THE CHALLENGES OF RESEARCH IN MANAGING NATURAL RESOURCES ON A SUSTAINABLE BASIS IN TANZANIA

Mugasha[1], A.G., Ishengoma[1], R.C., Nshubemuki[2], L., Gillah[1], P.R. & Songorwa[1], A .N.

[1]Faculty of Forestry and Nature Conservation
Sokoine University of Agriculture
P.O. Box 3009, Morogoro Tanzania

[2]Tanzania Forestry Research Institute
P.O. Box 1854, Morogoro, Tanzania

ABSTRACT

Tanzania is endowed with a wide range of natural resources, which support or potentially can support the livelihood of her people. That is why the Tanzania National Poverty Eradication Strategy (TNPES) recognizes the contribution of these resources to poverty alleviation and food security. However, these resources are under very high utilization pressure leading to degradation of ecosystems. This is mainly due to rapid increase in human population. For the benefit of the present and future generation, sustainable management of natural resources is indispensable. In fact, TNPES's goal is to reduce poverty in the society by 50% by the year 2010 and to eradicate it altogether by the year 2025. Research and development constitute an important input of reaching this goal. A multi-inter-disciplinary research approach to harness technologies, which will ensure sustainable management of natural resources and involvement of all stakeholders at different levels of this endeavour, is imperative. However, research into sustainable management of these resources faces challenges in several fronts.

This paper gives an overview of the current status of the natural resources in Tanzania with special emphasis on forestry, wildlife and fisheries. It also critically looks at (a) contribution of natural resources to food security and poverty alleviation, (b) sustainable utilization of natural resources, (c) the nature and institutions involved in research on these natural resources, (d) challenges faced by such research, and (e) the way forward.

1. INTRODUCTION

A resource is something that lies ready for use or that can be drawn upon for aid or to take care of a need, or something that a country, community, household, etc. has and can use to its advantage. Natural resources are those actual and potential forms of wealth supplied by nature (Webster's New World Dictionary 1991). In other words, natural resources are those un-captured providence given stores that are useful to mankind in any way. They include waters, soils, forests, grasslands, wildlife and minerals (Allen, 1966). These natural resources may be arranged for convenience as: (a) inexhaustible natural resources, which include the atmosphere and water in its cycle; (b) replaceable and maintainable natural resources, including water in place, soils, land in its spatial sense (for human activities, for the scenery and other amenities), forests, grasslands and other forage resources, wild animals, human powers (those of the body and those of the spirit); and (c) non-renewable natural resources, including minerals and land in natural condition. These resources support, or potentially can support, the livelihood of people by contributing to poverty alleviation and food security. According to Salafsky (1994), the concept of sustainable development and integrated rural development demands that natural resources be used to improve human welfare.

An increase in human population is resulting in degradation of renewable natural resources due to an increase in demand for agricultural land and forest/water products, settlements, and grazing. Some of the consequences of environmental degradation include: food insecurity and poverty, destruction and/or reduction of the quality of some habitats leading to extinction or endangering of certain plant and animal species, and overexploitation of resources. In order to arrest this trend, there is a need to develop and/or adopt technologies, which will ensure sustainable utilization of renewable natural resources. This calls for research into the development of technologies and approaches, which will ensure sustainable management of natural resources. However, research into sustainable management of natural resources faces formidable challenges.

The main objective of this paper is to bring to attention of researchers the challenges, which Tanzania faces in research into managing natural resources on sustainable basis. However, the paper does not dwell on all aspects of natural resources. It concentrates on forests, wildlife and fisheries in the country.

2. OVERVIEW OF FOREST, WILDLIFE AND FISHERIES RESOURCES

Tanzania is endowed with a wide range of natural resources. Apart from vast areas of arable land, she has extensive natural forest and wildlife resources, and abundant fishing potential (Anon, 1990).

2.1 Forest Resources

In Tanzania, there are both natural forests and plantation forests. In this paper, natural forests are defined to include afro-alpine heath and moorland, forests, savanna woodlands, and grasslands, bushlands and thickets, mangroves and swamps. Savanna woodland is the most dominant. Out of 88.6 million ha that make up mainland Tanzania, forests and woodlands are estimated to occupy about 33.5 million ha (about 37% of Tanzania's land area). Closed forests occupy 1.1 million ha (0.01% of total land area), while mangroves occupy 0.11 million ha. Forests and woodlands further include 90000 ha of industrial plantations on reserved lands and 150000 ha of privately owned plantation forests (MNRT, 1998a). Industrial plantations are concentrated in 19-forest plantation projects distributed throughout the country. Forest reserves cover a total of 12.5 million ha while catchment forests occupy an area of 1.6 million ha (MNRT, 1998a). Most forests and woodlands have been gazetted for production purposes and the rest mainly for protection purposes, including catchment areas. Currently, the management and administration of forest reserves fall under two different authorities namely the Central Government and the Local Governments.

2.2 Wildlife

Out of the total land area of Tanzania mainland 29.9% constitute protected areas devoted to wildlife conservation. National Parks and Game Reserves – areas where no human settlement is permitted - occupy 21.3% of the total land area. Although a big per cent of the total land area has been set aside as wildlife protected areas, much of the wildlife is still found outside these areas. Such wildlife is found on general lands, village lands and reserved lands that are not meant for wildlife conservation. This serves as evidence for the country's richness in wildlife. Species diversity and endemism are as shown in Tables 1 and 2.

Currently wildlife management and the administration of wildlife issues in Tanzania is assigned to three different authorities: (i) the Wildlife Division, which is responsible for the management of 16(-1) Game Reserves, Game Controlled Areas and all wildlife outside protected area boundaries; (ii) Tanzania National Parks Authority (TANAPA), which is a parastatal organization also under the Ministry of Natural Resources and Tourism (MNRT) responsible for the management of 12(+1) National Parks, and (iii) the Ngorongoro Conservation Area Authority

(NCAA), which is responsible for the management of Ngorongoro Conservation Area - a multiple use area where the Maasai people are allowed to live, graze their cattle and, of recent, carry out small scale cultivation.

The driving forces behind wildlife management are those of conservation (protection + sustainable utilization) and economics. Wildlife (or resource) economics has only recently become an important consideration in wildlife management. Wildlife management is one of the most complex of disciplines because of the wildlife managers' need to understand ecosystem and wildlife population dynamics within the framework of changing human needs and wants.

Table 1: Baseline data on species diversity and endemism in Tanzania

	Total No. of Species	No. of Endemic Species
Mammals	310	12
Birds	1016	13
Reptiles	273	48
Amphibians	121	40
Fish	250	230
Flowering plants	11000	110
Total	12970	453

Sources: Cumming (1999) and Griffin *et. al.* (1999)

Table 2: Summary of Biodiversity Rankings in Tanzania as compared to other countries in Southern Africa*

	Rank
Number of vertebrate species	1
Number of plant species	2
Species per 1,000 km^2	6
Number of endemic vertebrates	1
Number of endemic plants	5
Overall rank	2

Source: Cumming (1999). *In this case Southern Africa includes 11 countries (i.e. Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania and Zambia).

2.3 Fisheries

Tanzania is well endowed with water resources. The country shares three of the largest inland water lakes and has a diverse river system, numerous wetlands and 800 km-long coastline. The fisheries sector contributes 10% of the Gross Domestic Product (GDP) and forms 30% of the animal protein intake. Some 80,000 people are directly involved in fishing, while additional millions are engaged in fisheries-related employment (MNRT, 1997). The sector is also a tourist attraction.

The potential yield (Table 3) is estimated at 730,000 t $year^{-1}$. The potential catch for lake Tanganyika is explained by its depth of 1.4 km at the deepest point. Lake Victoria's deepest parts are only 80 m. Lake Tanganyika has, therefore, more water than Lake Victoria (Saggerson, 1962).

Table 3: Potential yield of main water bodies in Tanzania[1].

Water body	**Potential catch (x1000)**
Lake Tanganyika	300
Lake Victoria	200
Lake Nyasa	100
Territorial + marine waters	100
Other lakes, dams and reservoirs	30
Total	**730**

[1]*Source:* Ministry of Natural Resources and Tourism (MNRT, 1997)

The current annual catch is some 350,000 tones i.e. 48%. There is, therefore, a tremendous scope for improvement bearing in mind that there are areas whose fishery resources are fully or near full exploitation while others are virtually untapped. Also worth noting is the high degree of species diversity and endemism notably in Lake Tanganyika. The lake harbors over 500 endemic fish species.

3. NATURE OF RESEARCH AND INSTITUTIONS INVOLVED

As outlined earlier, this paper is addressing challenges of research in relation to managing natural resources on sustainable basis in Tanzania. It is axiomatic that sustainable management of natural resources is implicitly their conservation. Conservation is the management of the resources of the environment, i.e., air, water, soils, minerals, living species (including human beings) so as to achieve the highest quality of human life. In this context management includes surveys, research, legislation, administration, preservation, utilization, and implies education and training (Budowski, 1977). Thus in the quest for sustainable management of natural resources, research constitutes one of the facets in multi-faceted conservation.

From natural resources point of view, research can be defined in various ways: (a) process of inquiring using scientific method which will lead to creation of new knowledge or theories (Callaham, 1981); (b) an attempt to discover facts by systematic and accurate study of a subject or problem (Klem, 1987); (c) scientific investigation and study to discover facts (Chamshama, 1987); and (d) systematic data acquisition and analysis intended to provide information needed for generation of knowledge or new technology (Mgeni, 1992).

As far as management of natural resources is concerned, the main objective of research is to provide answers to management questions such as justification and distribution of resources, consequences of a particular course of action, courses of observed phenomena such as low population density or poor yield or quality and incidences of diseases (Okali, 1987, cited in Abeli, 1992). Research also serves to develop options in products, services and generates new technologies, tools and practices. Furthermore, research provides information and justification for improving policies, management and utilization of forest and wildlife resources.

Until recently the list of research priorities for the field of natural resource management was mostly concerned with technical aspects of management (Heinen, 1995; Mlingwa, 2001; Runyoro, 2001; Senzota, 2001; Tibanyenda, 2001). But the major contemporary conservation problems, e.g., deforestation,

poaching, encroachment and habitat destruction in Tanzania are more social, economic and political than biological or ecological. Thus more research is needed that helps Tanzanians extend their understanding of the socio-economic and political factors that affect natural resources and their conservation. Indicators of success will include, but not be limited to: (a) habitat types prioritised; (b) critical habitats conserved; (c) critical species protected; (d) denuded areas rehabilitated/restored; and (e) presence of functional local resource management stewardship, adoption of 'sustainable' practices, and economic benefits (Foster-Turley, 1996).

In developing countries, including Tanzania, where resources for research are a big problem, careful planning of research is very important in order to ensure that the resources available are applied and used effectively to achieve rapid development in the sustainable management of forest, wildlife and fisheries resources. There are various types of research undertaken in forestry, wildlife and fisheries sub-sectors. These can be divided into four categories namely basic, strategic, applied and adaptive research. Basic research aims at generating new understanding and knowledge with little application while strategic research is geared toward generating new understanding but for a solution of a specific management problem. Applied research uses basic and strategic research findings for producing new technology while adaptive research is involved in adapting or adjusting new technology to fit specific circumstance (ISNAR, 1992). All the four categories are important but which one, when and where to apply will largely depend on the nature of the problem, resources available and other factors.

Tanzania, like many other developing countries, has limited human and financial resources for research. However, there are countless natural resource management-related problems demanding research. Priorities have usually been set according to the needs of the relevant sub-sector and availability of resources. The nation has forest, wildlife and fisheries policies all of which have outlined the nature and direction of research geared towards developing the forest, wildlife and fisheries resources respectively.

Tanzania needs a national natural resources research policy. The main goal of that policy would be to undertake and intensify applied research in all branches of forestry, wildlife and fisheries, and disseminate the research findings (Chamshama, 1987; Monela, 1997). Its specific objectives would *inter alia* include: (a) to examine the problems which impede or hinder the progress of development of natural resources schemes; (b) to advise the public on the technical matter connected with development and exploitation of natural resources; and (c) to collect, record and disseminate information on all aspects of natural resources and related research in Tanzania.

The main role of the national natural resources research policy will be to serve as a broad framework for designing any natural resources research programme. However, such research policy needs to be reviewed as needs arise. Without the policy, planning of research programmes could lack coordination, direction and relevance. Identification of a country's needs and priorities for research is not an easy task. It requires marrying the priorities to available resources in terms of skilled manpower, facilities and funds. Priorities for research must be set according to the needs of the country. Criteria for the selection of programmes for research normally take into account the relative usefulness to socio-economic development, and availability of appropriate research resources for project implementation.

3.1 History of forestry research

In Tanzania, comprehensive reviews of the history of forestry and forestry-related research have been made by Klem (1980), DRT (1991), Mgeni (1992), Murira (1992), Abeli (1992) and Nshubemuki (1998). Generally, the history of forest research in Tanzania can be traced back to 1902, when research activities on exotic trees were started at Amani Biological and Agricultural Research Station. In 1948, the activities of this station were transferred to the then East African Agricultural and Forestry Research Organization (EAAFRO) under the then East African Community. Active research in wood utilization and silviculture started in the country around 1950. In 1949 and 1951 for example, Timber Utilization and Silviculture Research Stations were established in Moshi and Lushoto respectively.

In 1973, the Division of Forestry under University of Dar es Salaam was established to teach and conduct research in forestry and other related fields. By 1984 it was elevated to a Faculty of Forestry under the Sokoine University of Agriculture (SUA). In 1998 the Faculty changed name to Faculty of Forestry and Nature Conservation (FFNC) to give it a wider mandate.

After the collapse of the then East Africa Community, the government established the Tanzania Forestry Research Institute (TAFORI) in 1980. The mandate of TAFORI was, and still is, to carry out and coordinate forestry research activities throughout the country (TAFORI, 1992). Besides TAFORI and FFNC at Sokoine University of Agriculture (SUA), there are other institutions that are also engaged in forestry research. These include the Institute of Resource Assessment (IRA) and Department of Botany at the University of Dar-es-Salaam, Traditional Medicine Research Institute; Forestry Training Institute at Olmotonyi in Arusha, Forestry Industries Training Institute (FITI) at Moshi, and National Environmental Management Council (NEMC). For the last 95 years it has been evident that the government has, to some extent, encouraged and supported forestry research in the country.

3.2 History of wildlife research

Wildlife conservation in Tanzania dates back to 1891, when laws controlling hunting were first enacted by the German rulers. These laws regulated the off-take, the hunting methods and the trade in wildlife. It is worth stressing that these management interventions were strictly not fully-fledged research. However, a research input was essential to make them effective. Reservation was also characteristic of these formative years culminating in the establishment of the first reserve in 1905, which is now the Selous Game Reserve; whose gazettement took place in 1922. Further reservation involved Ngorongoro Crater (1928), and Serengeti (1929) Game Reserves.

Research activities became more apparent in the early 1930s. Game Controlled Areas were established in 1946, and were divided into hunting blocks. The present framework of wildlife Protected Areas (PAs) in Tanzania, comprising of National Parks, Game Reserves and Game Controlled Areas, is about 60 years old and has considerably influenced wildlife research in Tanzania.

A wildlife research section was an integral part of the Wildlife Division until 1980 when the Government established the Serengeti Wildlife Research Institute (SWRI) now known as Tanzania Wildlife Research Institute (TAWIRI). The mandate of TAWIRI is similar to that of TAFORI, i.e., to carry out and coordinate wildlife research activities in the country. The Institute is also responsible for disseminating information gathered through wildlife research, enhancing and providing opportunities for training and education of wildlife personnel in the country, and advising the government and wildlife authorities on wildlife conservation (Mlingwa & Sabuni, 2001). Other institutions involved in wildlife research include the College of African Wildlife Management at Mweka, Moshi, Department of Zoology and Marine Sciences of the University of Dar es Salaam, Department of Wildlife Management at SUA and, until March 2002, Tanzania Wildlife Conservation Monitoring (TWCM) – formerly run by Frankfurt Zoological Society (FZS) but now absorbed by TAWIRI. The Wildlife Division, which has a unit and an Assistant Director responsible for research, is also involved in wildlife research, but its activities are, in most cases, conducted through TAWIRI.

Most wildlife research has so far been basic, i.e., it has been focusing mostly on ecology and behaviour of single species (Tibanyenda, 2001). Worse still it has been and is, unfortunately, still dominated by foreign scientists (Mlingwa & Sabuni, 2001; Senzota, 2001), especially from affluent countries. Numbers of researchers given research permits by TAWIRI from 1996 to 2001 are shown in Table 4.

Table 4: Number of researchers given permits by TAWIRI during the period 1996-2001.

Year	Foreigners	TAWIRI Staff	Other Tanzanians
1996	23	3	5
1997	51	1	3
1998	50	2	2
1999	43	4	4
2000	35	4	3
2001	87	3	3
Total	**289**	**17**	**20**

Source: Mlingwa & Sabuni, (2001)

These scientists have almost always worked without research priorities predetermined by local institutions or authorities. Most of such studies have been conducted to suit academic interests of the individual researchers and/or their sponsors. Access to the generated information by wildlife managers has been and is still limited. As a result it has only minimally been used to improve management of the wildlife resource.

The Wildlife Policy of Tanzania is the mother policy for the wildlife sub-sector. As such all wildlife research in the county must abide by the vision of the Policy and wildlife sector in general (MNRT, 1998b).

3.3 History of fisheries research

Towards the end of the 19th Century, most major fisheries of the world had either collapsed or were at the blink of collapsing due to heavy fishing. This triggered the establishment of several research and management commissions to cater for some particular fisheries. The formation of the International Council for the exploration of the sea in 1902 is one of such efforts. Fisheries research was, therefore, recognized and initiated as an imperative tool for resource management notably after the United Nations Resolutions (December 1954), and the First Law of the Sea Conference held in 1958 (Royce, 1972; Cushing, 1975).

Tarbit (1984) outlines marine fisheries research in Tanzania. During the 1950–1977 period, the East African Marine Fisheries Research Organisation (EAMFRO) whose head office in Tanzania was in Zanzibar carried out all research in marine fisheries. This research in fisheries emphasized biology, taxonomy and production of different species, including assessment of potential for prawn and coastal reef fisheries (Bwathondi, 1984). The Department of Zoology and Marine Biology of the University of Dar es Salaam also participated in that research.

Fresh water fisheries research has a different background. Nyegezi in Mwanza was a station of the then East Africa Freshwater Fisheries Research Organization (EAFFRO). The Kigoma and Kyela stations were established in 1973 and 1978 respectively by MNRT. For the first five years (1973-1977) the Kigoma station was run in collaboration with experts from the Food and Agriculture Organization (FAO) of the United Nations. Thereafter all three stations were wholly run by MNRT under the Fisheries Division until 1980 when Act No. 6 established the Tanzania Fisheries Research Institute (TAFIRI). The institute became fully operational in 1983, taking over the former EAFFRO station in Mwanza, two MNRT research station at Kigoma and Kyela as well as the Dar es Salaam station as the institute headquarters. Respective stations are referred to as Centres of fisheries in Lake Victoria, Lake Tanganyika, Lake Nyasa, Indian ocean, and associated water bodies in pertinent locations (Bayona, 2001).

4. THE CONTRIBUTION OF NATURAL RESOURCES TOWARDS INCOME AND FOOD SECURITY

4.1 Forestry

It is estimated that the forestry sector's contribution to the GDP is between 2.3% and 10% of the country's registered exports (URT, 1998). The contribution of forestry sector is underestimated since there are other values that are not included. For example, forests provide over 92% of energy source, support development of other important sectors such as agriculture, tourism and alike mainly through support of water sources and catchments, hydrological balance and soil protection, recycling and fixation of carbon dioxide, provide construction materials, employment and others. The monetary value of all these is significantly higher but unrecorded (UNEP, 2001), leading to underestimation of the contribution of the forestry sector to the country's economy.

In Tanzania, the central government through Forest and Beekeeping Division (FBD) and the local governments through District Councils collect forestry revenues. Figure 1 shows the revenues collected by FBD between 1995 and 2000. As shown in this Figure, part of the revenues collected is retained by FBD for reinvestment into national and district forestry activities. The collection by FBD is much lower compared to that of District Councils. However, records of revenues collected by District Councils are not readily available.

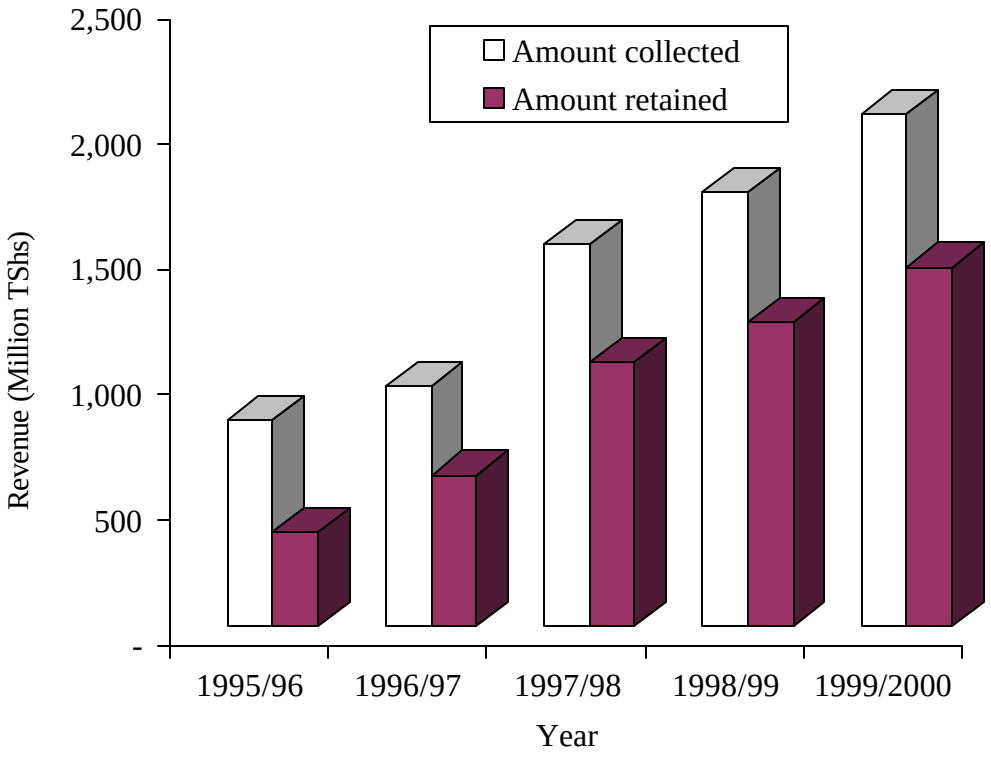

Figure 1: Revenues Collected and Partial Retention by FBD Between 1995 and 2000 (*Source*: data from FBD).

In addition to revenue collection through sales of traditional forest products, forests offer other products, which go unrecorded. These include indirect benefits, which were initially regarded as minor forest products but now are major products adding more value to forests. Non-traditional forest products include all the non-timber products, which add value to forests and help in income generation. The category includes building materials, round wood, poles for various local uses, wood fuel, and others. Moreover, forests also provide direct employment.

As opposed to traditional forest products, non-traditional forest products also provide other direct and indirect benefits, which also add value to forests such as animals browse from shrubs and trees. Other products of importance to rural communities include, but are not limited to, honey, fruits, fibres and medicines. Trees also provide shade and protection for rural people and their properties, including crops and animals.

Forestry has a big and indispensable role to play in household income generation and in improving food security. According to Hoskins (1990), trees and other forest resources contribute to food security by ensuring physical access to adequate food supplies since they: (a) provide direct sources of regularly utilized food, often in significantly greater quantities and variety than is generally recognized; (b) provide essential nutrients and medicines, increase the nutritional value of other foods, and help to maintain the health of rural people. Medicines from forests are especially important for populations with no access to other types of medication; (c) fill the gap by supplying food during seasonal shortages and act as emergency food items in times of drought or other crises; (d) yield fuel wood for cooking, preserving and processing foods; (e) support sustainable food and agricultural production by helping manage soil and water systems and by controlling winds; (d) support livestock systems by providing fodder, especially during seasonal shortages in arid and semi-arid zones; (e) provide a storehouse of genetic resources for improvement of domesticated food crops; and (f) increase soil fertility and thus crop yields through intercropping with nitrogen fixing trees. Moreover, shelterbelts reduce wind speed and consequently evapo-transpiration, thus also leading to increased crop yield.

Apart from the contribution of forests to food security, forest-based activities also provide substantial income to households in rural communities. In fact, some forests are located in remote areas. Such forests have greater potential to contribute to income and employment in the neighbouring communities where these are most needed. Poverty, which is the inability to attain a minimal standard of living (World Bank, 1990), is generally correlated with poor food security and income usually helps assure access to food (Hoskins, 1990).

Forestry alone cannot and should not be expected to resolve the totality of food security and income generation issues. When policies, customs and productive resources provide a suitable environment, trees and forests play an extremely important twofold role in food security. First, as stated above, the supporting role of forests and trees in sustainable agricultural systems is crucial to overall food production. This role will continue to be fundamental in guaranteeing physical access to food. Second, the income provided through small-scale enterprises involving the collection and processing of non-timber forest products, as well as poles, fuel wood and timber from managed forests or raised on farm or communal lands, is already essential to millions of people in rural areas. As economies become monetized and infrastructure supports facilitate transport and marketing, the incomes provided by forest products become even more important.

Much is still to be learned and researched about factors such as dependency and vulnerability, about organizational approaches and even about technology for

managing forests for multipurpose benefits, including the provision of food. As the situation is dynamic, people's different types of dependency on trees and forests are continually changing. Forest policies and planning need to become further tuned to these realities, if forestry is to play its potential role in improving rural household income and food security. However, enough is already known for foresters and researchers to take up the challenge, confident that they have relevant contributions to make.

4.2 Wildlife

As noted earlier, existing wildlife land uses cover several categories of Protected Areas (PAs), being reserved land, namely: (i) National Parks; (ii) Ngorogoro Conservation Area; (iii) Game Reserves; and (iv) Game Controlled Areas. However, wildlife occurs also on village lands as well as on general lands (lands that are neither reserved nor under village control).

The government and the public in general have benefited and continue to benefit from wildlife. The major revenue generating activities of the wildlife sector are both consumptive and non-consumptive. Tourism, almost all of which is wildlife-based, is now the largest single foreign exchange earner. The MNRT was quoted by the Daily News on 3 March 1999 as saying that the tourism sector contributed 16.5% of the country's GDP, earned the country 50% of its foreign income and employed about 35,000 people (Daily News, in Songorwa, 1999). Figure 2 shows international visitor arrivals and revenues collected from tourism from 1970 to 2000.

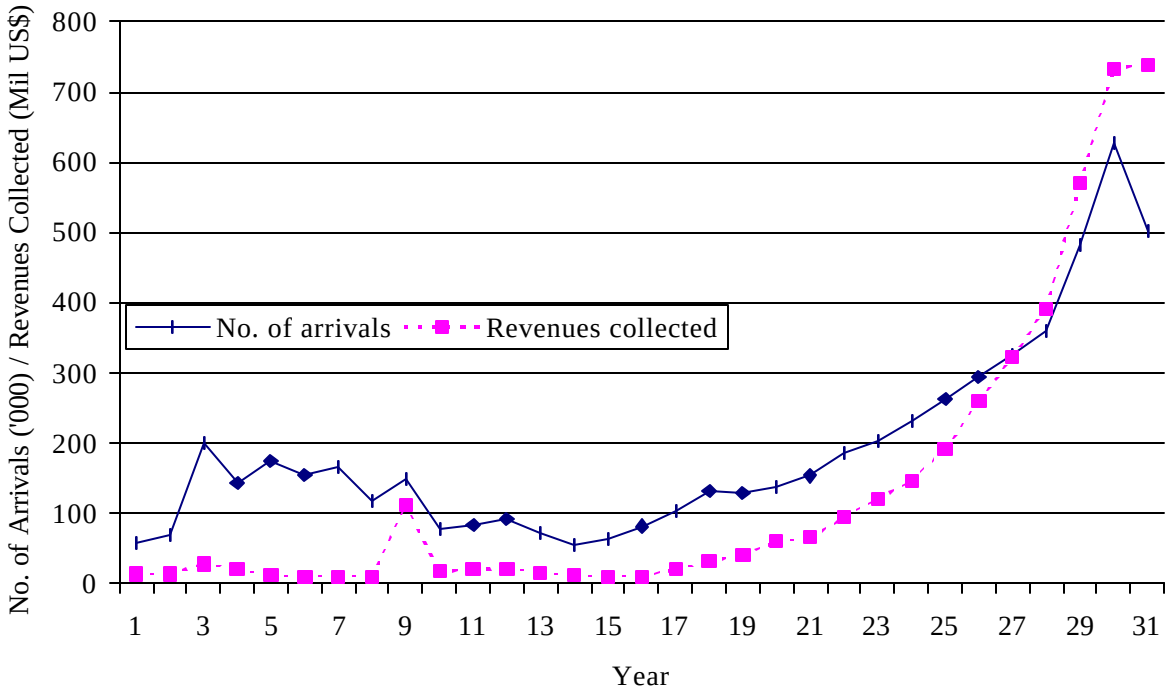

Figure 2: International Visitor Arrivals and Financial Receipts in Tanzania Between 1970 and 2000 (*Source*: data from MNRT).

In National Parks, no consumptive utilization of natural resources is allowed and legal financial benefits for local communities tend to be minimal. For instance, from 1994/95 to 2000/01 financial years TANAPA spent a total of 1.3 billion shillings on support of community-initiated projects (SCIP). This amount is very little compared to the revenues collected by the agency. Figure 3 shows the revenues collected from 1993/94 to 1998/99.

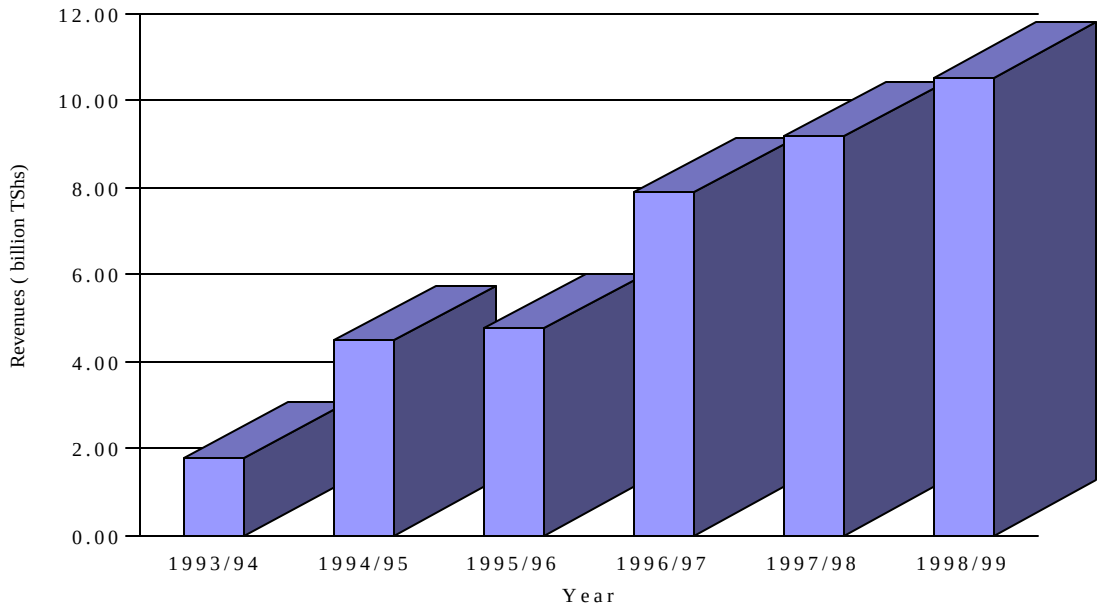

Figure 3: TANAPA's Revenue Collection Between 1993/94 and 1998/99 (*Source*: data from TANAPA)

In Game Reserves, some consumptive utilization of wildlife is allowed in the form of tourist hunting (in addition to game viewing), usually allocated to hunting concessionaires for a 5-year period, but also with very limited legal benefits for the local communities. Figure 4 shows government revenues collected by the Wildlife Division (WD) from tourist/safari hunting from 1988 to 2001 and the amounts sent to District Councils (DCs) from 1993 to 2000 (3.75%, 5.37%, 5.52%, 7.80%, 8.48%, 6.90%, 8.03% and 7.36% respectively).

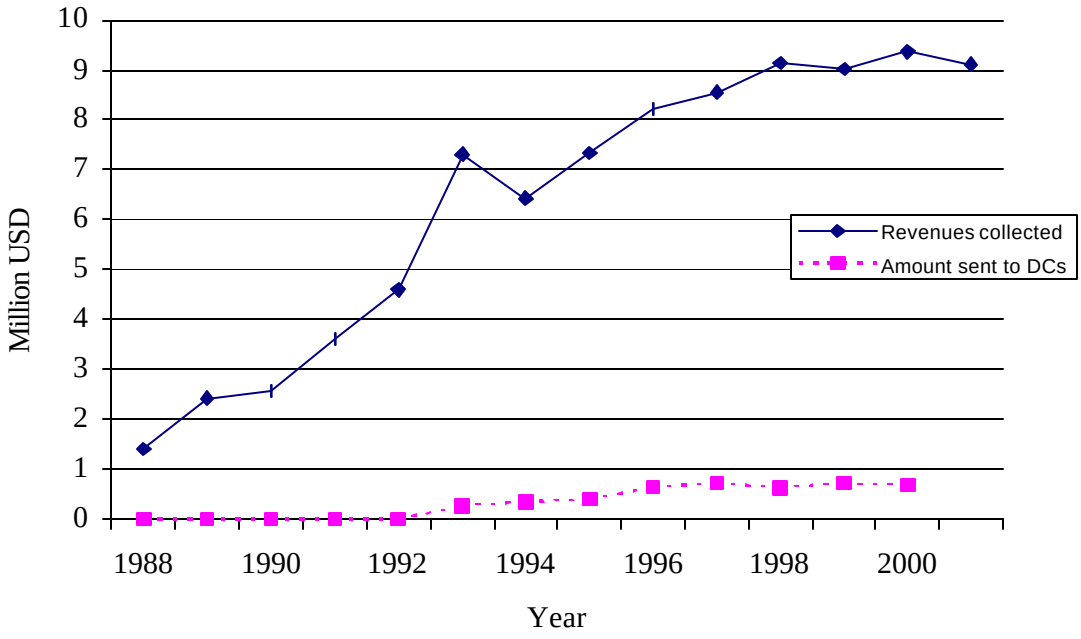

Figure 4: Revenues From Safari Hunting and Amounts Sent to District Councils (*Source*: data from WD)

Together with the facts and figures given above, one question remains unanswered. What role does the country's wildlife play in the economy and well being of rural communities? Although there are no figures to support the argument, at the community level wildlife is an important source of protein and part of the subsistence economy. Well over 20% of the total meat consumption in the countryside comes from wildlife (Songorwa, 1999). But at present, with the exception of a few communities participating in community-based wildlife management (CWM) and community conservation services (CCS) projects, most of the benefits are illegal or so indirect that they cannot clearly be linked to the wildlife resource. The wildlife revenues collected by the government (Figures 2, 3 and 4) are meaningless to rural communities as the latter receive very little, if any, of those revenues as direct benefits.

Non-traditional forms of wildlife utilization include game/wildlife farming and game/wildlife ranching. Game farming is the intensive husbandry (breeding/raising) of one or few wildlife species on relatively small surface areas wherever suitable infrastructures and services are available in urban or rural areas (usually less than 1 ha to about 25 ha), totally enclosed, and under more-or-less heavily managed conditions that tend to domesticate the animals, with live sales, meat and skins or other specific products being the main revenue -

with or without tourism (Lungren *et. al*., 2000). A game farm is of special interest to small investors or small landholders, and the farming of some species can start with very little investment.

Game ranching is the extensive management of several or many wildlife species on relatively large surface areas where a wide range of complementary production systems and uses are professionally managed so as to render them compatible and beneficial, including sport hunting, cropping, sale of live animals and game viewing (Lungren *et. al*., 2000). Due to economic factors, game ranches are usually on agriculturally marginal, arid or semi-arid lands. As a result of the past government policies and laws governing wildlife management, game farming and ranching are not well-developed forms of wildlife utilization in Tanzania (MNRT, 1998b). As such they contribute very little, if anything, to income and food security, especially at household level.

4.3 Fisheries

The contribution of the fisheries sector to the economy has been briefly touched vide section 2.3. A further look at the sector's contribution (Table 5) shows that currently most of the catches are from fresh water bodies. Furthermore, landings are well below the sustainable catch potential.

Table 5: Quantities and value of landed fish (1988–2001) in Tanzania

Year	Water body			
	Freshwater		Marine	
	Tonnage landed (x1000)	Value (million Tshs)	Tonnage landed (x1000)	Value (million Tshs)
1988	347.5	7.80	49.4	2.57
1989	327.5	11.50	50.2	3.92
1990	357.3	12.30	56.8	4.77
1991	272.4	12.58	54.3	6.29
1992	291.6	19.95	43.9	6.17
1993	294.8	32.24	36.7	10.21
1994	300.0	34.0	50.0	10.67
1995	310.0	34.50	50.0	14.99
1996	308.6	38.20	48.2	15.2
1997	306.8	42.27	50.2	25.35
1998	300.0	47.49	48.0	29.27
1999	260.0	44.09	50	33.50
2000	271.0	45.50	49.9	32.18
2001	283.4	47.11	52.9	34.11

Source: MNRT's 1988–2001 Budget Speeches. Discrepancies are due to rounding off.

It is worth stressing that the value of landed fish is likely to be improved when processing is undertaken. Nile perch (Table 6) and prawn (Table 7) exports provide a good example. Thus, apart from scaling up fishery landings, value added initiatives to the catch seems to be more important since it contributes to poverty alleviation more effectively.

Table 6: Quantity of and revenues accrued from export of Nile perch fillet from Tanzania (1996-2001).

	Quantity (mt. tons)	Value (million US$)
1996	20.3	52.28
1997	Year	54.82
1998	36.4	65.73
1999	23.8	52.00
2000	30.8	45.90
2001	31.4	77.21

Source: MNRT's 1996-2001 budget speeches.

Table 7: Quantity of and revenues accrued from sale of prawns in Tanzania (1987-1999).

Year	Quantity (mt. tons)	Value (x 1000 US$)
1987	117.6	931.84
1988	126.9	1097.94
1989	79.0	538.79
1990	96.2	931.92

Source: MNRT's 1987-1999 budget speeches.

There are also other revenue collections notably by fishing companies (Table 8), sale of other fish products, shells, and aquarium (ornamental) fish, all of which also contribute to poverty alleviation through employment.

5. SUSTAINABLE UTILIZATION OF NATURAL RESOURCES

The subject of sustainability in utilization of natural resources, i.e., forests, wildlife and fishery, is very important. Sustainable utilization of natural resources gives emphasis on adopting utilization strategies that ensure continuous production and environmental protection. Sustainable management of natural resources requires quantification of the amount and distribution in space and time of available resources, and the demand for these resources. The challenge of sustainable management of natural resources is not to prevent utilization but to manage it. The aim should be that the resources are utilized sustainably. It is widely believed that the concept is a desired ideal and natural resources managers need strive to reach it in successive management interventions.

Table 8: Revenues collected by fishing companies in Tanzania (1989-2000).

Year	No. of companies	Value (million Tshs.)
1989	21	318.87
1990	18	486.75
1991	20	475.01
1992	19	684.10
1993	n.a	123.98
1994	n.a.	n.a.
1995	19	2977.39
1996	n.a.	n.a.
1997	16	3232.44
1998	16	3734.60
1999	n.a.	n.a.
2000	20	3758.88

Source: MNRT's 1996-2001 budget speeches.

5.1 Sustainable utilization of forest resources

Forestry is the art and science of managing forest that aims at yielding, on a sustainable basis, maximum quality and quantity of forest products and services (Anderson and Smith, 1976). Thus sustainable utilization of forest resources needs to go hand in hand with sustainable forest management. As noted earlier, the demand for different forest products by different user groups and the current high population growth rate (standing at 3.36% per annum) (United Nations, 1993), puts natural forests under intense pressure for various purposes. This results in environmental degradation, including deforestation. Some of causes

and consequences of deforestation in Tanzania have been discussed elsewhere (Mugasha, 1996). Administrative structure of forest management in Tanzania is also a problem. The concept of sustainable utilization through proper management is not given enough emphasis by District Councils. This is because in most cases the Councils seem to be pre-occupied with revenue collection from forest products users.

The challenge of ensuring sustainable management for sustainable utilization of forests/woodlands is formidable. This is because the amounts of available forest resources and the demands for these resources have not been quantified, data on growth rates of different tree species is scanty, and annual allowable harvests of different products from different forest types have not been established. Ecological consequences of harvesting techniques of these products are yet to be quantified. Land-use plans are not adequate since decisions and actions by various authorities have sometimes resulted into jeopardizing the sustainability. For example, construction of the Lower Kihansi hydropower in 1990 on the Kihansi River is causing significant environmental damage, the drying out of the wetlands from reduced water flow is seriously threatening the Kihansi spray toad (*Nectophrynoides asperginis*) and two rare plant species, all of which are endemic to the Kihansi Gorge (The Natural History Museum, 2001).

Additional problems of sustainable management of the moist forests include: the large number of species, many of which are non-commercial; rapid and luxuriant growth of vines and clippers in the open space created by felling; fragility of the soils in the open space; and difficulties in inducing natural regeneration of commercially valuable species to ensure their continued availability. On the other hand, dry tropical forest (miombo) tree species exhibit slow growth rate and inadequate regeneration due to drought and fire. However, excluding an area from human activities and fire can remarkably induce regeneration from both coppice and seeds that have lain dormant in the soil in the miombo woodlands. The challenge is to exclude human activities in these areas that are mostly under common ownership and intense land use with people relying completely on what is left for browse and fuel (FAO, 1993).

Since the supply of wood from natural forests is inadequate, forest plantations are established in order to complement wood production from natural forests. These are not producing to their maximum potential due to the following factors: current tree initial spacing, pruning and thinning techniques borrowed from elsewhere are not ecologically adapted to specific site conditions in Tanzania, although some modifications are done based on field experience and some research results. In addition, there has been use of genetically inferior propagation materials.

The solutions to these problems need to have policy, fiscal and technical dimensions. Research has a room to fit in and contribute towards addressing the technical aspects. In order to ensure sustainable forest management for sustainable utilization of forest resources, research efforts should focus on the following: (a) detailed quantitative information on vegetation types in Tanzania; (b) the knowledge on the biodiversity in Tanzania forests; (c) thorough understanding of ecological functioning of catchment forests and their response to human intervention; (d) genetic improvement of indigenous tree species; (e) gathering ecological and silvicultural knowledge of lesser known and lesser utilized timber species; (f) documentation of distribution, status and use of plants producing non-wood forest products including collection of indigenous knowledge; (g) consequences of increased use of immature trees of commercially desirable timber species; (h) inadequate success in provision of alternative tree species for fuel-wood for various purposes; (i) further research on regeneration of miombo woodlands; (j) thorough understanding of the effect of fire on miombo woodlands and montane forests; (k) the restoration of degraded forest lands; and (l) in forest plantations, genetically improved propagation materials and appropriate establishment and tending techniques should be researched.

However, among the areas where research efforts need to be directed include: (a) botanical surveys in different forest ecosystems, including measures of biodiversity status and utilization potential of different plant species therein; (b) research on management of catchment forests and their response to human interventions; (c) collection of data on the rate of natural regeneration, growth and yield of indigenous tree species in selected forest ecosystems; (d) development of effective reforestation techniques for degraded lands; (d) quantification of seed banks and studies on natural plant succession following severe logging or fire; (e) effect of fire on biodiversity, soil biology, regeneration and tree growth in miombo woodlands and montane forests; (f) development of appropriate propagation techniques for indigenous species; (g) research and promotion of lesser known forest tree species and non wood forest products in different forest ecosystems; and (h) research on the different catchment forest management zones, focusing on environmental changes and species change. In addition, more emphasis should also be placed on socio-economic studies and indigenous knowledge of forest management.

5.2 Sustainable utilization of wildlife

Utilization of wildlife is a way of gaining benefits from the wildlife resource. Wise utilization of wildlife is a way of gaining benefits from the resource and protecting it at the same time - provided off-takes are sustainable. There are two main types of (economic) wildlife utilization namely consumptive and non-consumptive. Consumptive utilization involves killing or taking away the animal

and includes hunting (tourist and resident), cropping, culling, and sale of live animals. Both tourist and resident hunters receive quotas from the Wildlife Division. Game cropping is the organized shooting of wild animals for the production of game meat and other by-products on an extensive basis. It can also be defined as the commercial harvest of wildlife for meat (sold to individuals, butchers and restaurants), hides and other products. Culling is the most direct form of wildlife population control with an exact number of selected individuals being removed. It is ideally used as a mechanism to ensure that a certain species does not exceed the carrying capacity of its habitat.

Between 20 and 40 companies are currently involved in the capture and export of live animals in Tanzania. The companies receive quotas for live animal capture from the Wildlife Division. The quotas are, however, not backed by ecological/population studies. If it is easy to trap a species then it is assumed not to be rare. For the export of animals, the following administrational steps have to be taken: (a) Trappers need a capture permit (containing precise numbers and species which can be captured and also name(s) of the area(s) and the period in which trapping is permitted), which can be acquired by the exporter. It may only be issued, however, if an order for animals can be shown. An identity card with photo is required; (b) Trappers have to visit the Regional Game/Wildlife Officer of the region where trapping will take place, together with their capture permit, to talk about the intended activities. The captured animals have to be presented to the Regional Game/Wildlife Officer or District Game/Wildlife Officer to have the number confirmed officially; (c) Dealers who keep the captured animals until their export need a certificate of ownership. Members of the Anti-Poaching Units check the cages; (d) Birds have to be kept in the exporters' premises for at least 14 days, after which a veterinarian issues a health certificate; (e) For the exportation of even non-protected species, exporters need an export permit and, if necessary, a CITES permit – CITES is the Convention on International Trade in Endangered Species of Wild Fauna and Flora; and (f) At the airport, customs declaration of the documents and a personal inspection by the veterinary authorities take place. Also, members of the Anti-Poaching Units inspect shipments at the airports.

Non-consumptive utilization of wildlife includes game viewing or photo tourism (as a source of wonder and inspiration). Other uses of wildlife include contribution to the ecosystem, gene pool potentials and monitoring of environmental quality. Both consumptive and non-consumptive utilization of wildlife must be done within ecologically sustainable limits or quotas. To be sustainable, harvesting or consumptive use of wildlife must be based on good biology and ecology – on setting and respecting ecologically sustainable quotas for harvesting. A quota must be based on the biology and ecology of the respective species and population. Systems for monitoring the populations must be developed and implemented along with effective systems for enforcing the

quota. If these basic requirements are met and respected, and if the respective habitat is well maintained, consumptive uses become very viable economic enterprises. But Tanzania is only at the beginning of developing the economics of sustainable utilization of its wildlife resource – please, refer to the Wildlife Policy's five objectives and strategies regarding wildlife utilization (MNRT, 1998b).

Sustainable management of wildlife relies on a number of interventions, including sound cropping practices. The immediate question is: Are current utilization practices consistent with the concept of sustainable management and if not, on which areas should research be focused to convert this intervention into a realization? The answer to this question calls for periodic monitoring of wildlife populations and instituting requisite measures as dictated by the circumstances.

5.3 Sustainable utilization of fishery resources

The National Fisheries Sector Policy (MNRT, 1997) gives a long narrative of the problems militating against sustainable utilization of fishery resources in Tanzania. These may be viewed as: insufficient information on resource base, inadequate infrastructure and inefficient utilization, scanty information on traditional local knowledge of the resource, habitat degradation as evidenced by increased siltation and invasion of noxious weeds (e.g., water hyacinth in Lake Victoria), etc.

Solutions to the above-mentioned problems might be viewed at the policy and research levels. At the policy level there is a need to identify national priorities as well as strengthening national research institutions since these are there to serve as instruments to be used for realizing those priorities. Regional co-operation is also an important tool in securing cost effectiveness particularly on cross-boarder research and development issues.

At the research level, there is a need to develop prioritized short, medium and long-term national research plans, focusing on fish growth, multi-species harvesting, policy research, among others (Bayona, 20001). There is also a need for developing and maintaining a database on national/regional fishery resources. Noting that most fishing communities in Tanzania are artisanal, comprehensive artisanal focused studies are needed as one of the steps leading to the strength, which could be exploited for its further improvement.

5.4 Socio-economics and participatory management of natural resources

Approaches to natural resources management have, since the 1870s, slowly evolved from pure preservationist/protectionist models to the current integrated

management/conservation models. Together with other things the latter models acknowledge that conservation initiatives cannot, and will not, succeed, if local communities continue being locked outside the conservation equation. Therefore, the models emphasize *participation* of the communities in managing natural resources in their areas and a fare distribution of benefits accruing from the resources. In this context participation can be defined as "people's involvement in decision-making processes about what would be done and how; their involvement in implementing programs and decisions by contributing various resources or cooperating in specific organizations or activities; their sharing in the benefits of [conservation] programmes; and/or their involvement in efforts to evaluate such programs" (Cohen and Uphoff, 1977:6).

Community-Based Natural Resources Management (CBNRM) in Tanzania has a relatively recent history and much of it is based on poorly coordinated pilot projects and programmes. Examples of existing CBNRM projects/programmes include a number of wildlife management initiatives around national parks and game reserves, marine protected areas in Mafia and Zanzibar, and a number of community forest management initiatives. The numbers are growing and their sizes range from small ones consisting of just one village to extensive ones involving a big number of villages and several thousands of people.

There is a wide range of socio-economic issues affecting local communities and their individual members in natural resource-rich areas in Tanzania, including those where CBNRM initiatives have already been introduced. The presence or absence of such issues affects significantly the quality of lives of the people (Jambiya *et. al.,* 2000). For instance, most areas lack even the basic but important social services and infrastructure. On the other hand some CBNRM projects/programmes (e.g., Selous Conservation Project, Serengeti Regional Conservation Programme and Matumizi Bora ya Maliasili Idodi na Pawaga (MBOMIPA-Iringa)) have, mostly with donor funds, provided the required services and improved the existing infrastructure.

The communities that have CBNRM projects/programmes and those that are potential for such projects/programmes are rural and obtain their livelihoods from agriculture, livestock and from exploitation of natural resources (fish, forests and/or wildlife) present in their respective areas. But the annual rural population growth rate is estimated to be 2.7%. That means the resources are under immense and increasing pressure. As a result they are dwindling. This is unsustainable and undesirable from any point of view – conservation or economics. Some of the activities that cause this sad situation are legal and others are not.

There is a positive relationship between land ownership and willingness to make long-term investment. Unfortunately, in Tanzania, most of the rural populations

live on 'village lands' with unclear tenure. The creation of CBNRM initiatives also generates conflicts with existing economic activities in terms of 'loss' of land available for those activities and in terms of crop damage by wildlife. Research is expected to help the communities and all other stakeholders resolve these and other related issues.

6. SUSTAINABLE UTILIZATION OF NATURAL RESOURCES AS MEANS FOR POVERTY ERADICATION AND SUSTAINABLE DEVELOPMENT

Sustainable development has been defined as a process of change in which the exploitation of natural resources, the orientation of technological and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations (FAO, 1993). Thus natural resources play a significant role in development of the majority of Tanzanians through their exploitation. Ultimately, this contributes to poverty eradication.

Although forest sector's contribution to the national development is viewed to be marginal, this problem is primarily because of the problems faced in computation. Taken in totality, the sector's contribution, and its role in enhancing other sectors, is unparalleled. For example, the role of forests in supply of water and hydro-electricity generation is often not considered. As human population grows and land pressure rises, greater productivity per unit area of land and absorption of more labour into remunerative employment, are top priorities. Erosion and loss of soil fertility arising from the destruction of trees over large areas by man are among the most important problems of national development today.

As in many developing countries, in Tanzania attention has been, and is still being, drawn to the serious and mounting ecological problems caused by deforestation and loss of trees on farmlands and in watersheds. In view of the generally fragile ecological environment close attention must be given to ensure that new technologies emerging from research and development are sustainable.

Experience has shown that agricultural sustainability depends on a balanced ecosystem, of which forests and other vegetation cover form an important component. Forests influence agriculture through its influence on climate, soil fertility and water resources. Sustainable management and utilization of forests, therefore, play a very significant role in the country's economic development through the provision of intermediate inputs, intersectional linkages, income and employment generation, and environmental protection to mention just a few.

Natural resources have a diversity of contributions to national development. Forests, for example, play a significant role as a source of energy. Tanzania

relies heavily on fuel wood and other woodland-based products as a source of energy contributing to about 91% of the total energy used (Kakala, 1991). Unfortunately, with the recent hike in electricity tariffs, the dependency is going to increase. Likewise other industrial activities such as tobacco curing, brick burning, fish smoking, salt drying, lime burning and services sectors such as restaurants, schools, hospitals and prisons rely on wood fuel as the main source of energy. Shortage of fuel wood is undisputed energy crisis affecting most of the world's poorer countries. Nevertheless, with better forestry practices coupled with sustainable utilization, wood fuel is the most promising and probably cheapest energy source in developing countries, including Tanzania (Kakala, 1991).

The Wildlife Policy of Tanzania (MNRT, 1998b), which is operational since March 1998, is the lead policy as far as wildlife utilization in the country is concerned. The Policy admits that in the past the government made a mistake to alienate rural communities. Thus, it envisages to promote their involvement and to integrate wildlife conservation with community economic development. Local communities and the private sector are encouraged to invest in wildlife management and utilization. This is in line with the National Poverty Eradication Strategy's goal of reducing poverty in the society by 50% by the year 2010 and of eradicating it altogether by the year 2025 (VP's Office, 1998). The Strategy intends to use wildlife and other natural resources in the fight against poverty, although it has one shortfall: it only encourages local communities, households and individuals to utilize natural resources in their fight against poverty. It does not require them to do so in a sustainable way. In order to eradicate poverty, in addition to the national economy, significant wildlife benefits must reach all the communities in wildlife areas. Locally, three essential levels must realize the benefits: community, family or clan, and individual.

Furthermore, natural resources contribute to foreign exchange earnings, food and employment. Foreign exchange earning is through export of honey and beeswax, paper, logs and sawn wood. Others include wildlife activities and products such as game viewing, tourist/sport hunting, live animal sales and sale of trophies. In addition, Tanzanian forests provide a wide range of non-wood products such as wattle extract, tannin, gum arabic, medicinal plants, fruits, foodstuffs, etc. According to Kakala (1991), existing pine plantations could be a source of naval stores, gum resin and gum turpentine. These products have a wide application locally and can be exported. Little of economic potential value of medicinal and aromatic plants is known. This and many others discussed open room for more research to be carried out in this area.

6.1 Opportunities offered by exploitation of lesser known wildlife and tree species, and lesser known non-timber forest products in poverty eradication

6.1.1 Lesser known wildlife species

Lesser known wildlife species can successfully be 'produced' and utilized through wildlife farming. Two types of wildlife farming – subsistence farming and commercial farming – can be practiced to 'produce' wildlife populations for the purpose of poverty alleviation. The two differ in levels of investment and management complexity. The practice is appropriate for species that require little space, low investment, and those that make use of locally available and inexpensive foodstuffs. The farming can be for meat (for domestic consumption, supply to local restaurants or for export), skins, feathers, eggs, live sales (to stock other farms or game ranches, or exported to zoological gardens and animal fanciers world-wide), etc., either for domestic consumption, to supply to the local market or for export. The following is a list of some of the lesser known wildlife species that can be farmed at subsistence or commercial level: greater grass-cutter (*Thrynomys swinderianus*) also known as greater cane "rat" or "ndezi" in Kiswahili; lesser grass-cutter (*Thrynomys gregorianus*) also known as lesser cane "rat"; giant Gambian rat (*Cricetomys gambianus*) (known as "panya buku" in Kiswahili); giant forest rat (*Cricetomys emini*); crested porcupine (*Hystrix cristata*); brush-tailed porcupine (*Atherurus africanus*); sitatunga (*Tragelaphus spekei*); warthog (*Phacochoerus aethiopicus*); common duiker (*Sylvicapra grimmia*); striped ground squirrel (*Xerus erythropus*); giant African snails (*Echatina sp.* and *Archachatina sp.*); crocodiles (*Crocodilus niloticus*); civet species - for the perfume industry; tortoises; frog species; snakes; ostrich (*Struthio camelus*) also for oil for the cosmetic and health markets; African Button Quail (*Corturnix corturnix*); Helmeted Guinea Fowl (*Numida meleagris*); and other birds (Lungren *et. al.*, 2000).

The problem is, however, that many of the factors and issues relating to wildlife farming in Tanzania still need to be identified, satisfactorily addressed and publicised in order that all actors at community level and in the private sector and the public in general may increase their understanding. For instance, in order to diversify and enhance wildlife 'production', provision should be made to integrate the different forms/levels of wildlife farming (and game ranching) into the national legislation.

6.1.2 Subsistence wildlife farming

Once the public is informed as to the opportunity and benefits and that the activity has become legal, subsistence wildlife farming will probably become the

most numerous, and backyard farms will spring up everywhere where people have an interest in small animal husbandry. This level of farming can and should be promoted by keeping the rules as simple as possible. Registration with the relevant authorities should be required via the District Game/Wildlife Officer. A ceiling could be set for the number of animals that could be maintained before being obliged to upgrade the status of the farm to commercial category, according to the species involved (Lungren *et. al*., 2000).

6.1.3 Commercial wildlife farming

Commercial farming or farming for profit is based upon the commercial value of specific wildlife products. A little-developed but potentially large market exists in Tanzania for meat production from high performance species such as grass cutters, which reproduce and grow quickly, and/or fetch a good price. As well, meat export could be a major consideration in some cases. For some species, the sale of skins, hides or pelts (fur skins) will be the primary focus, but it can also form a secondary focus (ostrich farming), along with the sale of horns, hooves, claws or eggs (Lungren *et. al*., 2000).

6.1.4 Lesser known tree species

Although forests in Tanzania have a very rich species composition, only a few known tree species are utilized commercially and are often used for purposes which other, less known but equally suitable and cheaper, timber species could be used. If we could utilize commercially more of the less known species, then more volume of *Pterocarpus angolensis* (Muninga), *Milicia excelsa* (Mvule), etc. will be available for quality utilization or export. The few species that are utilized commercially are already scarce, and these owe their scarcity to heavy cutting (Ishengoma, 1990).

The management of natural forests in Tanzania was built on the basis of harvesting those species and qualities in demand. Since this removal of few species has occurred over years without much due provision being made for continuity of the forest in its original composition, it is inevitable that sooner or later supply problems will arise, either through depletion of commercially favored species and/or though cost pressure associated with the need to move logging operations to progressively less accessible areas.

Selective felling of better-known species for timber has raised a lot of concern among natural forest experts. This is because in some cases it could result in ecological drift (Alderman, 1982). It is imperative that a more rational system of utilizing natural forests should aim at, among other things, extending the range of species used and products produced.

There are a lot of timber species that are seldom used, in some cases for technical reasons. For example, they may be difficult to machine, or difficult to season properly but in other cases some species are less utilized because their properties are poorly known. There is a great possibility that the lesser-known and lesser-utilized species will become merchantable when more is known about them and this will reduce the present pressure on better known species.

With the rapid depletion of the few better-known species, it is essential to acquire more knowledge of properties of lesser-known and lesser-utilized species in order to technically and rationally assign them uses and to promote them to users. After studying properties of lesser-known and lesser-utilized species it is important to publicize the same, and their potential uses.

6.1.5 Lesser-known non-timber forest products

The term *non-timber forest products* (NTFPs) refers to those forest products other than timber, charcoal and fuel wood. FAO (1990) defines NTFPs as all goods of biological origin (both plants and animals) other than wood as well as services derived from forest and allied land uses. According to Van-Rijsoort (2000), NTFPs are also taken to mean all products removed from forests, except for industrial timber. They include foodstuffs, forage, medicines, roofing materials, aromatic substances, flavouring and colouring, and animals as trophies and for international trade, to mention just a few. Some NTFPs even play an important role in the national economy. Non-timber forest products have the potential of augmenting food production, including sustainability of food supplies and improving access to food for landless and poor people by proving substantial income and employment.

Non-timber forest products make a significant direct contribution to the household food and income security of rural population. According to Tewari (1994), NTFPs provide food security to large low-income populations, particularly during periods of drought, and work as an insurance against famine and crop failure. Plant food products from forests include shoots, tubers, roots, stems, flowers, fruits, oil seeds, spices, and mushrooms. On the other hand, animal food products from forests include honey, bush meat, insects, eggs, fish and snails.

For example, Makonda (1997) identified 156 useful plant species in Geita District, Mwanza, Tanzania. Out of these, 49 species were used as food, and out of the 49, 39 were fruits and 7 were vegetables, including mushrooms. Hine and Eckman (1993) generalized that Tanzanian people rely on surrounding forests for both meeting their subsistence needs and as a source of income. Kajembe (1994) and Kessy (1998) insist that in Tanzania wild foods are as important to diet today as ever before.

With few exceptions, NTFPs in Africa, and indeed Tanzania have not been studied in depth, neither in respect of quantities harvested nor of their socio-economic importance (Van Rijsoort, 2000). Furthermore, not all NTFPs are known or have been brought to attention of consumers. Thus research is needed to further exploitation of the lesser known NTFPs and to evaluate the benefits from known NTFPs and lesser known NTFPs and how they can contribute in improving conditions of rural communities in terms of food security and income generation. Chandasekharan (1994) has listed a number of factors constraining the sustainable development of NTFPs.

Research is also faced with a number of challenges, which need to be addressed for sustainable utilization of NTFPs. The challenges include: lack of ecological knowledge about individual species; lack of sustainable harvesting levels of NTFPs; need for certification of NTFPs; domestication of some NTFPs; identification of NTFPs with greater market potential; identify lesser known NTFPs; techniques of processing and marketing NTFPs; gender roles in utilization of NTFPs; setting up a comprehensive database and information system related to almost all aspects of NTFPs for rational utilization; transfer of technology and adaptive research also need to get adequate emphasis in the overall process of NTFPs development; ensuring of standards and stability of supply are vital conditions in International trade. Development of new products, improvement of old products, capturing of lost markets and promoting new markets have to be undertaken as part of strategy for NTFPs development; an assessment of NTFPs resources and future prospect; planning and implementing of integrated forest management for timber and NTFPs for sustainable production; and harvesting is a particularly weak link in the utilization of NWFPs due to the variety of tools, techniques and situations involved. Poor harvesting results in product wastage and resources damages. Special care is required to improve harvesting along with pre-harvesting preparations and post – harvest treatments.

6.2 Fisheries

Several communities around lakeshores or the maritime waters are in most cases poor and their livelihood is dependent on fishing. Economies of these communities are dictated by the quantity of fish available for food and sale or trading for other commodities. This has further attracted poor fishing practices, including illegal fishing, without regard to conservation measures.

All research geared towards protection of juveniles and promote sound recruitment has assumed recovery of the depleted stocks on account that all illegal fishing methods are grossly abandoned. This has not materialized in several fisheries despite the high quality of research being published because the poor fishing communities continue harvesting fish indiscriminately especially in

protected areas using illegal gears. They have to survive exclusively on fishing since no other alternatives are availed. The poor versus research and management expectations is yet a challenge to sustainable conservation, and implied poverty alleviation (Bayona, 2001).

One of the endemic weaknesses among fishing communities is little willingness to invest in improved fishing gear and other facilities, which lead to improvements in their earnings. This weakness coupled with the absence of co-ordination in activities say through co-operatives places these communities in an inescapable poverty trap. Even when catches are above normal levels, rudimentary processing facilities frequently reduce the value or even quantity.

Concerted efforts in terms of extension as well as provision of small loans seems to be a mandatory intervention needed to avert this problem. There is also need for having flexibility in attitude leading to participation in other income generating activities related with water bodies. One of such activities is seaweed farming notably marine waters, boat building, and wood-energy provision (through establishment of woodlots) for fish smoking notably fresh-water lakes. These activities and many others that are directly related to fishing industry might reduce the poverty faced by fishing communities if are carefully tailored.

6.3 Rehabilitation of degraded or denuded lands

In Tanzania, there are many economic practices, which have led to degradation of some lands. For example, topsoil is removed from sites to obtain access to material at depth. Excavation for gaining brick clay, land tripped for peat, sand, gravel, stones, etc. Also, topsoil may be removed in mining to obtain precious metals. These practices and many others generally leave big pits that are subject to flooding, more soil erosion and sometimes they become focal points for waste disposal. Occasionally wastes are often dumped in steep-sided spoil heaps. In addition, some sites may be of poor drainage or intrinsically dry. Such surface conditions lead to extremes of temperature, wind erosion and sand blasting effects. All of these provide an inhospitable physical environment for plant growth. Added to these effects will be various chemicals characteristic of the spoil material that inhibits plant growth. Fresh waste material usually lacks microorganisms. Furthermore, shifting cultivation, overgrazing and deforestation through fuel wood collection have turned larger area into degraded land. Natural ecological processes may be needed for producing soil of needed level for plant growth.

Rehabilitation or restoration of denuded or degraded areas is an attempt to rebuild denuded areas to their production potential through restoration of land. Its aim is to reclaim or to restore the original qualities of the environment (Bradshaw, 1980). This involves restoration of degraded or denuded ecosystem

in which normal biological systems are almost at stand still to the system in which normally functioning ecosystem is achieved, for example, in which the natural processes of nutrient release, plant growth and nutrient cycling go on at a normal rate.

The restoration of denuded or degraded land to optimum biological productivity or to a condition where it can once again be utilized might be valuable to surrounding communities. This is because restored areas contribute to upgrading of social and economic conditions. In Tanzania, rehabilitation is complicated by the lack of land ownership, especially on the denuded areas. The denuded areas owned by Local Authorities are usually not subjected to sound restoration management. However, the Central Government is in the process of preparing legislation on the mining and similar activities to rehabilitate spent sites.

Land may be considered up-graded from its denuded or degraded state to a previous state to support healthy plant and animal communities. In Tanzania, researchers need to venture into this area. One of the commonest methods of reclaiming or rehabilitating denuded areas is to use grass, notably vetiver (*Vetiveris zizanoides*). There are many other different types of grass species, but their adaptation to particular soil condition is important. Although they are important tools, matching grasses with site is a challenge to research. In Tanzania, different legumes have also been tried to rehabilitate denuded or degraded areas.

An alternative to sowing grass is to establish trees or shrubs. Trees or shrubs may be able to provide a commercial crop, if suitable species are chosen. They can be planted on steep slopes where normal cultivation is difficult. Trees and shrubs make attractive recreational areas even in the middle of industrial areas. The challenge to research is the choice of tree or shrub species. Researchers should come up with species known to be adapted to the local environment. Likewise they should develop effective reforestation techniques for degraded land to include both artificial and natural regeneration. For example, natural rehabilitation (regeneration) has been used effectively to reclaim degraded areas in HASHI (Shinyanga), DOVAP and HADO (Dodoma), SCAPA (Arusha) and HIMA (Iringa) projects. The remaining challenge for researchers is to evaluate the ecological processes of natural rehabilitation.

6.4 Improvement of soil fertility through agro-forestry and integrated bio-systems

Agroforestry is a land use system in which trees or shrubs are grown together with crops and/or livestock on the same piece of land either simultaneously or sequentially (Assmo, 1999). However, Leakey (1999) defines agroforestry as a collective name for land use systems and practices in which woody perennials

are deliberately integrated with crops and/or animals on the same land management unit/area. Proper management of trees and shrubs is essential if the interaction between the components is to be positive and thus beneficial to the farmer. This bio-system can improve the use of natural resources on a sustainable basis and can offer solutions for rural people to meet most of their daily needs in terms of fuel wood, poles, shade, fodder, food and timber to mention few. The system also contributes to soil conservation, reduces soil loss and improves soil fertility resulting in improved crop and fodder yields. Trees can also provide shade for homesteads and livestock and wood products that can be sold to generate income. In general, the products and services from agroforestry contribute significantly to poverty alleviation and food security.

Today there are agroforesters in almost every country doing research, publishing scientific papers in specialist journals, writing textbooks, lecturing to students, and helping farmers to implement numerous agroforestry systems. Agroforestry has become a multidisciplinary science. However there are limiting factors that need to be considered for sustainability and optimal implementation of agroforestry. The following factors are challenges, which researchers have to tackle in agroforestry: (a) selection and testing of tree species which can grow under certain conditions; (b) monitoring and control of pests or diseases which may hamper production; (c) since there are often some competition between trees and food crops especially in low potential areas, researchers need to suggest proper management regimes, which can reduce competition; (d) development of agroforestry technologies that can be adopted in high potential areas where shortage of land limits the number of trees that can be grown on each farm. In these areas farmers fear that trees would compete too much with crops; (e) there is generally a connection between land ownership and the willingness to make long-term investment, such as tree planting. Unclear laws that restrict harvesting/cutting of trees and taxation of tree harvesting are factors that restrict farmers' interest in tree planting.

7. CONTRIBUTION OF RESEARCH TOWARDS OPTIMIZING THE PERFORMANCE OF NATURAL RESOURCES

7.1 Past and on-going research activities

(a) It is through research that natural resources have been managed properly by providing the correct answers to some of the management questions. Through research it has been possible to:

(i) *Forestry*

- Establish about 19 industrial plantation forests in the country. Today these forests are the main sources of sawn timber, chipwood, pulp wood and poles;
- Change people's attitudes towards the use of softwood timber, instead of indigenous hardwoods, through proper seasoning and good workmanship. This has contributed positively to conserving and protecting the few remaining valuable indigenous hardwoods from indiscriminate harvesting;
- Restock denuded and dry areas with the suitable tree/shrub species, and encourage agroforestry practices to provide wood and fodder, improve soil fertility and serve as windbreaks;
- Collect, process and disseminate research results and information through research publications and research notes. Through these publications it has been possible, among other efforts, to efficiently contribute to sound natural resources management countrywide;
- Establish international contacts with other forestry and wildlife research institutions through exchange of staff, information, publications, research data, and other research material.

(ii) *Wildlife*

- Explain human-wildlife conflicts and understand land use conflicts;
- Determine distribution and abundance of wildlife;
- Understand behaviours of different populations;
- Outline relationships between herbivores and vegetation and between predator and prey species;
- Understand genetics of particular species;
- Understand and explain long-term effects of poaching to some animals (e.g. elephants).

(iii) *Fisheries*

- Identify species;
- Assess fish stocks;
- Establish harvesting levels for different water bodies;
- Find biological control of the water hyacinth;
- Understand and explain ecosystem dynamics in water bodies (e.g. the recovery of haplochromines and catadromons species following control of water hyacinths.

(b) Forestry, wildlife and fisheries research institutions employ and maintain a number of scientists and supporting staff that, in one way or another, contribute to the development of this country.

(c) Forestry, wildlife and fisheries research institutions have been providing contract research services and expert advice to private individuals, other institutions and non-governmental organizations.

7.2 Future outlook of research

In future, a lot need to be done to improve and enhance research in Tanzania in order to optimize the performance of natural resources. The following are strategies proposed to improve and enhance forestry, wildlife and fisheries research in Tanzania.

(a) There is a need to strengthen existing COSTECH Natural Resources Research Committees that oversee the formulation and implementation of national forestry; wildlife and fisheries research policies, national natural resources research priority areas and research programs. Formulation of research policies and priority areas is necessary in order to direct the efforts and the limited resources to tackling the most important forestry, wildlife and fisheries management problems. The same committees could also be charged with the responsibility of soliciting funds from various sources and coordinate research activities between various research institutions (Chamshama, 1992; Murira, 1992), including establishment of Research Fund (MNRT, 1998a – policy Statement No. 32), and the administration of that fund.

(b) Categorizing forestry, wildlife and fisheries ecology and management as rare professions and improving the motivation of researchers by giving them incentives such as research allowance, risk allowance, research awards to outstanding researchers and publication allowance. This will not only boost the working morale of researchers but will also minimize the rate of scientist turnover in research institutions.

(c) Provision of adequate scientific and administrative support facilities, including computing and communication facilities, publication and financial management.

(d) Facilitation of exchange of information and skill among scientists by connecting the institutions to the internet, proving opportunities for physical visits through meetings, conferences and workshops allowing scientists to take sabbatical leaves, and exchanging both staff and scientific publications.

(e) Developing and implementation of training programs aimed at increasing or improving human resources capacity. This could happen in the form of formal training, short courses, and staff attachments to other institutions, for both researchers and supporting staff (Mgeni, 1992)

(f) Improvement of research result dissemination by establishing Information Dissemination Units, which would serve as links between research institutions and end users. Such units should be able to translate scientific papers or technical reports into operational manuals, which would be simple, handy and practical-oriented (Mgeni *et. al*., 1992; Nshubemuki, 1992).

(g) Encouraging multidisciplinary and collaborative research within and between institutions in order to use the scarce resources efficiently.

Research institutions should strive to have as many as possible of memoranda of understanding with other institutions so as to facilitate sharing of experiences and resources, as well as the exchange of research information and scientific material. Standardization and sharing of equipment should be encouraged, as that would facilitate maintenance and procurement of spare parts (Chamshama, 1992; Kowero, 1992; TAFORI, 1992).

(h) Creation of competent and self-confident research leadership by assigning duties and responsibilities to researchers with minimum interference (Abeli, 1997).

(i) Establishment of research evaluation and monitoring teams at national, institutional and program levels. The duty of these teams would be to assess, before it is too late, whether the progress made is in line with the set objectives and the plan of action (Mgeni, 1992).

(j) Research institutions should concentrate on what has already been started or initiated before embarking on new programs. In this way they would avoid dispersing or over-stretching the few resources over too broad a spectrum (Moen, 1992).

(k) Involvement of end users of research outputs in planning, implementation and evaluation stages. This would promote understanding of traditional practices and propagation of viable endogenous technology (Mgeni, 1992; TAFORI, 1992).

(l) Research institutions should be aggressive in soliciting funds from both public and private institutions within and outside the country, international forestry- and wildlife management-affiliated institutions and other donor agencies. Other sources of funds could be the sale of research products, consultancy services, and undertaking 'contract' or demand-driven research tasks (Kowero, 1992).

(m) Involving or encouraging SUA and University of Dar-es-Salaam postgraduate students, especially the ones coming from research institutions, to undertake earmarked or ongoing Institutional research projects. With the current fees arrangement at SUA and University of Dar-es-Salaam, sponsors are supposed to pay the research fees directly to the students, and the amount will depend on the nature of the project. Research institutions would save significantly on their training budgets if their staff on training could participate in their research programs.

(n) So far the impact of human activities on natural forests, including that of timber harvesting, charcoal burning, animal grazing, cultivation, and collection of non-timber forest products has been unknown, although these activities have modified those forests quit considerably in terms of structure, composition and ecosystem (Chamshama *et. al.,* 1992). Considering the area of the nature forests, the role they play in ameliorating the environment, and their economic and ecological contribution, research emphasis should concentrate on these forest,

especially on Miombo woodlands, in order to get more information on the following (Chamshama *et. al.,* 1992; Refsdal, 1992):

- The impact of human activities (logging, grazing and cultivation), animals and fires on regeneration, nutrient cycling and soil degradation in these forests
- The optimal rotation age of most valuable species in these forests, in order to develop proper management plan
- The most appropriate methods of restocking the cleared forests, the majority of which lie in semiarid ecological zones

(o) Research on natural forests is also needed to ensure that solutions are found to the following problems (TAFORI, 1992)

- The drying-up of rivers in catchment forests as a result of inappropriate management practices
- Failure to meet the fuel wood, pole and construction timber demand in many rural and urban areas
- Progressive desertification of most of the dry areas in the country and deforestation in most heavily populated areas
- Deterioration of food production as a result of abuse and mismanagement of soil and water resources
- Increased involvement of stakeholders in forestry, wildlife and fisheries research

Involvement of stakeholders in wildlife, fisheries and forestry, and natural resources management (including research) has until quite recently, been almost non-existent. This is mainly due to the fact that management models pursued in the past advocated exclusivity leading in some instances, bitter rivalry. Recent developments that have culminated into the Forest, fisheries and Wildlife Policies (MNRT, 1998) and the recently promulgated Forest Act, have marked a westernised approach towards the management of these resources and by implication call for an increased involvement of research.

The establishment of Wildlife Management Areas (WMAs) and Village Forest Reserves, or even Joint Forest Management (JFM) initiatives provide good examples. These developments call for research inputs for better management. Conversely, there is a prospect that there are management problems that will arise in the process of putting these plans into actions, and they will need a research input for their solution. Thus apart from frequently mentioned problem of benefit sharing, there are issues pertaining to the economics of resource use, human resource interactions, sociology of participating communities, ecosystem processes, biology of threatened species and so on. Furthermore, some of these issues are likely to be time and place related and are therefore not subjects of generalization.

8. CHALLENGES TO RESEARCH IN NATURAL RESOURCES: A SYNTHESIS

8.1 Overview of the nature and diversity of the challenges

Before venturing into synthesis of challenges of research into natural resources in Tanzania, one must first appreciate the many problems faced by the country. Shortage of developed physical resources and expertise, lack of or limited infra-structural support, and a variety of interrelated problems jointly make natural resources research what it is today. Tanzania, like most other developing countries, is located in the tropical zone, where the rich flora and fauna present complex ecosystems, which are inherently fragile. This is a formidable challenge in the development of sustainable land management systems. Foresters, agriculturists, wildlife managers and other land users are therefore working in a situation where a large variety of vegetation resources is interacting with a large variety of wild and domestic animals in different combinations and often in a complex manner. The currently available expertise on such interactions and their consequences is at best, rudimentary (Temu, 1987).

For example, forestry research problems and strategies for a developing country such as Tanzania must be different from those of a developed country. This is made explicit by a close inspection of the differences in the types of forest resources and the patterns of exploitation. In a developing country, the most important direct products are fuel wood, building poles and fodder for domestic animals. Developed countries have industrial wood as the primary direct product from their forests. The indirect products for a developing country include, but are not limited to, medicine, fruits and vegetables, honey and beeswax, hunting, water catchment, conservation of wild animals and environmental protection. These do not differ very much from those of developed countries, but there are significant differences in their ranking. Further, for the developed countries, the function of each forest area is clearly stipulated, while in developing counties this is not usually the case. Here most forests are exploited liberally for various direct and indirect products. To a certain degree, this is a result of the agrarian-based economies. It is both difficult and expensive to predict with any degree of certainty the total effect of the rural populations on the forest, wildlife and fisheries resources in their vicinity.

In order to develop viable strategies for establishing and managing forest, wildlife and fisheries resources, intensive research into integrated land management is needed, and in order to do research, training, research facilities/equipment, good research programs and reasonable funding are needed. For effective research we need regional co-operation, researcher

evaluation and motivation, and an effective system for disseminating research results.

8.2 Constraints that research has to tackle in order to manage forest, wildlife and fisheries resources in a sustainable manner

Despite the fact that wildlife, forestry and fishery research has been undertaken in the country for almost a century now, research has encountered and continues facing a number of problems. These problems need to be addressed for managing natural resources in a sustainable manner. Among the problems include:

(i) Lack of comprehensive national natural resources research policy/policies on which to formulate long-term research priorities and programmes. This has led to a situation in which research institutions and individual researchers formulate their own research priorities and undertake research programmes in uncontrolled *ad hoc* manner, concentrating on just a few components of the entire biodiversity (Mlingwa and Sabuni, 2001; Murira, 1992; Senzota, 2001

(ii) Lack of adequate and sustainable research funding from the government and donor agencies (Iddi and Monela, 1992; Mgeni, 1992). This had led to:
- limitation on the types of research which can be carried out, i.e., short-term research projects have been preferred to long-term projects;
- poorly motivated and frustrated local researchers;
- deterioration of scientific infrastructure and facilities because of lack of service and maintenance plus a long idle time;
- lack of essential working facilities, vehicles and chemicals;
- irregular and inadequate supply of scientific publications, literature and other research material;
- brain drain of senior and experienced researchers to greener pastures;
- Project- as opposed to program-oriented research;

(iii) In case of forestry, there has been concentration of research in few regions and paying little attention to regions that have huge forest resource base e.g. Rukwa, Tabora and Ruvuma. In addition, there has been over-emphasis on plantation forests, in the case of forestry research. This means that very little research has been done on natural forests despite the fact that the latter covers about 99.6% of the total area covered by woody vegetation (Refsdal, 1992). This lack of research on natural forests has led to the use of expensive and sometimes ineffective reforestation techniques, usually used for exotics in climatically favourable areas.

(iv) Donor-driven research

(v) Almost non-existent collaboration and cooperation among research institutions. This state of affairs has led to duplication of efforts and under-utilization of both human and physical resources (Kowero, 1992).

(vi) Poor communication between researchers and users (including natural resources managers) because of inappropriate dissemination methods. Most of the research results are published in English and are too technical for extension workers and end users (Nshubemuki, 1992). Also, most of the journals where research results are published are out of reach of end users and even of fellow researchers. Research output that does not reach the intended audience has little influence on natural resources development (Mgeni *et al*., 1992).

(vii) Poor management in some of the research institutions because of inadequate funding, poor and inadequate working facilities, and lack of training and travelling opportunities within and outside the country.

(viii) Inadequate number of trained human resources to conduct effective research (Kowero, 1992; Mlingwa and Sabuni, 2001). Although there is high concentration of highly trained forestry and wildlife professionals at SUA, most of them are engaged in teaching, administration and consultancy. Consequently, they have very little time to do effective research. In TAFORI also, all senior researchers are busy engaged in administration and consultancy work and find little time for research. Though the number of technical staff appears to be high, only few are trained properly to collect and process field data without close supervision. The few trained ones usually strive to upgrade themselves to professionals.

(ix) Professions in the natural resources sector are not categorized as rare professions, despite the contribution of natural resources to the national economy and to the environment. This has led to low salaries and remuneration of research staff and discouragement of good scientists from joining research institutions.

9. CONCLUDING REMARKS

In the context of this paper, it is apparent that Tanzania is endowed with a variety of natural resources ranging from forests, wildlife and fisheries. People notably in rural areas depend on these resources for their livelihood through various economic production systems. An increase in human population is exerting pressure on these resources, resulting in reduced availability and environmental degradation.

Sustainable management and utilization of these resources does not deprive them from the users but it ensures availability for today's and future generations. Since the rural poor depend on the natural resources for their economic

production, sustainable management of these natural resources is likely to have considerable impact on food security and poverty alleviation. The Government of Tanzania through the NPES underscores the need for the sustainable management of natural resources. This requires knowledge on how the resources respond to various levels of exploitation and how they can be replenished. From the foregoing, this knowledge is of particular importance to the rural communities who are the principal users. In general, much more needs to be researched on the responses of natural resources to various management interventions. This requires multi-interdisciplinary research approach. These also need involvement of key stakeholders notably communities in the proximity of the resources, policy and decision-makers. However, researches into sustainable natural resources management faces formidable challenges such as shortage of financial and capital resources, trained and experienced human resources, lack of or limited infra-structural support, complex ecosystems which are inherently fragile, and, not forgetting; complex inter-relationships which render abstraction difficult. Nevertheless, if researchers ask themselves relevant questions, a stepwise approach towards the ideal will have been initiated.

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