Ethnobotanical Knowledge: Implications for Participatory Forest Management

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Abstract: *The Tanzanian Government has recognized the importance of participation of local people in forestry through recent forestry legislation. Participatory forestry has the potential to provide benefits to local people and improve livelihoods but communities are obliged to formulate management plans for their common forest resources to realize this potential. The aim of the present study is to describe the use and relative importance of woodland tree species to rural people in semi-arid Tanzania, and to compare the findings with the use and importance of trees retained or planted on private land. This was done in order to match local needs and preferences in planning communal forests management as well as tree planting on private land. Quantitative ethnobotany was used to estimate use-values for tree species found in the area. The Kaguru people utilized all available tree resources in a diversified and complex manner. Use differed between user groups and gender, varied with land tenure systems, and fluctuated with seasons. Most informants expressed concern about dwindling tree resources and the need for changes in management schemes. Key informants listed 22 indigenous tree species as extremely valuable for construction and commercial purposes of which 10 were locally extinct. Wood scarcity and commercialisation are suggested as the main driving forces for tree planting. Villagers achieved greater access to scarce tree resources by planting exotic species rather than increased management of indigenous species. Conservation measures seem necessary to maintain valuable indigenous species in the area. The community may agree to issue regulations on intensity of grazing and firewood collection. The community could also consider the collection of revenue from commercial extraction of forest resources. It is a daunting but urgent task for planners and extension workers to integrate indigenous knowledge in a new generation of community based management plans to be developed.*

Key words: ethnobotany, participatory forestry, forest policy, low income communal forests, gender, herders, planning, conservation, user group, Eastern Africa

1. Introduction

The Tanzanian government has recognized the importance of the participation of local people in forestry through the National Forest Policy (1998), The National Forestry Programme (MNRT 2001) and The Forest Act (2002). The Forest and Beekeeping Division supported by a number of donor organisations and NGOs guides the implementation of the policy through Joint Forest Management (JFM) in Forest Reserves and Community Based Forest Management (CBFM) on village and general lands. Forest reserves cover about 14 million ha. of which an estimated 1.6 million ha are currently under some kind of JFM (MNRT 2006). Less experience has been gained about the management of forests in village land, even though these cover about 20 million ha. and are less protected. Nevertheless, CBFM has the potential to provide huge benefits to local people and improve livelihoods, as these forestlands are not under the same management restrictions as National Forest Reserves (Blomley & Ramadhani 2006). To realize this potential, communities are obliged to submit management plans for their common forest resources.

One of the objectives stated in the Forest Act (2002) is to "ensure the sustainable supply of forest products and services by maintaining sufficient forest area under efficient, effective and economic management". While a lot of attention has been given to organisational models, power relations and the participatory process itself, very little research has been done to define the actual forest products of importance and whom in the community these products benefit. Most areas singled out for participatory management have either features of interest to the international conservation community or contain promising timber resources to be harvested (Campbell *et al.* 2004). The corresponding management plans are often developed with the help of international conservation associations or developmental NGOs. They tend to focus on biodiversity conservation or sustainable harvesting of timber of a few valuable species that provide revenue to the communities. In reality, most communal forests do not support outstanding biodiversity or timber resources. Instead, village woodlands provide subsistence products essential to rural communities. These include not only products for basic needs such as food, shelter and health but also benefits to agriculture such as browse for livestock (Clarke *et al.* 1996). Hence, management planning for communal woodlands or village forests cannot be restricted to a few species or products. Another related feature is that villagers have the option to convert forests to farms if deemed more beneficial. It is worth noting that the "communities" in community based forest management seldom exist in any simplistic sense (Cambell *et al.* 2004) and it is necessary to identify the various groupings and their forest-interests for the development of equitable management plans. This study is an attempt to map knowledge and importance of tree resources to different user groups in semi-arid Tanzania. The next step will be how to integrate such knowledge in development of real-world management plans for communal village forests.

2. Problems and Methods

Successful institutional models for participatory forest management are generally those where the resources have high value (Campbell *et al.* 2004). The research question in the present paper concerned how to manage low value communal forest resources. This is exemplified by degraded woodland in this study. Forest resources in such areas are not abundant enough for large scale commercialisation or as a basis for revenue collection by communities. Yet villagers in these areas extract resources on a subsistence basis and hundreds of species are used regularly by local people. If villagers were to develop common management plans for such areas – what exactly should they manage? Which species are more important and to whom? Is it true that livestock owners have little interest in forest resources and do women have more knowledge than men regarding uses of trees? Are certain species, in the opinion of villagers, in need of harvest regulations and how do people respond to changes in availability? In this study, we try to answer these questions using ethnobotany.

The field of ethnobotany has developed greatly during the last two decades. Originally, ethnobotany was based on qualitative methods, such as open-ended and semi-structured interviews. Ethnobotany produced the compilation of lists of plants used together with a description of how plants were used. Although it could reveal a good range and depth of information (Martin 1995, Cotton 1996), qualitative ethnobotany is unable to measure the importance of species, compare the relative usefulness of the plants, and rank the priorities of people. Data quantification and analysis, one of the more recent approaches to ethnobotany, supplant what formerly was the compilation of plants used by the local population. The terms quantitative ethnobotany and use-value are used to describe the study of the importance of trees to local people and compare the local importance of different species, plant families and forest types (Prance *et al.* 1987, Cotton 1996, Phillips and Gentry 1993). Numerical data can be analysed statistically, and confidence intervals and probability levels can be assigned to the values obtained. It also allows the investigator to check the reliability of the data collected. By quantitative ethnobotany, use values for trees can be calculated based on a number of repeated and independent events. Use values can be calculated and compared for specific uses (categories) and for particular user groups (young/elder, women/men, herders, landless people etc). Thus, the method tells us which tree species are most valuable for specific uses, for example firewood or beekeeping, and whether different groups attach different importance to certain species.

Quantitative ethnobotany takes a "plant-centric" approach and is primarily oriented towards botanical conservation or pharmaceutical goals, rather than strictly anthropological goals. The technique was devised for a development objective in order to answer the specific question: Which tree species are the most important to local people and should be planted and/or managed? The technique was used to answer questions such as: How significant is tree species x or y to the villagers? Do user groups value tree species differently and how is knowledge on tree resources distributed?

2.2 Advantages and Disadvantages of Quantification

Quantification should not be seen as an end in itself, but rather as a means to address particular ethnobiological questions. Perhaps the greatest danger with this approach is that by working with numbers and statistics we risk forgetting that their validity ultimately depends on the quality of the data used to generate them (Phillips 1996). If the researcher overlooks an important tree species in the check list, it will not be contributed a use value unless informants are asked whether they know of other valuable tree species than those visited on the "tree walk". If the interviewer shows great interest in medicinal uses and no interest in fodder values, informants may give more information and value to the first. Hence, interviewing is an essential skill for botanists conducting ethnobotanical field surveys. The researcher needs to understand in advance how the interview process itself might affect the "results" and must take steps to minimize these dangers. As such, many considerations about the advantages and disadvantages regarding interviews and questionnaires apply to quantitative ethnobotany as well as other disciplines.

Ultimately, quantitative ethnobotanical techniques are complementary to the more traditional forms of ethnobotanical inventory; they are not alternatives to them. Quantitative techniques allow us to analyse patterns of plant use knowledge and importance, but they cannot replace the need for careful qualitative description of indigenous knowledge together with observations. One of the strengths of working with quantitative ethnobotany is that it implies spending a lot of time with informants in the field which offers a great opportunity to ask and talk about qualitative aspects as well as doing observations in support of the quantitative data collection.

2.3 Study Area

The study was conducted at Majawanga village near Gairo 130 km west of Morogoro on the main road to Dodoma. The climate is semi-arid characterised by a long dry season. Rainfall is erratic and unevenly distributed with periodic droughts. The first ethnobotanical survey was conducted in the village and fields in 2002 and the second in Madali Village Forest situated 3 km north of Majawanga in 2004. Majawanga consists of several sub-villages of which one is dominated by livestock owners. The Madali village forest is an Acacia dominated woodland. Local people collect firewood and non-timber forest products such as materials for domestic utensils, plant parts for medicinal uses and wild foods especially fruits. In addition, the Madali forest serves as one of several grazing areas for livestock (Gervin, 2003). There are few mature trees and most vegetation bear marks of browsing and harvesting of firewood and other wood products.

2.4 Ethnobotanical Methods

The relative importance of tree species to local people was estimated using the method of quantitative ethnobotany as described by Phillips and Gentry (1993) and modified by Kvist *et al.* 1995. All tree and shrub species in the woodlands were collected and identified. Specimens were dried and mounted on herbarium sheets for reference. Botanical names follow the nomenclature of the International Plant Names Index (IPNI 2006). A total 47 species were found in the village or on village fields while 27 additional species were found in the communal village forest named Madali.

A single specimen of each of the 74 tree species was marked. Two tree walks were laid out to pass all of the marked trees in the farmland and woodland respectively. A tree walk consisted of one informant interviewed once about each species. Informants were selected among villagers in order to allow estimates of use-values of tree species according to different user groups (Table 1). In order to capture as much local knowledge as possible three key informants were included; a traditional village doctor, a traditional midwife and an older farmer recommended by fellow villagers as extremely knowledgeable about trees. The three key informants participated in both surveys. Likewise, elder informants were prioritized as studies have showed that they are more knowledgeable on tree species and their uses than younger people (Luoga *et al.*, 2000). A majority of the informants chosen were livestock owners because we wanted to collect local knowledge on tree species useful as fodder. A total of 13 informants participated in the survey of village and farmlands and 17 informants in the survey of the village forest.

Table 1. *Distribution of informants by user groups and gender*

User group / Gender	Men (N=16)	Women (N=11)	Total (N=27)
Age 50-75 years	7	4	11
Age 30-49 years	5	4	9
Age 15-29 years	4	3	7
Livestock owners	10	5	15
Land owners	12	6	18

Before the interviews, informants were instructed carefully about the method and encouraged to admit if they did not know tree species or uses. Interviews were performed on an individual basis. Informants were not allowed to discuss uses and values among themselves. Each event followed a standard procedure: first the informant looked at the tree and then cut, smelled or tasted parts to assist recognition. After this the following questions opened the interview: Do you know this tree? What is the tree called? What is it used for? Is this species more or less abundant than before? Is this species important to conserve? Some informants did not recognise some species or they did not have a local name. However, informants were often able to identify a number of uses, which were assessed and recorded. Informants were prompted to ensure that uses were not overlooked. Despite limited availability of mature trees in the woodland area, people still collect and use products from these species, though sometimes collected further away. Thus, lack of mature trees was not seen as an obstacle when investigating local knowledge about species, as informants readily identified root suckers and saplings. A tree walk usually took a day. The informality arising from spending a day together in the village fields or woodland allows for a wealth of other information to be obtained from informants as well as first hand observations.

Individual uses were grouped into use-categories defined by uses given by informants. The eleven use categories are: firewood, charcoal, construction, domestic utensils, food, medicine, fodder, commercial, bees and honey, shade, and other

Informants assessed the relative importance of each tree species for a given purpose. The basic assumption was that a useful product would score 1.0, and this was adjusted up or down half a point only when firm information indicated inferior or superior properties. The lower rating value 0.5 was assigned when a species was of low quality, little value or only used very occasionally. For example this was assigned to fruits eaten occasionally in the fields but not worth collecting. The score 1.5 was assigned when informants indicated the species as preferred or among the best (Phillips and Gentry 1993; Kvist *et al.* 1995; Krog *et al.* 2005; Theilade *et al.* 2007).

An average use-value was calculated as sum of scores for each species in each use-category across informants. Total use-values were calculated for each species as the sum of average use-values across use-categories. All scores were given the same weight in calculations of average and total use-value. An example of the informants' scores and calculation of average and total use-values is shown in table 2.

Table 2. *Example of calculation of average and total use-values for Dalbergia melanoxylon. Average use-values are measures of relative significance of a species to local people for a particular use. Total use-value is the sum of average use-values across use-categories. The values may be used to rank importance of species for specific uses and related to specific user groups.*

	No. of informants/score				Sum	Average use-value
Use-categories	1.5	1.0	0.5	0		
Firewood	15	1	0	1	23.5	1.4
Domestic utensils	13	2	0	2	21.5	1.3
Construction	13	1	0	3	20.5	1.2
Commercial	5	1	0	11	8.5	0.5
Fodder	1	5	5	6	9.0	0.5
Charcoal	4	0	0	13	6.0	0.4
Medicine	3	1	0	13	5.5	0.3
Bees and honey	0	2	0	15	2.0	0.1
Other	1	0	0	16	1.5	0.1
Shade	0	0	0	17	0	0.0
Food	0	0	0	17	0.0	0.0
Total use-value						5.8

The average and total use-values are measures of the relative importance of a particular tree species for a given use and for all uses combined. For further discussion of the methodology see Kvist *et al.* (1995), Krog *et al.* (2005), and Theilade *et al.* (2007).

In addition to the quantitative ethnobotany we used free listing. A group of five key informants were asked to name the most valuable species for the eleven use-categories. There was no limit as to how many species informants listed for each use-category. This exercise gave informants the possibility of listing species not found in the tree-walk. Finally, the five key informants were interviewed on changes in vegetation and on regulations guiding the use of the communal forest areas.

3. Results and Discussion

3.1 Use and Importance of Trees

The ethnobotanical study recorded the uses and relative importance of 74 trees and shrubs of semi-arid Tanzania. Kaguru names of local and exotic trees and shrubs have been recorded for the first time and a checklist of Kaguru and scientific plant names provided. The checklist is a valuable tool in future participatory and interdisciplinary research and can be obtained from the authors.

Trees and shrubs around homesteads, on village fields and in the common village forest were ranked in eleven use-categories based on villagers' valuation (Table 3). The table shows which species are most important to a specific livelihood need as for example firewood or medicine. It also tells that local people use all available tree resources in a complex manner.

The data may be further broken down to reflect valuation of particular user groups as for example herders, women or poorer segments of the village. The results may also be used to compare valuation of trees on farms against trees on common village land or exotics versus indigenous species. Such data is useful to predict which resources can be complemented or replaced by tree planting.

3.2 Distribution of Knowledge Between User Groups

When planning forest management it is useful to know which resources are of interest to different segments of the community. In this study we have focussed on livestock owners versus farmers without

Table 3. *Species´ total use-value across use-categories and average use-values for each of eleven use-categories. Species are listed according to their total use value.* **Bold** *indicates species in top 3 of at least one use category. N inf. = number of informants interviewed on species. NB. Four species was included in both surveys.*

Species	N inf.	Total Use-value	Firewood	Charcoal	Constr.	Food	Medicine	Domestic	Fodder	Comm.	Bees	Shade	Other
***Acacia tortilis* (Forssk.) Hayne**	13	7.0	1.3	0.6	1.1	0.0	0.0	0.7	1.1	0.3	0.9	0.9	0.1
Lannea schweinfurthii (Engl.) Engl.	13	6.3	1.2	0.0	0.7	0.9	0.7	0.7	0.6	0.3	0.7	0.4	0.2
Azanza garckeana (F. Hoffm.) Exell &Hillc	13	6.2	1.3	0.3	1.0	1.2	0.0	1.2	0.0	0.7	0.3	0.3	0.0
***Vangueria infausta* Burch.**	13	5.8	1.2	0.1	0.7	1.3	0.7	0.7	0.0	0.9	0.1	0.2	0.0
***Senna siamea* (Lam.) H.S. Irwine & Barneby**	13	5.8	1.4	0.1	1.2	0.0	0.6	0.3	0.5	0.3	0.3	1.0	0.1
***Dalbergia melanoxylon* Guillemin & Perrottet**	17	5.8	1.4	0.4	1.2	0.0	0.3	1.3	0.5	0.5	0.1	0.0	0.1
***Acacia nilotica* (L.) Willd. ex Delile**	27	5.6	1.3	0.4	0.9	0.0	1.1	0.2	1.1	0.2	0.2	0.2	0.1
Vitex payos (Lour.) Merr.	19	5.2	1.3	0.1	0.7	1.3	0.4	0.1	0.0	0.7	0.4	0.2	0.0
Albizia petersiana (Bolle) Oliv.	13	5.2	1.2	0.1	1.2	0.0	0.2	0.9	0.7	0.2	0.3	0.5	0.0
***Premna senensis* Klotzsch**	13	5.2	1.4	0.1	0.8	1.2	0.3	0.4	0.4	0.2	0.0	0.3	0.0
***Erythrina burttii* Baker f.**	13	5.0	0.5	0.0	1.2	0.0	0.0	0.4	0.0	0.3	1.5	1.0	0.1
Dichrostachys cinera (L.) Wight & Arn	25	4.9	1.3	0.1	0.9	0.0	0.9	0.1	1.1	0.2	0.1	0.1	0.1
***Acacia pentagona* (Schumach. & Thonn.) Hook. f.**	17	4.9	1.4	0.0	1.0	0.0	0.2	0.0	1.4	0.3	0.2	0.0	0.4
Melia azedarach L.	13	4.8	1.0	0.0	1.0	0.0	0.8	0.2	0.4	0.3	0.5	0.7	0.1
***Psidium guajava* L.**	13	4.8	0.8	0.0	0.0	1.5	0.5	0.0	0.2	1.2	0.0	0.7	0.0
***Erythrina abyssinica* Lam. ex DC.**	3	4.8	0.5	0.0	1.5	0.0	0.8	0.3	0.2	0.3	0.5	0.3	0.3
***Grewia similes* K. Schum.**	17	4.8	1.1	0.1	0.5	1.2	0.2	0.1	1.3	0.1	0.2	0.0	0.0
Dombeya sp.	13	4.7	1.2	0.1	1.2	0.0	0.5	1.0	0.3	0.2	0.0	0.2	0.0
Acacia robusta Burch.	13	4.7	1.1	0.1	0.8	0.0	0.8	0.3	0.7	0.2	0.3	0.3	0.1
***Acacia polyacantha* Willd.**	5	4.6	0.9	0.4	0.8	0.0	0.0	0.5	0.1	0.2	0.9	0.8	0.0
***Adansonia digitata* L.**	13	4.4	0.0	0.0	0.0	1.2	0.1	0.8	0.0	0.6	1.4	0.2	0.0
***Leucaena Leucocephala* (Lam.) de Wit**	13	4.4	1.2	0.0	0.5	0.0	0.0	0.2	1.3	0.2	0.2	0.9	0.0
Ormocarpum kirkii S. Moore	13	4.4	1.3	0.1	0.9	1.0	0.3	0.0	0.6	0.0	0.1	0.1	0.0
Zanthoxylum chalybeum Engl.	19	4.3	1.0	0.2	0.9	0.1	1.0	0.5	0.1	0.2	0.1	0.1	0.1
***Azadirachta indica* A. Juss.**	13	4.1	0.9	0.0	0.4	0.0	1.5	0.1	0.0	0.2	0.0	0.9	0.1
Boscia angustifolia A. Rich.	17	4.1	1.0	0.1	1.1	0.1	0.7	0.2	0.3	0.2	0.3	0.2	0.0
Combretum molle R. Br. ex G. Don	17	4.1	1.3	0.4	0.9	0.0	0.5	0.0	0.2	0.2	0.1	0.2	0.3
***Carica papaya* L.**	13	4.0	0.0	0.0	0.0	1.5	0.7	0.0	0.1	0.9	0.2	0.7	0.0
Ehretia amoena Klotzsch	17	4.0	0.9	0.1	0.7	0.6	0.8	0.3	0.3	0.3	0.1	0.0	0.1
***Canthium burttii* Bullock**	17	4.0	1.2	0.1	0.9	0.1	0.1	1.2	0.1	0.1	0.0	0.1	0.0
Ximenia caffra Sond.	17	4.0	0.9	0.1	0.3	1.2	0.9	0.1	0.2	0.1	0.1	0.1	0.0
Sclerocarya birrea (A. Rich.) Hochst.	13	4.0	0.5	0.0	0.4	0.8	0.3	0.5	0.2	0.1	0.6	0.4	0.1
Erythrococca menyharthii (Pax) Prain	17	3.9	1.0	0.1	0.1	1.2	0.6	0.0	0.9	0.1	0.1	0.0	0.0
Markhamia puberula (Klotzsch) K. Schum.	17	3.9	1.1	0.1	0.8	0.0	0.6	0.8	0.1	0.3	0.1	0.1	0.0
Markhamia obtusifolia (Baker) Sprague	17	3.9	1.2	0.1	0.9	0.0	0.3	0.7	0.2	0.1	0.1	0.1	0.0

Albizia harveyi E. Fourn.	13	3.8	1.0	0.0	0.8	0.0	0.0	0.5	0.7	0.3	0.1	0.5	0.0
Boscia mossambicensis Klotzsch	13	3.8	1.2	0.1	0.7	0.0	0.3	0.4	0.2	0.1	0.2	0.7	0.0
Allophylus rubifolius (Hochst. ex A. Rich.) Engl.	13	3.8	1.2	0.0	0.5	0.3	1.0	0.1	0.3	0.1	0.1	0.2	0.0
***Senna spectabilis* (DC.) Irwine & Barneby**	13	3.8	1.0	0.0	0.6	0.0	0.0	0.3	0.2	0.3	0.2	1.1	0.1
***Eucalyptus tereticornis* Sm.**	13	3.8	1.2	0.0	1.5	0.0	0.2	0.3	0.1	0.2	0.0	0.3	0.0
Strychnos potatorum L.f.	17	3.8	1.2	0.2	0.9	0.0	0.9	0.1	0.1	0.2	0.1	0.1	0.0
Acacia senegal (L.) Willd.	17	3.7	1.1	0.1	0.7	0.0	0.1	0.3	0.9	0.2	0.1	0.1	0.1
***Commiphora africana* (A. Rich.) Engl.**	13	3.7	0.3	0.0	0.3	0.0	0.1	0.5	0.3	0.1	0.4	0.4	1.1
Albizia anthelmintica Brongn.	13	3.6	0.7	0.1	0.6	0.0	1.0	0.5	0.3	0.1	0.2	0.1	0.0
Cordia sinensis Lam.	13	3.6	1.0	0.0	0.7	0.7	0.1	0.5	0.2	0.3	0.0	0.1	0.0
Cassipourea mollis (R.E. Fr.) Alston	17	3.5	1.4	0.2	1.0	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0
Grewia platyclada K. Schum.	17	3.5	1.1	0.0	0.8	0.2	0.5	0.2	0.4	0.1	0.2	0.0	0.0
Brackenridgea zanguebarica Oliv.	13	3.4	1.3	0.0	1.1	0.1	0.4	0.1	0.1	0.1	0.0	0.2	0.0
Commiphora habessinica (O. Berg) Engl.	13	3.3	0.4	0.0	0.4	0.2	0.1	0.3	0.2	0.0	0.7	0.3	0.8
***Schinus molle* L.**	13	3.3	0.7	0.0	0.3	0.2	0.3	0.0	0.2	0.0	0.4	1.0	0.2
***Indigofera swaziensis* Bolus**	17	3.3	0.9	0.0	0.0	0.1	0.1	1.2	0.5	0.2	0.1	0.0	0.1
***Senna singueana* (Delile) Lock**	13	3.2	1.4	0.0	0.5	0.0	0.3	0.1	0.3	0.3	0.1	0.2	0.0
Dyschoriste sp.	17	3.1	0.9	0.0	0.0	0.3	0.2	0.2	1.3	0.0	0.2	0.0	0.0
Heritiera sp.	12	3.1	0.9	0.0	0.5	0.2	0.7	0.5	0.2	0.1	0.0	0.1	0.0
Synodenium sp.	13	3.1	0.3	0.0	0.2	0.0	0.7	0.1	0.0	0.0	0.3	0.7	0.8
Jacaranda mimosifolia D. Don	13	3.1	1.0	0.1	0.5	0.0	0.0	0.0	0.2	0.0	0.2	0.8	0.3
Hoslundia opposite Vahl	17	3.1	0.6	0.0	0.0	1.4	0.5	0.0	0.3	0.1	0.1	0.0	0.1
Albizia lebbeck (L.) Benth.	13	3.0	0.9	0.0	0.5	0.0	0.0	0.2	0.3	0.1	0.3	0.8	0.0
***Lannea humilis* (Oliv.) Engl.**	13	2.9	0.2	0.0	0.2	0.0	0.1	0.6	0.1	0.0	0.2	0.5	1.1
Jatropha curcas L.	13	2.8	0.0	0.0	0.1	0.0	0.8	0.0	0.0	0.0	0.1	0.8	1.0
***Maerua parvifolia* Pax**	17	2.8	0.5	0.0	0.2	0.0	1.1	0.0	0.6	0.1	0.2	0.1	0.0
***Euphorbia tirucalli* L.**	13	2.7	0.6	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.2	0.3	1.1
***Manihot glaziovii* Müll. Arg.**	13	2.7	0.2	0.0	0.0	1.4	0.0	0.0	0.2	0.0	0.0	0.5	0.3
Mundulea sericea (Willd.) A. Rich.	17	2.7	1.1	0.1	0.1	0.1	0.4	0.1	0.1	0.2	0.1	0.1	0.1
Rhus natalensis Bernh.	17	2.6	0.9	0.1	0.3	0.2	0.4	0.2	0.4	0.1	0.0	0.1	0.0
Cedrela odorata L.	13	2.6	0.3	0.0	0.7	0.0	0.1	0.2	0.0	0.3	0.2	0.9	0.0
Croton polystrichus Pax	17	2.3	0.9	0.0	0.1	0.1	1.0	0.1	0.1	0.0	0.1	0.0	0.0
Dalbergia boehmii Taub.	17	2.2	0.6	0.2	0.4	0.0	0.1	0.0	0.4	0.2	0.1	0.2	0.0
Commiphora mollis (Oliv.) Engl.	13	2.2	0.3	0.0	0.2	0.0	0.1	0.3	0.2	0.0	0.1	0.4	0.6
Catunaregam spinosa (Thunb.) Tirveng.	17	1.9	0.7	0.0	0.1	0.0	0.4	0.4	0.1	0.1	0.0	0.1	0.0
Aspilia mossambicensis (Oliv.) Wild	17	1.9	0.4	0.0	0.0	0.0	0.8	0.2	0.1	0.0	0.2	0.0	0.1
Euphorbia candelabrum Kotschy	13	1.8	0.2	0.0	0.5	0.0	0.1	0.0	0.0	0.0	0.8	0.2	0.0
Blepharispermum zanguebaricum Oliv. & Hiern	17	1.8	0.5	0.0	0.5	0.0	0.5	0.1	0.3	0.0	0.0	0.0	0.0
Maytenus senegalensis (Lam.) Exell	17	1.8	0.5	0.1	0.4	0.0	0.3	0.1	0.2	0.1	0.0	0.0	0.1

livestock and on gender. Our data shows that generally livestock owners have more knowledge on uses, measured as the number of species mentioned as useful in a given category. Hence livestock owners listed more farmland species in 9 of 11 use-categories and more woodland species in 8 of 11 use-categories than did farmers without livestock. Livestock owners valued 44 of the 47 tree species found within the village and on fields higher than farmers without livestock. For tree species found in the communal

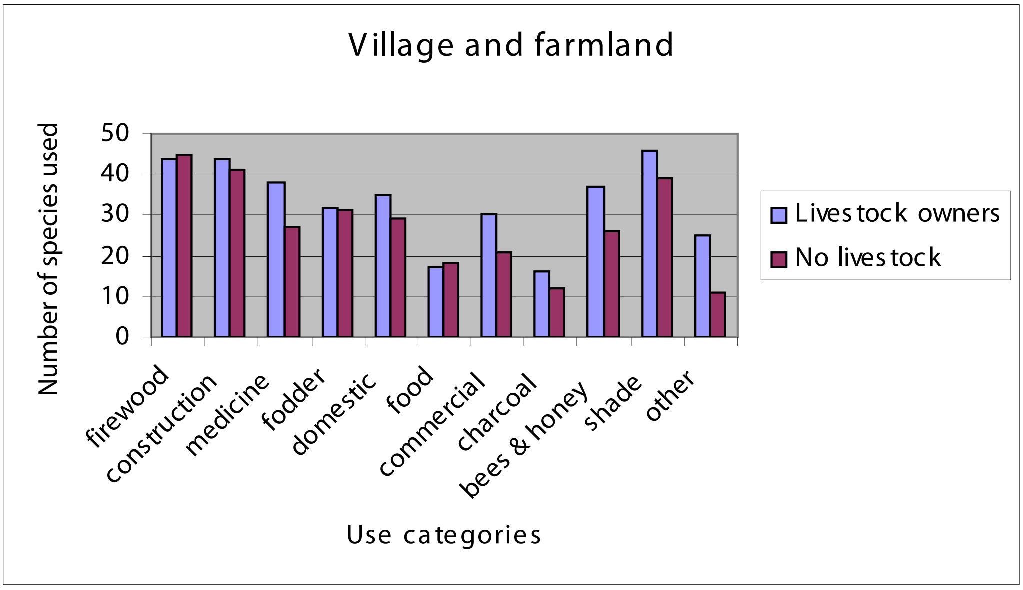

Figure 1. *Knowledge on tree uses measured as number of species from village and farmland listed per use category by livestock owners and farmers without livestock. On average livestock owners listed 33 species per use category while people with no livestock listed 27. Overall livestock owners valued 70% of the species higher than non-livestock owners. The findings are contrary to the popular perception that livestock owners have little interest in maintaining trees and shrubs, as there main interest is grazing.*

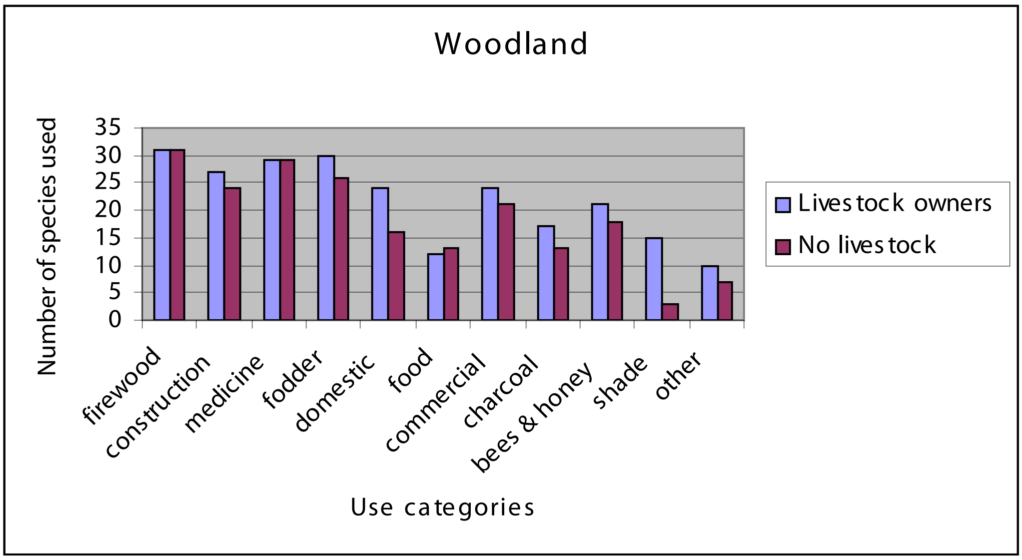

Figure 2. *Knowledge on tree uses measured as number of species from woodland listed per use category by livestock owners and farmers without livestock. On average livestock owners listed 22 species per use category while people with no livestock listed 18. The results suggests that livestock owners have more knowledge, use the resource in a more diverse way and benefit more from the tree resource.*

village forest livestock owners valued 9 of the 31 tree species higher than non-livestock owners. Overall, livestock owners valued 70% of the species higher than non-livestock owners.

Our findings are contrary to the popular perception that livestock owners have little interest in maintaining trees and shrubs, as their main concern is access to grazing. Livestock owners are likely to have spent their childhood as herders in the bush, which would advance intricate knowledge of plants. This includes vital knowledge on abundance and location of fodder trees, trees providing edible foliage in the end of the dry season when there is a shortage of feed, trees with edible and nutritious pods and trees used in treatment or prevention of livestock disease. This may explain their superior knowledge. Livestock are used as draft animals and ox-carts play an essential

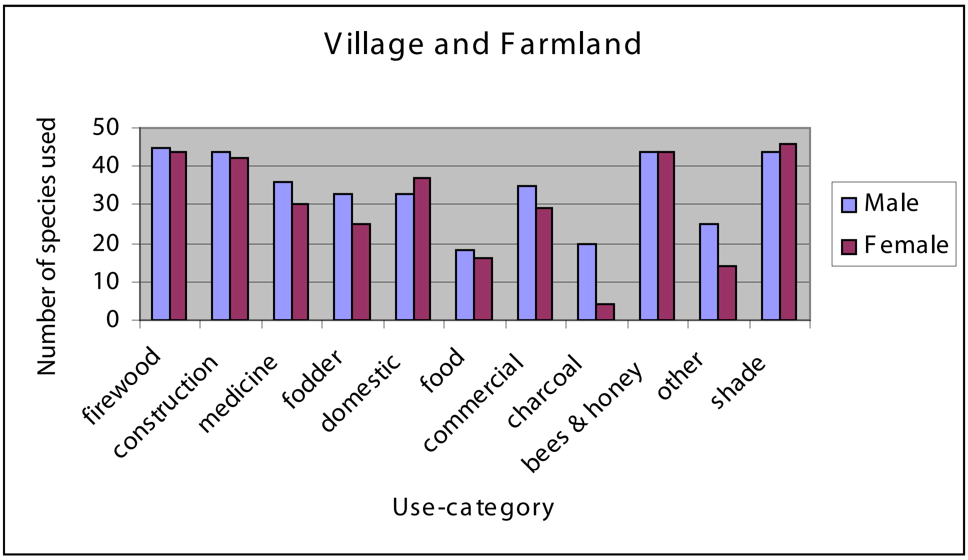

Figure 3. *Knowledge on tree uses by gender measured as number of species from village and farmland listed per use category. Men listed more farmland species in 8 of 11 use-categories. Female informants demonstrated more knowledge than men only for the categories "shade" and "domestic utensils".*

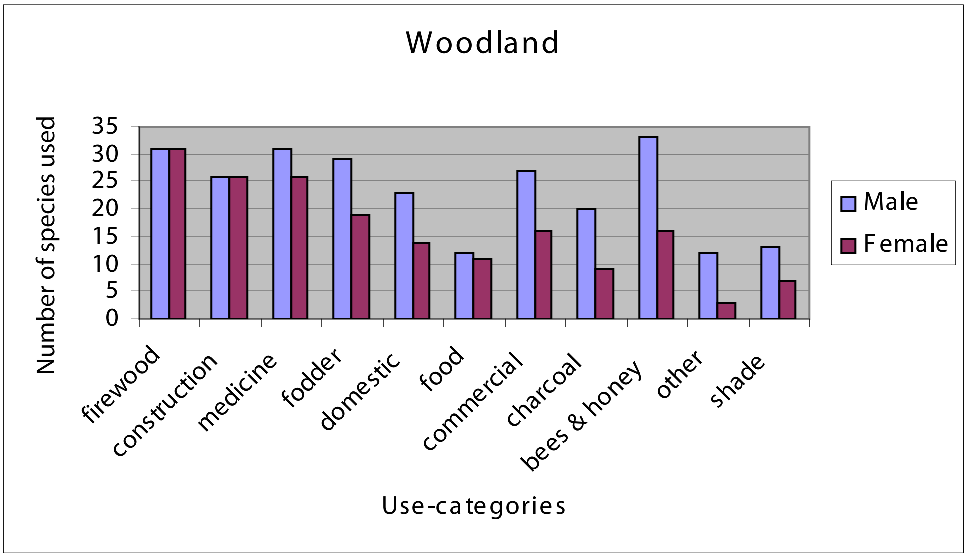

Figure 4. *Knowledge on tree uses by gender measured as number of species from communal woodland listed per use category. Men listed more woodland species in 9 of 11 use-categories. The difference in knowledge between men and women is wider for species found in the communal woodland than species within village and farmland. Apparently women use the woodland less intensively than men except for collection of firewood.*

role for transport of forest produce and access to markets. Thus livestock owners can travel further and transport more produce to the market. Our study suggests that livestock owners have more knowledge, use the resource in a more diverse way and benefit more from the tree resource.

Our study also reveals some clear gender based differences in scoring patterns. In general, male informants listed more uses and assigned higher use-values than women. Hence men listed more farmland species in 8 of 11 use-categories and more woodland species in 9 of 11 use-categories. Male informants valued 35 of the 47 tree species found within village and farmland higher than women. For the communal village forest men valued 29 of 31 species higher than women. Overall, men value 80% of the tree species higher than women.

The discrepancy in knowledge between men and women is wider for species in the communal village forest than species within village and farmland. For trees found within village and farmland, female informants listed more uses than men only in the categories "shade" and "domestic utensils". Women spend most of their time working at the homestead or in the fields including taking care of infants who need shade. Hence women mainly go to the woodlands to collect firewood and non-woody forest products such as thatch for roofs and vegetables. In contrast, most boys and young men spend much time in the woodlands tending livestock and men also undertake harvest of timber for construction purposes, domestic utensils and firewood on a commercial basis. It has often been argued that women hold a specific knowledge on wild food and medicinal plants, which will help the family in times of food shortage or disease (Clarke *et al.* 1996). This is either not the case among Kaguru people, - at least not regarding tree products, or Kaguru men may be more confident, express more uses and even value these higher than do women. Indeed, some of the younger female informants wondered why they were interviewed and stated that men would be more knowledgeable on trees. Mead (1968) found that men, in general, responded with a greater need to impress, while women acted to expedite the interview process, slightly uncomfortable with the intimate nature of interviews with a male foreigner. Even though the interviewer in our case was a woman, the informant's reaction may still be the same as that observed by Mead.

The free listing exercise confirmed many of the tree species ranked as important in the tree-walk. It also showed that people do not necessarily rank the same species highest in a given category. Probably the answers are dependent on which species the informants have the habit of using and on availability for each informant. The results confirm that Kaguru people have a range of species that can substitute each other in each use-category. This will allow villagers to switch from one species to another once a particular species is in short supply or distance to harvest becomes an obstacle. Key informants listed 22 tree species as "the best" within the categories "construction" and "commercial" of which 10 species were locally extinct revealing a specific pressure on priority timbers. Most of the species were later identified together with key informants on Gairo Hill, a forest reserve 10 km from the village. For two species it was not possible to verify the scientific name. In many cases only elder key informants knew of the locally extinct species. Hence, the "indigenous capital" as defined by local skills and expertise on use and importance of tree species (Diamond 2005) is disappearing fast for a subset of highly valuable species.

3.3 Ethnobotanical Knowledge - Implications for Management on the Local Level

Our research question concerned how to improve management planning of communal low value forest resources such as degraded woodland. Villagers in semi-arid Tanzania use tree resources in a different and much more diversified manner than is the case in the formal forestry sector based on logging. While a logging operation in semi-arid Tanzania would typically extract timber from 10-15 different tree species and the planning rely on growth and yield estimates of these, local communities harvest from the whole range of tree species available, often more than a hundred species. Ethnobotanical knowledge can tell which species are most significant to peoples' livelihood needs. Villagers can use the information they have generated as a point of departure in their discussions on how to manage their common forest resources. This knowledge is also useful to planners and extension workers within participatory forestry who wish to assist communities in management planning. At this step, the ethnobotanical knowledge must be combined with investigations of local livelihood needs. In our study, lack of tree resources for firewood and construction were the main problems identified by women and men respectively. Tree species that best fulfil these needs can be selected based on the users' own valuation, thereby boosting ownership and confidence in new management schemes or tree-planting initiatives.

Our ethnobotanical study shows that well-off segments of the villagers, as defined by land holdings and number of livestock, have better knowledge of the tree resources, engage in more varied use and probably benefit more from the available tree resources. This is the case whether trees are planted on private land or growing in the communal village forest. Conservation of tropical forests is often championed by the argument that forests are important for the survival of rural poor. In the case of the Kaguru people, this may be true but even more so the forest is a resource which the more well off farmers use to increase their income or as capital investment to start a small cottage business such as bee keeping, the sale of firewood, furniture or brick manufacturing. Thus, the forests definitely hold a potential for improving livelihoods of villagers. The well-off segment of the village possesses the indigenous knowledge and means to utilise this potential to derive relatively more benefits. Likewise, in our case men had more knowledge about tree uses and seemed to benefit more directly from forest products than did women. Planners and developers have to be well aware of this fact when working with participatory forestry whether it is JFM or CBFM. Ethnobotanical knowledge can tell us which groups of plants or forest areas are of special importance to marginalised groups, for example women or poorer households, and special strategies and measures may be put in place to ensure benefits to these groups. For example, fruit and shade trees on farms mainly benefit women as they sell fruits in the market and are dependent on shade trees in the fields for themselves and infants.

Our study showed that often numerous tree species are of almost equal importance for a given use. However, the overlap between priority species in different use categories is small. Thus, the Kaguru people use the full variety of trees for different purposes. If a management plan was to focus on the three most important species in each use-category 27 species would have to be included and 60 species would be included if a plan were to encompass the 10 most important species in each use-category (Table 3). Focusing on tree planting or the management of communal forests on one or a few species would meet only some demands for specific purposes or from particular user groups. Future planning in rural forestry will have to encompass a wider diversity of tree species in order to support their many uses and users. This is in line with the multiple forest uses required by more and more forestry laws.

We also asked whether certain species, in the opinion of villagers, were in need of harvest regulations and tried to understand how people responded to changes in availability? In our study area, there is only half as much communal village forestland as there was when it was mapped and gazetted in 1972. So far, villagers have responded by travelling further to extract forest resources. Women were likely to spend 2-3 days a week collecting firewood a great distance from the village. Likewise, herders are forced to migrate to other regions especially in the dry season in order to find suitable land for livestock grazing (Gervin 2003). The traditional doctor travelled by bus to distant hills to collect medicinal plants not available in the area anymore. The remaining communal village forest cannot provide all the tree resources necessary in the livelihood of nearby villagers. It has been estimated that the annual firewood consumption exceeds estimated volume production in communal forest areas by a factor ten (Moyo 2005). Improved planning, however, could optimize benefits and provide for a reasonable equity sharing among user groups to prevent conflicts. Guidelines may be issued on the use of the village forest for grazing and firewood collection; i.e. how many animals and which season, how many ox-carts of wood can be collected etc. Firewood and bricks manufactured with firewood from the communal woodland have become commercial goods. In the near future the community may consider how to benefit from commercial extraction of resources from the communal village forest for example by licensing and collection of revenue. At the same time plans have to be manageable by the community.

Key informants listed many tree species threatened with local extinction. Especially valuable timber species had become extinct locally or very rare. Villagers increasingly replaced valuable timber trees like

Dalbergia melanoxylon, *Commiphora africana* and *C. habessinica* with species of less quality or by planting exotic species on private land. However, some species cannot easily be substituted or replaced by plantings. This is mainly the case with indigenous medicinal trees like *Xanthoxylum chalybeum*, which is disappearing in many parts of Tanzania due to over-exploitation. Ethnobotanical knowledge is a direct way of identifying important species that cannot easily be replaced and hence requires conservation in order to be maintained within the local culture.

When asked, our informants unanimously expressed concern to maintain all tree species. Thus villagers recognised the value of the biodiversity and were concerned with the conservation of the resource. Many informants, especially the elders, expressed the need for corrective changes and were keen to discuss reforms to the present management of communal woodlands. In reality, villagers reacted to resource scarcity by extracting resources further away or by planting exotics rather than improved management or regulations regarding harvest of disappearing indigenous species. The substitution of tree resources by planting, of course, comes with a twist that only land owners can plant. For example women plant fewer trees than men perhaps because they own less land (Gausset *et al.* 2006). This may suggest that tree planting projects may fail to reach marginalised women unless specific arrangements are made to include this group for example by providing common land for women groups to plant on.

3.4 Limitations of the Study Methods

Finally, what happens if the indigenous knowledge provided by informants is incomplete or simply not correct? When asked to make a wish-list of tree species they would like to plant, villagers in our study ranked orange trees, teak and mango as their priorities. These species grow well in more humid regions where farmers had seen them. But farmers were unaware that the species would not grow or produce fruits in their area. Likewise, farmers in our study were unaware of the commercial potential of baobab fruits that were sold at the road side for high prices in the neighbouring district. Herders consistently told us that livestock would not eat certain species while microscopic studies of cattle and goat faeces showed these plant particles to be present (Hansen 2005). Other studies have shown that medicinal plants revered by locals may have strong toxic effects and should be eliminated from recipes (Arseculeratne *et al.* 1985, Christophersen and Larsen 1991). Hence, ethnobotanical knowledge should not be subject to romanticism. When ethnobotanical knowledge is combined with the knowledge of foresters, agriculturists, pharmacologists, marketing experts, and other professionals its full potential is best achieved for forest management planning or other development objectives.

3.5 Ethnobotanical Knowledge - Implications for Planning at National and International Level

At the national level, ethnobotanical knowledge may help policy makers set priorities in rural forestry programmes. Ethnobotany can highlight vegetation or species of special importance to local people. This information should be used in formulation of management plans not only in communal areas but also for national forest reserves used by rural communities. Development agencies and developmental NGOs may find it useful to identify forest products of special importance to marginalised groups or new products with a potential for processing or marketing. For example, baobab fruits were sold for high prices in neighbouring district Dodoma, while the fruits were not marketed by locals in our study, even though the village was close to the main road to Dodoma. Selling baobab fruits could be a source of income for the villagers in Majawanga.

Ethnobotanical knowledge should also be used to guide and prioritise future forest research and education. Traditional studies on commercial timber species are increasingly being replaced by research on forest species of significance to the health and well-being of rural households. Here, ethnobotany can tell us which species are important and for what. Likewise, formal forestry education in many tropical countries should be re-oriented to meet these new challenges. Forestry students that graduate are poorly equipped to meet the needs of communities or small farmers (Temu *et al.* 2005). Hence, in most African countries villagers cannot find the skilled people needed to improve their forestry management. Presently, Tanzania is one of the few African countries offering graduate programs in forestry but is not training sufficient foresters needed for a nation wide implementation of participatory forest management (FFNC 2005). Unfortunately, the huge potential of participatory forest management supported by one of Africa's most progressive forest law reforms may never be realised unless more forestry training is accomplished.

Ethnobotany is just one of many inter-disciplinary tools necessary to integrate indigenous knowledge in participatory management schemes. There is a need to provide African forestry students with a curriculum which meets the current forest management policies and expectations from their society to work with participatory forest management. That is, to identify forestry issues relevant to the practices of communities, small farmers, women's groups and the like and to collaborate with and advise these groups of people on sustainable management of local forest resources.

4. Conclusion

Most village forests with a potential for community based forest management consist of low-resource woodlands. Traditional commercial products such as timber and charcoal are often exhausted. Management plans for such areas have to focus on subsistence products essential to rural communities. The results from our study indicated that 27 or 60 species should be considered if a management plan were to be made for the top three or top ten species in each of the eleven identified use-categories. Hence, to cater to livelihood needs, management planning for communal woodlands or village forests cannot be restricted to a few species or products. Moreover, planning should consider interests of different user-groups. This kind of management planning is quite new within forestry, calling for re-orientation of forestry education and research and for closer collaboration between natural and social sciences.

Our study showed that several of the most valued tree species are disappearing or already locally extinct. Though ethnobotany can tell us which species need protection or regulation to persist in traditional cultures, it cannot tell us how to do this in practice. Proposed participatory forest management systems are based on formal rules, far removed from current institutional systems, which are based on a complex of norm-based controls. The enforcement of these controls is steeped in subtle processes. To advocate regulations within participatory forest management, natural and social sciences will have to work closely together to identify and agree on the criteria of success. To develop successful, acceptable and functional forest management plans together with communities is clearly a participatory, transdisciplinary field.

In this study we have limited ourselves to the use of woody species, even though we acknowledge the importance of non-woody products such as thatching material and vegetables. The question is whether sustainable forest management, in low value communal forests, can succeed without linking it to improvements in agricultural productivity and to the opportunities offered by a wider economy. In semi-arid Tanzania, agricultural production per hectare is decreasing, leading to increasing pressure on remaining forests. Woodland clearing of is one of the ways communities can provide farmland to the next generation. As researchers within forestry, we may be moving in a limited direction if we presume that communities can continue to extract subsistence products from limited communal forests on a sustainable basis. The future importance of ethnobotany may well be to identify new forest products to be marketed, thus linking community based forestry with a wider market economy. We have to remember that forest based activities are only a small part of a wide livelihood portfolio in rural Africa.

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