 shows results from a multiple regression analysis for several causes of the woodland degradation as analyzed from individual responses. It was found that each community blames social economic activities of another one as the main cause of tree resource degradation in the area. While farmers blame pastoralists for starting bush fires in an attempt to stimulate new pastures pastoralists raised their concern on farmers for been the source of most bush fires during farm preparations which in turn kill most of the small trees in the woodlands. It could no be established if the two sided blames arise from their existing conflict or otherwise. Despite the blames, the fact remains that bush fires affect seriously regeneration and recruitment of the Miombo species. According to Kielland-Lund (1990), most shrubs and regenerating trees below 3 – 4m are killed or heavily damaged by frequent grass fires in Miombo woodlands. Agriculture especially shifting cultivation and animal grazing and browsing were mentioned as the most leading activities in degrading the woodlands status. While about 90% of the pastoralists complained that agriculture was the main driver towards species loss and soil degradation.

Lusambo *et al.* (2007) found that many farmers in Kilosa district as for many areas

in the Miombo woodlands do expand their farms annually in search of fertile land by clearing the woodlands

Table 1: Regression analysis results for factors contributing to deforestation and degradation of Miombo woodlands in the selected villages, Kilosa, Tanzania.

Variable	N	B	SE B	Beta	T	P
(Constant)		-1.043	1.372		-0.616	0.381
Agriculture	30	2.09E-02	0.002	0.592	9.444	0.000 **
Grazing/pastoralism	32	0.215	0.027	0.502	7.562	0.000 **
Charcoal/seasonal fires	13	0.296	0.515	0.027	0.590	0.391 Ns
R^2 = 0.87						

Key: ** = 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.

The author further revealed that agriculture causes a deforestation of 0.04ha per household per year equivalent to 50% of total deforestation in Kilosa district. On the other hand 75% of the farmers mentioned grazing as influenced by high number of livestock as the main driver. Livestock free grazing was also associated with loss of soil fertility and compaction leading to poor productivity in farmers land as the pastoralists normally grass in farms after farmers have harvested their crops. Other reasons responsible for tree resource degradation included droughts, harvesting for building materials and reluctance in tree planting.

CONCLUSION AND RECOMMENDATIONS

The two forest types are subjected to high pressures from anthropological activities of both communities. The existing tensions over land resource ownership between the two communities of farmers and pastoralists may be contributing factors of unsustainable use of tree species and other forest resources as there were some senses of sabotage from each group. With the increasing pressures from physical and biological factors like drought, inversion by *Acacia nilotica* species especially in pastureland and uncertainties over land ownership and management between the two villages, we would like to recommend the following;

- There must be deliberate efforts by researchers and the government in combating spread of the *Acacia nilotica* species in pastoral lands so as to improve the quality of both pasture and increase tree and shrub species in these areas.
- The long existing tensions of boundary between the two villages must be resolve by a trusted side to both communities to as to go away with sabotages in resource use between them.
- Establishment of village environmental committee with the mandate of setting use regulations at village level
- Reduce the high demand of charcoal at national level through provision of subsidy on electricity charges by the government so majority of the people can afford it.

- Improve mode livestock keeping to suite with the carrying capacity of the available village land.
- Continue strengthening village conflict resolution committees so as to maintain the existing livestock routes to avoid trespassing in farmers land as a way to avoid conflict but also reduce browsing of the young tree species.

REFERENCES

Abdallah, J. M., Silayo, D. A., Mombo, F. M., Shemdoe, R., Luoga, E. J., Lyimo, C. and Ngeti, S. (2006). Situation analysis of livelihoods under pastoral-farming communities in Kilosa, Tanzania. Proceedings of the first annual PANTIL Research Workshop held in Morogoro 25-27 September 2006, 64-73.

Abdallah, J.M. and J. Sauer (2007). Forest Diversity, tobacco production and resource management in Tanzania. *Forest Policy and Economics,* 9(5): 421-439.

Brehony *et al, (*2003). A study on Conflict Between Pastoralist and Farming communities, August - October 2003 in Kilosa District, Morogoro Region, Tanzania, 78pp.

Chamshama, S.A.O. and Nduwayezu, J.B. (2002). Rehabilitation of degraded sub-humid lands in sub-Saharan Africa: A synthesis. Sokoine University of Agriculture, Morogoro, Tanzania.

Chidumayo, E.N. (1990). Above ground woody, biomass structure and productivity in Zambezian woodlands. Forest Ecology and Management. 36: 33 – 46.

Darlong, V.T. (2002). Traditional community-based fire management among the Mizo shifting cultivators of Mizoram in northeast India. Communities in flames: proceedings of an international conference on community involvement in fire management. Edited by Peter Moore, David Ganz, Lay Cheng Tan, Thomas Enters and Patrick B. Durst. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific, Bangkok, Thailand. 119 – 125.

Kielland-Lund, J. (1990) Phytosociology and productivity of four forest and woodland communities near Morogoro. In: Mgeni. A.S.M., Abel, W.S., Chamshama, S.A.O and Kowero, G.S (eds). Proceedings of a joint seminar/workshop on "Management of natural resources of Tanzania" Under SUA/AUN cooperation. 5 – 10th Dec. 1990, Arusha, Tanzania. Faculty of Forestry, Record No. 43: 210 – 229.

Lawton, R.M. (1982). Natural resources of Miombo woodlands and recent changes in agricultural and land-use practices. *Forest Ecology and Management* 4:287-297.

Lovett, J.C. (1996). Elevational and latitudinal changes in tree associations and diversity in the Eastern Arc Mountains of Tanzania. *Journal of Tropical Ecology*, **12**: 629 - 650.

Lusambo, L.P.; Monela, G.C, Katani J. & Mombo, F. (2007). Socio-economic analysis of land use factors causing degradation and deforestation of Miombo woodlands in Kilosa district, Tanzania. *Tanzania Association of Foresters Journal,* 11: 148 – 161.

Mahunnah, R.L.A. and Mishigeni, K.E. (1996). Tanzania's Policy on biodiversity prospecting and drug discovery programs. *Ethnopharmacology*. **14,** 221-228.

Malimbwi, R.E., Nduwamungu, J., Misana, S., Jambiya, G.C., Monela, G.C. & Zahabu, E (2004). Charcoal supply in Dar es Salaam City, Tanzania. *Tanzania Journal of Forestry and Nature Conservation, 75: 108 - 118.*

Mgeni, A.S.M. & Malimbwi, R.E (1990). Natural forest resources of Tanzania and their management needs. Forestry Record (**43):** 67 - 76.

Miina, J., Saramaki, J. and Mwihomeke, S. (1999). Describing Tree/crop Interaction in Agroforestry. Farmers Tree Planting in Tanzania. In: *Off-forest Tree Resources of Africa*. (Eds. A.B Temu, G.S. Lund, R.E.Malimbwi, G. Kowero, K. Kleinn, Y. Malende, I. Kone). 156p.

Mombo, F. M., Abdallah, J.M., Silayo, D. A., Shemdoe, R., Luoga, E.J., Lymo, C. and Ngeti, M. (2006). The role of resource use on farmers-pastoralists conflicts in Kilosa district, Tanzania. Proceedings of the first annual PANTIL Research Workshop held in Morogoro 25-27 Sept 2006, 74-81.

Munishi, P. K. T. & Shear, T. H (2005). Canopy Interception and Rainfall Partitioning in two Afromontane rain forests of the Eastern Arc Mountains of Tanzania *Journal of Tropical Forest Sciences* **17(3),** 355-365.

Nair, P. K. R. (1990). Tropical agroforestry system and practices. In: J.I. Furtato, W.B. Morgan, J.R. Pfafflin and K.J.Ruddla (eds.), Tropical Resources Ecology and Development, *Resource Management and Optimization* **7**, 1-4

NBS (2002). The 2002 Human population and Settlements Census. The National Bureau of Statistics, Dar es Salaam Tanzania.

Nduwamungu, J., Kajembe, G.C., Malimbwi, R.E., Mbilinyi, B.P. & Luoga, E.J (2004). Household tree planting in Kilosa District, Tanzania. *Tanzania Journal of Forestry and Nature Conservation, 75: 99 – 107.*

Njana, R. (1998). Involvement of local people in the management of Catchment Forest Reserves in Tanzania: A case study of North Mamiwa-Kisara Catchment Forest Reserve. Unpublished Dissertation for Award of MSc. Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 137 pp.

Rocheleau, D.; Weber, F.; & Field-Juma (1988). *Agroforestry in Dryland Africa*, ICRAF Nairobi. Pp110.

Shaba, M.W.M. (1993). A perspective of indigenous forests management in the SADCC Region In: Pearce, G.D. and Gumbo , D.J. (eds). The ecology and management of indigenous forests in Southern Africa, 29-37. Proceedings of an international symposium, Victoria Falls , Zimbabwe, 27-29 July 1992. Zimbabwe Forestry Commission and SAREC, Harare.

Silayo**, D.A**., M.C.T. Tarimo, Amini R.E. Kweka and Muganda, A.M. (2006). Impacts of human induced activities on species composition and diversity in Miombo woodlands of Bagamoyo district, Tanzania. *Journal of Korean Association of African Studies Vol. 2: 223-243.*

Temu, A.B. (1980) Miombo woodland Inventory design A response to fuel scarcity in Tabora, Tanzania. PhD thesis, University of Dar Es Salaam Tanzania. Unpublished. 173-177pp.

Young, A. (1990). *Maintenance of soil fertility for sustainable production of tree crops through agroforestry systems.* Soil constraints on sustainable plant production in the tropics. *Tropical Agriculture Research Series* 24, 197-208

Zahabu, E. (2000) Impact of charcoal extraction to the miombo woodlands. The case of Kitulanghalo area, Tanzania. Msc. Dissertation, SUA. Unpublished.

Zoungrana, I. and Temu, A.B. (1996). Structure, Composition and Management of Vegetation Along the Niger River, in Mali. Proceedings: International Symposium on Assessment and Monitoring of Forests in Tropical Dry Regions with Special Reference to Gallery Forests. Nov 4 – 7, 1996. 39-52pp.