9. The analysis of sustainable charcoal production systems in Tanzania

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EXECUTIVE SUMMARY

Charcoal is a woodfuel produced in rural areas and consumed in cities and towns. Some of the factors influencing the choice of using charcoal instead of firewood in urban areas include: Charcoal has a higher calorific value per unit weight that firewood, it is therefore more economic to transport charcoal over longer distances as compared to firewood; Storage of charcoal takes less room as compared to firewood; Charcoal is not liable to deterioration by insects and fungi which attack firewood; Charcoal is almost smokeless and sulphur – free, as such it is ideal fuel for towns and cities. In year 2000, the actual charcoal consumption was estimated in three African cities to about 140,000 tons for Maputo (Mozambique), about 314,000 tons for Dar es Salaam (Tanzania) and about 245,000 tons Lusaka (Zambia).

Some households tend to use certain fuel energy sources for cooking certain foods or for other kind of activity requiring energy such as lighting or heating. As for Dar es Salaam, 69% of the households used charcoal as their first choice fuel for cooking. However, most of the households (88%) combine two or more types of fuels. Major factors influencing choice of fuel or fuel mix are; availability, affordability and reliability. A comparison of fuel preferences between 1991/92 and 2000/01 showed that many households in Dar es Salaam city are shifting from other fuels to charcoal.

Most charcoal produced comes from the woodlands although insignificant amount also comes from plantations and trees outside the forests. The potential for woodland to produce charcoal mainly hinges on the ability of the woody species to regenerate and grow. Miombo woodlands cut for charcoal production would normally regenerate by coppicing and recruitment from stunted saplings. Because of regeneration in areas previously cut, and if there is no further disturbance, such areas usually revert to woodland, thus increasing the potential of the area to supply charcoal over a much longer time period.

The stand density of woody plants in dry forests varies widely. For instance, in miombo woodland the stand density of woody species mostly ranges between 380 and 1400 stems. In most miombo stands, the basal areas range from 7 to 25 m^2 per ha. In Eastern Tanzania, the volume of harvestable trees for charcoal in miombo woodland is 35 m^3ha^{-1}. The mean annual volume increment (MAI) in mature miombo woodland ranges from 0.58 to 3 m^3ha-1yr-1.

Woodland degradation in charcoal producing areas are due to other human disturbances, such as grazing, frequent fires and extended cultivation periods, which may prolong the recovery period. As such charcoal burning contributes to deforestation. Charcoal production has largely been responsible for the degradation of the woodlands and, together with agriculture, for large scale deforestation that has occurred in Southern Africa over time. In Tanzania, for example, charcoal production was responsible for degradation of 29,268 hectares (24.6 %) of closed woodland and deforestation of 23,308 hectares (19.58 %) of closed woodland and 92761 hectares (50.8%) of open woodland in the catchment area to the west and North of Dar es Salaam that supplied charcoal to Dar es Salaam City.

Charcoal production has far reaching socioeconomic dimensions. The economy of people in the charcoal producing areas largely depends on subsistence agriculture. In areas with reasonable accessibility, charcoal is the main cash crop of the rural households. For example

in eastern Tanzania communities adjacent to the Morogoro – Dar es Salaam highway earn about USD 176 to 645. This indicates a growing dependence on charcoal for household income whereby about 75% of farmers in charcoal producing areas had charcoal as an important source of income. The income from the sale of charcoal was also found to be above the minimum wage paid to most of the governments' employees. This has a consequence of attracting more people to engage in charcoal making. Migration to charcoal producing areas is common. In Tanzania 40% of the charcoal makers have no formal education. The activity requires neither formal education nor large capital investment although it is time consuming and labour intensive which is usually drawn from household. Therefore given the low education level required, the income is attractive to other people to join the business, and thus more deforestation to the woodlands.

Charcoal production sites are usually located close to access roads to simplify transportation and sale. Normally, charcoal kilns are located within 5 to 15 km. However, as woodlands deplete on favourable distances or when preferred species are exhausted, charcoal producers move even further and take the burden of carrying charcoal loads to the roadside. From the roadside, several means of transport are used to carry charcoal loads usually in bags weighing around 50 to 60 kg once packed with charcoal. These include open trucks buses and minibuses; bicycles; motorcycles, head loads and other types of vehicles (e.g. tankers and saloon cars). Despite bicycles hauling relatively smaller percentage (< 10%) all of charcoal to the city, they are the most frequent means of transporting charcoal suggesting that most people involved in charcoal business are poor who can not afford to pay for better means of transport, but are engaged in this business just to earn their living.

The profit margin in charcoal transportation and trade is relatively small, particularly for trucks in the dry season, which provide for a strong incentive to evade paying taxes and levies. Evasion is apparently through many means, including night time transportation which is forbidden for biomass resources and various forms of collusion and payments to guards at the check points (Malimbwi *et al*. 2004). In Zambia, it was also found that profits from the charcoal business are marginal both at production and retail stages. Yet, the business continue because of low opportunity costs in rural areas as a result of failure in the agriculture industry and decline in formal employment opportunities in urban areas. In many cases, charcoal production seems to happen out of necessity as a last resort to earn income to the rural households. Thus, lack of alternative income sources is a compelling factor for the decision to engage in charcoal production. Commercial production is only induced from urban centres (CHAPOSA, 2002). Charcoal retailing in many African cities is very well structured so as to make charcoal accessible to different consumers. Charcoal prices do not increase in real terms, even though inflation causes the current prices to increase. In most African cities for at least the last two decades, urban consumers have been paying slightly less than US $ 0.10 per kg of charcoal.

According to the recent regulations for charcoal preparation, transportation and selling of 2006 (URT, 2006) amendments to the Forest Act No. 14 of 2002 (URT 2002), it is required that District harvesting committee be established and charged with the roles to prepare and maintain a register of all charcoal dealers in the district under the custodian of the District Forest Office. The local government in turn, shall, in areas of jurisdiction, set special areas for preparation and selling of charcoal. The rules emphasize that any charcoal prepared, must comply to any fee, levy or charge by the village government, the Committee or any other relevant authority. However, a survey showed that 75% of the 24,000 bags of charcoal consumed daily in Dar es Salaam city are not accounted for at the checkpoints.

Several sectors have reviewed their policies as a response to the Poverty Reduction Strategy Paper popularly known as *Mkukuta* in Kiswahili in Tanzania. Sectors that are related to wood energy include forestry, energy, agriculture and livestock, environment, wildlife, fishery, science and technology, women and gender development. Some of these have been discussed in relation to wood energy.

There are few woodfuel projects established in Tanzania. These include; The Ruvu Fuelwood Pilot Project, The Maseyu Eco-Charcoal, TANWAT (Tanganyika Wattle Company), Kibena Tea Limited, Njombe, Wakulima Tea Company Ltd, Tukuyu However only two are targeted to produce charcoal; The Ruvu Fuelwood Pilot Project and The Maseyu Eco-Charcoal

Forest Certification is a process designed to ensure that forests are well managed and that the interests of local people are protected. It helps to ensure that forests are managed properly - so that they can continue to provide benefits and services for current and future generations. Certification provides assurance that people who live in or close to the forest must benefit from its management and use. Forest certification therefore is a process that leads to the issue of a certificate by an independent party, which verifies that an area of forest is managed to a defined standard.

Relevance of certification of woodfuel in Tanzania is based on the fact that current woodfuel production practices are not sustainable. Woodfuel extraction is the principle factor responsible for deforestation in Tropical countries including Tanzania.

Criteria and indicators are tools which will help guide national policies, regulations and legislation, and which will guide monitoring and reporting on status and overall trends in forest management. Desirable developments will be demonstrated by positive aggregate trends in the identified indicators. Based on information on the trends at national level, and on forecasts for the future based on these, policy and decision making can be rationalised and action can be adjusted and improved. Seven common thematic areas of sustainable forest management have emerged based on the regional and international criteria and indicators initiatives. These are: Extent of forest resources; Biological diversity; Forest health and vitality; Productive functions and forest resources; Protective functions of forest resources; Socio-economic functions; Legal, policy and institutional framework.

Although not much explicitly for charcoal production the thematic areas have been used in setting the criteria and indicators for charcoal certification in Tanzania, with additions to encompass charcoal from plantations and natural forests.

The following constrains are foreseen in implementing wood fuel certification in Tanzania: lack of proper management plans insecure land tenure; lack of local certifying agencies; uncertainty of the market for certified woodfuel; lack of awareness among stakeholders. Policy options necessary to support certified wood fuel production should: allow time for markets to develop for certified products so that risks to investors are reduced; build on local market conditions and opportunities; provide adequate time and space for the development of appropriate local institutions; develop effective partnerships for training, technical assistance, processing and marketing appropriate to local goals; include feedback mechanisms for mutual learning so that local knowledge and wisdom can also inform international trade institutions so they can be more responsive to equity and sustainability issues.

In light of these strategies the following research areas are proposed: Development of standards for woodfuel forests management in Tanzania; Development of participatory forest assessment techniques in order to capacitate different forestry practitioners and provide them will appropriate monitoring tools; Applied research on efficient woodfuel production, processing (packaging, labelling and branding) and marketing; Applied research on efficient

woodfuel storage and use; Applied research on development of appropriate local institutions to support the certification process; Applied research on the development of market for certified wood.

It is concluded that the concept of certification is new to Tanzania. Certified woodfuel is obviously going to be expensive. The question is whether people are willing to buy the clean woodfuel at the new price. This is a research area to be pursued. Research is also needed to take stock of all woodfuel using industries and their views on certification. Otherwise mandatory certification would be possible if it were a government policy to reinforce the existing policy for sustainable forest management. In this case awareness raising and sensitization to all stakeholders especially policy makers is necessary.

INTRODUCTION

According to UBET (Unified Energy Terminology) woodfuels include all types of biofuels derived directly and indirectly from trees and shrubs grown in forests and non forest land (FAO 2004). Woodfuels can be divided into four main types of products: charcoal, fuelwood, black liquor and other. Fuelwood is not therefore synonymous with woodfuel as often regarded (Johnsen 1999). Woodfuel constitutes a major source of energy in most countries, both developing and developed, and its contribution is expected to grow in the future as a result of the application of stricter environmental regulations and the use of more competitive sources of locally-available energy. In most cases methods used to extract wood energy are not sustainable, leading to land degradation. Wood energy production has therefore direct consequences on the environment. Other entities that affect production and availability of wood energy are socio-economic, cultural, institutional and legal aspects.

In Tanzania, around 91% of all energy consumed is woodfuel (CHAPOSA, 2002), miombo woodland being the source of 60-70% of the annual consumption (Monela *et al*. 1993). It accounts for 97.6% of the total wood products consumed in the country (MNRT, 2001). The estimated national annual woodfuel consumption in Tanzania is 44.8 million m^3 (Kaale, 2005). The major consumer centres (Table 1) are households for cooking (95.4%), rural industries (2.8%) and agriculture (1.4%). The rural industries and agriculture use exclusively firewood. On the other hand the rural households use almost firewood exclusively while in urban areas charcoal is used.

Forest Certification is a process designed to ensure that forests are well managed and that the interests of local people are protected. It helps to ensure that forests are managed properly - so that they can continue to provide benefits and services for current and future generations. Under certification people who live in or close to the forest must benefit from its management and use.

Under proper forest certification schemes, independent auditors issue a certificate to the forest manager after the quality of forest management has been assessed using nationally agreed standards that meet internationally agreed principles. Once a certificate is given, the auditor makes annual follow-up visits to ensure that the forest continues to be managed to the agreed standard. This report reviews the status of firewood in Tanzania and the potential for sustainable production through certification. It should be noted that accurate figures on woodfuel consumption are not readily available. The estimates given in this text are mainly based on literature that could be accessed

CURRENT CHARCOAL CONSUMPTION IN TANZANIA

Charcoal is a woodfuel produced in rural areas and consumed in cities and towns. Some of the factors influencing the choice of using charcoal instead of firewood in urban areas include (Kaale 2005):

- Charcoal has a higher calorific value per unit weight that firewood (About 31.8 MJ per kg of completely carbonized charcoal with about 5 percent moisture content as compared to about 16 MJ per kg of firewood with about 15 percent moisture content on dry basis.
- Due to its high calorific value per unit weight, it is more economic to transport charcoal over longer distances as compared to firewood.
- Storage of charcoal takes less room as compared to firewood.
- Charcoal is not liable to deterioration by insects and fungi which attack firewood.
- Charcoal is almost smokeless and sulphur – free, as such it is ideal fuel for towns and cities

In year 2000, the actual charcoal consumption was estimated in three African cities to about 140,000 tons for Maputo (Mozambique), about 314,000 tons for Dar es Salaam (Tanzania) and about 245,000 tons Lusaka (Zambia) (CHAPOSA, 2002).

Some households tend to use certain fuel energy sources for cooking certain foods or for other kind of activity requiring energy such as lighting or heating. CHAPOSA (2002) reported that in Lusaka (Zambia), 65% of the households used charcoal as the only energy source while the rest of the households used charcoal in combination with firewood (23%), kerosene (17%) and electricity (1%). As for Dar es Salaam, 69% of the households used charcoal as their first choice fuel for cooking. However, most of the households (88%) combine two or more types of fuels.

Major factors influencing choice of fuel or fuel mix are; availability, affordability and reliability. A comparison of fuel preferences between 1991/92 and 2000/01 shows that many households in Dar es Salaam city are shifting from other fuels to charcoal (Table 1).

Table 1. Household fuel preferences between 1991/92 and 2000/01

Type of fuel	Percentage preference	
	1991/92*	2000/01
Charcoal	51	69
Kerosene	28	25
Electricity	15	4
Wood	1	1

** Source: CHAPOSA (2002)*

Most city households (88%) combine two or more types of energy sources/fuels. This is partly because they tend to use certain fuel energy sources for certain foods. For example the cooking of dried beans or maize cereals require longer cooking times and in such instances most people resort to using charcoal or firewood instead of electricity. The same households will use kerosene or other more expensive but convenient energy sources such as electricity to cook quick meals or heat pre-cooked food

CHARCOAL SUPPLY POTENTIAL

The natural forests

Most charcoal produced comes from the woodlands (Johnsen, 1999). . It has been estimated that 4354 ha of woodland are cleared per year in order to supply Dar es Salaam with charcoal (Monela *et al.*, 1993). The potential for woodland to produce charcoal mainly hinges on the ability of the woody species to regenerate and grow.

Woodland regeneration

Woodland regeneration generally involves seed production, seedling development and vegetative regeneration. In absence of intense disturbance such as frequent late fires and overgrazing, the dominant trend in regenerating woodland is towards the recovery to original state. For example, if a woodland stand cleared for charcoal production is abandoned to regenerate, it will regrow virtually unchanged in species composition following clearing. Unless the trees have been thoroughly uprooted, most of the subsequent development of woodland will derive from regrowth of coppice from the surviving stems, stump/root sucker shoots and recruitment from old stunted seedlings already present in the grass layer at the time of tree cut, fall or death (Chidumayo, 1993). Thus, one year after clearing a miombo woodland stand, the sapling population in regrowth may consist of one third coppiced stumps and two thirds seedlings recruited from the stunted seedling pool (Chidumayo, 1997). Frost (1996) recognised four phases in regenerating woodland: (i) initial regrowth, just after sprouting and coppicing (most woody plants in the initial regrowth phase are less than 1 m tall), (ii) dense coppice, some two to five years after clear felling, (iii) tall sapling phase, starting from six to eight years after regeneration, and (iv) mature woodland.

Most seedlings and other tree regeneration (e.g. suckers and coppices) experience a prolonged period of successive annual die back during their development phase. Their success to attain the canopy generally depends on their ability to survive fires and to exhibit rapid growth in years without grass fires (Kielland-Lund, 1982). In general, fire and water-stress during the dry season are responsible for the annual shoot die-backs (Ernst, 1988). This is probably why seedlings in miombo woodlands grow very slowly in height as they initially allocate more biomass to root growth. The under ground parts of seedlings of many miombo trees grow faster than shoots during the establishment period (Chidumayo, 1993). Lees (1962) observed that a comparison of growth rings of root stocks and the established shoots revealed that at least eight years may be needed for miombo woodland seedlings to reach the sapling phase.

After removal or death of the above ground parts of the trees, most woodland stumps produce many sucker shoots. However, during the establishment period the number of shoots would decrease as a result of inter-shoot competition and only dominant shoots contribute to the next generation of regrowth woodland. Sucker shoots grow relatively faster than shoots of stunted old seedlings. This is because stumps retain their well-developed root systems after tree cutting. However, stem height growth in regrowth woodland declines after 5-6 years and remains extremely slow thereafter (Chidumayo, 1993, 1997).

Woodland productivity and charcoal yield

The stand density of woody plants in dry forests varies widely. For instance, in miombo woodland the stand density of woody species mostly ranges between 380 and 1400 stems per ha (Malaisse, 1978; Nduwamungu and Malimbwi, 1997; Nduwamungu, 2001). In most miombo stands, the basal areas range from 7 to 25 m^2 per ha (Lowore et al., 1994; Nduwamungu, 2001; Malimbwi and Mugasha 2001). Both stand basal area and mean biomass increase with increasing rainfall of a site (Frost, 1996). Stand basal area is linearly

related to both harvestable volume and aboveground woody biomass. The mean harvestable volumes in miombo range between 14 m^3 per ha in dry miombo of Malawi (Lowore et al., 1994) and 117 m^3 per ha in Zambian wet miombo (Chidumayo, 1988). In Eastern Tanzania, the volume of harvestable trees for charcoal in miombo woodland is $35m^3ha^{-1}$(Malimbwi *et al* 2005). Average aboveground biomass in old growth miombo woodland varies mostly from around 30 tons per ha to about 140 tons per ha (Malaisse, 1978; Malimbwi et al., 1994) generally depending on the amount of annual rainfall and edaphic properties.

The annual increment of girth varies widely depending on species and site conditions. In area protected from fire and human disturbance, the mean growth in girth range from 0.27 cm/year (Grundy, 1995) to 2.2 cm/year (Chidumayo, 1988). The mean annual volume increment (MAI) in mature miombo woodland ranges from 0.58 to 3 m3ha-1yr-1 (Zahabu, 2001; CHAPOSA, 2002). As for the biomass the mean annual increment of biomass in coppice woodland range from 1.2 to 3.4 tons ha-1yr-1, which is about 4-7% of above ground biomass (Chidumayo, 1993). In mature woodlands, the mean annual biomass increment is estimated at 2-3% of the standing stock (CHAPOSA, 2002). In 2002, about 17.84 million m^3 of wood were used for charcoal production in Tanzania. It is estimated that clearing of one hectare of Miombo woodland provides on average $35m^3$ of firewood for charcoal production. Based on this figure, an equivalent of 509,714 hectares, of woodland could have been cleared in 2002 to provide wood for charcoal production (Kaale, 2005).

Fate of current and previous charcoal production areas

In most cases, charcoal producers are not planting trees to replace those cut from miombo woodlands for charcoal burning hence contributing to deforestation at the magnitude of over 400,000 ha per year. Charcoal production has largely been responsible for the degradation of the woodlands and, together with agriculture, for large scale deforestation that has occurred in Southern Africa over time (CHAPOSA 2002; Malimbwi et al., 2001, Dewees, 1994). In Tanzania, for example, charcoal production was responsible for degradation of 29,268 hectares (24.6 %) of closed woodland and deforestation of 23,308 hectares (19.58 %) of closed woodland and 92761 hectares (50.8%) of open woodland in the catchment area to the west and North of Dar es Salaam that supplied charcoal to Dar es Salaam City (CHAPOSA, 2002). It will be noted that where there is bushland, most of it is regenerating from coppice, indicating that trees had been cut most probably for charcoal production. The development trend for the woodlands shows that if no management measures or interventions are put in place, the remaining woodlands in the Dar es Salaam study area will be down to 40% of the present in 2015.

A number of factors, however, play an important role in influencing the trend of miombo woodland development in the current and previous charcoal production areas. Miombo woodlands cut for charcoal production would normally regenerate by coppicing and recruitment from stunted saplings. Because of regeneration in areas previously cut, and if there is no further disturbance, such areas may revert to woodland, thus increasing the potential of the area to supply charcoal over a much longer time period. According to Hosier (1993) woodland appears to recover relatively well following harvesting for charcoal production and in the absence of other human disturbances, such as grazing, frequent fires and extended cultivation periods, which may prolong the recovery period.

This was observed in Tanzania where regeneration was taking place in areas where trees were previously cut for charcoal production with no subsequent cultivation (CHAPOSA, 2002). Typical of such areas are the areas around Mboga and between Lugoba and Msata in Coast region, Tanzania, which are characterized by regenerating Combretum bushland. These areas are believed to have had trees in 1970s-80s but were clear-felled for charcoal production. The

re-growth was cut again for charcoal in 1990s. Apparently, most of the areas where trees were cut have not been converted to cultivation; instead they were left to regenerate.

Plantations

The total forest plantation area in Tanzania is about 100,000 ha, most of these are for timber and pulp production. In most of these plantations firewood collection of dead branches is done free of charge by women in the surrounding villages. During harvesting the non merchantable (crooked, deformed and smaller ends of the stem) are staked and sold as firewood to urban customers for use in bakeries and few households. This is especially so for forest plantations in close proximity to urban centres such as Meru forest project in Arusha. The quantity of firewood from the forest plantations is yet to be established.

Few plantations in Tanzania are established purely fore the production of woodfuel (See Chapter 7), but these are mostly targeted to produce fuelwood. These include forest plantations established for wood production for curing tea. The Tanganyika Wattle Company (TANWAT) is currently producing wood volumes in excess of 60,000 tonnes per annum which is used to generate 2.5 mega watts of power connected to national grid system. The company also supplies woodfuel to Kibena Tea Limited, Njombe. These are only a few of the forest plantations that are supplying woodfuel, indicating their tremendous potential if sustainably managed. The Ruvu Fuelwood Pilot Project and the Maseyu Eco-charcoal are probably the only recent initiatives to establish forest plantations for commercial charcoal production.

Trees outside the forests

There is hardly any data on how much firewood is collected from agroforestry home gardens in Tanzania. Observations in Coast region however indicates that farm land trees, mainly old cashew nut, mango and occasionally jack fruit trees are also used for charcoal production (IUCN 2000 in Kaale, 2005). Based on the limited experience from the Coast region, it is assumed that around 10% of the charcoal produced in Tanzania is coming from farm land trees. The amount of woodlands cleared for charcoal production in 2002 could therefore be reduced by 10% (50,971 ha). Theoretical net forest area cleared for charcoal production is therefore estimated at 458,743 ha for year 2002 alone.

A biomass survey carried out in Zanzibar in 1996 showed that out of the 10.3 million m^3 of wood volume estimated in the islands 40.8% (4.2 million m^3) were coconut trees, 7.5% were cloves, 6.8% were mango trees (Ali *et al* 1999). These wood sources are used as firewood in most occasions. The forest policy (URT, 1998) recognizes trees on farmland as the major sources of fuel wood for rural house holds.

ENERGY SAVING APPLIANCES AND PRACTICES

The advantages of energy saving kilns and stoves are:

- Minimize consumption of woodfuel
- Provide time for women for other development activities
- Promotion of the utilization of local resources
- Enhancing environmental sanitation by utilizing waste products such as sawdust and rice husks whose disposal is sometimes a problem

Improvement of charcoal stoves

Most of the NGOs making improved firewood stoves also do make improved charcoal stoves. The thermal efficiency of commonly used metal charcoal stoves in Tanzania is reported to

range between 12-15% (MEM 1998) compared to 25% of improved ceramic charcoal. Adoption is however low. Reasons for the slow adoption rates include the higher initial costs (investments) of shifting from standard (less efficient) stoves to the improved types characterized with fragility and shorter lifespan. According to Kaale (2005) ceramic liners are the main component contributing to improvement of energy efficiency of charcoal stoves. However, production of the ceramic stove liners requires suitable clay soil and curing kiln. Without suitable clay soil and proper curing kiln the ceramic liners break easily. Furthermore, the current charcoal price does not exert enough pressure to cause the shift.

With respect to charcoal use, low-income households buy charcoal in small amounts almost on a daily basis, but the small amounts tend to be the most expensive. Thus, perhaps the low-income households in towns have the highest expenditure per unit on cooking energy. The concept that there are longer-term savings with the use of efficient stoves has yet to be realized by most households. Against this situation, a combination of approaches will be required. These range from further technological improvements that focus not only on efficiencies but also on duration of use, low cost repair and other conveniences associated with the use of improved stoves. Included here is also the possibility of subsidizing these strategies using funds from taxes on the same wood energy resources and/or through levies on petroleum at central governments levels to enhance quality control.

Improved charcoal kilns

In charcoal production, improved kilns could contribute significantly to efficient production. Bailis (2003) reported that in earth-mound kiln, which is the most common method of making charcoal in sub-Saharan Africa, between five and ten tons of wood are needed to make 1 ton of charcoal (at a mass-based conversion efficiency of 10-20%). Thus, using such kiln between 60-80% of the wood's energy is lost in the production process of charcoal (Bailis, 2003). Experience from CHAPOSA (2002) shows that kiln efficiencies in Zambia ranged from 20-28% while in Mozambique the range was 14-20. In Tanzania, at an average of 19% kiln efficiency, 18 trees of 32 cm DBH (diameter at breast height, measured at 1.3 m) on average are used to produce 26 bags each weighing 53 kg of charcoal. That is 1 m^3 of wood yields 2.6 bags of about 53 kg of charcoal (CHAPOSA, 2002).

In spite of their efficiency the use of improved kilns has failed due to lack of capital for kiln construction. The need to process the billets into specific sizes and transport them to kiln sites is an added cost which is limiting. However, there is evidence that experienced producers who use traditional kilns achieve more efficiency than less experienced ones. This calls for studying the techniques used by the experienced producers and disseminate them to less experienced producers. According to CHAPOSA (2002) in Zambia a manual for best practice for charcoal making has been produced based on the experience of charcoal producers. In the current system there are no incentives for charcoal makers to adopt efficient production technologies, because of a combination of reasons, including: market failure; unrealistic fees and royalties; behaviour towards open access resources; weak monitoring of forests and reserves; haphazard issuance of permits (legal and otherwise); ignorance; long term problems associated with land and tree tenure/ownership and poor monitoring. These have to be addressed.

Improvement of kitchen management to save energy

At the household level adoption of improved kitchen management skills is also essential in reducing fuelwood consumption (Kaale, 2005). Such skills include:

- Use of dry firewood to increase burning efficiency

- Extinguishing fuelwood after cooking
- Pre-treatment of some food stuffs through soaking to reduce cooking time
- Construction of cooking shelters instead of cooking in the open to increase fuelwood utilization efficiency.

SOCIO-CULTURAL AND ECONOMIC ASPECTS OF CHARCOAL

Household dynamics in charcoal making

The economy of people in the charcoal producing areas largely depends on subsistence agriculture. There are three main charcoal producers in the charcoal market: *full time*, *seasonal* and *occasional producers*. Full time producers live in forest areas and produce charcoal throughout the year, shifting to new areas when the need arises such as when the resource becomes depleted. These are in most cases immigrants to the charcoal producing areas. In one of the active charcoal making areas in eastern Tanzania about 60% of charcoal makers are migrants from other parts of the country (Zahabu 2001). Seasonal producers practice agriculture as their main occupations and produce charcoal only in the off-farming season. Occasional producers make charcoal to meet specific cash needs during the year (CHAPOSA, 2002).

According to CHAPOSA (2002) in areas with reasonable accessibility, charcoal is the main cash crop of the rural households. In eastern Tanzania communities adjacent to the Morogoro – Dar es Salaam highway earn about USD 176 annually (Monela *et al.* 1993). Another study by Monela *et al*. (2000) revealed that about 278 bags of charcoal are produced per household per year which when sold at Tshs. 1000 (USD 1.6) about USD 445 was obtained. CHAPOSA (2002) revealed that on average each charcoal making household produce about 43 bags of charcoal per month which when sold provide an income of about USD 645 per year per household. This indicates a growing dependence on charcoal for household income whereby about 75% of farmers in charcoal producing areas had charcoal as an important source of income.

Similarly, household dependence on charcoal in other Sub-Saharan countries is widely reported (CHAPOSA, 2002). In the Licuati region south of Maputo, extractives activities such as charcoal making, fishing and local brewing were the main source of income in rural areas. The annual average household income is USD 690 per year of which USD 450 is derived from charcoal production. This was about 70% of the household cash income showing that charcoal provides a considerable income in rural areas. In Zambia, with the collapse of agricultural market, charcoal is virtually the only income source in rural areas.

The income from the sale of charcoal was also found to be above the minimum wage paid to most of the governments' employees. This has a consequence of attracting more people to engage in charcoal making. Migration to charcoal producing areas is common. In Tanzania 40% of the charcoal makers have no formal education (CHAPOSA 2002). This is because the activity requires neither formal education nor large capital investment although it is time consuming and labour intensive. The required labour is usually drawn from household members or other producers collaborating for specific tasks in the production process. While men carry out most of the production activities such as tree felling, cross-cutting and kiln building, women participate in breaking the kiln after carbonization and in recovering and bagging the charcoal (CHAPOSA, 2002; Brigham *et al*., 1996). Therefore given the low education level required, the income may attractive other people to join the business, and thus more deforestation to the woodlands.

Charcoal transportation and marketing

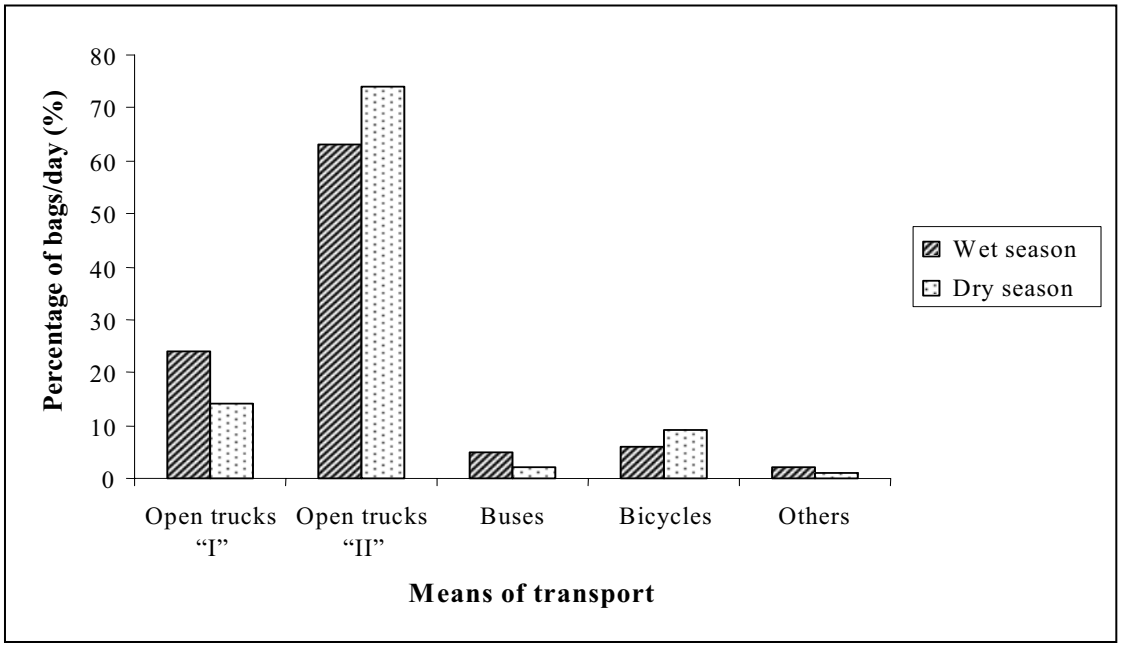
Charcoal productions sites are usually located close to access roads to allow simplify transportation and sale. Normally, charcoal kilns are located within 5 to 15 km (Brigham *et al*. 1996). However, as woodlands deplete on favourable distances or when preferred species are exhausted, charcoal producers move even further and take the burden of carrying charcoal loads to the roadside. For example, the depletion of preferred species in the vicinity of the Dar es Salaam – Morogoro highway has led to extensive woodland degradation and deforestation up to a distance of 30 km from the road to supply charcoal to Dar es Salaam city. The transport of charcoal from the kiln site to the roadside may be carried out by ox-carts, wheelbarrows, bicycles or on foot by head. As a result of increased labour costs involved in the movement, usually charcoal is sold at a higher price at the roadside than at the kiln site (Monela *et al*. 1993, Zahabu, 2001).

From the roadside, several means of transport are used to carry charcoal loads usually in bags weighing around 50 to 60 kg once packed with charcoal. In a study conducted by Malimbwi *et al*. (2004) along the major entrances to Dar es Salaam city, it was observed that the major means of transporting charcoal to the city could be grouped into five categories as follows:

- *Open trucks "I"*: all types of vehicles with a carrying capacity of 1 – 2 tons;
- *Open trucks "II"*: all types of vehicles with a carrying capacity greater than 2 tons;
- *Buses and Minibuses;*
- *Bicycles;* and *Others:* motorcycles, head loads and other types of vehicles (e.g. tankers and saloon cars).

Malimbwi *et al*. (2004) further observed that among the grouped means of transporting charcoal to Dar es Salaam (Figure 1), *Open trucks "II"* accounted for the highest daily load during the period of the study, accounting for about 88% of all charcoal entering Dar es Salaam City. Moreover, most of the charcoal is transported during morning hours (6:00 a.m. to 12:00 p.m.)

Figure 1. Means of charcoal transportation to Dar es Salaam during the wet and dry season



Source: Malimbwi et al. 2004

Despite bicycles hauling relatively smaller percentage (< 10%) all of charcoal to the city, they are the most frequent means of transporting charcoal. Cyclists accounted for about 63% and 70% of the daily means of charcoal transport to the city in the wet and dry seasons, respectively (Malimbwi *et al*., 2004). This seems to suggest that may be many people involved in charcoal business are poor who can not afford to pay for better means of transport, but are engaged in this business just to earn their living. The cyclists come in from production sites in the peri-urban and rural areas and deliver the charcoal to specific points just at the outskirts of the city and wait for city based consumers to come and buy the charcoal (e.g. Plate 1). The buyers are generally small charcoal traders with small businesses that use charcoal, but even some of the wealthier households buy charcoal from the cyclists. A few of the cyclists go to deliver to specific customers further into the city. The cyclists transporters may just deliver charcoal and get paid for it, or be actually involved in charcoal production and/or retailing sale.

Most of the charcoal transporters by trucks are traders who are licensed to transport and trade in charcoal or firewood (Monela *et al*., 1993). These traders usually use hired vehicles though a few use their own vehicles. Arrangements between transporters, traders and producers are informal and generally do not involve long-term contracts. Charcoal transporters are involved in the business due to the following reasons:

- It is a business with ready market in the urban areas
- The business requires neither high starting nor operating capital nor specialized skills to operate (Malimbwi *et al*., 2004).
- Transporters usually make good profit by transporting charcoal on the return trip to the city using the otherwise empty trucks after taking goods upcountry.

Difficult conditions under which charcoal transporters must operate make traders reluctant to use their own vehicles or new ones. Old age of most charcoal transporting trucks results in unreliability and frequent vehicle breakdown during transport (Mangue, 2000). During the rainy season vehicles often fail to reach production areas because of poor state of access roads, resulting in a reduction in charcoal supply and a seasonal slight increase in charcoal price (Mangue, 2000; Malimbwi *et al*., 2004). However, another explanation for the drop of charcoal supply during rainy season may be that at this time, seasonal producers turn to agricultural activities (Monela *et al*. 1993).

The profit margin in charcoal transportation and trade is relatively small, particularly for trucks in the dry season, which provide for a strong incentive to evade paying taxes and levies. Evasion is apparently through many means, including night time transportation which is forbidden for biomass resources and various forms of collusion and payments to guards at the check points (Malimbwi *et al*. 2004). In Zambia, it was also found that profits from the charcoal business are marginal both at production and retail stages. Yet, the business continue because of low opportunity costs in rural areas as a result of failure in the agriculture industry and decline in formal employment opportunities in urban areas. In many cases, charcoal production seems to happen out of necessity as a last resort to earn income to the rural households. Thus, lack of alternative income sources is a compelling factor for the decision to engage in charcoal production. Commercial production is only induced from urban centres (CHAPOSA, 2002).

Charcoal retailing in many African cities is very well structured so as to make charcoal accessible to different consumers. Charcoal prices do not increase in real terms, even though inflation causes the current prices to increase. In most African cities for at least the last two decades, urban consumers have been paying slightly less than US $ 0.10 per kg of charcoal (CHAPOSA, 2002). Charcoal is retailed in a variety of different quantities. At the one end of

the retailing system there are outlets for bulk purchase that are often along main roads of cities. At the other end, there are small shops with some type of tin or other standard container used as measuring device or even some kind of heaps as measure for charcoal that are often found within very close proximity to the households, often less than 1-2 minutes walk (Mangue, 2000, CHAPOSA, 2002).

Figure 2. Bicycles loaded with charcoal waiting for customers, Kilwa Road, Dar es Salaam

Source: Malimbwi et al 2004

LEGAL ASPECTS AND POLICIES INFLUENCING WOOD FUEL SUPPLY AND USE

Land and tree tenure systems in Tanzania

During the colonial period, indigenous peoples' rights to harvest and dispose of trees was significantly restricted. Similarly, after independence, forest policies in many developing countries have been characterized by the strong concentration of power over forest resources in the central state apparatus, and the corresponding lack of local participation in forest and tree management. Failure to recognize indigenous systems of forest management and indigenous rights to resources at policy level has led to:

- loss of incentives by the local communities to protect trees-hence indiscriminate tree felling;
- discouragement of local people to engage in tree planting and reforestation projects; and
- excessive reliance by the state on punitive measures to enforce the law.

The present land tenure system in Tanzania for example, provides four main possibilities of acquiring land for one's use as specified in the Land Act 1999 (MLHSD,1999b) as follows:

- Government leasehold (33, 66 and 99 years renewable)
- Right of occupancy (statutory or deemed);
- Customary land tenure; and
- Village land ownership.

In strictly ownership terms, land in Tanzania may be regarded as:

- General land - administered by the commissioners of lands;
- Reserved land - under statutory or other bodies
- Village land - administered by the village council.

It is from the general land where most charcoal is produced. Despite that the new Land Law in Tanzania recognizes the existence of customary rights of rural communities; ownership still remains strictly under the state. The government as the land owner has the power to revoke customary land rights, creating levels of land insecurity. It is now apparent that privatization offers a chance to introduce a private land hold.

Insecurity of tenure among others has promoted open access to forests and woodlands. Tenure determines whether local people are willing to participate in the management and protection of forests in terms of rights, ownership and access. If these are not well defined, effective participation of the local people in the management of the miombo woodlands may hardly be achieved. For the case of Tanzania it is therefore, stressed that the current Village Land Act of 1999 (MLHSD, 1999b) be put into action to make people own land and trees growing on the land. Thus, their participation in woodland management in public lands would be under the custodian of the Commissioner for Lands.

Past legal rules for charcoal making in Tanzania

The Forest Ordinance Cap. 389 which regulate the use of forests in the country divide forests into basically two categories: those forests reserved by the government for commercial exploitation or for conservation/protection of water sources and habitats among others and forests on the unreserved public (general) lands. It is clearly stipulated by law that no use of the reserved forest area is permitted without a license unless otherwise permitted by the Director of Forestry and Beekeeping Division, the District or under the Ordinance or other lawful authority (§ 56(1) of the Forests Ordinance).

The Forest Rules of 1959 as amended specify fees for licenses and methods for marking and identifying timber taken from forest reserves. It includes also permits for grazing, cultivating, building and residing in the forest reserves. Local Governments Act 1982 give both Village and District governments explicit authority to regulate the use of forests and forest produce (§ 118(1)(b), 118(2)(n) and the First Schedule of the District Authorities Act). However, the Forest Ordinance does not directly impact the production of charcoal because charcoal is regarded as a secondary product from harvested or gathered timber. In the current legal framework, only registration form is issued to charcoal dealers. The registration fee is TAS 50,000/= paid to the government through regional or district forest office. In addition, the dealer is charged a levy per bag which is set in accordance with the district council's by-laws. Such levies therefore differ from one district to another. With the current alarming rate of woodland degradation in Tanzania due to excessive charcoal making, the government has decided to take immediate measures to set a new charcoal making procedure in order to reduce if not contain the unlawful charcoal making.

Recent regulations and amendments for charcoal making in Tanzania

According to the recent regulations for charcoal preparation, transportation and selling of 2006 (URT, 2006) amendments to the Forest Act No. 14 of 2002 (URT 2002), it is required that District harvesting committee be established and charged with the roles to prepare and maintain a register of all charcoal dealers in the district under the custodian of the District Forest Office. The local government in turn, shall, in areas of jurisdiction, set special areas for preparation and selling of charcoal. Also every village shall prepare and maintain a roll of charcoal dealers and no person shall prepare charcoal unless:

a) the activity is undertaken in areas set by the Committee;
b) the trees used have been selected as provided under the district harvesting plan;
c) a pit has been dug for that purpose;
d) the charcoal is prepared in the manner provided in the harvesting plan; and
e) in the area where trees have been felled, trees are planted and maintained by such person, either alone or in group, as the case may be; however, trees under this paragraph may be replanted in any other area as may be directed by the village responsible for that area.

Implementation of the first four rules needs only effective monitoring. The last rule is difficult to implement if charcoal making is done in the dry season when tree planting is not possible.

The rules emphasize further that any charcoal prepared, must comply to any fee, levy or charge by the village government, the Committee or any other relevant authority. However, a survey by CHAPOSA (2002) showed that 75% of the 24,000 bags of charcoal consumed daily in Dar es Salaam city are not accounted for at the checkpoints. It is also doubtful if the charcoal making rules are followed.

Relevant sector policies related to woodfuel production

Several sectors have reviewed their policies as a response to the Poverty Reduction Strategy Paper popularly known as *Mkukuta* in Kiswahili in Tanzania. Sectors that are related to wood energy include forestry, energy, agriculture and livestock, environment, wildlife, fishery, science and technology, women and gender development.

The Forest Policy

The first Forest Policy of Tanzania was published in 1953 and revised after 45 years in 1998 (URT 1998). Salient features of the current forest policy that did not surface in the old policy include

- The goal is enhance the contribution of the forest sector for the sustainable development of Tanzania and the conservation and management of present and future generations
- Recognition of farmland trees as a major source of firewood for rural communities
- Singles out deforestation due to charcoal production, agriculture expansion, overgrazing, wildfires and overexploitation of other wood resources as the major problem facing the forest sector. Estimates deforestation rate at 130,000 to 500,000 ha per annum
- Recognizes government failure to protect forest reserves due to inadequate resources and recommends collaborative management initiatives as possible solution
- Recognizes the contribution of wood fuel to the energy balance and its dwindling supply. Consequently encourages tree planting for woodfuel, use of efficient

conversion technologies and promotion of affordable energy alternatives as strategies to address the woodfuel crisis.

The Energy Policy

The first National Energy Policy was published in 1992 and revised in 2003 (MEM 2003). The policy has the following salient features

- The vision of the energy sector is to effectively contribute to the growth of the national economy and hereby improve the standards of living for the entire nation in a sustainable and environmentally sound manner
- The mission of the energy sector is, to create conditions for the provision of safe, reliable, efficient, cost-effective and environmentally appropriate energy services to all sectors on a sustainable basis.
- The policy provides a very comprehensive analysis of the energy supply and demand situation in Tanzania, including wood fuel and other renewable energy sources.
- The policy states that *"Wood fuel for the foreseeable future will remain the main energy source"*. To ensure sustainable supply of biomass fuels, the policy emphasizes that *"Biomass, particularly woodfuel should be conserved through efficient conversion and end-use technologies which could be complemented by tree growing at household level and beyond"*.

In view of the above, it can be observed that the policy gives high emphasis on the need to sustain rural energy and in particular wood fuel. It also promotes efficient wood fuel conservation and end-use technologies in order to save resources: reduce rate of deforestation and land degradation: and minimizing threats on climate change. This feature is also observed in the forest policy. Although A Renewable Energy Fund has been provided for in the Energy policy, it is not yet operational. One of its possible uses could be to meet cost of mainstreaming certification of woodfuel.

The Agriculture Policy

The Agriculture Policy calls for timely delivery and efficient use of energy inputs, including renewable energy sources into agriculture. It emphasizes the need for agricultural sector to collaborate with forestry in environmental conservation programs. It specifically singles out tobacco production as a cause of deforestation and encourages tobacco farmers to plant trees to meet their woodfuel requirement for tobacco curing.

The Agricultural Sector Development Strategy (URT 2001) developed to implement the policy advocates the use of animal manure for biogas production and planting of nitrogen fixing trees in agroforestry systems in order to increase agricultural production and provide firewood to rural communities.

WOODFUEL PROJECTS IN TANZANIA

There few woodfuel projects established in Tanzania. However only two are targeted to produce charcoal. These are The Ruvu Fuelwood Pilot Project and The Maseyu Eco-Charcoal

The Ruvu Fuelwood Pilot Project

The Ruvu Fuelwood Pilot Project (RFPP) which started in 2000 is located in North Ruvu Forest Reserve, about 60 Km west of Dar es Salaam (MNRT, 2004). Being a production forest, closer and accessible to Dar es Salaam, North Ruvu Forest Reserve which covers a total 67, 000 ha is a victim of severe degradation due to woodfuel exploitation for the urban population. About 80% of Dar es Salaam city population depend on wood fuel as a first

choice domestic energy. About 1900 ha have been provided by the government under special agreement with 670 households which have been allocated 3 ha plots each to be planted with agroforestry tree species which potential as woodfuel. The participating villages are Kongowe Msangani, Mkuza, and Mwendapole. The planted tree species *are Acacia crassicarpa, A mangium, Brachystea kirkii, Khaya anthotheca, casuarinas equisetifolia, Senna seamea, and Eucalyptus terreticornis*. Insitu conservation of *Afzelia quanzensis, Dalbergia melanoxylon, Jurbernardia magnistipula*, and *Khaya anthotheca* is also practiced. The average production in farmer managed plots is 6.3m^3/ha/yr compared to 0.96 m^3/ha/yr in non managed areas. The project has trained farmers on growing wood fuel trees how make charcoal kilns and firewood stoves. Between 2000 and 2004 a total of 1,240,000 trees of different species have been planted (Kaale 2005). This is essentially a participatory one. The main goal is to promote sustainable forest resources management, through increasing forest regeneration and forest products to meet rural and urban primary energy requirements, while providing realistic economic base for the communities surrounding the forest reserve.

The Maseyu Eco-Charcoal

Maseyu is a village 40 km from Morogoro on the Dar es Salaam highway in an area where the production of charcoal is a major business with a long tradition.

The production of Maseyu Eco-Charcoal has two goals: The improvement of the livelihood of the producers of charcoal and the sustainable use of wood as an important natural resource. These two goals are achieved by:

1. Tree nursing and woodland management: to ensure sustainable production and thereby the source of income trees are being nursed continuously to replace the wood used for charcoal

2. Efficient production: with improved brick kilns less wood is needed to produce the same amount of charcoal (3-4 tonnes of wood per tonne of charcoal)

3. Marketing: sustainable Eco-Charcoal will be sold directly to big consumers and in special places (e.g. hotels, supermarkets), assuring a better remuneration of the producers. The intent to help shifting charcoal business from the informal to the formal sector of Tanzania's economy is an important additional goal of this initiative.

Since February 2006,40 villagers from Maseyu organised in two charcoal groups have nursed 80 000 trees, most of them indigenous Mgunga (*Acacia polyacantha*). Burned bricks have been made locally and the first improved half-orange-shaped kiln was built in which carbonization trials have started in October 2006. The project aims at 5 charcoal groups operating 5-10 kilns. The eventual goal of the project is to certify the charcoal from this project.

To achieve this Eco-Charcoal has the following stakeholders. The local stakeholders are the Maseyu village and the Wami-Mbiki Society, a CBO of 24 villages with the goals of sustainable wildlife management and improvement of well being in its communities, while ESDA (Energy for Sustainable Development Africa) provides the technical backstopping. This pilot is funded by RLDC (Rural Livelihood Development Company) who acts as a facilitator with funds from SDC (Swiss Agency for Development and Cooperation)

TANWAT (Tanganyika Wattle Company)

TANWAT was founded in 1949, when the Commonwealth Development Corporation (CDC) took responsibility for a forest development project set up two years earlier by the Forest, Land Timber and Railways Company, located in the Southern Highlands of Tanzania with

15,000 hectares of private forest business (TaTEDO 2004). Production of tannin from wattle was the major source of revenue for the business until late 1960's when a decline in demand for leather goods, brought about by availability of cheaper synthetic alternatives. This resulted in an initiative aimed at exploring new global forestry product opportunities, reducing reliance on tannin products and creating prospects for increased revenue on a long-term basis. The Tanganyika Wattle Company is a fully owned subsidiary of CDC capital fund.

The forest estate comprises 8000 hectares of wattle trees, 4000 hectares of pine and 1000 hectares of eucalyptus. The wattle bark is rich in tannin. The bark is separated from the wood in the field and transported to the factory for processing and manufacture of wattle extract. The wood, which is effectively a waste product, is transported to the power station for use as fuelwood for boilers. At the current wattle extract production levels, wood volumes in excess of 60,000 tonnes are available per annum. Once the tannin has been boiled out, the (waste) bark provides a further fuel source for the boilers. At current production levels, 10,000 tonnes of spent barks is available per annum the eucalyptus in the forest is available in a range of species, some of which are not suitable for conversion into poles. Planting of these species has been discontinued but there is a residual 60,000 tonnes available in the forest (TaTEDO 2004).The sawmill produces 3,000 tonnes sawn timber per annum at a recovery rate of 40% from the pine trees. As such, 4500 tonnes of pine waste is produced per annum, comprising off-cuts and sawdust.

The Tanzania's first commercial wood-fired power plant was commissioned in mid 1995 with an installed capacity of 2.5MW. The plant provides power to the Njombe/TANESCO mini grid. The plant is composed of fuel handling and processing facilities that include a hydraulic feeder or logger, a drum chipper with a capacity of 70m³ loose chips per hour, chip belt conveyor and two silos, each capable of storing 17 tons of chips. Sustainability of raw material supply is achieved by adhering to the annual planting target of 1200ha (900Wattle, 100ha Eucalyptus and 200ha Pine). At harvesting the wood productivity is 80T/ha Wattle, 400 m^3ha^{-1} Pine and 300T/ha Eucalyptus (Aza Mbaga 2007, personal communication.[9]) The rotation ages are 10 years for Wattle, 20 years for Pine and 10 -12 for Eucalyptus. Kibena Tea Ltd, Njombe (Section 7.5 below) meets her firewood requirement for curing tea from TANWAT.

Kibena Tea Limited, Njombe

Produces tea at the rate of 3500m tons/yr from a 700 ha farm. (Miraji Gembe, 2007, personal Communication). The tea is steam cured using firewood from Eucalyptus and wattle wood. It takes 1 m^3 or 0.65 tons of dry wood to cure 350 kg of tea. With an annual capacity of producing 3.5 kg of tea the total amount of wood needed annually is 10,000m^3. Kibena Tea Ltd have contracted TANWAT to produce the required firewood, and have not faced any problems regarding supply of firewood. Assuming productivity of 300 m^3ha^{-1} at harvesting, about 35 ha of plantation need to be harvested annually

Wakulima Tea Company Ltd, Tukuyu

This company has the capacity to produce up to 3985 tons per year. The tea is steam cured using firewood from Eucalyptus grown by outgrowers. One m^3 of wood costs TAS 7000 at the factory at it can cure 332 kg of tea. The annual requirement of wood for tea is therefore 12000 m^3. The factory prefers mature wood which has hire calorific value but since the wood comes from different out growers there is high variation in maturity. Availability of firewood during the rain season is also a problem due to poor accessibility and increased distance to the

[9] Aza Mbaga is the Chief Forest Manager at TANWAT

resource. The company is considering producing there own firewood and they have set aside 80 ha for planting Eucalyptus. Otherwise future firewood supply may not be sustainable

Other tea companies in Tanzania

Other tea companies using woodfuel for curing tea but whose details could not be obtained include Mufindi Tea Company - Mufindi, Herkulu Lushoto, East Usambara Tea Company - Tanga (Amani).

WOODFUEL CERTIFICATION

What is certification?

Forest Certification is a process designed to ensure that forests are well managed and that the interests of local people are protected. It helps to ensure that forests are managed properly - so that they can continue to provide benefits and services for current and future generations. Certification provides assurance that people who live in or close to the forest must benefit from its management and use. Under proper forest certification schemes, independent auditors issue a certificate to the forest manager after the quality of forest management has been assessed using nationally agreed standards that meet internationally agreed principles. Once a certificate is given, the auditor makes annual follow-up visits to ensure that the forest continues to be managed to the agreed standard. Forest certification therefore is a process that leads to the issue of a certificate by an independent party, which verifies that an area of forest is managed to a defined standard.

Requirements for forest certification

The credibility of certification as key to sustainable forest management hinges on the following requirements:

- The standard has been defined and accepted by stakeholders - local people, forest owners, industry, government, consumers
- The standard is compatible with globally acceptable principles that balance economic, ecological and social objectives
- There is independent and credible verification with reporting of results to stakeholders, Certification and the market place
- Certified products can carry a label, which verifies that the timber or wood product originates from well-managed forests
- Companies in the supply chain hold chain of custody certificates so that the label can follow the wood from the forest to the consumer.

Steps in certification process

Preparing for certification

This involves development of certification standards for sustainable forest management based on Principles and Criteria for the national context by supplementing them with relevant indicators. These national standards provide detailed and specific management requirements. In the absence of nationally adapted certification standards such guidance will be provided by the certifiers using generic or local interim standards. The certification standards, though not designed as a forest management manual, provide clear objectives. Certification itself adds the incentive to achieve those objectives.

Also at this stage preliminary visit (scoping visit) is carried out by the certifier. Scoping visits identify major strengths and weaknesses based on a briefing with the managers and/or a

rough estimation of the applicant performance. This helps the enterprise preparing for certification to deal with any major gaps before the full assessment.

Field assessment

Although certifiers have to remain independent of other interests, and therefore are not allowed to provide consultancy services to an operation they certify, in practice the field assessment serves as an informal training opportunity concerning how to reach certification standards. When the assessors interview forest managers and operators about the performance of the operation under investigation the discussions provide a lot of useful hints and recommendations to those involved.

Meeting the conditions

The third phase starts when certification has been achieved, but conditionally on certain improvements. The summary of field results provided in the certification report identifies strengths and weaknesses of an operation. It indicates to forest managers what needs to be consolidated and what needs to be improved. It normally contains a list of corrective actions, or conditions, that have to be met within a given time-frame. If there are major issues these have to be met (and will be checked) before a certificate can be granted. Minor issues can be dealt with subsequently. Together with specific recommendations it provides a clear guide to what kind of training or other measure might be needed to address any areas of non-compliance with the standards. The regular (at least annual) monitoring visits by the certifier ensure that the corrective actions are followed up.

Production of certified charcoal in Tanzania

Relevance of certification of woodfuel in Tanzania

About 80 percent of all wood used in the tropics each year is consumed as fuel, mainly as firewood, in the country of origin. Firewood is the primary source of energy for hundreds of millions of people who do not have access to fossil fuels, or can not afford them. The remaining 20 per cent of the yearly production of tropical wood is used as industrial timber, of which four-fifths are also consumed in the country of origin (Julio 1997). Woodfuel extraction is therefore the principle factor responsible for deforestation in Tropical countries including Tanzania.

Tanzania has a total area of about 94.5 million ha out of which 88.6 million ha is covered by landmass and the rest is inland water. Forests cover about 34 million hectare of the total land area. There are 13.9 million hectares of declared forest reserves in a country of which 12.3 million (81.5%) are under central government and the rest under local governments (district/town or city councils) and private ownership. Village Forest Reserves cover about 3 million ha. These are under Collaborative Forests Management (CBFM) an initiative that was introduced in Tanzania in the early 1980's with some experiences of success stories from Nepal and India. The practice is already legitimized by the parliament through the current forest act of 2002. Most of the CBFM forests are demarcated as part of village general land. Thus they are also called village forest reserves. There are more than 9000 villages in Tanzania but currently CBFM is confined to only a few.

Apart from the aforesaid different forest management regimes in place, current statistics also reveal that the remaining forest area in general land is about 18 million ha. These forests are "open access" characterized with insecure land tenure, shifting cultivation, harvesting for woodfuel, poles and timber, and heavy pressure for conversion to other competing land uses, such as agriculture, livestock grazing, settlements, industrial development in addition to wild fires. The rate of deforestation in Tanzania which is estimated at more than 500,000 hectares

per annum is mostly impacting such general land forests. On the other hand reforestation and aforestation activities by private and local communities are also done in general land areas. Therefore there is a room for much more sustainable forest management activities that may alter the observed high rate of deforestation in the country. Forest certification may offer a better control for forest exploitation for both reserved and unreserved forests in the country.

Criteria and indicators for the production cycles

The first set of internationally agreed guidelines and criteria for sustainable forest management are those of the International Tropical Timber Organization, ITTO. The commitment of tropical countries to manage production forests according to these criteria is thus part of an international agreement, under the auspices of the United Nations. Most tropical countries continue to support this unique and challenging commitment (Julio 1997). Other certification systems in practice are

- The Forest Stewardship Council (FSC)
- Program for the Endorsement of Forest certification (PEFC) Council
- Canadian Standards Association (CSA)
- Sustainable Forest Initiative (SFI)
- The Indonesian Eco labeling Institute (LEI)
- Malaysian Timber Certification Council (MTCC)
- The Austrian Forestry Standard (AFS)

Different users and stakeholders have different expectations of a certification scheme. Potential users decide which one or more of the available are credible for their purposes. Forest management standards are the yardstick by which the performance of a forest manager is assessed for certification purposes. The standards should balance the economic, ecological and social equity dimensions of forest management. For the certification scheme to be credible, all major stakeholders should participate in the process for defining the standards.

Criteria and indicators are tools which will help guide national policies, regulations and legislation, and which will guide monitoring and reporting on status and overall trends in forest management. Desirable developments will be demonstrated by positive aggregate trends in the identified indicators. Based on information on the trends at national level, and on forecasts for the future based on these, policy and decision making can be rationalised and action can be adjusted and improved. There appears to be growing international consensus on the key elements of sustainable forest management. Seven common thematic areas of sustainable forest management have emerged based on the regional and international criteria and indicators initiatives:

- Extent of forest resources
- Biological diversity
- Forest health and vitality
- Productive functions and forest resources
- Protective functions of forest resources
- Socio-economic functions
- Legal, policy and institutional framework.

Criteria and Indicators of charcoal certification in Tanzania

Although not much explicitly for charcoal production the thematic areas may be used in setting the criteria and indicators for charcoal certification in Tanzania, with additions to encompass charcoal from plantations and natural forests. The proposed C&I for sustainable production of woodfuel in Tanzania are presented as Appendix 1 of this report. The following sources of Criteria and Indicators were consulted in compiling the criteria and indicators

- The Analysis of sustainable fuelwood and charcoal production systems in Nepal (Bhattarai and Shrestha 2007)
- The Tarapoto Proposal of Criteria and Indicators for Sustainability of the Amazon Forest (ACT, 1995)
- International Tropical Timber Organization (ITTO) (Anon. 1998 a)
- African Timber Organization (ATO) (Anon. 1998 b)
- The CIFOR Criteria and Indicators Generic Template (CIFOR, 1999)
- Criteria and Indicators for SADC countries within the framework of the Dry-Zone Africa Process (Anon. 1999)

Tanzania is member to the SADC and ATO. Some of the features of these C&I are therefore related to Tanzanian policy. For example the establishment of a Forest Service in charge of the management of all the forests as a necessary indicator in the institutional framework is currently an ongoing process in Tanzania.

The implementation of C&I developed for a particular product and country involve several stakeholders. Similarly rigorous consultations are pre requisite during preparation of C&I. In Malaysia final C&I for woodfuel were compiled by an appointed committee of stakeholders assigned to refine the C&I in addition to identification of activities for each indicator (Tang, 2001). This is a necessary step for the Tanzanian case whereby the current document should form the draft for the final document acceptable to relevant stakeholders.

Constraints for woodfuel certification in Tanzania

Although woodfuel certification is still lacking in Tanzania, the following limitations are foreseen:

Lack of proper management plans

As is the case with most developing countries there is no reliable data on forest extent, characteristics, and growth and yield because national forest inventory is not carried out (FAO, 2006) due to limited capacity in terms of number of staff and finance. This has lead to poor forest management because of lack of data for making informed management decisions. The Tanzania forest policy (URT, 1998) and its forest act (URT, 2002) clearly stipulate the need for proper forest management based on specific forest management plans but except for private forests there is hardly a forest reserve with a proper management plan. This could affect the certification process.

Insecure land tenure

Long-term tenure and use rights to the land and forest resources are required for the forest certification. In Tanzania most of the land is under local communities with customary tenure or use right but not formally surveyed and mapped. As such sometimes land may be set aside by the government for other uses including establishment of private forests. When such circumstances happen, disputes of substantial magnitude involving a significant number of interests normally occur. This may affect the certification process unless clear evidence of long-term forestland use rights (e.g. land title, customary rights, or lease agreements) is demonstrated. It is required that local communities with legal or customary tenure or use rights shall maintain control, to the extent necessary to protect their rights or resources, over forest operations unless they delegate control with free and informed consent to other agencies.

Lack of local certifying agencies

World wide certifications generally have had support from local and international NGOs, government and bilateral aid organizations. However, in Tanzania currently there are not local supporting organizations for the certification process. Lack of local organizations means additional costs for the certification process, as it has to be carried out by expatriates. The costs of certification include both direct assessment costs as well as indirect costs to improve management practices and to meet certification requirements. Such costs are high and a burden for any small-scale enterprise. In this respect woodland management for charcoal production will be difficulty to cover these costs. This is the case with most community based forest management projects and small private forestlands. Economies of scale do not favour any of these operations and appropriate solutions will need to be found for each of them.

Equally important at the national level, certification initiatives and associated standard setting processes facilitate a redefinition of roles and responsibilities with regard to forest management. However, there is so far no clearly developed national or regional forest certification systems based on broad stakeholder consensus and acceptance. This to a greater extent will limit certification process in Tanzania.

Uncertainty of the market for certified woodfuel

Experiences with forest certification show that contrary to expectations frequently raised by NGOs and donors, certification has no mechanism to facilitate consistent access to the market potential for certified products (Irvine, 2002). The certification, as it has been structured to date, reinforces an existing trend which is for forestry products to try to enter international markets. This requires the creation of higher order regional processing and marketing structures, as well as closer links with industry. The lack of domestic markets for certified products is especially problematic for forest enterprises. Because certification is at an early stage in its development as a market tool, certified markets still represent a high risk for most forest enterprises. This could be minimized by developing certification trade networks in different parts of the world and retail companies. However large-scale industrial producers are more likely to be able to provide the needed quantities and qualities to out-compete small scale enterprises.

Lack of awareness among stakeholders

Forest certification is still a new concept in Tanzania. As such effort are needed to raise awareness among deferent stakeholders including foresters, environmental and conservation organisations, loggers, forest dwellers, research and academic institutions, social and human rights advocacy groups, indigenous communities, development and aid organisations, government representatives, timber trade dealers and associations, and concerned individuals. It is also important not to forget groups which are often excluded from decision making processes such as underrepresented social and ethnic groups, women, youth, rural communities, land owners, and foresters.

Policy options necessary to support certified wood fuel production

The local existing markets in Tanzania offer very low value and therefore low prices for charcoal. This is because wood for charcoal has been regarded as a free good that require just the producer effort to extract. To a great extent this situation is brought about by the fact that forests from which the woodfuel is extracted are not managed. Policy interventions to support sustainable forest management of the charcoal producing woodlands should therefore be developed. This may be building on woodfuel certification that among other things ensures that charcoal in the market is produced from sustainably managed forests.

Increasing stakeholders' awareness in participation, and benefits from forestry certification will require strategies that:

- Allow time for markets to develop for certified products so that risks to investors are reduced;
- Build on local market conditions and opportunities;
- Provide adequate time and space for the development of appropriate local institutions;
- Develop effective partnerships for training, technical assistance, processing and marketing appropriate to local goals;
- Include feedback mechanisms for mutual learning so that local knowledge and wisdom can also inform international trade institutions so they can be more responsive to equity and sustainability issues.

On the light of these strategies the following research areas are proposed:

- Development of standards for woodfuel forests management in Tanzania
- Development of participatory forest assessment techniques in order to capacitate different forestry practitioners and provide them will appropriate monitoring tools
- Applied research on efficient woodfuel production, processing (packaging, labelling and branding) and marketing
- Applied research on efficient woodfuel storage and use
- Applied research on development of appropriate local institutions to support the certification process
- Applied research on the development of market for certified wood

PROPOSED CRITERIA AND INDICATORS OF CHARCOAL CERTIFICATION IN TANZANIA

PRINCIPLE 1. POLICY, PLANNING AND INSTITUTIONAL FRAMEWORK

This principle involves the government commitment to support sustainable forest management in harmony with national and international laws and policies

Criterion 1.1. Government commitment to support sustainable forest management for woodfuel production

Indicators:

- *Appropriate political and legal framework that stimulates sustainable development*
- *Clear and focused policy statements supporting sustainable forest management*
- *Existence of a forestry service in charge of the management of all the forests, with adequate staffing to fulfil its mandate*

Criterion 1.2. Policy formulation and implementation are carried out in a participatory manner.

Indicators:

- *Existence of a mechanism for enhancing participatory policy formulation*
- *Existence of multi-sectoral interactions during policy formulation and implementation*

- *Regularity of meetings, discussions and other forums for which records of minutes of meetings prepared and made available*
- *Policy statements in non-forestry sectors (e.g. Agriculture, Energy, Fisheries) that recognizes and supports sustainable forest management for woodfuel production*

Criterion 1.3. Recognition of international laws and conventions addressing forestry and other environmental issues

Indicators:

- *Capacity to represent the country to international instruments and conventions to which the country is part of (e.g. ILO, CITES, ITTO, FAO, ATO, UNCED)*
- *Compliance of government circulars and directives to provisions of international laws*

Criterion 1.4. Extent of the forest resource well defined

Indicators:

- *There exists a map showing the boundaries of the forests.*
- *The boundaries of the forests estate are well marked on the field.*
- *Areas and percentages of forest lands and non forest land that produce woodfuel, in relation to total land area are known*
- *No evidence of forest encroachment*

Criterion 1.5 Effective structure for the promotion of private forestry and trees outside the forests (ToF)

Indicators:

- *Effective institutional support for commercial production of woodfuel from private forestry and TOF*
- *Existence of inter-sectoral coordination between sectors related to forestry*

PRINCIPLE 2: CONSERVATION OF BIODIVERSITY AND MAINTANANCE OF ECOSYSTEM FOR ENVIRONMENTAL PROTECTION ENHANCED

Criterion 2.1 Conservation of biodiversity in natural and planted forests at all tenure levels (e.g. government forests, private forests, community forests)

Indicators:

- *Diversity of habitat in terms of flora and fauna maintained*
- *Identification of endangered, rare and threatened species that should be exempted from woodfuel production*
- *Identification and zonation of biodiversity hotspots of flora and fauna that should be protected from any disturbance*
- *Species richness maintained*
- *Other specific management activities in place to conserve biodiversity of special biological interest, such as seed trees, nesting sites, niches and keystone species*

Criterion 2.2 Ecosystem and protective functions of the forest maintained

Indicators:

- *Special provisions for the protection of sensitive areas, plains, stream banks, steep slopes should be defined*

- *Erosion and other forms of soil degradation are minimized (sensitive areas identified and appropriate control measures applied)*
- *Soil and water restoration programs are implemented when necessary*

Criterion 2.3 Forest health and vitality maintained or improved

Forest condition and health can be affected by a variety of human actions and natural occurrences, from air pollution, fire, flooding and storms to insects and disease.

Indicators:

- *Absence of damaging human activities such as: encroachment, agriculture, roads, mining, dams, unplanned fire, nomadic grazing, illegal exploitation, inappropriate harvesting practices, hunting, and other forms of forest damage such as change in hydrological regime, pollution, introduction of harmful exotic plant and animal species.*
- *Degree of forest damage by natural causes: wild fire, drought, storms or natural catastrophes, pests and diseases, and other natural causes*
- *Existence of procedures to prevent/control: fires, diseases and pests*

PRINCIPLE 3 SOCIO-ECONOMIC FUNCTIONS ARE SUSTAINED

Criterion 3.1 Improved income through sustainable production and consumption of woodfuel

Indicators:

- *Employment generation from woodfuel production activities in relation to total national employment.*
- *Average per capita income in different woodfuel production activities.*
- *Efficiency and competitiveness of woodfuel production and processing systems*
- *This includes improved kiln efficiency and minimization of waste through briquetting in charcoal making.*
- *Economic profitability of management of the forests for woodfuel production.*
- *Sustainable production, consumption and extraction of woodfuel.*

Criterion 3.2. Investment and Economic Growth in the Forest Sector

Indicators:

- *Annual investment in woodfuel plantations, sustainable forest management and conservation in relation to total forest sector investment.*
- *Aggregate value of sustainable woodfuel production.*
- *Rate of return on investment on sustainable production of woodfuel, compared with rates of return in other sources of energy, considering all costs and benefits.*

Criterion 3.3 Enhanced Cultural, and Social Values

Indicators

- *Level of reduction of drudgery for women and children as a result of sustainable availability of woodfuel*
- *Level of participation of local populations in the management and in the benefits generated by woodfuel production activities.*
- *Absence of activities that compromise human culture*

PRINCIPLE 4: FOREST (WOOD ENERGY) RESOURCE MANAGEMENT INCREASES BENEFITS THROUGH BETTER FOREST MANAGEMENT

Criterion 4.1 Effective local management in place for maintaining and assessing the forest (wood energy) resources.

Indicators:

- *Ownership and use rights to resources are clear and respected*
- *Rules and norms of resources use are successfully enforced and monitored (existence of rules and norms, patrolling, incidences of violation of rules, number of forest offence cases registered, etc).*
- *Effective and accepted conflict management mechanisms in place (number of cases resolved).*
- *Access to forest (wood energy) resources is perceived locally to be fair (deprived and poor users get fair concession, access to woodfuel and NTFP, evidence of discussion in meetings on access to resources, attendance of gender, class, and ethnicity in meetings).*
- *Local people feel secure about their access to forest resources, including woodfuels.*

Criterion. 4.2 Stakeholders get equitable share from the benefits of forest (wood energy) resource management.

Indicators:

- *Mechanisms for equitable benefit sharing are developed and implemented (local people express satisfaction on the benefits received)*
- *Employment opportunities exist for poor and deprived users (number of such people involved in carpentry works, livestock raring, fuelwood collection for trade, charcoal making and other income raising activities).*

Criterion 4.3 All production forests under different systems of management be considered as means of livelihood by rural communities

Indicators:

- *The above people invest significant amount of time and efforts in wood energy resource management.*
- *Destruction of natural resources by the local people is rare.*
- *Maximum utilization of the productive national forests (all types) by local forestry stakeholders.*

PRINCIPLE 5: YIELD AND QUALITY OF DESIRED FORESTRY GOODS AND SERVICES ARE SUSTAINABLE

Criterion 5.1 Forest management units are implemented on the basis of legal ownership, scientific forestry practices and recognized traditional rights.

Indicators:

- *Forest management takes place on the basis of inventory information and relevant silvicultural practices.*
- *Information on the identity, location and population of communities living in the vicinity of the managed forests exist*

Criterion 5.2 Management plans are detailed and clearly documented.

Indicators:

- *Management objectives (both long-and short-term) are clearly stated reflecting the condition of forest, expressed public interest of the forestry goods and services, and the local forest users needs.*
- *Harvesting plans are in place taking into consideration available stock and capacity of forest staff to monitor operations.*
- *Forest Working Plan is comprehensive (identifies boundaries, provide inventory of resources, protection, includes management and utilization plans, biodiversity hot spots and cultural and conservation areas).*
- *Appropriate involvement of stakeholders in Management Plan preparation and takes into account all components and functions of the forest (i.e. timber, woodfuel, NTFP etc).*
- *Yield regulation by area and/or volume is prescribed in Forest Harvesting Plan (allowable cuts, minimum exploitable diameter, number of trees or total volume to be harvested per year etc).*
- *Silvicultural systems are prescribed and are appropriate to forest types.*
- *Prescribed harvesting systems and equipment match the condition of forest in order to reduce impact.*
- *Forest Management/Harvesting Plan is periodically revised and approved by the Director of Forestry and Beekeeping*
- *Programs and estimated costs of forest management activities are covered in the Management Plan on a priority basis.*

Criterion 5.3 Effective monitoring system is implemented

Indicators:

- *Mechanisms for monitoring and evaluation are clearly described in the Forest Working/Operational Plan, including chain of custody monitoring of products.*
- *Documentation and record of all forest management and forest activities are kept in forms that enable monitoring, also for product tracking during transportation and transformation*

Criterion 5.4 Costs and benefits from all types of forests are properly accounted for, distributed and shared among relevant stakeholders

Indicators:

- *Mechanisms for sale and/or equitable distribution of forest products (including woodfuels) to relevant stakeholders are clearly described in the Harvesting Plan*
- *Re-investment of the benefits from forestry management for forestry development.*

Criterion 5.5 Promotion of user and environment friendly wood energy technologies, government initiatives of R & D on woody and non-woody biomass based modern energy applications

Indicators:

- *List of environment friendly modern wood energy technologies relevant to Tanzania.*

- *Priority R & D areas in modern wood energy applications (i.e. technologies and end-uses).*
- *Priority R & D areas in non-wood biomass based modern energy applications (i.e. technologies and end-uses).*

PRINCIPLE 6: TECHNOLOGIES USED FOR CHARCOAL MAKING ARE EFFICIENT (PRODUCE HIGHER OUTPUT), NON-HAZARDOUS TO CHARCOAL MAKERS AND LEAST POLLUTING TO THE ENVIRONMENT

Criterion 6.1 Fuelwood supply sources are sustainable and the supply is legal

Indicators:

- *Supply sources (national forests) are under sustainable management.*
- *Fuelwood procurement is legal with payment of royalty fee, taxes etc.*
- *Record of every batch of fuelwood purchase, charcoal production and trade maintained, including number of people employed by gender and ethnic group.*

Criterion 6.2 Inventory of charcoal making technologies currently in use, assessment of their average efficiency and selection of efficient models

Indicators:

- *List of prevailing charcoal making technologies*
- *Average efficiency of common technologies assessed (record/report, fuelwood input to charcoal output ratio).*
- *List of tested efficient modals for promotion.*

Criterion 6.3 Implementation of Harvesting Plan is effective i.e. according to Tanzania Forest regulations (Government Notice No. 70 of 09/06/2006)

Indicators:

- *Charcoal production is undertaken in the approved area*
- *The trees used have been selected as provided under the district harvesting plan*
- *The charcoal is prepared in the manner provided in the harvesting plans*

Criterion 6.3 Assessment of health and the environmental impacts of common charcoal making technologies

Indicators:

- *Health related complaint and cost of medication to the charcoal makers, transporters and traders.*
- *Analysis of chemical constituents of the smoke emitted out of the chimney/exhaust pipe of charcoal kilns/pits, including green house gases (GHG) such as carbon dioxide and methane, and health damaging emissions (HDE) such as particulates and sulphur dioxide).*

Criterion 6.4 Field-testing, demonstration and extension of efficient charcoal making technology to directly relevant occupational group(s)

Indicators:

- *Different types of models tested and demonstrated in the field*
- *Selection of accepted models and efficiency*

- *Extension program for dissemination and training*
- *Continuation of R & D for further improvement*

Criterion 6.5 Guidelines for quality control of charcoal produced

Indicators:

- *Species used*
- *Particle size*
- *Packaging – type of bags, weight*
- *Labels*

CONCLUSIONS

The concept of certification is new to Tanzania. There is evidence of only one project, Kilombero Forest Limited which is striving to develop CDM (Clean Development Mechanism) the year 2000 whereby certification is one of the basic requirements in order to qualify for carbon credits. To date the goal has not been achieved, probably indicating the complexity of the process. Kilombero Forest Limited is not a woodfuel project but a timber project.

Among the woodfuel projects in chapter 7, it is only the Maseyu Eco-Charcoal, which has a clear objective of achieving certification of her future charcoal, but they also face the obvious uncertainty of market. Certified charcoal is obviously going to be expensive. In Malaysia it is estimated that the initial cost required to improve harvesting for certified timber is US$ 65.05 ha^{-1} which is equivalent to 65% of total harvesting cost without the improvement (Thang, 2001). Other sources of cost will be packaging, labelling and monitoring. The question is whether people are willing to buy the clean charcoal at the new price. This is a research area to be pursued.

On the other the tea factories obviously have some mechanism of ensuring continued supply of charcoal but it is not clear whether the systems are sustainable to meet certification requirements. It is also not known whether they would like to use certified woodfuel. Unless there is pressure from above such business enterprises would like to reduce production cost by using easily available and cheap woodfuel. Research is needed to take stock of all such woodfuel using industries and their views on certification. Otherwise mandatory certification would be possible if it were a government policy to reinforce the existing policy for sustainable forest management. In this case awareness raising and sensitization to all stakeholders especially policy makers is necessary.

REFERENCES

ACT. 1995. *Proposal of criteria and indicators for sustainability of the Amazon Forest*. Pro Tempore Secretariat.

Anon. 1998a. *Criteria and indicators for sustainable management of natural tropical forests*. International Tropical Timber Organization (ITTO), Policy Development Series 7.

Anon. 1998b. *The African Timber Organisation (ATO) initiative on principles, criteria and indicators for sustainable management of African Forests.* General Presentation. Organisation Africana de la Madera. Liberville, République.

Anon. 1999. *Criteria and indicators for sustainable forest management in SADC countries within the framework of the dry-zone Africa process.* UNDP/FAO/SADC Meeting, Lilongwe, Malawi, December 1998.

Bailis, R. 2003. *Environmental and Socioeconomic Impacts of Charcoal Production in Kenya*. Paper presented in The International Seminar on Bioenergy and Sustainable Rural Development Morella, México, 26–28 June 2003.

Bhattarai, T.N. & Kumud, S. 2007. *The analysis of sustainable fuelwood and charcoal Production systems in Nepal.* FAO Forest Department. Forest Products Service-FOPP (draft).

Centeno, J.C. 1997. *A view from the tropics.* International Conference on Sustainable Forest Management: Certification, Criteria and Indicators. 21–26 September 1997, Prince George, Canada (also available at http://www.ciens.ula.ve/~jcenteno/viewcert.htm of 25 January 2007.

***CHAPOPSA**. 2002.* Charcoal potential in Southern Africa. *INCO_DEV: International cooperation with developing countries (1998-2002).*

***Chidumayo, E. N.** 1988. Regeneration of Brachystegia woodland canopy following felling for tsetse-fly control in Zambia.* Tropical Ecology*, 29:24-32.*

***Chidumayo, E. N.** 1993. Responses of miombo to harvesting: ecology and management. Stockholm Environment Institute, Stockholm.*

***Chidumayo, E.M**. 1997. Woodfuel and deforestation in Southern Africa - A Misconceived Association. Renewable Energy for Development.* SEI, 10(2)*,July 1997.*

CIFOR. 1999. *The CIFOR Criteria and Indicators Generic Template.* Tool Box Series No. 2. ISBN:979-8764-29-3. Center for International Forestry Research, Jakarta, Indonesia.

Ernst, W. 1988. Seed and seedling ecology of Brachystegia Speciformis, a predominant tree component in miombo woodland in South Central Africa. *Forest Ecology and Management*, 25:195–201.

FAO. 2004. UBET - *Unified Bioenergy Technology*. FAO CORPORATE DOCUMENT RESPOSITORY (available at http://www.fao.org/DOCREP/007/j4504E/j4504E00.HTM).

Frost, P. 1996. The ecology of miombo woodlands. – *In* Campbell, B. (ed.) 1996: *The Miombo in Transition: Woodlands and Welfare in Africa*. Center for International Forestry Research (CIFOR), Bogor:11–57.

Hosier, H.H. 1993. Charcoal production and environmental degradation. *Energy Policy*, 21:491–509.

Johnsen, F. H. 1999. Burning with enthusiasm: fuelwood scarcity in Tanzania in terms of severity, impacts and remedies. *Forum for Development Studies,*1: 107-131.

Kaale, B.K. 2005. Baseline study on biomass energy conservation in Tanzania. SADC Programme for Biomass Energy Conservation (ProBEC) Report:55.

Kaaya, A. N. 1981. *An economic analysis of substituting coal for wood in the production of flue cured tobacco in Tanzania.* Morgantown, West Virginia, West Virginia University. Unpublished MSc thesis.

Kielland-Lund, J. 1982. Structure and morphology of four woodland communities of the Morogoro Area, Tanzania. *In* Dierschke, H. (ed.), Struktur und Dynamic von Wader, Vaduz: 69–93.

Lees, H. M. N. 1962. Working plan for the forests supplying the Copperbelt, Western Province. Government Printer, Lusaka (cited from Chidumayo, 1997).

Lowore, J.D., Abbot, P.G. & Werren, M. 1994. Stackwood volume estimations for miombo woodlands in Malawi. *Commonwealth Forestry Review,* 73: 193-197.

Luoga, E.J., Witkowski, E.T.F. & Balkwill, K. 2000. Economics of charcoal production in miombo woodland of Eastern Tanzania: some hidden costs associated with commercialization of the resources. *Ecol.Econ.35,* 2000:243–257.

Malaisse, F. 1978. The miombo ecosystem. *In* UNESCO/UNEP/FAO (ed.) *Tropical Forest Ecosystems.* UNESCO, Paris:589–612.

Malimbwi, R.E. & Mugasha A.G. 2001. Inventory report of Kitulangalo forest reserve, Morogoro, Tanzania. Forest and Beekeeping Division, Dar es Salaam:43.

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

Malimbwi, R.E. Zahabu, Misana S. Monela, G.C., Jambiya, G.C. & Mchome B. 2005. Charcoal supplying potential of the miombo woodlands: the case of Kitulangalo Area, Tanzania. *Journal of Tropical Forest Science,* 17(2):197-210.

Mangue, P.D. 2000. *Review of the existing studies related to fuelwood and/or charcoal in Mozambique*, EC-FAO Partnership Programme (1998-2002) - Project GCP/INT/679/EC.

Mbarouk, A.S., Leskinen, J. & Pohjonen, M.V. 1999. *Wood biomass inventory in Zanzibar proceedings*. Off-forest tree resources of Africa, Arusha, 12-16 July 1999:107–110.

MLHSD. 1999a. *The Land Act 1999*. Ministry of Lands and Human Settlements Development. Government Printers, Dar es Salaam. The United Republic of Tanzania.

MLHSD. 1999b. T*he Village Act 1999.* Ministry of Lands and Human Settlements Development. Government Printers, Dar es Salaam. The United Republic of Tanzania.

MEM. 2003. *The National Energy Policy*. Ministry of Energy and Minerals. The United Republic of Tanzania.

MNRT. 2001. *National Forestry Program in Tanzania*. Ministry of Natural Resources and Tourism. United Republic of Tanzania.

Mnzava, E.M. 1981, Fuelwood and charcoal in Africa. In W. Palz, P. Chartier and D.O. Hall, (eds.) *Energy from biomass. 1st E.C. Conference*, London: Applied Science Publishers Ltd.

Monela, G.C., Kowero, G. Kaoneka, A.R.S. & Kajembe, G.C. (2000). *Household livelihood strategies in the miombo woodlands of Tanzania*: e*merging trends*. Faculty of Forestry and Nature Conservation, SUA.

Monela, G.C., OKtingáti, A. & Kiwele, P.M. 1993. Socioeconomic aspects of charcoal consumption and environmental consequences along Dar es Salaam - Morogoro highway, Tanzania. *Journal of Forest Ecology and Management,* 58: 249-258.

Nduwamungu, J. 2001. *Dynamics of Deforestation in Miombo Woodlands: The Case of Kilosa District, Tanzania.* Morogoro, Tanzania, Sokoine University of Agriculture. PhD dissertation.

Nduwamungu, J. and Malimbwi, R.E. 1997. Tree and shrub species diversity in miombo woodland, a case study in Kitulanghalo Forest Reserve, Morogoro, Tanzania. *In* Imana-Encinas, J. & C. Kleinn (eds.) *Proceedings of an International Symposium on Assessment and Monitoring of Forests in Tropical Dry Regions with Special Reference to Gallery Forests*, 4–7 November 1996, Brasilia, Brazil:239–258

TaTEDO. 2004. Biomass based electricity production: TANWAT Case Study, Tanzania (also available at http://db.sparknet.info/goto.php 23Jan 2007 (unpublished document requested by SPARKNET).

Temu A.B. 1979. Fuelwood scarcity and other problems associated with tobacco production in Tabora, Tanzania. University of Dar es Salaam, Division of Forestry, Mororogoro. Faculty of Forestry Record No 12:1–22.

Thang C. H. 2001. International expert meeting on monitoring, and assessment and reporting on progress toward sustainable forest management. 5–8 November 2001 Yokohama, Japan.

Thang C. H. 2003. Current perspectives of sustainable forest management and timber certification XII. Forestry Congress. Quebec, Canada 2003, 21–28 September.

URT. 1998. *National Forest Policy*. Ministry of Natural Resources and Tourism. Government Printers, Dar es Salaam. The United Republic of Tanzania.

URT. 2001. *Agricultural Sector Development Strategy*. Ministry of Agriculture and Food Security. United Republic of Tanzania.

URT. 2002. *Forest Act 2002* (Act No 14 of 2002). Ministry of Natural Resources and Tourism. Government Printers, Dar es Salaam. The United Republic of Tanzania.

URT. 2004. *Ruvu fuelwood development project*. Ministry of Natural Resources and Tourism. Government, Division of Forestry and Beekeeping:10.

URT. 2006. *The forest (amendment) regulations and the forest (charcoal preparation, transportation and selling) Regulations 2006.* The United Republic of Tanzania. The Forest Act No. 14, 2002 (Amendments) GN No. 70.

Zahabu, E. 2001. *Impact of charcoal extraction on the miombo woodlands: the case of Kitulangalo Area, Tanzania.* Sokoine University of Agriculture. Unpublished MSc Thesis.