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Full Length Research Paper

A resource survey for medicinal and edible plant species in the four ecological zones of rural Swaziland

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Increased and uncontrolled harvesting of non-timber forest products (NTFPs) often leads to disappearance of numerous plant species and ultimately forest degradation. The objective of this study was to conduct resource surveys to assess the condition and actual quantities of standing stock of species of edible and medicinal NTFPs, and to do an economic analysis of the value of the standing stock. The methods used incorporated a total of ten sampling plots (50 m × 50 m) under each landscape area in each study area. Various indigenous species of plants that supply NTFPs were captured in the study sites. However, this study indicated a lack of the common NTFP species in most plots sampled over the four natural woodlands. This was assumed to be due to uncontrolled and unsustainable harvesting for commercial purposes that have led to obvious patches in the forest and forest degradation. Economic analysis showed that the standing stock of NTFP species is highly valuable and comparable to results from South Africa and elsewhere. There were highly significant differences in the number of individual stems per species per plot between sites. There were no significant differences in the inventory value per plot between sites.

Key words: Resource assessment, NTFPs resource inventory, resource management, edible, medicinal, standing stock, farm gate prices, natural forests.

INTRODUCTION

Non-timber forest products (NTFPs) refers to a vast array of goods and services of biological origin derived from the forest, other wooded land and trees outside forests, including small wood and fuel wood (Dlamini, 2007). Resource assessment for NTFPs is a basis for improved resource management. The dynamics of the community and their livelihoods needs must be matched with the availability and dynamics of the natural resource in order to sustain development. Furthermore, the forest components and processes within both the physical and human environments provide the foundation and building blocks for the development of integrated, sustainable rural resource management policies, strategies and practices (Geldenhuys, 2002, 2003, 2004).

However, recent developments in NTFPs have shifted from valuing standing stock towards calculating direct use values of selected NTFPs as demonstrated in studies done (Godoy et al., 2000; Shackleton and Shackleton, 2000, 2002, 2004, 2005; Dovie et al., 2001; Clarke and Grundy, 2004).

Nevertheless, for policy and strategy development it is important to undertake a resource inventory of NTFPs to assess the condition of the NTFP resources in selected nominated forests. This would be followed by valuation of the existing species to monitor the abundancy of preferred NTFPs, and further investigate the economic potential of the remaining species to local livelihoods in the absence of top priority species. The resource survey is a means towards evaluation of potential inventory value from NTFP species in the studied nominated natural forests and woodlands. This will also contribute towards a strategy to be developed for local-level sustainable forest management and conservation options, as well as income generation programmes from existing NTFP species (Gluck, 2000; Geldenhuys, 2002, 2003, 2004).

In addition to that, natural resource valuation is composed of a series of techniques aimed at attaching monetary values on natural resources as a means of

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Table 1. Brief description of the four ecological zones of Swaziland.

Ecological zone and characteristics
Highveld: The Swaziland Highveld (altitude: 900-1400m) is the upper part of an overall escarpment, comprising complex steep slopes between low and high levels, dissected plateaux, plateau remnants, and associated hills, valleys and basins. Mean annual rainfall is 850-1400 mm. Characterized by Short grassland with evergreen forest patches.
Middleveld: The Upper Middleveld (altitude: 600-800m) consists of strongly eroded plateau remnants and hills at intermediate level of the overall escarpment. It also has structurally defined basins in relatively protected positions, which are only weakly eroded. The Lower Middleveld (altitude: 400-600m) is a piedmont zone of the escarpment, with generally strongly eroded foot slopes. The slopes are mostly moderate and the zone classifies at the first level as a plain. Mean annual rainfall is 650-1000 mm. Dominated by Tall grassland with scattered trees and shrubs and Broad-leaved savanna.
Lowveld: The Lowveld plain comprises sedimentary and volcanic Karroo beds as opposed to the igneous and metamorphic rocks of the Highveld and Middleveld. The Lowveld is subdivided into the higher Western Lowveld (altitude: 250-400m) on sandstone or claystone and the lower Eastern Lowveld (altitude: 200-400m) on basalt. Mean annual rainfall is 550-725 mm. There is a combination of Mixed savanna and Acacia savanna.
Lubombo: The Lubombo Range (altitude: 250-600m) is a cuesta with a steep escarpment bordering the Eastern Lowveld and a gradual dip slope of about 5% descending east. As a major landform the Lubombo qualifies as a plateau. Mean annual rainfall is 700-825 mm. Usually has Hillside bush and plateau savanna.

Dlamini (2007).

demonstrating their worth (Dovie et al., 2001). The ultimate aim of many applications of natural resource valuation is to promote sustainable use of the resources and prevent degradation. The ultimate product of the resource survey would be development of pioneer programmes for modeling the sustainable natural forests and woodlands management for NTFPs in Swaziland as seen for Miombo woodlands (Nhantumbo and Kowero, 2001). This is further consolidated by Geldenhuys (2002) in his concept and approach towards development of sustainable resource use of NTFPs in bark harvesting for traditional medicine in South Africa.

Resource assessment is an evaluation of some aspects of the resource, based on information that is collected from a variety of sources, which can include socio-economic issues, market issues, or the quantity or quality of the resource (Wong et al., 2001; FAO, 2001; Richards et al., 2003). The local, national, regional and international recognition of the role of NTFPs in the community-level livelihoods has stimulated scientific research into the inventory, distribution, classification and economic valuation of NTFPs, and most of all, the bringing back of the previously marginalized NTFPs into forest management (Peters et al., 1989; Godoy et al., 1993, 2000; Hall and Bawa, 1993; Peters, 1996; Crafter et al., 1997; Dovie et al., 2001).

This study was carried out in Swaziland across the four ecological zones covering four distinct natural forests and woodlands.

The specific objective of the study was to conduct resource surveys to assess the condition and actual quantities of standing stock of species for edible and medicinal NTFPs, and to do an economic analysis of the value of the standing stock in the various natural woodlands selected in the study sites.The associated research questions were:

1. What is the actual status of the preferred edible and medicinal NTFPs in the natural woodlands in terms of species distribution, that is, key NTFP species still available, and in what quantities?
2. What is the likely income if the standing stock were to be harvested and sold at current local farm gate prices?

The Hypothesis to be tested was increased demand for NTFPs leads to the depletion of edible and medicinal NTFPs, which may promote natural forest/woodland degradation and deforestation

METHODS

Selection of study sites

The study sites were selected based on the following three key criteria:

1. The sites were distributed across the four ecological zones (Table 1) to capture and represent the eight forest types. This

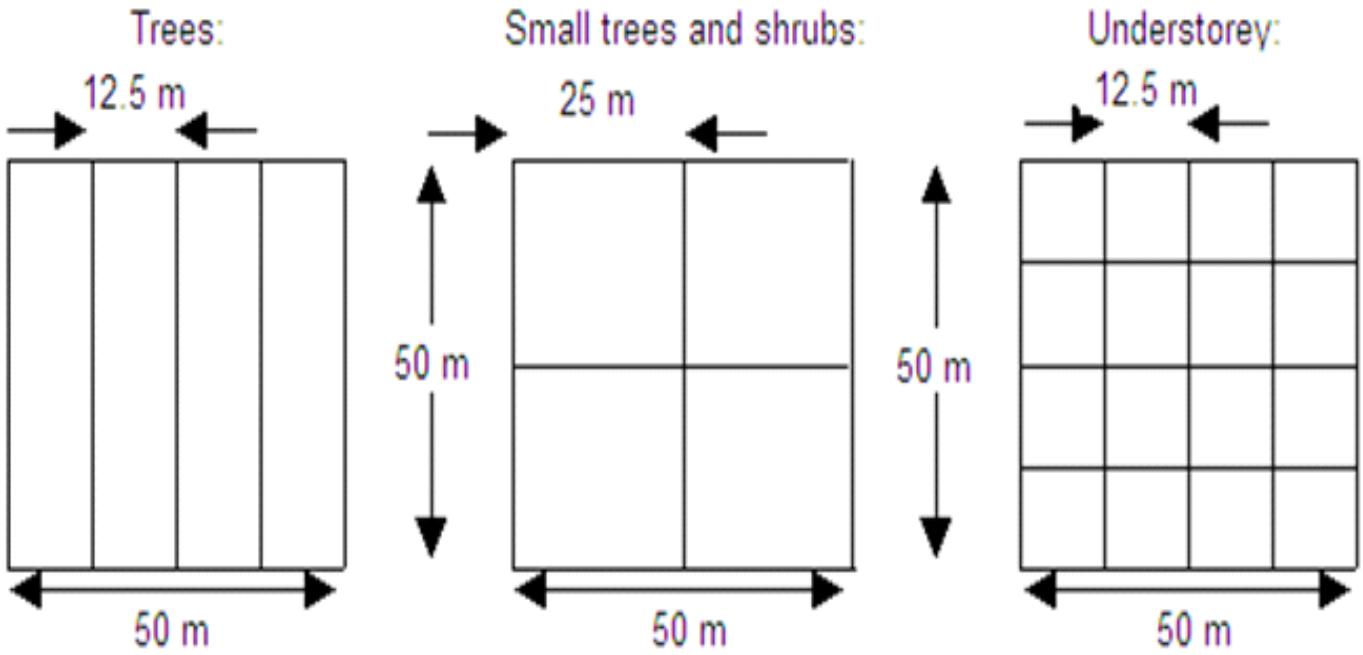

Figure 1. An illustration of the design of main plots and two levels of sub-plots for the resource surveys.

would also capture the variability in climatic and socio-economic conditions between those regions across the country (Falconer, 1992; Peters and Tode, 1998; FAO, 2001; Hassan et al., 2002).
2. The sites comprised natural forests and woodlands adjacent to rural communities that harvest, collect or extract NTFPs on a full-time basis. This renders the selected natural forests and woodlands of significant economic, social and cultural, ecological and environmental importance to the local communities (Balick and Mendelson, 1992; Appasamy, 1993; Chopra, 1993; Godoy and Bawa, 1993; Godoy et al., 1993; McKenney and Sarker, 1994; FAO, 1993; Crafter et al., 1997; Gram, 2001; Geldenhuys, 2002; Shackleton, 2002).
3. The natural forests and woodlands selected for the study were nominated during community consultations (FAO, 2003a).

Resource surveys and economic valuation-procedures

Community meetings were held, literature from local, regional and national sources was reviewed, and key informant interviews were conducted with 28 subject matter specialists, 40 traditional healers and 136 local collectors to gather general information on the anatomy, botany, physiology and flowering/fruiting phenology of the various plant species in the selected natural woodlands modified from Sharma and Bhatt (1982), Wong et al. (2001) and Neuman (2003).

The inventory design followed a nested sampling approach where a sample of larger plots was selected with a systematic group of sub-plots in a fixed pattern within the larger plots and even smaller plots within the sub-plots in Figure 1.

Layout of the sampling plots in the field

Four study sites were selected in each of the four ecological zones of Swaziland and four coordinates were established as boundaries for each sampling site and called A, B, C and D as shown in Table 2. The local Lo 31 system was used in the marking of boundaries around sampling sites and the extend area was given in hectares.

Middleveld, grand valley (KaKholwane), Umtfumunye natural woodlands: The starting point was a Methula homestead where there is a *Combretum species* tree. The first point was located 220 m from the tree and the next points were located in the northerly direction at 300 m intervals, and parallel to these in the same order were the last five points. The total area within the four coordinates is approximately is 284.44 ha.

Lubombo Plateau (Shewula nature reserve): The starting point was 220 m from sampling plot 5. The sampling plots are located at 400 m intervals. The total area within the four coordinates is approximately 269.10 ha.

Lowveld (Siphofaneni), Hlutse natural woodlands: The starting point was at the intersection of a river escarpment and fence boundary. The starting point was 100 m from the first sampling plot. Thereafter, the other plots are distributed at 200 m intervals to the east of the first column of the sampling plots. The total area within the four coordinates is approximately 206.50 ha.

Highveld (Hhelehhele North), Lufafa natural woodlands: The starting point was located 74 m from the first sampling point. The points 1, 4, 7 and 10 are located at 200 m from each other and form a line as do points 1, 2 and 3 and 4, 5 and 6. Sampling points 5, 8 and 11 are also linear and are also at 200m away from each other. The total area within the four coordinates is approximately 218.79 ha.

Economic valuation

The economic valuation model was based on the recommendations of Godoy et al. (2000) and Gram (2001) where:

Table 2. Location and size of the resource survey sites in the 4 natural forests and woodlands nominated in the 4 ecological zones.

Ecological zone	Natural woodlands (area)	Points/Coordinates within which the sample plots were located	System Lo 31 metric	
			Y	X
Lubombo Plateau	Shewula nature reserve (269.10 ha)	A	-104164.29	2890026.46
		B	-104164.29	2893683.07
		C	-101572.16	2893683.07
		D	-101572.16	2890026.46
Middleveld	Umtfumunye (284.44 ha)	A	-42766.67	2956217.45
		B	-42766.67	2958681.43
		C	-40903.51	2958681.43
		D	-40903.51	2956217.45
Lowveld	Hlutse (206.50 ha)	A	-60008.08	2946272.60
		B	-60008.08	2947765.17
		C	-59006.25	2947765.17
		D	-59006.25	2946272.60
Highveld	Lufafa (218.79 ha)	A	-30797.06	2856076.01
		B	-30797.06	2857423.90
		C	-29533.29	2857423.90
		D	-29533.29	2856076.01

1. Trees/Shrubs: Total value = number of trees X annual yield per tree X unit price;
2. Under-storey: Total value = number of individuals X annual production X unit price.

Statistical analysis

The data were continuous data. Appropriate analyses of variance were performed using SAS version 8.2 (SAS, 1999). The Shapiro-Wilk test was performed to test for non-normality (Shapiro and Wilk, 1965; Glass and Saunders, 1972). Student's t-least significant difference was calculated at the 5% confidence level to compare treatment means (Ott, 1998).

The Model for statistical analysis was modified Ott (1998): $Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$, where Yij= resource inventory and inventory value, μ =population mean, α_i =main effect (site or species), ε_{ij} = error.

RESULTS AND DISCUSSION

Species distribution in nominated natural forests and woodlands

The actual number species captured in the various nominated natural forests and woodlands in the four ecological zones of Swaziland is presented in Table 3. While summary statistics of means for inventory and economic valuation in the various study sites are presented in Tables 4 and 5 gives the ANOVA for inventory and economic valuation in the various study sites.

Even though the differences in number of species was not statistical significant, they do show some variation. Umtfumunye natural forests and woodlands, in the Middleveld, had the highest number of species, for both edible (15) and medicinal (26) NTFPs. The Shewula nature reserve, in the Lubombo Plateau had the highest number individual stems of multi-purpose plant species (21). Hlutse, in the Lowveld, had the lowest number of species (6 each). Overall the findings of the study indicate that the natural forests and woodlands selected for the resource surveys are denuded or heavily depleted of the preferred tree species of edible and medicinal NTFPs. As a result there were far too few trees per sampling plot and it is not possible to establish relative frequencies of tree species based on DBH and height. Whilst it is the most important output from a resource inventory point of view to establish resource status through relative frequency of tree species based on DBH and height, only the number of individuals per species was considered for assessment of resource status in the sampled areas. The results of the inventory and economic valuation indicated high significant differences in inventory value, yields and unit prices between the four nominated woodlands (Table 5).

The findings of the inventory have shown that the Siphofaneni woodlands in Hlutse had the highest number of individual stems per species per ha, while the Hhelehhele north woodlands in Lufafa show the lowest population per ha. Unit prices were variable. The highest

Table 3. Species distribution in terms of number of individuals per species per category in the various natural forests and woodlands, from resource surveys.

Study area	Landscape area	Name of forest	Individual species total (medicinal and edible)	Individual stems total (medicinal and edible)	Categories						
					Number of individual stems (Number of individual species)						
					Edible plants	Medicinal plants	Multipurpose plants	Trees	Shrubs	Under-story	Other
Hhelehhele north	Highveld	Lufafa	18	41	22 (7)	16 (11)	3 (3)	21	62	2	62
Shewula	Lubombo Plateau	Shewula nature reserve	18	58	13 (8)	24 (11)	21 (3)	31	12	10	26
Siphofaneni	Lowveld	Hlutse	12	51	15 (6)	23 (6)	13 (4)	35	11	3	12
Grand Valley	Middleveld	Umtfumunye	34	160	62 (15)	88 (26)	10 (7)	62	26	12	60

Table 4. Summary statistics of means for inventory and economic valuation in the various study sites.

Study area	Landscape area	Name of forest	Number of species	No. of stems per species per ha	Inventory value per ha (US$)	Unit prices per species (US$)	Annual yield per ha (kg)
Hhelehhele north	Highveld	Lufafa	18	20.1	230.8	7.6	20.9
Shewula	Lubombo Plateau	Shewula nature reserve	18	36.1	785.2	12.0	31.5
Siphofaneni	Lowveld	Hlutse	12	23.5	852.0	11.5	43.1
Grand Valley	Middleveld	Untfumunye	34	20.2	510.0	14.6	17.8

Exchange rate: 1US$ is equivalent to R6.50 as at 2004 (Times of Swaziland, 2004).

inventory value came from Hlutse as well and the lowest from Lufafa. Annual yield was highest at Hlutse and lowest at Mtfumunye woodlands in grand valley (Table 3). This could be attributed to the fact that the Siphofaneni site was fenced and entry is regulated and monitored (low deforestation), while in grand valley there is free entry into unfenced woodlands (high deforestation).

The specific objective of assessing the condition of the natural forests and woodlands in the selected study sites was accomplished. The obvious sign that the condition of the forest is poor is shown by the disappearance of the so-called key species of edible and medicinal NTFPs. A list of some of the already missing species is given in Table 6. In addition to the disappearance of important species, patches of bare land were most noticeably in all the sampling plots in the nominated woodlands in all study sites.

This resource assessment for edible and medicinal NTFPs clearly concur with this aspect of the previous national inventories, as the Middleveld study site has the highest number of species above all the other study sites that fall under other forest strata. The resource assessment shows that the Hlutse natural woodlands have the lowest number of edible and medicinal NTFP species (12 species), while the Lufafa natural woodlands and the Shewula nature reserve have 18 species each. According to Hess at al. (1990) and DANCED (1999), the Hlutse woodlands fall under the Acacia savanna forest stratum which is limited in the number of species available, and the same reports show that the Lufafa woodlands fall under the Montane and highland forest stratum, which also has a few species but is slightly better than the Acacia savanna. This resource assessment is congruent. The Shewula nature reserve falls under the mixed

Table 5. ANOVA for inventory and economic valuation in the various study sites.

Source of variation	Degrees of freedom	Mean squares	P-values
No. of stems per species	3	10464924.2	0.1100
Inventory value per ha	3	229.1	0.0050
Unit prices per species	3	23843.7	0.0034
Annual yield per ha	3	587.1	0.0008

Exchange rate: 1US$ is equivalent to R6.50 as at 2004 (Times of Swaziland, 2004).

Table 6. List of missing common/key species (according to available local literature and community consultations) in the inventory results across study sites.

Edible species	Medicinal Species
Psalliota campestris (Mushrooms)	*Pittosporum viridiflorum* (Sims)
Aloe maculate (Ker Gawl)	*Drimia delagoensis* (Barker) Jessop
Syzygium cordatum (Hochst ex. C. Krauss)	*Schotia brachypetala* (Sond.)
Ficus sur (Forssk)	*Manilkara species* (Gilly)
Cephalanthus natalensis (Oliv)	*Harpephyllum caffrum* (Bernh. ex Krauss)
Lannea discolor (Engl.)	*Encephalartos species* (R.A. Dryer)
Vangueria infausta (Burch)	*Senecio rhyncholaenus*
Lantana rugosa (Thunb)	*Pterocarpus angolensis* (DC.)
Berchemia zeyheri (Sond.) Grubov	*Maesa lanceolata* (G. Don)

woodland stratum, but the number of recorded species is far below those in the Umtfumunye natural woodlands, which falls in the same stratum. Subsequent research into this strange phenomenon is necessary.

A notable observation is that all the study sites share the same multi-purpose plant species. These are Aloe maculate (Ker Gawl), Berchemia zeyheri (Sond. Grubov) and Sclerocarya birrea (Hochst), the latter was scarce in the highveld.

This is a good indication that these species are both multi-purpose and well adapted to the varied altitudes and climatic conditions of the four ecological zones of the country. Another important observation is that trees are the most dominant preferred species of edible and medicinal NTFPs followed by shrubs and lastly the under-story species, across all the studied natural woodlands. During the resource surveys it was noted that there are some edible wild mammals living in all the sampled natural woodlands, and the community volunteers taking part in the surveys disclosed that there was some hunting and bushmeat is utilized though mainly during the summer season.

There were no statistically significant differences in the inventory values of the standing stock of edible and medicinal NTFPs between sites. The results, however, show a range between US$85.2 and US$230.8 per hectare between sites. There were no significant differences between species in inventory value but the range of the top ten species was between US$4395.2 and US$752. These values are lower than those of the annual yield and market value of fruit and latex produced in 1 ha of forest at Mishana, Rio Nanay, Peru of US$697 per ha (Peters et al., 1989). This could be attributed to the fact that in the current study a totally different set of species of NTFPs were assessed. However, comparatively, the inventory values of this study are higher than those found by Robles-Diaz-De-Leon and Kangas (1999) through an economic model for the harvesting of NTFPs from a riparian forest model buffer zone in Chesapeake bay region in Maryland in the USA. The gross income from the model forest was estimated at US$61.2 per ha per year.

Economic valuation of the standing stock gives the inventory value of the forest/woodland portion in terms of the specific products under consideration (Godoy et al., 1993, 2000; Robles-Diaz-De-Leon and Kangas, 1999). The inventory value of the NTFPs is a conservative figure because the natural forests and woodlands also produce other benefits, such as biological diversity and environmental services (Godoy et al., 1993, 2000; Peters et al., 1989; Dovie et al., 2001). Policy-makers and decision-makers, as well as development organizations need an accurate estimate of the opportunity cost of the forest to evaluate proposed projects and filter out economically disadvantageous ones. Under some circumstances leaving the forest unlogged and using it to get non-timber forest goods, environmental services may be socially and economically optimal (Godoy et al., 1993). This may be verified through the use of cost benefit analysis (CBA) of forest land use options (Bishop,

1999). The strength of a CBA is the use of explicit and directly comparable decision criteria. The underlying logic of CBA is that, for any given set of alternative activities (e.g. land use options), the net benefits of each should be compared, where the net benefits (NB) of a given option are simply the sum of benefits (B) less the total costs (C): NB = B-C. Thus for any two alternative land uses, A and B, the net benefits of A (NB^A) must exceed the net benefits of B (NB^B), if A is to be the preferred land use option on purely economic grounds, hence: $NB^A - NB^B > 0$ (Bishop, 1999).

Challenges encountered in working with NTFPs would be short-listed as follows: difficulties with traditional forestry designs; lack of properly tested sampling designs tailored for NTFPs; few NTFP mensuration techniques available; little cross-disciplinary exchange of ideas or techniques and conceptual and practical difficulties in the determination of sustainable yields (Wong, 2000; FAO, 2001). Problems with NTFP resource inventories also come due to the rarity, clumped distribution, imperfect detectability, seasonality, mobility (in case of animals) and quantification of yield for non-destructive harvesting, for NTFPs only a small part of the individual is harvested, as opposed to methods for determining timber yield where the whole individual is harvested (Peters et al., 1989; Hall and Bawa, 1993; Peters, 1996; Wong et al., 2001; FAO, 2001).

To overcome the challenges of NTFP resource assessments, there are three spatial scales on which a successful approach can be based and these are species, community and national (Wong, 2000). At the species level there should be better understanding of how to design biometric sampling schemes, suitable mensuration techniques, effective monitoring strategies and for analyses including the determination of sustainable yield of individual species. At the community level (village) these technical problems are exacerbated by the need for protocols suitable for use by the community. Local communities have impeccable local knowledge and experience of the ecology and management of NTFPs. A vital step towards promoting community management of these resources is the integration of local knowledge systems and scientific knowledge. At national or macro scale these issues are compounded by the need to integrate NTFPs into the multi-purpose national forest inventory designs.

CONCLUSIONS AND RECOMMENDATIONS

The study shows a varied distribution and economic values of species between plots within sites and between sites and between plots irrespective of sites, though not statistically significant.

During the resource assessment it was evident that the distribution of preferred species of forest foods and forest medicines is sporadic and erratic. There were open patches of bare land within the sampling plots and rills, gulleys and dongas between sampling plots. This is a clear sign of mismanagement of the natural forests and woodlands resulting in over-exploitation and unsustainable harvesting of timber and NTFPs leading to forest degradation and disappearance of some species of high socio-economic value.

The following issues and recommendations emanate from the study:

Issue

Though the exact rate of extraction of forest products from the studied natural forests and woodlands is not known, it is apparent that the current harvesting intensity of timber and NTFPs is very great, and there may not be sufficient propagules for dispersal for regeneration and the preferred species populations will rapidly go extinct. Already most of the species mentioned earlier are scarce, threatened or extinct in all the study sites. This was confirmed by informal interviews with the resource inventory team of local volunteers who mentioned that most species have disappeared due to overexploitation without proper management of the source habitats.

Recommendation 1

It is therefore, strongly recommended that appropriately designed resource inventories are undertaken to capture the status of the resource and to understand resource dynamics and response to use (Geldenhuys, 2003).

Recommendation 2

The approach to resource conservation should change from the protectionist approach where local resource users are prohibited from harvesting NTFPs from adjacent forests by the law, to the participatory resource management approach where all potential users are involved in natural resource management. Governments, NGO's, the private sector and academia should be integrated in all the stages of natural resource management. This new system has been successful in sustainable forest management (Abubakr et al., 1997).

Issue

The inventory values, net annual revenue, net present values and annual yields and unit prices per species in the four study sites show that the NTFP sub-sector is an economically viable business sector. However, presently communities are not making efficient and economic use of NTFPs by setting up small processing industries.

Recommendation 3

Government and other institutions should support the development of small sustainable industries specializing in the processing of natural forests and woodland products. Communities need to be advised on the options for small industries and the possibilities of financial and technical assistance. The benefits of industries such as bee keeping, food collection, woodcarvings include increased employment through additional labour inputs and increased revenue through value addition to the forest product.

Issue

The current land tenure system of Swaziland has a huge impact on the use and management of forest resources from the communal areas.

Recommendation 4

It is suggested that participatory management can improve control of resource use. Therefore, efforts should be made to organize local communities to promote effective participatory management of natural resources.

Issue

Most of the national policies and laws do not specifically address issues related to the NTFPs of socio economic importance that enhance the livehoods of rural communities that reside adjacent to natural forests and woodlands.

Recommendation 5

It is recommended that appropriate laws should adopt the following features:

1. To recognize the full extent of local demands of the forest resource.
2. To fully consider the local knowledge of the resource that has developed over time.
3. To engage nearby communities as stakeholders in managing the resource and ensuring their commitment to long-term management goals.
4. To engage the energies of local people in their own economic change, which can include decisions on social and cultural priorities that outsiders do not realize.
5. Substitution of resources, preserving scarce NTFPs and utilizing suitable alternatives.

The challenge ahead is to develop single and multi-purpose forest resource inventories and data analysis procedures ranging from the local to national level without excluding the beneficiaries (communities); this is in simple terms to adopt a participatory resource assessment process involving the indigenous/local people (FAO, 2001). It is imperative to formulate guidelines for long-term and interdisciplinary monitoring of the use of NTFPs (Crafter et al., 1997; Geldenhuys, 2002, 2003, 2004; Amsallem et al., 2003).

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