Tropentag 2008
University of Hohenheim, October 7-9, 2008
Conference on International Research on Food Security, Natural Resource Management and Rural Development

Tree utilization and management in Africa: A case study from semi-arid Tanzania

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Introduction

Rural people in Africa often harvest tree products from both private and communal lands to provide necessary raw material for firewood and charcoal, construction wood and domestic utensils. Furthermore, trees yield fruits, traditional medicine and fodder. Trees are found on private farmland in tree plots, as border trees or agroforestry species and as single trees in fields or around homesteads. Village forests, community forests and communal rangelands also provide tree products. While trees found on private farmland are either planted or retained for a specific purpose, trees found on communal lands are managed more extensively through collection of tree products or grazing.

Forested area is decreasing in Tanzania (FAO 2005). Before interventions to improve tree use can be planned, it is necessary to determine to what extent and the rate at which forested areas are decreasing, to what extent trees planted on farmland are able to replace tree resources previously obtained from woodlands and try to understand the reason for depletion. Changes that build on the local customs and needs and are participatory in nature instead of revolutionary are expected to have a more realistic and sustainable outcome (Chambers, 1997).

Study area, material and methods

The village of Majawanga is located in the Gairo division, in the Kilosa District in Tanzania. The village is 1500 metres above sea level. The climate is semi-arid with between 500 and 600 mm of erratic, seasonal rain per year. The natural vegetation is dry Miombo woodlands. The first permanent agriculturalist settlers established their households in the 1930s, in a landscape dominated by dense woodland. Majawanga was officially recognised as a village in 1971-72 as a result of the cooperative village (*Ujamaa*) policies. At this time the village council reserved three common woodlands. These woodlands are, from the closest to farthest from the village: Madali, Kwa Malundo and Kwa Lembile.

Field research for the present study was conducted in a joint research program by an interdisciplinary team of researchers. This team included scientists and students from the disciplines of agroforestry, animal sciences, forestry, botany, zoology, anthropology, political science, and development studies. Published and unpublished results, together with supporting literature form the basis for the discussion and conclusions. Results from the following 5 sets of research activities are reported in this article:

1) Household incomes, social structures and general agricultural and forestry practices were determined through a baseline survey of 68 households. Participatory wealth ranking by key informants and participatory mapping was undertaken of the village, its fields and common

woodlands to determine areas for further research. Elder informants were used to map the common woodlands (village forests) as they were originally allocated by the village council in 1972 and as they exist today. General area importance ranking of the village common lands was obtained by questionnaire of 56 households. 2) Ethnobotanical studies were undertaken in private lands in and around the village and in the common woodlands. Focus group discussions were conducted in order to discuss constraints on tree planting and to produce matrix rankings describing the local use of tree and shrub species. 3) Species richness and densities were determined in three common woodlands within Majawanga. 4) The use of trees and shrubs for grazing livestock was investigated through identification and quantification of plant fragments in the feces of free ranging cattle and goats throughout a year. The diet eaten by the animals was related to the protein content and digestibility value of specific tree species. 5) The effect of conversion of woodland into maize fields on dung beetle frequency and diversity was investigated. The activity of dung beetles enhances soil nutrient cycling and increases the soil's ability to absorb and hold water. Consequently, these beetles are particularly important in semi-arid environments.

Results: Characterization of the households and resources of Majawanga:

The average household size in Majawanga was 6 persons (2 adults and 4 children). Agriculture is the most important activity for sustaining livelihoods. Yearly incomes were reported to range tenfold from the poorest to the richest (30000 to 300,000 TzS or 26 to 260 USD) and half of the population earned and average of 160,000 TzS. Wealth ranking revealed that the villagers considered 'most wealthy' by key informants were also those with most livestock. The average size of the land farmed was reported to be 3.1 hectares for farmers without cattle and 3.0 ha for farmers with cattle. Twenty one % of the respondents owned more than 4 ha., while 42% of the respondents owned less than 2 ha. The farmers with cattle reported planting 3.8 trees per ha., while those without cattle reported planting 4.0 trees per ha. cropland. Only 43 of the 359 families (12%) in Majawanga owned cattle or sheep and only 7% had more than 16 animals, according to the official village documents. However, 55% of the respondents reported owning livestock. None of the respondents in the baseline study (N=68) reported keeping livestock exclusively for commercial use. Nine % of the respondents reported no income, and were totally dependant on agricultural production for their livelihood.

All interviews and questionnaire studies indicated that the villagers perceive the vegetation of their common woodlands to be important to livelihood. Additionally they perceived the woodland resources to be degraded and the number of woody species as well as quantity of each species available to be declining. Primary causes of vegetation degradation were given as the removal of too much timber and firewood as well as overgrazing and soil-trampling.

Particpatory mapping and determination of important areas:

More than 81% of 56 respondents used the woodland closest to the village center (Madali). The comparison of present day forested areas with historical data showed that only 1.3 ha. of the original 43 ha. allocated are still available for common grazing in the Madali woodland. The Kwa Lembile woodland has decreased from 44 to 18 ha and the Kwa Malundo from 100 to 57 ha. Thus an average of about 60% of these three woodlands has been cleared for agriculture with the most conversion of woodland to cropland closest to the village. The present day borders of all remaining woodlands are delineated by homesteads and crop fields. This indicates that new cropland is more important than maintaining woodlands.

Uses of trees

Firewood and construction were identified as the most important uses of trees out of the uses identified by the informants for species found in fields and homesteads (Krog et al. 2005) and

species found in the communal forests (Theilade et al. 2007). Forty-two of the 79 tree species found in the village, fields or in the communal forest area were ranked by informants as within the top three for at least one of the identified uses. This suggests that a wide diversity of trees plays an important part in the livelihoods of the villagers.

Tree diversity and density

The number of tree species of the three common woodlands around Majawanga was 8, 4 and 1 species per 100 sq. meters. Stem frequency for stems > 50 cm in height was 873, 276 and 191 per ha for the same three woodlands. The woodland area closest to the village (Madali) has the greatest species diversity and highest density of stems over 0.5 meters when compared to the other two common woodlands. Stem frequency was also significantly greatest in Madali for stems less than 0.5 meters **(**133, 39 and 21 per 100m^2 in Madali, Kwa Lembile and Kwa Malundo**)**. These large differences suggest that tree regeneration and growth is possible and occurring. Large trees over 2 meters in height are almost only found in the two woodlands farthest away from the village and all show signs of cutting or browsing. The village council has rules to prevent cutting of trees and use by people or livestock from neighboring villages, but these rules are not respected or enforced.

Livestock use of trees

The proportion of the tree component of the diets of small ruminants and cattle was different and different by season. A larger proportion of the particles identified in the faeces of small ruminants were tree or bush species compared to cattle and both cattle and small ruminants ate a larger proportion of trees and bush fodder in the dry season. Small ruminants ate an average of 60 and 75% woody species during the wet and dry seasons while cows ate an average of 12 and 25% during the wet and dry season. The nutritional value of *Croton polystrichus, Acacia robusta, Grewia bicolor, Grewia similes, Grewia platyclada, Azanza garckeana, Boscia mosambiscensis* and *Lannea humilis* corresponded to the rank with which the species were eaten by the livestock (Berg, 2003) with the most nutritious species eaten in the relative greatest quantities. These results support the villagers perception that browse is an important nutritional aspect of livestock production. Likewise, these results pinpoint possible fodder trees for regeneration investigations.

Effects of cultivation on dung beetles

The quantity and species diversity of dung beetles was higher in a common woodland area than in the cultivated maize fields (Nielsen, 2007). In total, 6037 dung beetles (Scarabaeidae: Scarabaeinae), representing 77 species from 25 genera, were collected. Species richness was significantly higher and absolute number of trapped beetles was higher in the woodland patches than in the cultivated sites.

A simple deficit of manure in the croplands may explain some of these differences, and these differences may explain why the villagers perceive the woodlands to have relative superior soil fertility. These small areas of woodland have an important conservation value in order to maintain the high diversity of dung beetles and further degradation and or depletion of these areas will probably result in a local extinction of species. The high diversity and abundance of dung beetles may be related to the soil fertility in these areas and thereby an important aspect of maintaining crop productivity.

Conclusion and outlook

Rural livelihoods in Tanzania, as elsewhere, are undergoing rapid changes. There is a growing tendency among forest-adjacent communities to seek a livelihood strategy which combines forest-based production with farming and off-farm activities. This is also the case in Majawanga. All results from this program suggest that trees in general and a variety of individual tree species in

particular are perceived as a very important resource to the people. Trees are used for food, feed, timber and non-timber products for basic livelihood functions. Actual and potential use of trees and desire to plant trees are enormous for both livestock owners and those without livestock.

The differences in tree species richness and density between the three forested areas suggest that utilization is the determining factor for tree growth in Majawanga. This is supported by the fact that the woodland most used for grazing and firewood extraction had the highest stem density and species richness but fewest large trees.

Securing firewood, forage and food from trees is now often undertaken in more distant forested areas where a larger amount of goods can be extracted to make the trip worthwhile. This strongly suggests that the importance of tree growth within Majawanga is secondary to the importance of crop land and food production. Indeed, respondents valued the forest areas highest for its potential as crop land. This may be because it is still possible to obtain the necessary woodland resources, with an acceptable effort, elsewhere.

Krog et al (2005) and Theilade et al (2007) showed that tree species retained or planted on farmland and around homesteads were valued higher than woodland species for beekeeping, shade, construction, utensils, food, commercial properties and other specified uses. Woodland species were valued higher for fodder, firewood, medicine, and charcoal. These results indicate the actual valuation of existing trees, but the research was not aimed at investigating the relative value of woodland compared to cropland.

Despite the perceived importance of trees, widespread use of trees, and ability of seedlings to grow in the area, the three communal forest/grazing areas have decreased drastically since allotment in 1972 with new homesteads and maize fields surrounding the present boundaries. The creation of private fields can only be done by encroachment on common woodlands area within the village and this practice has reduced the three forested areas by 97, 59 and 43%. It can be assumed that because of an increasing population, grazing and wood product extraction pressures on the area have increased. If the same type and the same or greater amount of woody products are needed from these delineated areas, then a decrease in common woodland area could be offset by either an increase in the number of trees planted around homesteads or in the fields or an intensification of agriculture to obtain more crop yield per ha thereby allowing a reduction of necessary cropland. A small part of the woodland loss is being compensated by tree planting on private land, primarily as a result of donor funded forestry projects. However, neither newly planted trees, nor intensification practices of agriculture were evident during the visits throughout 2 consecutive years. The possibilities to intensify food production may be limited because of lack of soil amendments. Dung beetles, as a factor of soil improvement, need dung in order to survive. Allowing cattle to graze crop residues and leave their manure is one way to ensure this, but unrestricted grazing can destroy seedlings and can be a point of contention between neighbors at the family and village level.

The success of private planting requires the acceptance of fencing or exclusion of grazing livestock. It is still perceived rude or hostile to fence land in these semi-pastoral cultures and this attitude needs to be addressed before private tree planting can be successful. Agreement to protect seedlings from grazing, assignment of the burden of cost, acceptance and implementation of the agreed plan, adherence to the stipulations in the plan and recourse for enforcement that is perceived as just, is necessary if grazing management shall allow tree seedling survival and growth. Common grazing land management is different from private tree planting efforts and seasonal and personal stocking rate limits, allowing a perceived fair access to the resource, monitoring the vegetation and enforcement of agreements are important in factors in management. The lack of enforcement of existing rules about grazing and cutting trees suggests that other considerations, such as trade, family bonds with or dependence upon livestock owning neighbours within or from neighbouring villages is of more vital importance. The lack of enforcement could also reflect a lack of authority

to enforce laws. Finally, the lack of enforcement may be a collective recognition that the rules are not acceptable for livestock owners in the village and/or from neighbouring villages.

It was concluded from these studies that the goods and services from woodlands and cropland have a high utility value (Anderson et al, 1977) to the people with a scarcity of food and availability of wood as in Majawanga. However, the marginal utility of cropland is far greater than the marginal utility of maintaining or planting woodlands or practicing grazing management. A change in this utility value is needed before forestry will become a major priority and this situation is expected to be the same for much of semi-arid Africa.

ACKNOWLEDGEMENTS

We are indebted to the people of Majawanga who shared their knowledge, experience, and hospitality. The late Professor A.G. Mugasha, Sokoine University of Agriculture, Morogoro made the conduction of fieldwork possible. Danida's Council for Development Research supported the study as part of the interdisciplinary research programme PETREA (People, Trees and Agriculture in Africa).

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