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DIVERSITY AND CONSERVATION OF WILD FOOD PLANTS IN CHENENE MIOMBO WOODLAND, DODOMA RURAL DISTRICT, TANZANIA

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DEDICATION

This sudy is dedicated to my parents, Emmanuel Tairo and Grecesanta Tairo and other family members, who in their love initiated and inspired me to pursue my studies. To my wife, Rahel and our children Julie and Jacque, who suffered a lot during my absence but remain my richest source of confidence.

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ACRONYMS

FAO	Food and Agriculture Organisation of the United Nations
a.s.l	above sea level
CMW	Chenen Miombo Woodland
RUPSUD	Research Programme on Sustainable Use of Dryland Biodiversity
SIDA	Swedish International Development Agency
UNEP	United Nations Environmental programme
UNICEF	United Nations International Children and Education Fund
URT	United Republic of Tanzania
FSC	Foundation for Statistical Computing
NMK	National Museums of Kenya
MLNRT	Ministry of Lands, Natural Resources and Tourism
SPSS	Statistical Package for Social Science
WCMC	World Conservation Monitoring Centre
NCSSD	National Conservation Strategy for Sustainable Development

ABSTRACT

This study was done to assess the diversity and conservation of edible wild-food plants in Chenene Miombo Woodland (CMW) in Dodoma Rural District, Central Tanzania. A total of 64 species of plants representing 23 families were identified. Out of these, 31 were wild food plants, distributed in 20 families. Among the studied plant species, 48% were used for food. Most of these belong to the families Caparidaceae and Fabaceae. The preferred species were *Vitex doniana* Sweet, *Tamarindus indica* L. and *Strychnos cocculoides* (Baker.). The wild food plants in CMW had a significant difference ($p<0.05$) in growth forms in which the number of shrubs was significantly higher in both lowland and mountain forest reserves whereas the unreserved forest had the lowest. Height and diameter classes distribution indicated highest number of individuals in the lower classes and this suggests that there is high rate of recruitment. The seedling and sapling densities of wild food plants indicated significant difference (One-way ANOVA, $P<0.05$) in the three sites. The community type analysis provided four (4) main types of communities named as *Julbernadia globiflora-Brachystegia bussei* (Community I), *Dichrostachys cinerea–Combretum zeyheri* (Community II), *Combretum zeyheri -Acacia negrescens* (Community III) and *Cordia monoica-Strychnos cocculoides* (Community IV). The wild food plants distributed in all the community types showed that 26 (48%) wild food plants were found in Community I, five species of wild food plants found in Community II, seven plant species in Community III and 18 plant species of food plants found in Community IV. The results on species diversity, richness and evenness showed a significant difference (One-way ANOVA, $P<0.05$) among the communities in which diversity in community IV and I were much higher than in communities II and III. The similarity index of wild food plants in all the studied communities was 0.36 and the common species reflected to the similarity were *Acacia negrescens* Oliver and *A. senegal* (L.) Willd. The results also revealed that the use of wild foods as a component of local response to increasing food insecurity it has caused the declining trend of wild food. Several conservation practices for wild food plants have been in place conteract this, including domestication of wild food plants such as *Tamarindus indica* L. and *Vitex doniana* Sweet, in situ conservation and protection in the farmlands and water sources. However, implementation of these practices has been proved illusive due to the persistent drought, lack of conservation advisors, soil infertility as well as due to lack of local institutions for resource management. All these signify the lack of policy favouring institutional development in conservation efforts. Therefore, there is a need of policy reforms to emphasize recognition of local institutions, agroforestry practices and creating awareness on the significant roles of wild food plants in the area.

1. INTRODUCTION

The livelihoods of the majority of rural people in Tanzanian depend on the woodlands, bushlands and thickets as sources of agricultural land, fuelwood as well as non-timber forest products such as wild food plants (Hines and Eckman, 1993). Experience has shown that for many decades the importance of wild food plants in the developing world including Tanzania has been recognized during times of drought and famine (Ruffo, 1989).

The consumption of wild plants seems more common and widespread in food insecure areas, where wide ranges of species are consumed (Ruffo *et al.*, 2002). The linkage has given rise to the notion of 'famine-foods', plants consumed only at times of food stress and therefore an indicator of famine conditions. Local people know about the importance and the contribution of wild plants to their daily diet as well as being aware of possible health hazards such as stomach irritation occasionally occurring after consumption of certain wild plants (FAO, 1989). Nevertheless, whereas the rich indigenous knowledge on the medicinal use of wild plants has been relatively well documented, research, particularly concerning the diversity, regeneration status and conservation strategies of wild-food plants still lack adequate attention (Missana *et al.*, 1994).

Tanzania's Ministry of Natural Resources and Tourism and other conservation agencies have given high conservation priority to the Chenene Miombo Woodland (CMW) in Dodoma rural district, Central Tanzania due to its socio-economic, ecological, and environmental roles (MLNRT, 1989). However, a quantitative study of the wild-food plants in terms of species types, growth forms, size distribution and regeneration status, which has an implication on utilization and conservation, is rather rudimentary and inadequate. It is widely recognized that the local communities around the Chenene Miombo Woodland (CMW), consider wild-food plants as one of the important local survival strategies. This consideration appears to have intensified due to the repeated climatic shocks hampering agricultural production and leading to food shortages (URT, 2002). However, little research has been done to promote and improve the protection and management of such resources in the area.

Generally, the information on wild food plants in Tanzania is scanty and dispersed (Mzava, 1993), especially in the CMW. On the other hand, indigenous knowledge of the nutritive values, methods of production, preservation and utilization of wild food plants is disappearing as the systematic transmission of the information from the old generation breaks down (Mzava, 1993). Studies by Mukamuri (2000), Mwihomeke *et al.* (2000) and Ruffo *et al.* (2002), revealed that some wild plant species, which have been used as food are on the verge of disappearance in some areas owing to changes in the ecology of many areas due to prolonged drought, overgrazing, bush fires, deforestation, etc. and introduction of exotic species, resulting in a gradual decline in the use of wild wild food species.

Tanzania is currently developing strategies for forest products conservation and this requires quantitative information on the extent, pattern, and present conditions of the resources (MNRT, 1989). According to Ruffo *et al.* (2002), there is a realization that, some of the wild plants are used locally for consumption at times of food shortage, have the potential to become valuable staple foods and important alternatives to the usual food crops cultivated by farmers. The resolution of this requires accurate and refined ecological information on wild food plants and its rate of change over time with varying utilization models. This study intended to gather information on wild food plants primarily on the type of species used, growth forms, size distribution, regeneration potential, diversity and conservation strategies in the CMW. The information obtained in this study is expected to contribute to the policy changes regarding to the conservation methods and approaches of wild food plants and other plant resources in Tanzania.

2. OBJECTIVES

2.1 General Objective

To assess the diversity and conservation of edible wild-food plants in Chinene Miombo Woodland (CMW) in Dodoma Rural District in Dodoma Region, Central Tanzania.

2.2 Specific Objectives

i. To describe and compile the wild food plants in CMW

ii. To assess size distribution of wild food plants

iii. To assess the regeneration potential of wild food plants

iv. To examine the diversity and distribution of wild food plants in relation to vegetation community types.

v. To assess the practices and constraints practised by local communities to conserve wild food plants in the study area

3. LITERATURE REVIEW

3.1 What are Wild Plants?

According to Amare Getahun (1974), the term "wild" when applied to plants or plant species refers to those that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action. The term is contrasted with "cultivated" or "domesticated" plants or plant species that have arisen through human action, such as selection or breeding, and that depend on management for their continued existence. Wild plants may be transferred from forests or other ecosystems to trailsides or near human habitations as well as into fields so that they are readily available and easily collected (Ruffo *et al.*, 2002). According to FAO (1990), the minimal form of domestication seems quite common and is practiced by many people in the world. The use of wild foods as a component of local response to increasing food insecurity is widely documented and this gave rise to famine foods such as wild vegetables, berries, nuts, fruits, insects, etc. In periods of limited food stress, such foods may be eaten only occasionally and more often by children and poorer sectors of society (Mzava, 1993). However, in periods of heightened food insecurity such foods may be widely consumed.

3.2 Nutritional Value of Wild Food Plants

Wild foods are part of rural people's diets not only during periods of food shortages, but also on a daily basis (Campbell, 1996). Most dietary studies emphasize the value of calorific intake from staples. However, the amounts of wild foods consumed, their frequencies of consumption as well as their nutrient contents have also been explored (Fleuret, 1979). According to FAO (1990), a range of studies provides evidence for the every day use of wild food products as side dishes or snack foods and sometimes as replacements for staples. The chemical composition of some wild food sources has also been analysed demonstrating their nutritional significance.

The nutritional analysis of wild plant foods from all over Africa has shown them to be very nutritious and not inferior to domesticated varieties. Wild grains, seeds and kernels provide significant amounts of calories, protein and oil (Ruffo *et al.*, 2002). Their

calorific value is frequently greater than that of the cultivated varieties. The results of analysis of the grass grains are impressive with a range of 310 - 391 kcals per 100 gms which compares favourably with sorghum and maize 355 and 363 kcals/100gms, respectively (FAO, 1990; Kavishe, 1993; Ruffo *et al.*, 2002).

Fruits, leaves and tubers, particularly those consumed raw, contain vitamin C. For example, *Adansonia digitata* fruits and *Ziziphus* contain 360mg/100g and 1000mg /100g of vitamin C whilst an orange contains only approximately 57 mg / 100g (Kavishe, 1993). In other countries like Sudan, when people become ill, it is a common practice to increase consumption of wild fruits or wild fruit juices such as 'cuei' (*Tamarindus indica*), 'lang' (*Ziziphus* sp.), which are believed to help recovery (Hamza, 1990). Many wild leaves are rich in iron and have a higher content than the cultivated varieties e.g. *Cleome gynandra* and *Tamarindus indica* have an iron content of up to 6.2 mg per 100g. Potassium levels tend to be high in all leafy vegetables and fruits (Ruffo *et al.*, 2002).

Wild foods also enhance palatability for instance the use of leaves with a mucilaginous sap which gives the food a slimy texture is a recognised way of easing ingestion of accompanying foods (Kavishe, 1993). According to UNICEF (1990), the improvements of texture and taste from wild foods are of particular importance to children, who are often unable to consume the quantity of the bulky staple foods needed to meet their nutritional requirements.

3.3 Role of Edible Wild Food in Tanzania

In recent years, forests have increasingly been recognized as rich reservoirs of many valuable food resources, apart from timber (Hines and Eckman, 1993). From time immemorial, these products and services have contributed greatly to human welfare and progress. In most cases, wild food plants play an important role in the daily life and well being of the local population (Mendelsohn, 1992). Furthermore, wild plants commonly served as critical foods during periods just before harvest of domestic crops. Widespread use of these so-called "famine foods" during the pre-harvest or "hungry months," has been extensively documented. However, as generations passed, the ability to identify

"famine foods" declined abruptly. Once families and societies survived by using on edible wild plants, but inability to identify sustaining species led to increased malnutrition and famine in certain areas of the world. In earlier studies by Ruffo *et al* (2002) several types of wild food plants have been used by the local communities and common parts used were leaves, seeds and nuts, fruits and tubers, gums and sap. Experience has shown that this utilization pattern reflects on additions to individual family supplies, also wild food plants can contribute to household food security in other ways. Income and employment can be obtained from sale or exchange of fruits, nuts, alcoholic drinks from *Adansonia digitata* L. and vegetables.

3.4 The Status of Wild Food Plants in Tanzania

According to Lawton (1982), the vast woodlands of central Tanzania are mostly regenerated, after long time degradation that was reported in these areas in the 1960s. The main cause of this was the increasing demand of the local communities for agricultural land and non-wood products for food and income. However, over time, such products were increasingly marginalized as the emphasis in forest management shifted to timber production. Presently, the increased interest in wild food plants has been prompted by the rediscovery of the role of edible wild food plants to small-scale livelihoods and has resulted in a rapid rise in interest among conservationists, foresters, protected area managers, social development advisors and indigenous rights groups (Campbell *et al.*, 1993). Campbell *et al.* (1993) further reported that this has generated a proliferation of studies into the potentials of wild food plants for income generation and as a means of involving local people in forest management and benefit sharing to ensure sustainable utilization of these resources. Previous study by Ruffo *et al.* (2002) revealed that despite the fact that many wild food plants are used by the majority of rural population, they are still not as much appreciated or valued as some of the introduced food plants such as mango, orange or cabbage. This is to say, these wild food plants are still regarded as inferior and only appropriate for the poor. Studies by FAO (1990) and Kavishe (1993) have revealed that there has been a widespread decline in knowledge about wild food plants, especially among young people and those who live in urban areas.

3.5 Need for Assessing Wild Food Plants

According to FAO (2001), biological resource quantification or inventory aims at understanding, which resource is more useful commercially and what consequences of exploitation are on the resources base itself. This can provide information for sensible and appropriate management of biological resources. For biologically sustainable harvest levels of a product to be determined, there must be a minimum set of good information available on the resource species in terms of abundance, distribution and reproductive biology. Experience has shown that the assessment of different biological resources was done by using inventory and participatory resource assessment techniques to determine species composition, structure and diversities. However, the formal resource assessment of forest products, especially food plants in developing countries is relatively new and has received little attention to date. Due to inadequate data for each of the above methods and variations in utilities of wild food plants in forest ecosystem, Wong *et al.* (2001) asserted that field quantification of plant products, utilization potential and conservation strategies for specific forest ecosystems are essential and can significantly improve our understanding about the missing information and statistical data on wild food plants. Furthermore, existing information on wild food plants availability, utilization pattern and conservation aspects are often based on case studies, often unclear, inconsistent and contradictory. In many cases methodologies to collect and analyze viable key information do not exist.

3.6 The Role of Regeneration Studies in the Management of Wild Food Plants

Regeneration may be promoted by certain types of forest manipulation that intentionally lead to new and more stages of forest regeneration. Natural regeneration in the forest ecosystem is fundamental for evolution (Ackzel, 1994). Because of human disturbances, the majority of today's forests are secondary forests. Understanding how forest regeneration dynamics are influenced by human impacts is a prerequisite to formulating management actions needed to conserve biodiversity. A range of human disturbances created a heterogeneous mosaic of forest types, both in terms of structure and species composition. Studies on regeneration are good indicators for human disturbances. Hall and Bawa (1993) reported that the regeneration status of species harvested for wild food

plants as inferred from population structure is a useful indicator of whether products harvest is likely to be detrimental to the target population in the long term. Also, monitoring seedlings and saplings can provide information on the succession of forest ecosystems and identify any problems in tree regeneration.

3.7 Diversity and Conservation of Wild Food Plants

For many species of plants, habitat loss represents the greatest threat to their survival (UNEP, 1995). While there is considerable uncertainty about the extinction rate caused by human activities, it is generally acknowledged that species loss and the erosion of genetic diversity are highest in the tropics (Myers, 1988; Whitmore and Saver, 1993). This is a result of high deforestation rates in many tropical countries (FAO, 1993). Some efforts have been made to conserve areas of natural vegetation and give them various degree of protection. This continues to be an important and urgent task, but it is clear that severe disturbance and destruction will not stop soon (Whitmore and Saver, 1993). Myers (1988) and UNEP (1991) suggested that it is necessary to study not only diversity in pristine environments but also the impact of alternative uses and management practices on biodiversity to conserve as much as possible where disturbances and deforestation cannot be prevented and to improve the conservation value of areas already degraded.

In Tanzania, as a consequence of increasing deforestation, exploitation, changes in land use systems, the wild food plants are declining and many of these food plants are in the danger of extinction (Mwihomeke *et al.* (2000). A solution for this has been suggested by Ruffo *et al.* (2002), that there is a need for these food plants to be domesticated, starting with those that have high nutritive value and are easy to propagate. The conservation of natural resources in Tanzania is now carried out by numerous sectors including wildlife, forestry and national environmental facility and the government supports all these. Yet, there has been reluctance in conserving wild food plants compared to other economically important resources such as timber.

3.8 Significance of Assessing the Diversity of Wild Food Plants

Species diversity is a measure of the number (richness) and abundance (in the sense of number of individuals/species) of species in a community (Gimaret-Carpentier *et al.*, 1998), while a diversity index is a mathematical measure of species diversity in a community. According to Magnussen and Boyle (1995) and Gimaret-Carpentier *et al.*, (1998), diversity indices provide more information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundances of different species into account. Other findings by Tóthmérész (1995) revealed that analysis of differences in diversity among areas allows prioritization of activities. However, an understanding of the underlying factors for differences among diversity may be crucial to select priority areas. For instance, a relationship between proximity to forests on the evenness of the dominant species. However, as proximity to forest is correlated with other factors such as altitude, rainfall, and population density, we could not separate the influence of proximity to forests from these co-varying factors. In this context, species diversity in natural ecosystems is one of the important measures to evaluate their conservation value (Magurran, 1998; Purvis and Hector, 2000).

3.9 Loss of wild food resources

Threats of wild plants are mostly caused by human beings (Rodgers and Homewood, 1982). Results from this array of human threats, rates of extinction are now estimated to be between 1,000 and 10,000 times greater than in the past (Pearce and Moran, 1994). Recent global and national information sources show significant and still increasing loss of biological resources in most tropical regions. For instance in Tanzania, over 80% of the population live in rural areas and like any other developing countries they draw their livelihood from plant resources (NCSSD, 1995). In addition, the country ranks the second out of 48 countries in afro-tropical realms in terms of number of plant species with about 11,000 distinct species and at least 1,000 of these are endemic (WCMC, 1992). However, the total number of threatened plant species is 436 (4.4%) (URT, 1996). Some of these are at verge of extinction even before their uses are identified (UNEP, 1991). The factors leading to the loss of the biological resources including wild food plants are described bellow:-

(a) Habitat loss, fragmentation and degradation

Wild plants, by definition, grow in natural or semi-natural ecosystems in different biomes around the world (Ruffo *et al.*, 2002). At present all these biomes have been greatly affected and modified by human activities such as the conversion for other uses (agriculture, pasture, urbanization, industrial, etc.), and these lead to removal of large proportions of the natural ecosystem and replace them with a greatly modified matrix, within which small remnants of the native ecosystem remain (FAO, 2001). According to Amare Getahun (1974), one of the consequences of habitat loss, fragmentation or degradation is the large number of wild species that are threatened with local or total extinction, including many that are used by farm households.

(b) Overexploitation and overharvesting

The increase in the number of urban dwellers who still rely on traditional plant-based remedies has added to the pressure on wild resources and has led several species to face a serious risk of population loss and genetic erosion through unsustainable harvesting practices such as decortications (Rodgers and Homewood, 1982; Pearce and Moran, 1994). However, overharvesting is encouraged by market requirements. There is a widely held perception that plants collected from the wild are more effective than cultivated ones (Ruffo *et al.*, 2002) and this idea is even used as a marketing strategy. It may, however, have the effect of allowing producers to charge higher prices. Sustained harvesting plant species for which there is a commercial demand may lead to genetic erosion (UNEP, 1991).

(c) Introduced and invasive species

One of the greatest threats to natural and semi-natural vegetation, which is often overlooked, is the deliberate human introduction of species of trees and fodder crops which have largely replaced the native ecosystems (Sisk *et al.*, 1994). Introduced species may also be a threat to productive systems. On the other hand, many weedy species are tolerated or even encouraged in traditional farm systems such as home gardens, where they may be an important resource.

3.10 Conservation Practices of Wild Food Plants

Both *ex situ* and *in situ* conservation actions are needed to achieve the target (Rehm and Espig, 1991) and they will need to be used in complementary ways to maximize the diversity conserved. The specific combinations are likely to differ substantially depending on species. Crops are likely to involve substantially more *ex situ* conservation than other socio-economically valuable species. However, some countries already have experience of *in situ* conservation of wild species (including forestry species) through "gene management zones" which can be utilized by others.

In general, *ex situ* conservation is one of the practices, which involve conservation outside of the natural environment, which can contribute to the conservation of cultivated and non-cultivated in the farming systems. Berg (1992) and Martin (1995) revealed that the farming systems are able to maintain a rich diversity of genetic resources of food species and other crops as the people who use them have developed sophisticated mechanisms of selection, transfer, exchange and maintenance in their farmland as a measure of conservation.

Sacred places and places of worships like the compounds of churches and mosques, graveyards and monasteries have been important sites for the protection of the indigenous flora. The conservation of non-cultivated plants can be enhanced in such areas through increased awareness on the part of the users of the areas, including both those responsible for their maintenance and the general public (Kajembe *et al.*, 2003).

Also experience has shown that areas such as state forests and community forests and national parks and reserves where the wild flora have been afforded a degree of statutory protection could be used to specifically safeguard wild species used as food by local people.

4. STUDY AREA AND METHODS

4.1 The Study Area

4.1.1 Location

Chenene Miombo Woodland (CMW) is one of the woodlands in Tanzania. It is located in Dodoma Rural District in Dodoma Region, Central Tanzania (Figure 1). Also this woodland is found in the Somali-Maasai phytogeographical region in the central part of Tanzania. According to Lyaruu (1999), this woodland lies approximately between latitudes 5^{o} 50' and 7^{o} 00'S and longitudes 35^{o}10'E and 36^{o} 20'E. The area of the woodland is estimated to be 48,000 ha in which 10,000 ha is unreserved (Moshi, pers comm., 2004).

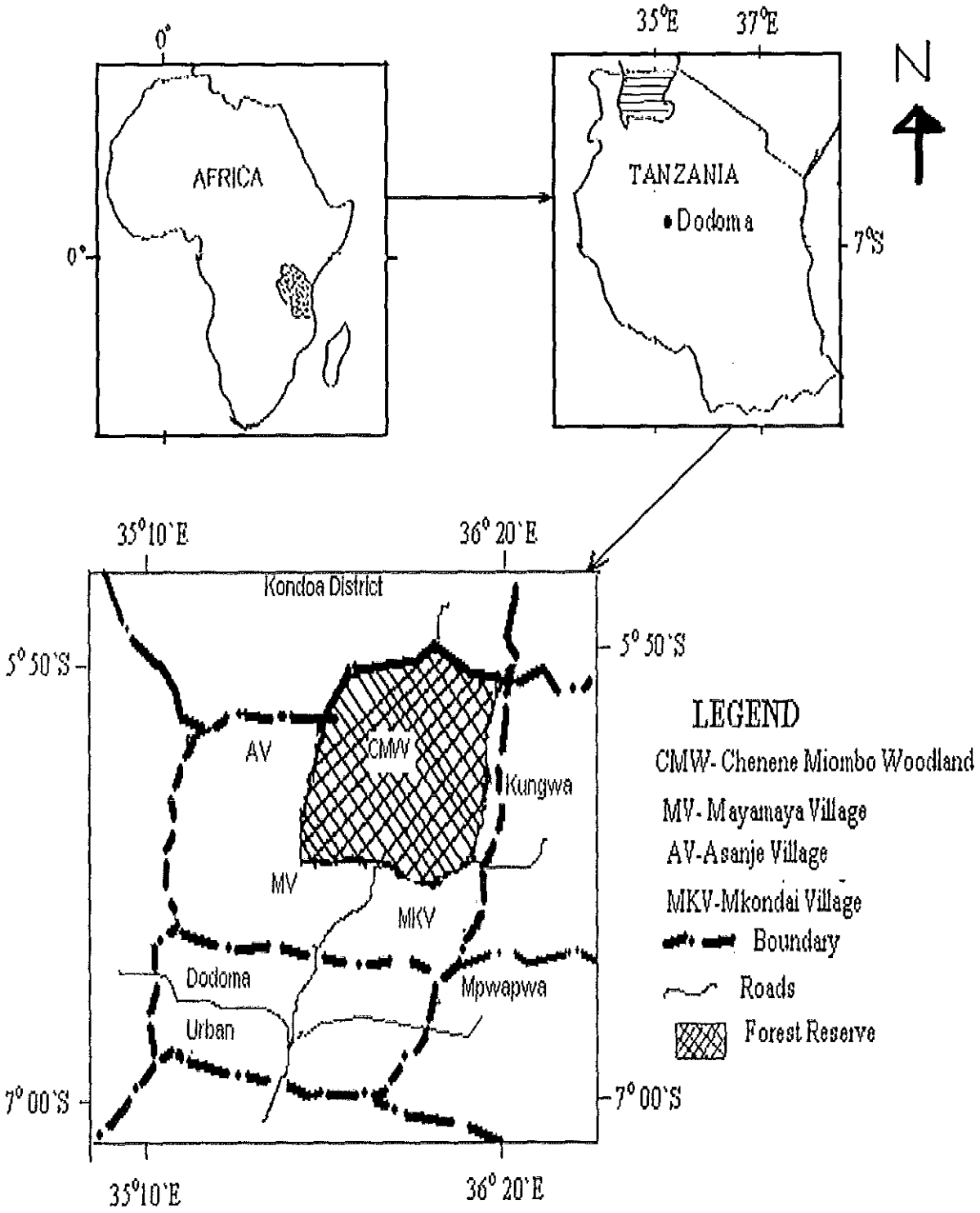

Figure 1. Map of Tanzania indicating the location of Dodoma Region, Dodoma Rural District and Chenene Miombo Woodland (Adopted in URT, 2002)

4.1.2 Topography

The bulk of Dodoma Rural District is characterised by broad upland plains, occasionally broken by steep escarpments and isolated hills. The average altitude of the plains differs in different parts of the District, with a mean altitude of about 1100 m above sea-level (URT, 2002).

4.1.3 Climate

Dodoma Rural District has a semi-arid climate (URT, 2002). Annual rainfall ranges from 400-700 mm. The unreliability of rainfall and its high intensity over a short period from December to February is an important factor in determining the land use pattern. The rainy season is from November to April with long and dry season of about 6 months from May to October. Mean temperature for all seasons is 25.5° C (Figure 2).

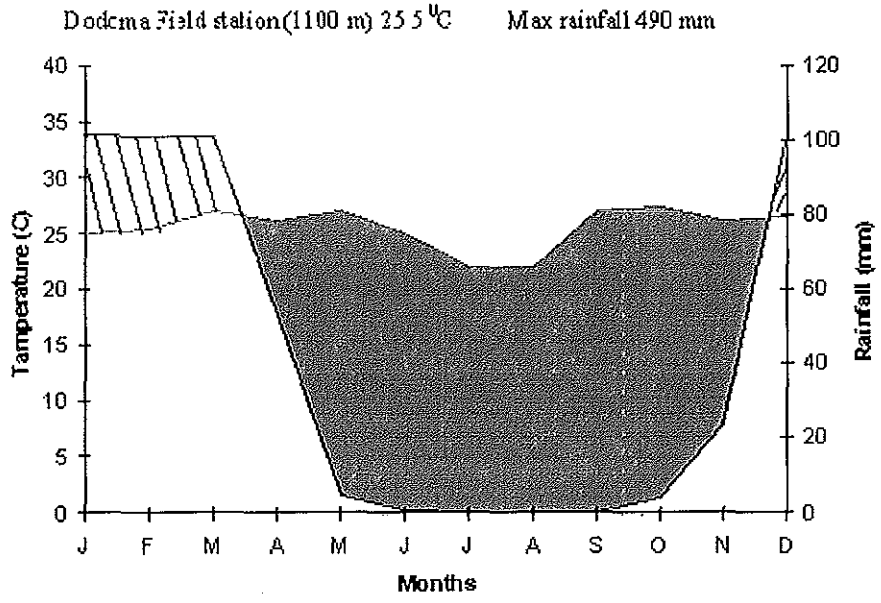

Figure 2. Climatic diagram showing mean annual temperature and rainfall of Dodoma Rural District for 24 years (1980-2004).

4.1.3 Soils

The most common soils in the area can be described as thin stony soils on hill tops, with predominantly sand or sandy loams on the slopes varying from grey to red , with lighter

colour sands or dark clays on the bottom land depending upon whether the drainage is free or impeded. The dark clay soils (Mbuga soils) are found in the flood plains, and they are more fertile than those found on the slopes.

4.1.4 Vegetation

The natural vegetation is mainly secondary in nature due to shifting cultivation, grazing and fires. Basically four types of vegetation can be distinguished (White, 1983): bushland, woodland, wooded grassland and grassland. Bushland is the most common type of natural vegetation. The most dominant tree species are *Acacia* spp., *Combretum* spp., and *Commiphora spp.* (White, 1983). The grass layer consists of annual herbs and grasses the major ones being *Hyparrhenia* species and *Themeda* species. When this vegetation is quite dense it is called a thicket. Woodland has nearly disappeared from this area. It consists of trees whose crowns touch each other. Here the real miombo trees (*Brachystegia* spp.) are prominent in the woodlands. The wooded grasslands were common, but now overgrazing has turned them more into bushlands and thickets. Still woodland can be seen in other areas where overgrazing was not so severe. Baobabs are very prominent in these areas.

4.1.5 Economy

The economy in the District depends entirely on arable and stock farming. People depend on agriculture for subsistence, but maintain large herds of cattle, goats and sheep for economic and social purposes (animals give food and income particularly during dry periods). Livestock and small-holder cultivation are the main land use types, found in the district. More than 70% of the area is used for seasonal grazing by individuals. Crops cultivated consist of millet, sorghum, maize, and cassava for subsistence and groundnuts, castor oil, sunflower and grapes for cash. Rice is cultivated in swampy areas (western zone). Maize is widely grown for food and cash. Economically, they have to rely both on crop production and livestock (Rigby, 1968).

4.1.6 Demography

According to the population census of 1986, the total population of the rural area in the District was 353,478 people and projected to 495, 800 in 2002, with population growth

rate of 2.9% per annum (Bureau of Statistics, 1989). The average population density is 25 people per km^2, but this varies from area to area. The *Gogo* tribe is dominant in the area. They are agro-pastoralists, i.e. cultivating pastoralists.

4.2 RESEARCH METHODOLOGY

4.2 1 Data collection

4.2.2 Vegetation data

In sampling for vegetation data, a straight line method was used to achieve a systematic distribution of sample plots. A straight line method was used to achieve a systematic distribution sample plots. The distance between transects was 200m. A total of 8 transects were laid in all the sites with the plots varying from 5-8 plots. The plots were established along transects and the interval between plots was 100m. A total of 51 plots were laid to census vegetation data.

In the CMW, three areas of study were identified in which the mountain area (20 plots) was considered as its own stratum, lowland (20 plots) and unreserved forest (11 plots) were also considered as the other strata. In all these sites, a concentric or circular plots were used in vegetation data collection in which the measuremnents of the large trees were done on the plots of greatest area whereas that of the smaller trees were enumerated and meausred to the inner plot of smallest area.

Circular plots with three concentric rings of different radii were used to census vegetation (Figure 3). Within the inermost 5 m radius, all seedlings and saplings were assessed to know their regeneration potential; the second ring was within 15 m radius and all the (trees/shrubs) were identified and their diameter at breast height (DBH) less than 5cm were assessed, the third ring was within 20m and all trees/ shrubs and their DBH above 5 cm were identified and measured. In each plot (within 20 m) dominant canopy trees were selected and their heights were also measured. Also, in each plot within 20m all the wild food plants were identified. The wild food plants within each plot were idenfied and their ground cover and abundance in the presence or absence fashion were recorded. Species that were not identified in the field were collected and pressed for identification in

herbarium at the University of Dar es Salaam and Sokoine University. Threats such as fire, human disturbances, i.e. stumps and animal disturbance were also identified.

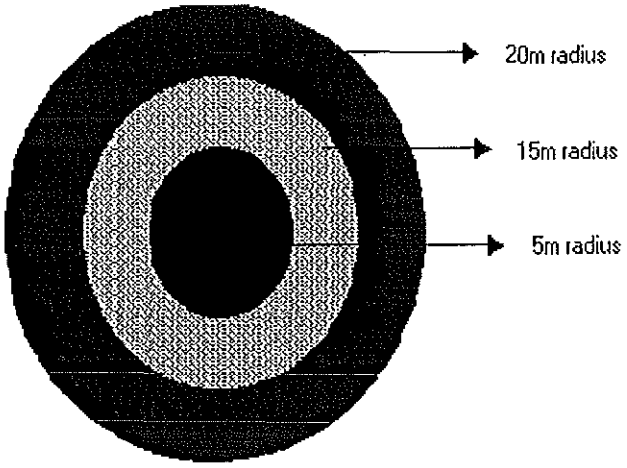

Figure 3. Schematic presentation of concentric circular plots for assessing wild food plants distribution

4.2.3 Household survey data

4.2.3.1 Research designs

A cross-sectional research design was used and this involves the measurements of all variables for all cases within a narrow time span so that the measuremnets may be viwed as contemporaneous. Essentially, data were colleted at only one point in time, comparing different participants at different ages. This design is advantageous in the sense that it is economical in time and costs. Also there is only one period for data collection (Cotton, 1996). The inability to directly assess intra-individual change inferences to group averages are significant disadvantages of this design.

4.2.3.2 Sampling frame

The sampling was based on the selection of villages in the vicinity of the CMW, and three villages qualified for such criterion. The number of villagers or household interviewed was randomly selected using the village registers. From the register, the name of household heads were sampled using a systematic random sampling technique (that is, every fifth person on the list was interviewed) since the names were listed in a completely random manner and this type of sampling minimized selection bias. Basing

on the sampling frame, the study was caried out in Mkondai (n = 30), Asanje (n = 30) and Mayamaya (n = 30).

4.2.3.3 Research Methods

a) Questionnaire methods

In social science study, the most common method of formal research is the questionnaire survey (Appendix 4). Questionnaires can be used for descriptive, explanatory research purposes, and are also an excelent vehicle for measuring attitude and oriantation in large population. This method is chiefly used in studies that have individual people as the units of analysis, and is advocated as the best method available to the social scientist interested in collecting original data for describing a population too large to observe directly (Martin, 1995).

The technique that was used to collect information in this study was semi-structured interviews (Martin, 1995; Cotton, 1996) and this is the best way to learn from local people. As the questions were semi-structured, the respondents were given an opportunity to include more explanantions wherever necessary. The interviews basically relied on the knowledge of the wild food plants including type of tree species used for food, distance to acquire the food plants, season of availability, trend of availability, how they are conserved and the conservation methods. Each respondent was asked questions which were pertinent to the objectives.

b) Village meetings, group discussions and particpatory rural appraisal

Village meetings and group discussions were also used. Meetings in the sellected villages were done in the guidance of village leaders. This was followed by the Particpatory Rural Appraisal (PRA) procedure in which the villagers were given several topics to discuss and were asked to write their results. PRA is a cross-disciplinary and cross-sectoral approach to engaging communities in development projects through interactive and participatory processes. Before people devide into groups, they were introduced to the study objectives which covered issues related to the wild food plants, availability of these resources and the ways of conserving the food resources.

In general, PRA as a research tool serves the purpose of opening up discussion with villagers on a particular topic of interest (Coe *et al.*, 1999). PRA makes use of various techniques such as resource mapping, venn diagrams, time line and matrix scoring to achieve a desired purpose. All these can be handled by the villagers with minimum level of education and yet provide useful information (Maundu, 1995). In the present study, resource mapping, time line, matrix scoring for valuing and prioritising the food plants and transect walk were used. In the general, meeting the villagers were asked to range issues pertaining to the use of wild food plants and managemnt. This included mentioning all wild food plants and how to consrve them. The extent to which the community participation in managemnt and conservation of the forest resources was also explored.

The participants were given time to express their feelings on the changes in the availability of resources that may occur in recent years, including the distance from which they were obtained. They identified tree species which they normally maintain in farms as a sign of conservation. In this case, the villagers were asked to reveal the events occurered as far back as colonial era until to date. These events might have influenced the ulitization and conservation aspects of food resources.

c) Participant observation

Participant observation was another method used in this study. This involved direct observation in the field during the study period and this was done by living with people and share with them many facets of their life from subsistence activities such as farming or gathering of wild foods, the extent of harvesting these products, and their awareness on conservation of these products.

d) Species preference

Species preferences were done in the field following the technique reported by Martin (1995), in which the first 10 plant species preferred and mostly valued were identified. This was done by assigning a rank from values of 1-10 in which the most preferred one was given the highest value. This was done for 5 respondents from each village, thus

accounting for 15 respondents. The same procedure was used to determine five mostly valued species for domestication.

4.2.3.4 Reliability

Reliability of results depend on the questionnaire pretesting and this is important to know the time to undertake interviews, if the questions were pertinent to the objectives and costs estimation for interview.

4.3 Data Analysis

Data which were recorded from the transect survey were sorted to identify the wild food plants and organized into tables with the diameter at breast height, heights, growth forms, number of seedlings and saplings, species abundance, size distributions as variables. These variables were tested across the forest utilization zones (mountain forest and lowland reserved forest and unreserved) using One-way Analysis of Variance (ANOVA). The stem densities at various diameter classes were tallied and analyzed to determine the species population size class distributions of wild food plants. The regeneration potential was calculated by using the following formula: Seedling/Sapling Density/ha = No. of plant counts/Plot area x10,000. The resulting data were subjected to SPSS statistical software for comparison.

For vegetation data analysis, matrices for abundance values versus plots were produced. These were subjected to multivariate numerical analyses to produce dendrograms of Agnes by using *BIODIVERSITY. **R*** software (RFSC, 2004), which was based on the type of division that is agglomerative. This analysis indicated the different sample sites forming the distinct community types against the similarity scale ranging between 0-0.8. From the community types deduced from the dendrograms, several biodiversity analyses were done. Species diversity was evaluated using the Shannon diversity index (*H'*), which is another index that is commonly used to characterize species diversity in a community (Magurran, 1988). Simpson's similarity index was calculated as SI=4C/A+B+C+D where by C, represents common species in communities and A-C represent number of individual species in every community. Both Simpson similarity

index and Shannon's diversity index accounts for both abundance and evenness of the species present (Krebs, 1998). The proportion of species (i) relative to the total number of species (p_i) was calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product is summed across species, and multiplied by -1: Also according to Krebs (1998) the Shannon's equitability (E_H) or species evenness can be calculated by dividing H by H_{max} (here $H_{max} = \ln S$). Equitability assumes a value between 0 and 1 with 1 being complete evenness. The number of species per sample was considered as a measure of richness. Separate analyses were performed for each community type and vegetative variables to assess the difference in One way-ANOVA or Multivariate analysis by using SPSS software.

Before the questionnaires were entered into an appropriate statistical packages, they were edited and coded and the variables analysed were the background of the respondents, in terms of frequency distribution, measures of central tendency, compare the behaviour of various demographic categories (age, education, gender, etc) in relation to use and conservation of wild food plants. Other variables were:- determination of the existing relationship between the wild food plants utilization on variables such age, sex, marital status, education. Generally, analysis for questionnare was mainly descriptive as the chi-square (X^2) statistics, tables and associated graphs used in the interpretation of the results. The data were analysed by using Statistical Package for Social Science (SPSS).

5. RESULTS

5.1 Vegetation Description in Relation to Wild Food Plants

The study was conducted in the Chenene Miombo Woodland (CMW) in which three sites namely lowland, mountain and unreserved woodlands were examined. A total of 64 species of plants representing 21 families (Table 1, Appendix 1) were identified in a total 51 plots. The studied species were from the family Fabaceae (45.3%). Among the studied plant species, 31 were wild food plants (Table 2) and were distributed in 18 families. Thus, 48.5% of the studied tree species are used as wild food (Table 3a) of which 25.8% of the wild food plants are in the families Fabaceae, 12.9% in Capparidaceae and 6.5% were in the families Anacardiaceae, Burseraceae, Rhamnaceae and Verbenaceae, respectively. The wild food plants encountered in the study area were highly utilized by the local communities and their number and parts used are indicated in Table 3a. It is revealed that 64% of the plants were consumed as seeds and fruits, while 18% were consumed as leaves, flowers and stems. The underground parts consumed accounted to 15% and those plants utilized as sap, gums and bark accounted to only 3%.

The distribution of families in different sites is indicated in Table 3b in which the lowland forest reserve had more families, followed by mountain forest reserve. The unreserved forest had very few families. As indicated in Table 3b, five families are present in both sites, 14 families are present in both lowland and mountain forest reserves and 5 families are present in both unreserved forest and mountain forest reserve.

Among the studied wild food plants, the most commonly preferred species are indicated in Table 4 in which *Vitex doniana* and *Tamarindus indica* were mostly preferred food plants, while *Dalbelgia nitidula* was the last among the first 10 tree species.

Table 1. Distribution of plant species of different families in Chenene Miombo Woodland (CMW)
in Dodoma Rural District, Tanzania

Family name	Number of Species	Percent (%)
Anacardiaceae	3	4.7
Balanitaceae	1	1.6
Bombacaceae	1	1.6
Boraginaceae	2	3.1
Burseraceae	2	3.1
Capparidaceae	5	7.8
Chenopodiaceae	1	1.6
Combretaceae	2	3.1
Euphobiaceae	3	4.7
Fabaceae	29	45.3
Longaniaceae	1	1.6
Moraceae	1	1.6
Rhamnaceae	2	3.1
Rhizophoraceae	1	1.6
Rubiaceae	1	1.6
Rutaceae	1	1.6
Sapindaceae	2	3.1
Sapotaceae	1	1.6
Sterculiaceae	2	3.1
Tiliaceae	1	1.6
Verbenaceae	2	3.1
	64	100.0

Table 2. Distribution of wild food plants of different families in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Family	Number of Species	Percent (%)
Anacardiaceae	2	6.5
Balanitaceae	1	3.2
Bombacaceae	1	3.2
Boraginaceae	1	3.2
Burseraceae	2	6.5
Capparidaceae	4	12.9
Chenopodiaceae	1	3.2
Fabaceae	8	25.8
Longaniaceae	1	3.2
Moraceae	1	3.2
Rhamnaceae	2	6.5
Rubiaceae	1	3.2
Sapindaceae	1	3.2
Sapotaceae	1	3.2
Sterculiaceae	1	3.2
Tiliaceae	1	3.2
Verbenaceae	2	6.5
	31	100.0

Table 3a. The list of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Species	Family	Part(s) Used
Acacia negrescens Oliver.	Fabaceae	Seeds, fruits
Acacia senegal (L.) Willd.	Fabaceae	Resins/gums
Adansonia digitata L.	Bombacaceae	Leaves, flowers
Albizia amara (Robx.) Boiv.	Fabaceae	Seeds, fruits
Balanites aegyptiaca (L.) Del.	Balanitaceae	Seeds, fruits
Berchemia discolar (Klotzsch) Hemsley.	Rhamnaceae	Seeds, fruits
Boscia angustifolia (A.) Rich.	Capparidaceae	Leaves, flowers
Boscia salicifolia Oliv.	Capparidaceae	Leaves, flowers
Bussea massaiensis (Tambert) Harms.	Fabaceae	Rootstock
Cadaba farinosa Forssk.	Capparidaceae	Seeds, fruits
Canthium burtii Bullock.	Rubiaceae	Seeds, fruits
Senna singuena (Del.) Lock.	Fabaceae	Seeds, fruits
Chenopodium opulifolium Schrad ex Kock & Ziz	Chenopodiaceae	Leaves, flowers
Commiphora africana (A.Rich.) Engl.	Burseraceae	Rootstock
Commiphora eminii subsp *zimmermannii*	Burseraceae	Rootstock
Cordia monoica Robx.	Boraginaceae	Leaves, flowers
Dalbergia nitidula Welw.ex Baker	Fabaceae	Seeds, fruits
Dombeya rotundifolia Mast.	Sterculiaceae	Leaves, flowers
Ficus vallis-choudae Del.	Moraceae	Seeds, fruits
Grewia burtii L.	Tiliaceae	Seeds, fruits
Indigofera spinosa Forssk.	Fabaceae	Rootstock
Lannea schweinfurthii (Engl.) Engl	Anacardiaceae	Leaves, flowers
Lannea humilis (Oliv.) Engl.	Anacardiaceae	Leaves, flowers
Maerua triphylla A. Rich. Var	Capparidaceae	Rootstock
Manilkara mochisia (Bak.) Dubard	Sapotaceae	Leaves, flowers
Pappea capensis Eckl and Zey	Sapindaceae	Leaves, flowers
Strychnos cocculoides (Baker).	Longaniaceae	Leaves, flowers
Tamarindus indica L.	Fabaceae	Leaves, flowers
Vitex doniana Sweet	Verbenaceae	Leaves, flowers
Vitex payos (Lour.) Merr.	Verbenaceae	Leaves, flowers
Ziziphus mucronata Willd	Rhamnaceae	Leaves, flowers

Table 3b. Distribution of wild food plants of different families in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Family	Lowland forest reserve	Mountainous forest reserve	Free access forest	Number of Species
Anacardiaceae	+*	+	+	3
Balanitaceae	+	+	+	3
Bombacaceae	+	+	-	2
Boraginaceae	+	+	-	2
Burseraceae	+	+	+	4
Capparidaceae	+	+	-	6
Chenopodiaceae	+	+	-	2
Fabaceae	+	+	+	11
Longaniaceae	+	-	-	1
Moraceae	+	-	-	1
Rhamnaceae	+	+	-	3
Rubiaceae	+	+	-	2
Sapindaceae	+	+	-	3
Sapotaceae	+	-	-	1
Sterculiaceae	-	+	-	1
Tiliaceae	+	+	-	2
Verbenaceae	+	+	-	3

* + Present - Absent

Table 4. Commonly preferred wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

	Villages					
Species	**Mkondai**	**Mayamaya**	**Asanje**	**Total**	**Average**	**Rank**
Acacia negrescens	18*	37	74	130	43	9th
A. senegal	65	38	28	131	44	8th
Balanites aegyptiaca	84	56	37	177	59	5th
Senna singuena	81	84	9	174	58	6th
Commiphora africana	65	56	47	167	56	7th
Dalbergia nitidula	47	19	37	102	34	10th
Strychnos cocculoides	74	82	74	231	77	3rd
Tamarindus indica	65	84	84	233	78	2nd
Vitex doniana	84	85	74	243	81	1st
Vitex payos	56	74	84	214	71	4th

** Sum of the scores of the most preferred species reported by respondents.*

5.2 Growth Forms of Wild Food Plants in Chenene Miombo Woodland (CMW)

The results indicated that there was a significant difference ($p<0.05$) in the growth forms of wild food plants among the sites. Among the identified plant species the lowland forest reserve had the highest number of shrubs, which accounted to 51%, followed by 44% trees and 5% herbs. In the mountain forest reserve, the number of trees was lower (42%) than the number of shrubs (51%). In the unreserved forest, the number of trees was significantly higher (62%) than the number of shrubs. In this site, herbs were absent but they were identified in the other sites. The lowland reserved forest had the highest number of trees, followed by the unreserved forest. The various growth forms of species are indicated in Figure 4 and Appendix 1.

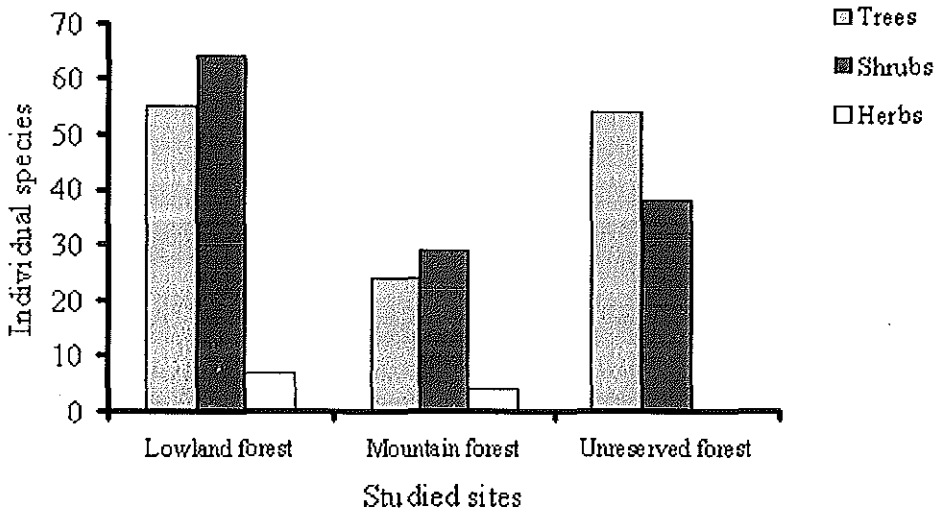

Figure 4. Growth forms of wild food plants in the different sites studied in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

5.3 Size Distribution of Wild Food Plants in Chenene Miombo Woodland (CMW)

The wild food plants in the forest were distributed into different diameter and height classes. In all the sites studied, the tree species of low diameter classes were more than four fold, compared with other classes. As indicated in Figure 5, 216 trees and shrubs found in the range of 5-14.5 cm in which 41% of the species found in lowland forest reserve and unreserved forests, respectively and the mountain had the lowest number of species in the lowest class. At diameter class of >25cm, there were few number of species in the mountainous forest reserve and unreserved forest. It was calculated that 59% of the individuals were found in the lowland forest, 41% in the mountain forest reserve and none were found in the unreserved forest. The diameter class distribution of the species and individuals revealed that the percentages of individual decreases with the increase of diameter classes. The lowest diameter classes included many species and the highest diameter class included only few species.

The height distribution of the wild food plants is indicated in Figure 6. The height class of 2-12m had many individuals accounting for 55% of the total number of individuals whereas the height classes above 30m had only 5.6% of the number of individual species. In all cases, the dbh and height distribution decreased in every site as indicated in the Figures 5 and 6.

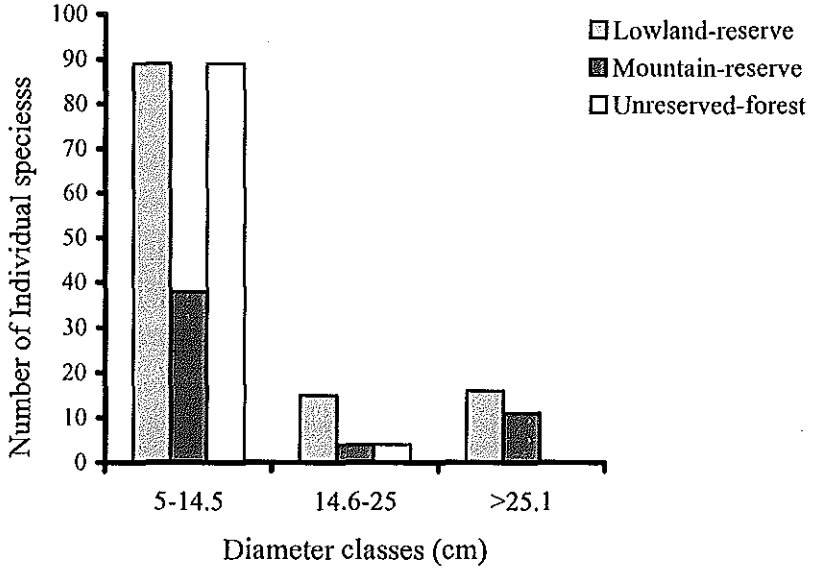

Figure 5. Diameter class distribution of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

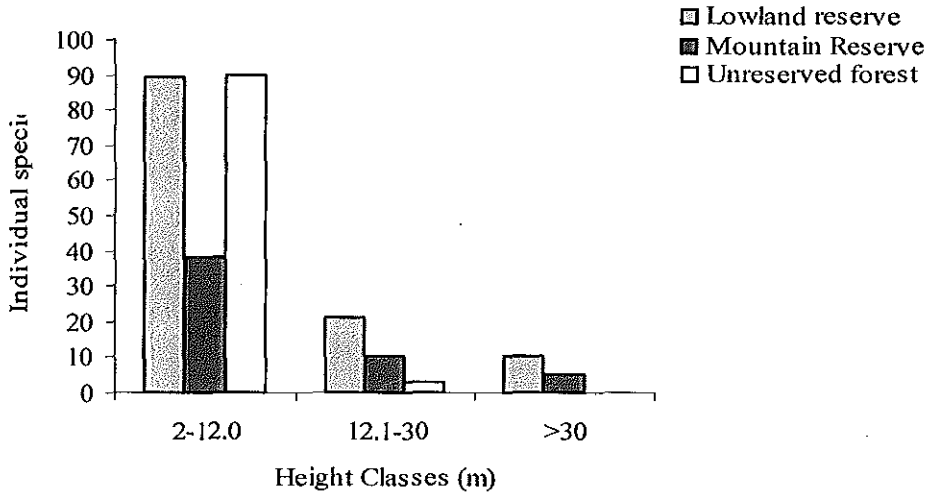

Figure 6. Height class distribution of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

5.4 Regeneration Status of Wild Food Plants in Chenene Miombo Woodland (CMW)

5.4.1 Seedlings

There was significant difference (One-way ANOVA, $p<0.05$) in the tree sites and this shows a declining trend from the lowland forest reserve, to the mountain forest reserve and unreserved forest (Figure 7, Appendix 5). As shown in the figure there was a striking difference between the three sites in which in the lowland forest reserve, the mean seedlings density was 1140 per ha while in the mountain forest reserve the density was 660 seedlings per ha. The unreserved forest had the lowest mean of 327 seedlings per ha.

5.4.2 Saplings

The species densities of saplings in the three sites were significantly different (One-way ANOVA, $p<0.05$) (Appendix 5). The mean densities in all the sites were 840, 240 and 73 saplings per ha in lowland forest reserve, mountain forest reserve and unreserved forest, respectively (Figure 8). This type of distribution indicates that the lowland forest reserves had the highest level of seedlings recruitment.

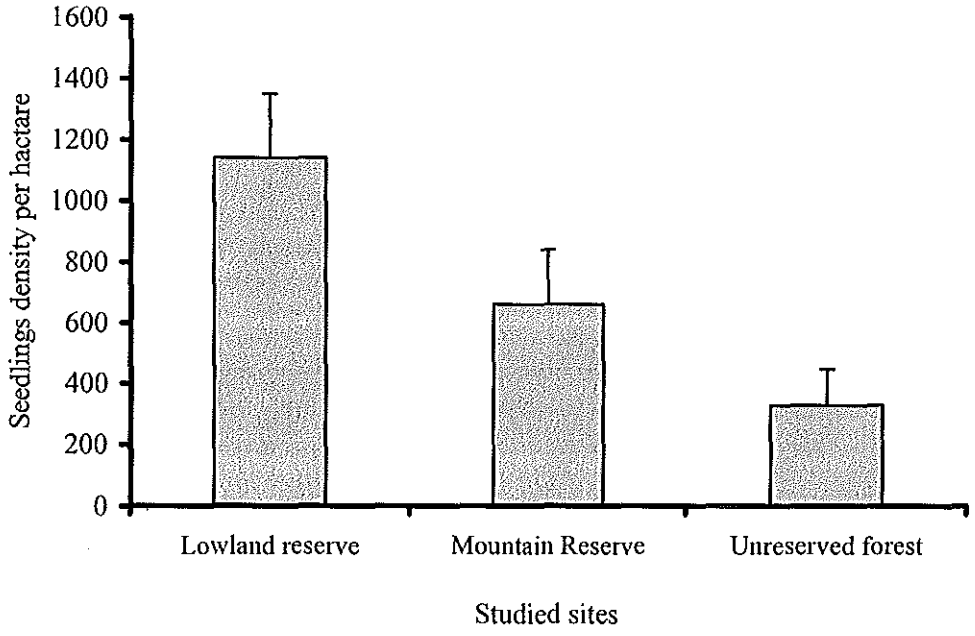

Figure 7. Seedlings distribution of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

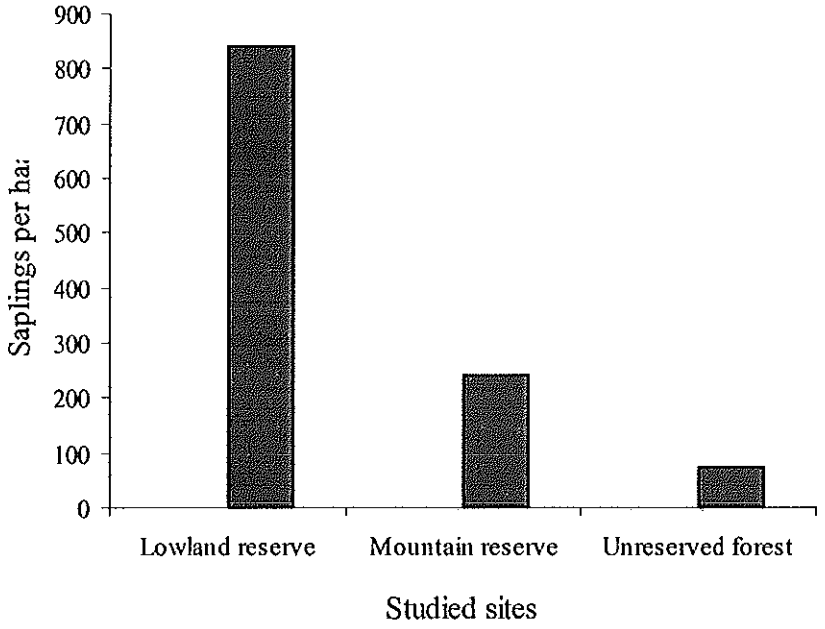

Figure 8. Saplings distribution of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

5.4.3 Diversity, Evenness and Richness of Wild Food Plants in Three Sites Of Chenene Miombo Woodland (CMW)

The results on species diversity showed a significant difference (One-way ANOVA, $p<0.05$) among the three sites (Table 5, Appendix 5). The results show that the diversity in the lowland forest reserve had the highest value (1.267) and the lowest was in the mountain forest reserve (0.352). In the case of equitability or evenness, there was a significant difference ($p<0.05$) between the sites (Appendix 5) in which the lowland again had the highest (0.850) while the mountain forest reserve had the lowest (0.388). The species richness was also different in both sites whereby the unreserved forest had the highest value (8.36) that the lowland forest reserves (6.47).

18.8% of the total species. Five species in this community are wild food plants. This type of community was completely restricted in the unreserved forest (Table 11). This community was absent in other sites. The distribution of species and plots in relation to communities and abundances are indicated in Appendices 2 and 3.

III. *Combretum zeyheri -Acacia negrescens* community (Community III)

This community is dominated by the *Combretum zeyheri* Sond and *Acacia negrescens* Sond. Community III is made up of 23 plant species in which 7 are wild food plants. The community also is widespread in the mountain forest reserve and partly in the lowland forest (Table 11) and was completely absent in the unreserved forest. The distribution of species in relation to plots and abundances is indicated in Appendices 2 and 3.

IV. *Cordia monoica -Strychnos cocculoides* community (Community IV)

The *Cordia monoica* Robx and *Strychnos cocculoides* (Baker.) are the dominant species of this community. Community IV is made up of 41 plant species of which 18 plant species are food plants. *Cordia monoica -Strychnos cocculoides* community was dominant in the lowland and mountain forest reserves and was not found in the unreserved forest (Table 6). The distribution of species in relation to plots and abundances is indicated in Appendices 2 and 3.

Table 6. Distribution of communities in the lowland reserve, mountain reserve and unreserved sites of Chenene Miombo Woodland (CMW)

Sites	**Community type**			
	I	**II**	**III**	**IV**
Lowland Forest Reserve	+*	-	+	+
Mountain Forest Reserve	+	-	+	+
Unreserved forest	+	+	-	-

*(+) Present (-) absent

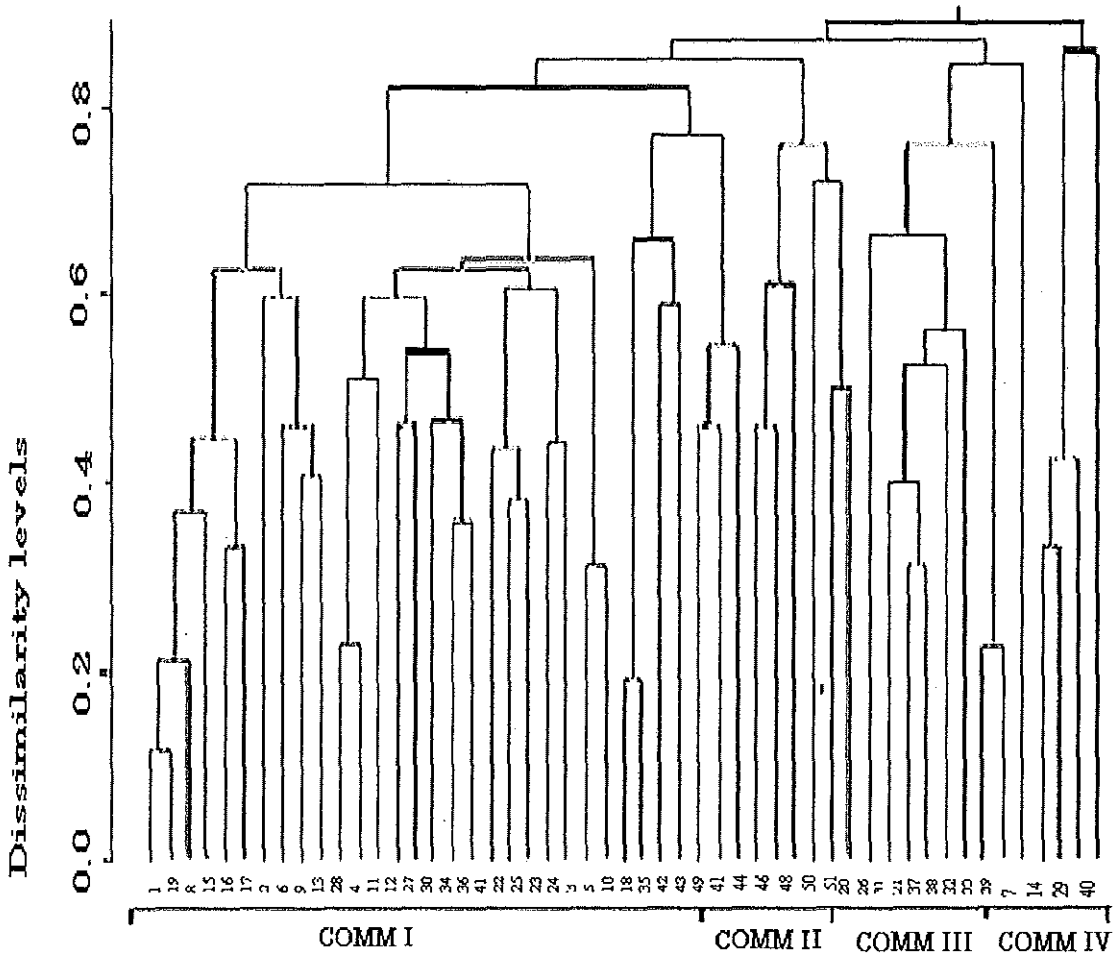

Figure 9. Dendrograms indicating communities I-IV in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

5.5.2 Diversity, Richness and Similarity of Wild Food Plants in Community Types

(a)The Shannon diversity index (H) and Shannon's equitability (E_H)

The results on species diversity showed a significant difference (One-way ANOVA, $p<0.05$) among the communities (Table 7, Appendix 5). The diversities in community IV and I were much higher than two fold compared to communities II and III. In the case of equitability or evenness, there was a significant difference ($p<0.05$) between the communities in which communities IV and III had the highest values.

(b)Species richness of wild food plants

There was a significant difference (One-way ANOVA, $p<0.05$) in species richness among the communities (Table 7, Appendix 5). Results for species richness were compared between community types and indicated that, community IV had highest species richness for wild food plants, followed by communities III and I, whereas community II had the lowest species richness.

Table 7. Diversity, evenness and species richness of wild food plants in different communities (I-IV) in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

	Community type			
	I	**II**	**III**	**IV**
Shannon's diversity index (H)	1.19^{b*}	0.18^{a}	0.82^{b}	2.15^{c}
Equitability (evenness) (E_H)	0.82^{b}	0.15^{a}	0.90^{b}	0.98^{b}
Species richness	7.73^{ab}	3.83^{a}	7.67^{ab}	11.75^{b}

*Values with the same letters in the same rows are not significantly different ($P<0.05$)

(c) Similarity indices

Similarities in species composition among communities were assessed using Sørensen similarity index for presence/absence (Krebs, 1989). In the present study, the general similarity index of wild food plants in all the studied communities was 0.36 and the common species reflected to the similarity were *Acacia negrescens* Oliver and *A. senegal* (L.) Willd. The similarity Indices between the communities ranges from 0.23-0.83. Results on similarity indices are indicated in Table 8.

Table 8. Similarity indices of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

	Similarity index for all species	**Similarity index for wild food plants**
General SI	0.15	0.36
Community 1 and II	0.15	0.32
Community I and III	0.13	0.30
Community I and IV	0.11	0.23
Community II and III	0.29	0.83
Community II and IV	0.19	0.44
Community III and IV	0.16	0.4

5.6 Conservation of Wild Food Plants in Chenene Miombo Woodland (CMW)

5.6.1 Current status of CMW

In the CMW, the conservation of resource is lagging behind in the sense that human and animal disturbances are severe. As indicated in Figure 10, forest disturbances were severe and this indicates that there was a significant difference (One-way ANOVA, $p<0.05$) on the disturbances caused by human (Plate 1) and livestock in both sites. This implies that the disturbances caused by man were higher in lowland forest reserve and unreserved forest and slightly lower in mountain forest reserve. Results further indicated the number of stump remnants in the study were significantly different (One-way ANOVA, $p<0.05$) in both sites (Table 8, Appendix 5). The number of stumps in the unreserved is more that 15 and 20-fold of mountain and lowland forest reserve, respectively (Table 9). This indicates that the destruction was more severe in the unreserved forest reserve. Wild animals were the threats of the resources in the low land forest reserve and very low cases were reported in the other sites. Fire was the main cause of resource destruction in the unreserved forest but not serious in the other sites (Plate 2).

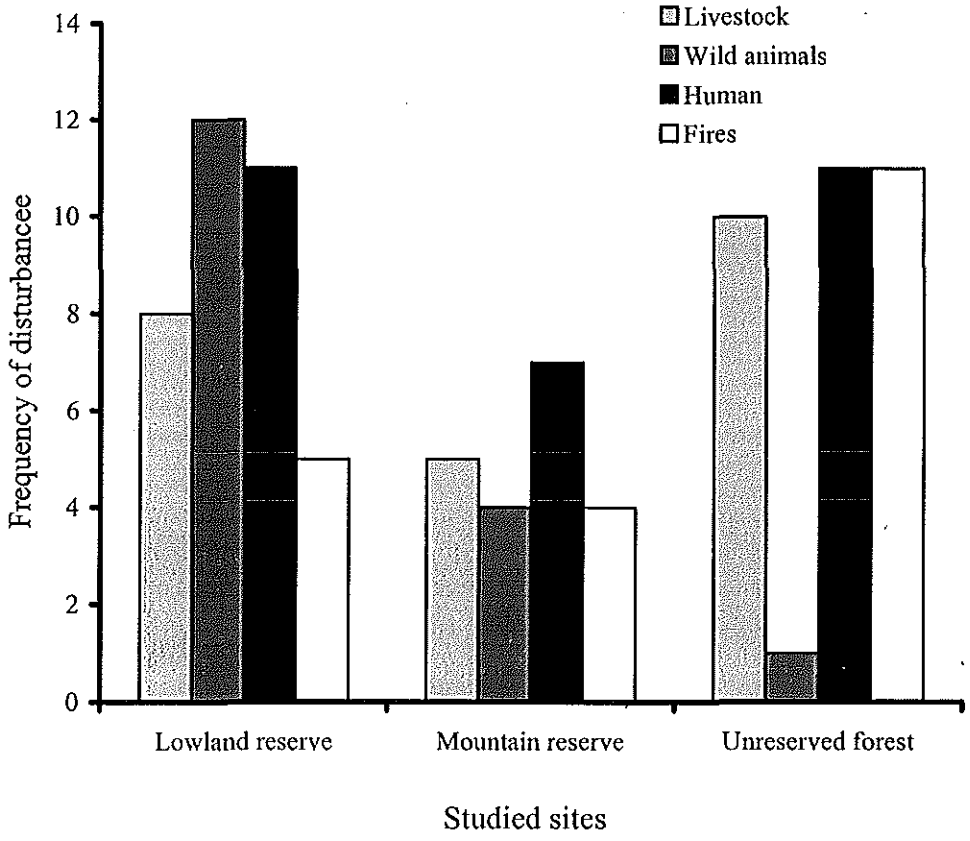

Figure 10. Different types of disturbances in the Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Plate 1. Human disturbances in wild food plants in Chenene Miombo Woodland, Dodoma Rural District, Tanzania.

Plate 2. The disturbances caused by wildfires in Chenene Miombo Woodland, Dodoma Rural District, Tanzania.

Table 9. The number of stumps found in the Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Site	Number of stumps per ha
Lowland Forest Reserve	6 ± 15.97
Mountain Forest Reserve	10 ± 20.52
Unreserved Forest	150 ± 143.18

4.6.2 Conservation of Wild Food Plants

The local community surrounding the CMW are highly dependent on the wild food plants during food scarcity. The results indicated that due to the high dependency of these wild food plants, there is decreasing trend of plants resources and this has been reported by 94.4% (n=85) of the respondents (Table 10). As indicated in the table, the respondents from Mayamaya are experiencing a significant decline of wild food resources than the other villages of Asanje and Mkondai. The reasons for decline of these wild food plants are indicated in Table 11, which shows over harvesting of the wild food plants by human being.. The animals' disturbances by browsing, burrowing and their frequent movements in the forestland lead also to the severe declines.

Table 10. The declining trend of wild food plants in the Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Trend	Villages			Percentage Total
	Mkondai (n=30)	Asanje (n=30)	Mayamaya (n=30)	
Increasing	-	-	-	-
Decreasing	31.1 (28)*	31.1(28)	32.2 (28)	94.4 (85)
Constant	2.2 (2)	2.2 (2)	1.1 (1)	5.6 (5)

*Values in brackets are number of respondents and without brackets are percentages

Table 11. Reasons for the decline of wild food plants in CMW, Dodoma Rural District, Tanzania

Reasons	Villages		
	Mkondai (n=30)	Asanje (n=30)	Mayamaya (n=30)
Over-harvesting	56.7(17)*	23.3(7)	33.3(10)
Animal destructions	23.3(7)	20(6)	30(9)
Persistent drought	3.3(1)	30(9)	10(3)
Wild fires	10(3)	10(5)	3.3 (1)
Lack of harvesting techniques	6.7(2)	16.7(5)	23.3(7)
Total	**100**	**100**	**100**

*Values in brackets are number of respondents and without brackets are percentages

5.6.3 Conservation Practices for Wild Food Plants in Chenene Miombo Woodland (CMW)

In the villages surrounding the CMW, community participation was a common practice and the results showed that 84.4% (n=76) of all the respondents participated in conservation of the wild food plants, whereas 15.6% (n=14) were not participating. These results showed that there was no significant difference on the response of the local communities from all the villages in the process of participating in conservation of food plants. Despite the fact that a significant number of local communities are participating in the conservation of wild food plants, several practices had been used including domestication of wild food plants. Domestication was a popular and main practice for conserving wild food plants (Plate 3). The findings showed that 68.9% (n=62) of the respondents domesticated some of the food plants, 12.2% (n=11) considered protection of the food plants in the graveyards, water sources, rivers and sacred areas, as the means of conserving the food plant resources. Other practices used for conservation were to maintain the wild food plants in their natural habitat (*in situ* conservation) (8.9% n=8), harvesting of non-reproductive parts (3.3% n=3), control of wild fires in the natural habitat and farmlands (3.3% n=3) and storing the harvested food for future use. The village-wise results for conservation practices are indicated in Table 12. In all the villages, domestication of wild food plants was highly practiced and most of the respondents had their own food plants in their farmlands. The number of tree/plants found in the farmlands of the respondents is indicated in Figure 11. The results indicated that 38% of all the plant species domesticated were found in Mayamaya, 34% were found in Mkondai, whereas Asanje village had only 28% of the domesticated species. The most commonly preferred species for domestication are given in Table 13. The most preferred species were the *Vitex doniana* Sweet, *Tamarindus indica* L. and last was *Balanites aegyptiaca* (L) Del among the first five plants species preferred for domestication.

Plate 3. The domestication of *Tamarindus indica* as a strategy of conserving wild food plants in Dodoma Rural District, Tanzania.

Table 12. Conservation practices of wild food plants in the Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Practice(s)	**Villages**		
	Mkondai (n=30)	**Asanje (n=30)**	**Mayamaya (n=30)**
Domestication	70 (21)*	70 (21)	66.7 (20)
In situ conservation	10 (3)	10 (3)	6.7 (2)
Harvesting of non reproductive parts	3.3 (1)	3.3 (1)	3.3 (1)
Control Wild fires	3.3 (1)	3.3 (1)	3.3 (1)
Food storage for future use	3.3 (1)	3.3 (1)	3.3 (1)
Protection in the farmlands, streams and rivers	10 (3)	10 (3)	16.5 (5)
Total	100	100	100

*Values in brackets are number of respondents and without brackets are percentages

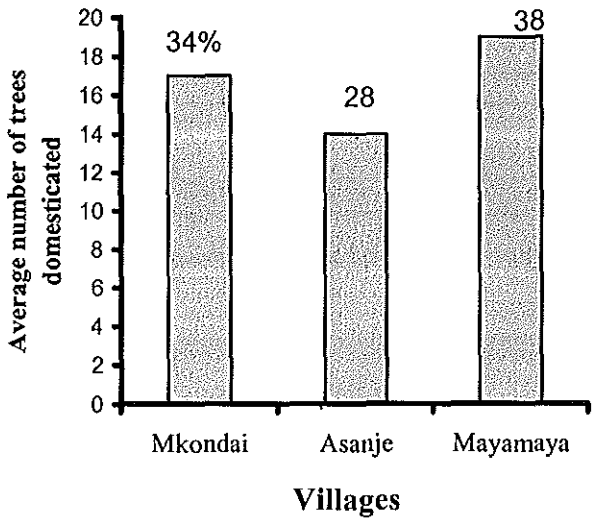

Figure 11. Number of tree species domesticated in the villages around Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Table 13. The most preferred wild food plants for domestication in the villages around Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Species	Villages			Total	Average	Total
	Mkondai	Mayamaya	Asanje			
Balanites aegyptica	56*	40	21	117	23	5th
Commiphora africana	49	40	31	119	24	4th
Strychros cocculoides	58	68	58	185	37	3rd
Tamarindus indica	49	68	68	185	37	2nd
Vitex doniana	68	69	58	195	39	1st

*Sum of the scores of the most preferred plant species reported by the respondents

5.6.4 Constraints Associated With Wild Food Plants Conservation in Chenene Miombo Woodland (CMW)

Despite the fact that conservation practices were taking place in the villages surrounding the forest reserve, the present study revealed several problems hindering the conservation and promotion of the wild food plants. One of the most important problems hindering conservation was persistent drought which led the domestication practices unsuccessful and this accounted for 53.3% (n=48) of all the respondents (Plate 4). Other problems were associated with the lack of planting materials, lack of conservation advisors, poor growth of the planted trees due to soil infertility and lack of local institutions responsible for resource conservation and management (Table 14).

Plate 4. The part of Chenene miombo woodland, indicating the extent of degradation and aridity nature of the area

Table 14. Problems in conservation of wild food plants in Chenene Miombo Woodland (CMW), Dodoma Rural District, Tanzania

Practice(s)	Villages		
	Mkondai (n=30)	**Asanje (n=30)**	**Mayamaya (n=30)**
Lack of planting material (seedlings)	13.3 (4)*	13.3 (4)	10 (3)
Lack of conservation advisors	16.7 (5)	10 (3)	10 (3)
Persistent drought	46.7 (14)	50 (15)	63.3 (19)
Infertility of the land	16.7 (5)	13.3 (4)	6.7 (2)
Lack of community institutions	6.7 (2)	13.3 (4)	10 (1)
Total	**100**	**100**	**100**

*Values in brackets are number of respondents and without brackets are percentages

6. DISCUSSION

6.1 Vegetation Description in Relation to Wild Food Plants

In this study, 31 plant species were wild food plants and they were frequently collected from the forest. This amount is very low and it is evident that the CMW is highly degraded. In other areas of Tanzania, about 83 indigenous tree species, which bear fruits and nuts throughout the year, have been identified in the Miombo woodland (Temu and Chihongo, 1997). In line within this study, the species composition of the wild food plants in the CMW is lower than the ones reported in Tabora woodland in which more that 50 plant species were used as food. The lower value explains the fact that the woodland was highly degraded due to human activities or probably due to the aridity of the area. Furthermore, in the CMW, the family Fabaceae and Capparidaceae were the most dominant families and this indicates that they were the common and popular groups used as wild food plants. These families are distributed more in the lowland area of the forest reserve and this indicates that the area is richer in species composition than the mountain area. This also can be attributed to the fact that the lowland forest reserve is more fertile than the highland and thus support high number of species. On the other hand, there are groups of families, which are restricted in either lowland, mountain, or in the unreserved, forests and this tendency of a family being restricted in a particular location is related to the niche differentiation of the species and associated families. These results concur with the earlier study by Obiri *et al.* (2002) which indicated that area restricted species suggest some degree of niche differentiation based on the site environment or disturbance tolerance within the Miombo forest community.

6.2 Growth Forms of Wild Food Plants

The results implied that the shrub layer was almost by far the most species rich in the different sites and it was significantly more diverse and species-rich than the tree and herbaceous layers. Moreover, shrubs contributed less in the mountainous forest reserve in relation to other sites and these results suggest that shrub layer was indicator for diversity in the lowland and unreserved sites. Contrary to this, Obiri *et al.* (2002) revealed that shrub layer alone may not be a good indicator for the diversity of species and any assessment of plant diversity consider growth form such as shrubs, climbers and herbs.

The presence and diversity of growth forms such as shrubs and herbs is dependent on species diversity and the tree species diversity may mirror the diversity of life forms or strata. The distribution patterns of growth forms obtained in this study do suggest that the area falls within a series of unpopulated woodland in Tanzania.

6.3 Size Distribution of Wild Food Plants in Chenene Miombo Woodland (CMW)

The wild food plants in the woodland were distributed into different diameter and height classes. The results indicated that in all the studied sites, the tree species of low diameter classes were more than two fold compared to other classes. The diameter class distribution of the species and individuals revealed that percentage of individual decreases with the increase of diameter classes. This depicted that the recent protection measures helped the process of enrolment. This also implies that the selective management system based on diameter class distribution practiced in the CMW, favours the sustained production of commercially valuable species while ensuring an overall species diversity. This management system may be applied in the study area to maintain diversity and sustainable productivity of valuable. The findings of this study concur with earlier reports by Agarwal *et al* (1996) and Manilal (1997) that diameter class distribution has strong relation with biodiversity conservation and their associated benefits.

The height distribution of the wild food plants indicates highest value of the individuals with the lowest heights whereas the height classes above 30 m had few number of individual species. This result suggests that the percentage of trees is decreased with increasing height classes. The number of individuals and species were decreasing by increasing height class and this also indicates that there is addition of new species and individuals in the lower height classes. This also explains the fact that the species, which are coming up through natural regeneration, constituted much to the forest vegetation. Consequently, the study area is suitable for natural regeneration and the diversity of the tree species is increasing subsequently in the lowest height classes. Number of individuals and species decreased with the increasing diameter and height classes, which might indicate that, once upon a time it was completely deforested (Nath *et al*, 1997) and

now it is in a process of recruitment with diverse composition. Therefore, the area may turn into a potential biodiversity conservation area for Tanzania.

6. 4 Regeneration Status of Wild Food Plants in Chenene Miombo Woodland (CMW)

High seedlings density in the lowland forest reserve was manifested by successful seed germination and establishment, and is affected by a suit of biotic and abiotic factors, including amounts of fruit produced every season. Also the abundance of seedlings in lowland site, leading to an inverse J-shaped type of distribution, is generally regarded as an indicator of adequate regeneration and population maintenance (Uma Shankar *et al.*, 1998). Likewise, high seedling densities imply the existence of a good potential for the restoration of woody communities. Also the low proportion of seedling density indicates the impact of human and animal interference on their regeneration.

The saplings density was also higher and it is a manifestation of successful recruitment of seedlings into the sapling size class. In the case of the two sites that had significantly fewer saplings implies lower recruitment into the sapling size class, or greater mortality of the sapling size class (or some combination of the two). Moreover, a low proportion of saplings density has possibly aggravated by the greater intensity of disturbance caused by animals or humans. Human disturbance has caused many forests to become secondary forests and therefore regeneration dynamics are influenced by this agent. The findings obtained in this study are now a prerequisite to formulating management actions needed to conserve biodiversity in the area. These results also concur to those reported by Hall and Bawa (1993) that the regeneration status of species is a useful indicator of monitoring seedlings and saplings to provide information on the succession of forest ecosystems and identify any problems in tree regeneration.

6.5 Diversity, Richness and Similarity of Wild Food Plants in Chenene Miombo Woodland (CMW)

The Shannon diversity index (*H*) is commonly used to characterize species diversity in a community and it accounts for both abundance and evenness of the species present.

Shannon's equitability (E_H) is important to know the distribution of species in the community. Diversity indices provide important information about rarity and commonness of species in a community. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure. In the current study, the results are not conclusive whether these communities have the greater number of wild food plant species, but the individuals in the communities are distributed more equitably among these species. In Community II for instance, there were 23 and fewer species and over 53% of the individuals belong to one species, *Pappea capensis*. The same applies to Community III, there were 69 species of wild food plants of which 65% were dominated by *Dombeya rotundifolia* and *Acacia negrescens*. From the diversity point of view, this implies that different levels of disturbance have different effects on plant diversity. If the goal is to preserve biodiversity in a given area, we need to be able to understand how diversity is impacted by different management strategies. Because diversity indices provide more information than simply the number of species present (i.e., they account for some species being rare and others being common), they serve as valuable tools that enable biologists to quantify diversity in a community and describe its numerical structure. On the other hand, the pattern of diversity in a community may also be obtained from a species area curve. High species diversity within a community and sites may result from the ability of a large number of species to coexist in a relatively homogeneous environment or from patchiness in the community or environment (Al-Amin *et al.*, 2005). Although few species may actually coexist in any one relatively uniform patch, many species may exist in an area due to the diversity of patches in the area. The lowest values of diversity indices in the sites and community types explain that different levels of disturbance have different effects on plant diversity. To preserve biodiversity in CMW, there is a need to understand how diversity is impacted by different management strategies.

Species in Communities I, III and IV, can be ranked higher with ecosystem function, and on the other hand Community II showed a significant reduction of richness to the point that the area services are presumably degraded. Also, in the lowland mountain reserve and unreserved forest the species richness ranked higher. These results suggest that

species richness has a significant link to ecosystem function. Therefore, the lowest values obtained from this study further indicate that diversity and the stability of ecosystem is significantly low due to the lack of diverse communities and thus high susceptibility to changes brought about through disturbances. In most cases, many individual species provide benefits to us, and the argument is that the species richness is lower and this implies the loss of potential human benefit (Mwihomeke *et al.*, 2000). Based on the findings, the lower level of species richness in CMW, reflects the limited number of species, and thus, low level of wild food plants.

The low similarity between the species composition of the forest community indicates that the forest harbours different species, which are highly restricted in one site or community. Also, it is suggested that the low similarity index relied for their diversity on the mosaic structure. Therefore, spatial and also temporal variation should be maintained to conserve optimal species diversity. Increase in the similarity indices for Communities II and III suggests that there was the same species composition.

6.6 Current Conservation Status in Chenene Miombo Woodland (CMW)

It is evident that the conservation of resource is lagging behind in the CMW because of severe disturbances caused by human and livestock. This is probably due to poor allocation of resources in which the grazing land and agricultural land are sometimes not distinctive. This results into dwindling of the wild food resources and had adversely affected the food security of vulnerable groups. In general, the environmental degradation is of highest degree in CMW, and the loss of edible plant resources sustainability seems linked to rural people's attitude to the land resource and this concurs with report by Gobin *et al.* (2001). In woodland, the rural people are often considered to place their own short-term survival ahead of long-term forest resource sustainability and it is certainly known that open access to forests is one of the primary determinants of the ongoing forest degradation processes. Also, the main disturbances of the wild food resources has been caused by the lack of the common property regimes on a resource. Earlier studies by Arnold (1998) reported that, in areas where the communal management is practiced, privatization is unlikely to improve the efficiency of meeting the needs of those who have

used the resource as common property. In fact, by transferring control of the resources to a limited number of individuals, who thereby acquire the social and legal sanction to exclude others, privatisation is likely to exacerbate the problems of those without access to private property (Bromley and Cernea, 1989). Despite the fact that, CMW being highly valued by local people for both economic and social reasons, the woodland is ranked lower in importance by local farmers than agricultural land and this is why the conservation of the plant resources is lower. These results are the same as those reported by Goebel *et al.* (2000) and Campbell *et al.* (2000) that private benefits of cropland are greater than those related to state or local use of the woodland.

5.6.1 Conservation of Wild Food Plants

The use of wild foods as a component of local response to increasing food insecurity is widely known in the CMW. 'Famine foods' include wild vegetables, berries, nuts, fruits, insects, etc. In periods of limited food stress, such foods may be eaten only occasionally and more often by the poorer sectors of society. However, in periods of heightened food insecurity, such foods may become widely consumed and this had brought a significant dependence of wild food plants in the area. Due to that dependency, the trend of wild food plants had been declining from time to time. The study conducted in Zimbabwe, indicated that the availability of most woodland resources had declined very quickly between 1980 and 1998 (Tyynelä and Mudavanhu, 2000) and this trend is likely to continue in CMW. This has caused problems especially for the poor and for women as they have been the primary users of many of the wild food plants obtainable from the woodlands, and these products have been becoming increasingly difficult to find in the area. The main causes of decline of wild food resources are not different from those reported by Peter *et al* (2004) in which the main causes of declines was agricultural expansion, ever increasing human and livestock population. In general all these factors threaten this untapped renewable resource of the woodland in Tanzania.

In line with this, nowadays, people collecting and using wild-food have to travel ever further from their villages in the mid- and highlands because more and more bushland is being destroyed and turned into arable land for cultivation. Previous studies of Campbell

et al. (1993) indicated that the wildfire and deliberate burning are major threats to the biodiversity and this is the same to what was happening in the woodland ecosystem. Many useful indigenous plant species are gradually being disappeared, being the unfortunate victims of deforestation and the general destruction of land and trees. Experience from CMW shows that charcoal production was the main cause of the disappearance of the food plants and in places where charcoal production relies on open bushland and natural forests, indigenous trees are rapidly and irreversibly disappearing.

6.6.2 Conservation Practices of Wild Food Plants

The increased rate of collection of wild foods generally precedes large-scale disappearance of particular species. To control this trend, it needs a greater understanding of indigenous responses to food insecurity together with the evolution locally specific monitoring and conservation strategies. The communities surrounding CMW use several practices to conserve the wild food plants and the most popular technique were domestication of wild food plants, conservation in their natural habitat and protection in the farmland, rivers and streams. In CMW, like other parts of Tanzania, tree species selected by farmers based on their availability, multiple uses and commercial value have been planted. These include *Vitex doniana*, *Adansonia digitata*, *Strychnos cocculoides*, *Sclerocarya birrea*, *Tamarindus indica* and *Berchemia discolor*. Domestication of indigenous food plants is an emerging industry for Tanzania. However, this is not the case with the communities around the CMW. Very few species such as *Tamarindus indica* and *Vitex doniana* were found in the farmland and they were the most preferred ones by the local communities. This implies that the industry of domestication is still poor in CMW. In 1997, International Centre for Research in Agroforestry (ICRAF) in collaboration with national partners in Southern Africa started the domestication programme for food plants and medicinal trees in the Miombo ecozone basing on the farmers choices of indigenous fruit and medicinal trees for domestication (Maghembe *et al* 1998, Dery *et al* 1999). Although the projects have been in place but yet has proved illusive in the CMW.

The conservation of wild food plants in their natural habitat and protection in the rivers graveyards and other areas of beliefs have been practiced by very few numbers of communities. The experience form the CMW, indicated that there is no practical examples whereby these practices are in use. Other practices reported in the earlier studies in Tanzania, indicated that the people still value traditional rituals and traditional protected forests even in villages where new Christian and Islamic religions have got a strong hold (Mwihomeke *et al.*, 2000). In addition, Mwihomeke *et al.* (2000) revealed several practices such as burial graves, sacred forests, which are places, used for rain ceremonies, places to protect important water sources and also some forests are used as boundary between clans. Generally in Tanzania, Joint Forest Management (JFM) represents a fundamental shift in forest management methods and conceptually envisages a movement from centralized to decentralized management (Kajembe and Kessy, 2000). Though JFM seems to be accepted in the CMW, progress towards this strategy has been slow and not supporting the conservation practices of the local communities.

6.6.3 Constraints Associated With Wild Food Plants Conservation in Chenene Miombo Woodland (CMW)

The conservation of the wild food plant by the communities around CMW is constrained by persistent drought, lack of conservation advisors, soil infertility as well as the lack of local institutions for resource management. All these factors were hindering the development of conservation practices and results to less conservation efforts on conservation of wild food plants. Despite the fact that, drought has becoming significant problems especially in domestication, there is no institution maintaining traditional wild food plants, which is predominantly semi-arid. The constraints reported in this study are not far from those reported by Peters *et al* (2004) that skills, storage and seasonality of fruits. Lack of conservation advisors had also posed significant problems in which there was no sensitization of local communities on the importance of indigenous wild food plants and how to add value through processing of various products to improve nutritional status, health, income and livelihoods of rural communities. From such point, it is anticipated that through awareness creation on the importance of wild food plants and their production on farms will result in their conservation and sustainable use.

On the other hand in other countries like Zimbabwe, controls on harvesting of wood products from the natural woodlands involve protection of whole woodlands (sacred forests or woodlands) as well as of individual tree species (often fruit tree species or other tree species associated with cultural or spiritual values). The controls are managed over by the local chiefs and headmen. In most cases, the controls are more stringently enforced if the villagers still have stronger cultural values and respect for the sacred woodland (Zharare and Mudavanhu, 2000). Contrary, Campbell *et al.* (1993) found that local traditional institutions tend to collapse when resource scarcity develops, and a diverse range of locally illegal practices emerges. According to Mukamuri (1998), local institutional arrangements in communal areas have often collapsed in the face of substantial spontaneous immigration of people from elsewhere in the country. People moving from urban to rural areas do not want to pay allegiance to traditional leaders because they consider the institutions to be ancient. This fact has also led to conservation efforts of the CMW unsuccessful. However, some community leaders have been successful in re-asserting their rights over resource use in communal areas. Until recently, it is not clear yet which circumstances lead to breakdown of rules and which lead to rules being reinforced, but it can be speculated that the basic differences lie in the nature, history, coherence, strength and legitimacy of the institution in power as well as the nature of the resource (e.g. the extent of deforestation) and the economic value of the woodland products.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Based on the results and subsequent discussion, it can be concluded that edible wild plants make a major contribution to dietary intake of rural people during times of food shortage. Hence, the consumption of wild plants is a necessary part of the strategies adopted by people in order to survive in a harsh and unforgiving environment. However, there was few number of edible plant species in CMW and this shows that the area was highly degraded due to human activities or probably due to the aridity of the area. Also, this reflects on the limited number of species in the area and thus low level of wild food plants necessary for human beings. The increased rate of collection of wild foods precedes large-scale disappearance of food species and to counteract this trend, the communities surrounding CMW used several practices to conserve the wild food plants including domestication of wild food plants, *in situ* conservation and protection in the farmlands and water sources. In the case of domestication of indigenous food plants only few species such as *Tamarindus indica* and *Vitex doniana* were found in the farmlands. The conservation of wild food plants in their natural habitat and protection in the rivers, graveyards and other areas of beliefs have been practiced by few numbers of communities. The experience from the CMW, indicated that there was no any practical examples of these practices in the area due to the persistent drought, lack of conservation advisors, soil infertility as well as the lack of local institutions for resource management.

7.2 Recommendations

The conservation of natural resources in CMW is still poor and there is a need for these food plants to be domesticated, starting with those that have high nutritive value and easiness to propagate.

There is a need to conduct research on the nutritional values of these plants and their potential impact on human health as a result of prolonged consumption. It is still as yet unclear if over time some of the wild food plants have long-term positive or negative effects on the health of consumers.

There is also a need to identify what plant resources and associated local and indigenous knowledge innovations and practices support sustainable livelihoods, local food security and health care. The need for measures and definition of sustainable livelihoods is both problematic and politically sensitive. Therefore this might be focused primarily on the decline of the food plant resources, rather than what are sustainable livelihoods, although it is recognized that declines of resources and socio-economic factors operating needs to be incorporated and addressed.

Achievement of conservation practices of wild food plant will depend on the evolution of policies towards rural livelihoods. From the positive perspective, attainment of this will be assisted by current trends in the policies of development agencies towards rural livelihoods. However, much more attention needs to be paid to food plant resources within these policies than is currently the case.

To enable an appropriate conservation of wild food plants and increase their diversities and richness in CMW, there is a need to:-

- Create awareness on the importance of wild food plants and their production on farms will result in their conservation and sustainable use;

- Enable institutional frameworks to function at the macro-level is a crucial factor in natural resources management: here the state can not be bypassed, as it is the only institution with power at this level;
- Recognition of the existing local institutions (both traditional and modern) and when incorporating them into resource-management regimes, their quality and representability must be carefully considered;
- Promotion of home gardening/ agroforestry of wild food plants.
- Collecting and cataloguing of indigenous vegetable germplasm in the district where collecting has not yet been done

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APPENDICES

Appendix 1. List of plant species in Chenene Miombo Woodland

Botanical name	Family	Growth form
Acacia albida Del.	Fabaceae	Tree
A. mellifera (Vahl.) Benth.	Fabaceae	Tree
A. negrescens Oliver.	Fabaceae	Tree
A. nilotica (L.) Del.	Fabaceae	Tree
A. polyacantha Willd.	Fabaceae	Tree
A. senegal (L.) Willd.	Fabaceae	Tree
A. seyal Del.	Fabaceae	Tree
A. tanganyikensis Brenan.	Fabaceae	Tree
A. tortilis (Forssk) Hayne.	Fabaceae	Tree
Adansonia digitata L.	Bombacaceae	Tree
Albizia amara (Robx.) Boiv.	Fabaceae	Tree
A. anthelminitica Brongn.	Fabaceae	Tree
A. schimperariana Oliver.	Fabaceae	Tree
Allophylla africanus (P.) Beaunv.	Sapindaceae	Tree
Balanites aegyptiaca (L.) Del	Balanitaceae	Tree
Berchemia discolar (Klotzsch) Hemsley.	Rhamnaceae	Tree
Boscia angustifolia (A.) Rich.	Capparidaceae	Tree
B. salicifolia Oliv.	Capparidaceae	Tree
Brachystegia bussei Benth.	Fabaceae	Tree
B. microphylla Harm.	Fabaceae	Tree
B. speciformis Benth.	Fabaceae	Tree
Bussea massaiensis (Tambert) Harms.	Fabaceae	Shrub
Cadaba farinosa Forssk.	Capparidaceae	Shrub
Canthium burtii Bullock.	Rubiaceae	Shrub
Capparis fascicularis Lam.	Capparidaceae	S
Cassia abbreviata Oliv.	Fabaceae	Tree
Cassia singuena (Del.) Lock.	Fabaceae	Tree
Cassiopourea mollis (R.E.Fr.) Alston.	Rhizophoraceae	Tree
Chenopodium opulifolium Schrad ex Kock & Ziz.	Chenopodiaceae	Tree
Combretum zeyheri Sond.	Combretaceae	Tree
Commiphora africana (A.Rich.) Engl.	Burseraceae	Shrub
C. eminii subsp zimmermannii Engl.	Burseraceae	Shrub
Cordia monoica Robx.	Boraginaceae	Shrub
Dalbergia nitidula Welw.ex Baker	Fabaceae	Tree
Delonix elata (L.) Gamble	Fabaceae	Tree
Dichrostachys cinerea (L.) wight et Arn	Fabaceae	Shrub
Dombeya rotundifolia Mast	Sterculiaceae	Shrub
Ehretia obtusilolia (amoeana) Klotzsh	Boraginaceae	Tree
Erythrina abyssinica Lam.	Fabaceae	Tree
Euphorbia candelabrum Kotschy	Euphobiaceae	Tree

Appendix 1 continue

E. grantii L.	Euphobiaceae	Shrub
Ficus vallis-choudae Del.	Moraceae	Tree
Grewia burtii L.	Tiliaceae	Shrub
Indigofera spinosa Forssk	Fabaceae	Herb
Julbernadia globiflora (Benth) Troupin	Fabaceae	Tree
Lannea schweinfurthii (Engl.) Engl.	Anacardiaceae	Tree
L. humilis (Oliv) Engl.	Anacardiaceae	Tree
Lonchocarpus bussei Harms	Fabaceae	Tree
L. carpassa Harms	Fabaceae	Tree
Maerua triphylla A. Rich. Var	Capparidaceae	Tree
Manilkara mochisia (Bak.) Dubard.	Sapotaceae	Tree
Margaritaria discoidea (Bail.) Webster.	Euphobiaceae	Tree
Pappea capensis Eckl.and Zey	Sapindaceae	Tree
Pterocarpus angolensis Dc	Fabaceae	Tree
Salvadora persica L.	Fabaceae	Herb climber
Sclerocarya birrea (A. Rich.)	Anacardiaceae	Tree
Sterculia Africana (lour.) Fiori.	Sterculiaceae	Tree
Strychnos cocculoides (Baker).	Longaniaceae	Shrub
Tamarindus indica L.	Fabaceae	Tree
Terminalia serecea Burch. Ex DC	Combretaceae	Tree
Vepris glomerata (F. Hoffm.) Engl.	Rutaceae	Shrub
Vitex doniana Sweet	Verbenaceae	Tree
V. payos (Lour.) Merr.	Verbenaceae	Tree
Ziziphus mucronata Willd	Rhamnaceae	Shrub

Appendix 2. Distribution of plots in different communities in Chenene Miombo Woodland

COMMUNITY TYPE	PLOTS		
COMMUNITY I	1	4	23
	19	11	24
	8	12	3
	15	27	5
	16	30	10
	17	34	18
	2	36	35
	6	41	42
	9	22	43
	13	25	45
	28	-	49
COMMUNITY II	41	46	50
	44	48	51
COMMUNITY III	20	21	32
	26	37	33
	31	38	39
COMMUNITY IV	7	29	-
	14	40	-

Appendix 3. Distribution of different species in different community types of Chenene Miombo Woodland, Dodoma Rural District, Tanzania

	COMMUNITY TYPES			
	I	II	III	IV
Acacia albida	*		*	*
Acacia mellifera	*		*	
Acacia negrescens	*	*	*	*
acacia polyacantha	*			*
Acacia senegal	*	*	*	*
Acacia seyal	*	*	*	*
Acacia thoningii	*	*		*
Acacia tortilis	*		*	
Adansonia digitata	*			
Albizia amara	*			*
Albizia anthelminitica	*			*
Albizia schimperariana				*
Albizia tanganyikensis	*		*	*
Allophylla africanus	*			*
Balanites aegyptica	*			*
Berchemia discolar	*	*		*
Boscia angustifolia	*			
Boscia salicifolia	*			
Brachystegia bussei	*		*	*
Brachystegia microphylla			*	
Brachystegia speciformis	*	*	*	
Bussea massaiensis	*			
Cadaba farinosa	*	*		*
canthrium burtii				*
Capparis fascicularis	*			*
Cassia abbreviata	*			
Cassia singuena	*			
Cassiopourea mollis	*			*
Chenopidium opulifolium	*		*	
Combretum zeyheri	*	*	*	*

Appendix 3 cont				
Commiphora africana	*		*	
Commiphora eminii	*			
Dalbergia nitidula	*			
Delonix elata	*	*		*
Dichrostachys cinerea	*	*	*	*
Dombeya rotundifolia	*			*
Ehretia obtusilolia	*			*
Erythrina abysinica	*			
Euphorbia candelabrum	*		*	*
Euphorbia grantii				*
Ficus vallis-choudae	*			
Grewia burtii	*		*	*
Indigofera spinosa	*			
Julbernadia globiflora	*		*	
Lannea schweinfurthii	*			
Lennea humilis				*
Lonchocarpus bussei			*	
Lonchocarpus carpassa	*		*	*
Maerua triphylla	*			*
Manilkara mochisia	*			
Margaritaria discoidea	*	*		*
Pappea capensis	*	*		*
Pterocarpus angolensis	*		*	*
Salvadora persica			*	*
Sclerocarya birrea	*		*	*
Sterculia africana	*			*
Strychros cocculoides	*			*
Tamarindus indica				*
Terminalia serecea	*			
Vepris glomerata	*			*
Vitex doniana	*			
Vitex payos				*
Ziziphus mucronata	*		*	*

Bolded species are wild food plants

Appendix 4. The questionnaires for household survey

1. Village----------
2. Name----------
3. Sex----------
4. Marital status----a) married b) single c) divorced d) separate
5. Household size----------
6. Education level----a) primary b) secondary c) college d) no formal education
7. Occupation---a) Employed b) petty business c) farming
8. Source of income a) employment b) business c) farming
9. Are prefer wild food plants---a) Yes b) No
10. If yes/or No why
11. Where do you get the wild food plants ---a)farmland—b) forest
12. If in the forest how often?
13. Which species are more preferable?
14. How do you weigh the trend of the wild food plants ---a) decreasing b) increasing c) constant
15. If decreasing/increasing/ constant, why?
16. Are you conserving the wild food plants in the farmland---a) Yes b)No
17. If Yes how?
18. What are the existing practices for conserving wild food plants?
19. What are the existing institutions to support conservation initiatives?
20. Are the institutions effective of ineffective
21. What are the factors constrains the conservation effort in the area

Appendix 5. Analysis of Variance (ANOVA) indicating significant differences in the regeneration potential, sites, disturbances, diversity, evenness and richness of wild food plants in three sites of Chenene Miombo Woodland, Dodoma Rural District, Tanzania

Variables		Sum of Squares	df	Mean Square	F	*p*. value
Saplings density	Between Groups	5483750.446	2	2741875.223	8.729	.001
Seedlings density	Between Groups	5133946.524	2	2566973.262	4.080	.023
Shannon Index (sites)	Between Groups	8.567	2	4.283	13.524	.000
Evenness (sites)	Between Groups	2.130	2	1.065	6.945	.002
Richness (sites)	Between Groups	254.303	2	127.152	8.771	.001
Shanonn Index (communities)	Between Groups	9.983	3	3.328	8.653	.000
Evenness (communities)	Between Groups	2.594	3	.865	8.812	.000
Richness (communities)	Between Groups	154.550	3	51.517	2.893	.046
Stumps	Between Groups	173798.407	2	86899.203	19.147	.000