THE STATE OF THE WORLD's FOREST GENETIC RESOURCES

COUNTRY REPORT

ZIMBABWE

This country report is prepared as a contribution to the FAO publication, The Report on the State of the World's Forest Genetic Resources. The content and the structure are in accordance with the recommendations and guidelines given by FAO in the document Guidelines for Preparation of Country Reports for the State of the World's Forest Genetic Resources (2010). These guidelines set out recommendations for the objective, scope and structure of the country reports. Countries were requested to consider the current state of knowledge of forest genetic diversity, including:

- Between and within species diversity
- List of priority species; their roles and values and importance
- List of threatened/endangered species
- Threats, opportunities and challenges for the conservation, use and development of forest genetic resources

These reports were submitted to FAO as official government documents. The report is presented on www. fao.org/documents as supportive and contextual information to be used in conjunction with other documentation on world forest genetic resources.

STATE OF FOREST GENETIC RESOURCES

IN

ZIMBABWE

2002–2011

A Country Report

Republic of Zimbabwe

Ministry of Environment and
Natural Resources Management

11th Floor, Kaguvi Building, cnr. 4th Street/Central Avenue, Harare.

State of Zimbabwe's Forest Genetic Resources

Compiled by:

Dr B.I. Nyoka: Forest Genetic Resources Expert for the Country Report and consultant for ICRAF-Southern Africa Regional Programme (Malawi).

Mr M. C. Tembani: Forest Research Centre, Forestry Commission

Miss T. P. Madhibha: Forest Research Centre, Forestry Commission

Mr M. Mushongahande: Biodiversity office Ministry of Environment and Natural Resources Management

Mr P. Gondo: SAFIRE, 10 Lawson Avenue, Milton Park, Harare, P.O. Box BE 398, Belvedere, Harare.

Dr. C. Machena: CAMPFIRE Association, Mukuvisi Woodlands, Corner Glenara South/Hillside

Miss Y. T. Chingarande: Ministry of Environment and Natural Resources Management,

Mr K. Kusena: Gene Bank, DR & SS, P O Box CY550, Causeway, Harare

Dr. S. Kativu: Tropical Resources Ecology Programme, Department of Biological Sciences, University of Zimbabwe

Mrs L. Mujuru: Bindura University of Science Education, Department of Environmental Sciences

Mr R. Mafuratidze: Community Technology Development Trust (CTDT)

Mr A. Mudhefi: Department of Agriculture, Technical services and Extension (AGRITEX)

Edited by:

Mr C. M. Gumbie: Forest Research Centre, Forestry Commission

Mr I. D. Kunene: Ministry of Environment and Natural Resources Management

Mr E. Samuriwo: Ministry of Environment and Natural Resources Management

ISBN 0-7974-5000-4

CONTENTS

EXECUTIVE SUMMARY

The Ecosystem Land Classification Approach adopted by the Convention on Biological Diversity (CBD) divides Zimbabwe into five eco-regions: the Kalahari, 46,891km^2 (12%); Central, 195,379 km^2 (50%); Zambezi, 62,521km^2 (16%); Save-Limpopo, 78,151km^2 (20 %) and the eastern highlands covering 7,815km^2 (2%) of the total land area.

Indigenous forests

The natural forest ecosystem is classified into Flora Zambesiaca and Afromontane phyto region. The Flora Zambesiaca comprises five woodlands types: dry Miombo (17,690,074ha), Mopane (12,277,515ha), *Combretum-Terminalia* (2,374,729ha), Acacia (1,581,070ha) and Zambezi teak (1,404,544ha). The main commercial timber species are *Baikiaea plurijuga* and *Pterocarpus angolensis* found in the Zambezi teak woodlands. The Afromontane phyto region covers 781,500ha.

Exotic Forest Plantations

The forest plantations are found in the eastern part of the country where rainfall is high enough to sustain tree growth and productivity. There are also smaller plantations of eucalypts in the central part of the country (Mvuma, Norton and Marondera, Eagle's nest). The plantation forests (155,000ha) account for 0.4% of the land area. The plantations are all of exotic species of pines, eucalypts and the black wattle *(Acacia mearnsii)*. The exotic plantations provide timber, poles, pulp and paper, tannin and furniture. The success of the plantation industry is largely linked to the genetic improvement programme of exotic timber species that began in 1958. Dozens of exotic tropical and sub-tropical Pinus spp. were introduced and tested for adaptation, growth and timber qualities. Zimbabwe has a very simple but effective advanced generation breeding programme of *Pinus patula*, *P. taeda*, *P. elliottii* and *P. kesiya*, *Eucalyptus grandis*, *Eucalyptus tererticornis* and *E. camaldulensis* that produce and markets high quality tree seed locally, regionally and internationally. There are over 3,100 Plus trees that were selected in all the exotic species.

Contribution of the forestry sector

The commercial forestry industry based on exotic trees contributes about 4% to the Gross Dometic Product. The commercial plantation based industry employed an average of 14,600 people between the period 2005 and 2010. However there was a general decline in the industry as shown by a significant decline of 29% between 2009 and 2010. The production of paper and paper products declined between 2005 and 2009. In 2002, exports of forestry products were US$20 million and increased to over US$30 million in 2010.

The indigenous hardwood industry based on *B. plurijuga* and *P. angolensis* employs an additional 2,000 people and a significant number in the downstream furniture industry. Commercial harvesting of hardwoods has declined over the years from 44,000m^3 in 1990, to 22,000 in 1996 and 20,000m^3 in 2002 mainly due to raw material shortages as a result of over-harvesting in the past decades. Other than the commercial timber industry, the contribution of the forests to the national economy is grossly under-estimated as reliable statistics are not available for both the environmental services and the informal sector. It is estimated that firewood provides over 80% of the energy used by rural households and 40% of the urban population. Other than fuelwood, forests provide fruits, mushrooms, honey, bush meat, edible caterpillars and insects, vegetables, medicines, poles, bark string and browse for livestock and wildlife. Over 78% of the rural households in Zimbabwe use herbal medicines at least once in a year for both humans and livestock.

Forests protect important watersheds which support large irrigation dams in the country as well as many water courses. Forests also provide habitats for wildlife which is the major basis for the country's tourism industry, the third highest foreign currency earner after agriculture and mining. There is a need for the country to develop reliable methods to capture all these contributions to better understand the role.

Protection of forests

Cumulatively, over 867,000ha of forest land were burnt by fire in the protected forests between 2004 and 2010. In 2010 alone, over 79,000ha of protected indigenous forests were burnt by fire. In the forest plantations, a cumulative 32,000ha of plantation area was burnt between 2005 and 2010. In one single year (2009), almost 20% of the exotic plantation area was burnt by fires. There is a need for the country to urgently strengthen the capacity of the forest authorities to enable them to control wild fires that evidently, have had a huge impact on both the economy and forest resources.

Changes in forest cover

The latest statistics available (2008) indicate that woodlands have declined from 53.2% to 42.3%; bushland from 12.7% to 10.8%; wooded grasslands from 3.1% to 2.3% and grasslands from 1.8% to 1.2%. The natural moist forest has not changed and remains at 0.03% while the exotic plantations marginally increased from 0.40% to 0.43%. The area under cultivation increased from 27.5% to 41.2%. More than 330,000ha of land are now being lost to agriculture (crops) annually compared to 70,000ha per year prior to this upsurge. Unless this is translated into increased agricultural output from the converted land, it will represent a huge loss nationally.

Invasive woody species

The new environmental law (Environmental Management Act) recognises the threat posed by invasive trees and other woody species. The major invasive species include Lantana camara, Pinus patula, Populus canescens, Acacia mearnsii, Jacaranda mimosifolia and Psidium spp. The priority must now be to quantify the extent of the invasion in all areas by species, develop control strategies, estimate the cost of controlling the invasions, determine the environmental costs, to ensure that progress on control is quantified and monitored.

In situ and Ex situ Conservation of forest genetic resources

Zimbabwe uses multiple strategies to conserve forest genetic resources. In situ conservation in the country's formally protected areas (protected forests and parks wildlife areas) add up to 49,700km^2 while a further 56,135km^2 is protected under the CAMPFIRE. There are also sacred trees, forests and landscapes whose protection is mostly cultural. The exact number of sacred forests and woodlands and their extent in Zimbabwe is however not known. The National Herbarium and Botanic Garden in Harare and its outstation in Mazowe (Mazowe Botanical Reserve) have built a comprehensive collection of plants found in Zimbabwe and the southern African region totalling 1,060 plant species, representing 82% of the 1,230 woody species found in Zimbabwe.

The Nationals Parks and Wildlife Management Authority manages ex situ forest genetic resources through two botanic gardens, Ewanrigg near Shamva (area of 286-ha) and Vumba, near Mutare, (area of 242ha). Exotic industrial tree species are mostly conserved as seed (23,000 accessions) and in arboreta and clone banks. There are more than 3,100 Plus trees being conserved.

Legislation and Policies on Forest Genetic Resources

The management of forest resources in Zimbabwe is still dualised; the Forest Act regulates the use of forest resources on state and private land, and the Communal Lands Forest Produce Act (CLFPA) governs the use of forestry resources in communal areas. The Forest Act mandates the Forestry Commission to manage forest genetic resources in the country and regulate its activities specifically on protected forests (state forests) and forests on private land while the CLFPA gives local communities limited rights to exploit the forest resources in their area for subsistence use only. The Parks and Wildlife Act provides for the protection of six types of areas: national parks, safari areas, sanctuaries, botanical gardens, botanical reserves and ecreational parks, each with a specific objective. The Environmental Management Act provides for the conservation of and access to biological diversity and the regulation of biological and genetic resources. The other pieces of legislation with relevance to the management of forest genetic resources in Zimbabwe include: Traditional Leaders Act, Seeds Act and Plant Pests and Diseases Act. National policies and action plans that relate to the management, conservation and utilisation forest genetic resources in Zimbabwe are the National Environment Policy (NEP), Forest Based Land Reform Policy (FBLRP) and Zimbabwe National Biodiversity Strategy and Action Plan (NBSAP).

Threatened Trees and shrubs

A number of trees and shrubs are listed as endangered or threatened. Most of the endangered or threatened woody species are either endemic or have a very restricted distribution in Zimbabwe. The species include *Warbugia salutaris*, *Swynnertonia cardinea*, *Combretum umbricola, Combretum coriifolium, Juniperus procera, Bivinia jalbertii, Homalium abdessammadii, Scolopia mundii, Cassia afrofistula, Ficus bubu, Ficus fischeri, Ficus ottoniifolia subsp. ulugurensis, Milicia excelsa, Morus mesozygia, Streblus usambarensis* and *Turraea eylesii.* The challenge now is to reverse the decline in the populations and number of the trees of these species.

Important tree species

There are both indigenous and exotic tree species that are important in Zimbabwe for timber, poles, fodder, gum Arabic, fruit and medicinal. They include exotic timber species (Pinus patula, P. taeda, P. elliottii and P. tecunumanii), exotic species for poles *(Eucalyptus grandis, E. tereticornis* and *E. camaldulensis)*, furniture *(Baikia plurijuga, Pterocarpus angolensis* and *Afzelia quanzensis)*, indigenous fodder tree species *(Faidherbia albida* and *Acacia erioloba)*, medicinal (*Warbugia salutaris*), gum Arabic (*Acacia karroo*) and indigenous fruit tree species (*Uapaca kirkina, Strychnos cocculoides, Adansonia digitata, Sclerocarya birrea* and *Vangueria infausta*). Some of these important species have active breeding programmes while others are in conservation programmes.

Education and Training

There are now several state and quasi-state colleges and universities in Zimbabwe that offer training from Diploma to MSc level in general forestry, forestry and wildlife management, wildlife and rangeland management, natural resource management, agroforestry and tropical resources ecology. Two colleges: Zimbabwe College of Forestry and Mushandike Natural Resources College offer training at Diploma level in forestry and natural resources management respectively; Bindura University offers training up to MSc in forestry; the National University of Science and Technology, Midlands State University, Chinhoyi University of Technology and Africa University offer training at BSc level in natural resources. The Institute for Environmental Studies of the University of Zimbabwe offers an MSc programme on tropical ecology and resources. No university however offers training in specialist areas such as forest genetics and conservation.

Research

The main forestry research projects are on breeding of industrial exotic tree species. There is also limited research on breeding of non-industrial exotic and indigenous tree species. Besides their usual teaching activities, some universities have also complemented the Forestry Commission in conducting research particularly on the management of indigenous forests. There have been collaborative projects involving international research organisations (ICRAF, CIFOR and IPGRI) but these were mostly scaled down during the hyperinflationary period. A number of NGOs (SAFIRE and CTDT) have been carrying out research on value addition (processing of wild fruits) and other non-wood forest products.

Future Needs and Priorities

Due to economic challenges in the past decade, some of the planned activities on conservation of forest genetic resources were scaled down. The stabilisation of the economy presents opportunities to revisit some of the planned activities. In future therefore:

- There will be a need to conduct expeditions to verify the existence or disappearance of some of the tree species that have been reported as extinct or critically endangered.
- There will be a need to map the important sacred forests and determine their number, location and size as well as their floristic composition.
- There is a need to conduct comprehensive genetic studies (molecular and quantitative) on the endangered tree species and develop optimum conservation strategies for them.
- The research and development in forest trees in Zimbabwe has remained basic, relying on what may now be inefficient approaches. There is a need to use modern methods that are fast, efficient and more reliable and perhaps cost effective in the long run.
- On invasive woody species, the priority must be to quantify the extent of the invasion in all areas; the cost in terms of control and lost environmental services to ensure that progress on control is quantified and monitored.
- In the short term there will be a need to prioritise ex situ conservation of the trees species listed on the National Red Data List. Efforts must be placed on both the protection of the remaining trees and stands as well as artificially aiding their reproduction.
- There will be an urgent need for the relevant institutions to initiate the re-introduction into natural habitats of species that now only exist in the home gardens.
- There is a need to review forest policies and laws to align them with current land ownership as well as global trends on ABS. In view of the concluded land reform, there is a need to review the applicability of the present laws to the new land ownership system.
- Zimbabwe does not as yet have any programmes and projects exploring Carbon trade. This is an area that can potentially strengthen the conservation of forest genetic resources.
- Restoration of the membership of the Forestry Commission to major cooperatives and networks (CAMCORE, SAFORGEN, IUFRO, etc) should be a major priority. This is expected to enable Zimbabwe to not only access germplasm but also allow local scientists to engage with their peers in international fora.

ACRONYMS

AA	Appropriate Authority
ABS	Access and Benefit Sharing
AGRITEX	Agricultural Technical and Extension Services (department of)
CAMCORE	Central America and Mexico Coniferous Resources cooperative
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CBD	Convention on Biological Diversity
CBDC	Community Biodiversity Development and Conservation
CBO	Community Based Organization
CBNRM	Community Based Natural Resource Management
CIFOR	International Centre for Forestry Research
CITES	Convention on International Trade on Endangered Species
CLFPA	Communal Lands Forest Produce Act
DR&SS	Department of Research & Specialist Services
EMA	Environmental Management Agency
FAO	Food and Agricultural Organization
FA	Forest Act
GDP	Gross Domestic Product
GLTP	Greater Limpopo Transfrontier Park
KAZA	Kavango-Zambezi
IAS	Invasive Alien Species
ICRAF	International Centre for Research in Agroforestry (World Agroforestry Centre)
IES	Institute of Environmental Studies
IPGRI	International Plant Genetics Resources Institute
IUCN	International Union for the Conservation of Nature
IUFRO	International Union of Forestry Research Organisations
MAT	Mutually Agreed Terms
NRM	Natural Resource Management
NGO	Non Governmental Organization
NTFP	Non-Timber Forest Products (see also NWFP)
NWFP	Non-Wood Forest Products (see also NTFP)
PIC	Prior Informed Consent
RDC	Rural District Council
RMC	Resource Management Committees
SADC	Southern African Development Community
SAFIRE	Southern Alliance for Indigenous Resources
TFCA	Trans Frontier Conservation Areas
TPF	Timber Producers' Federation
TRIPS	Trade Related Aspects of Intellectual Property Rights
TSCN	Tree Seed Centres Network
WWC	Ward Wildlife Committees
WWF	World Wide Fund for Nature
ZIMOZA	Zimbabwe-Mozambique-Zambia
ZINATHA	Zimbabwe National Traditional Healers Association

ACKNOWLEDGEMENTS

The production of this report was made possible by the financial support from the Food and Agriculture Organisation (FAO) of the United Nations (UN), for which we are grateful. The contribution of the various stakeholders in the production of the report is gratefully acknowledged.

This report was produced by a Team of experts drawn from the Forestry Commission, Southern Alliance for Indigenous Resources (SAFIRE), Agriculture Technical and Extension services department (Agritex), Communal Area Management Programme for Indigenous Resources (CAMPFIRE), Community Technology Development Trust (CTDT), Bindura University, Biodiversity Office, Ministry of Environment and Natural Resources Management and the Gene Bank.

The Team acknowledges the contribution of the National Multi-stakeholder Steering Committee of the National Forestry Programme for their support and facilitating the compilation process of the Forest Genetics Country Report. The Team is specifically grateful for the support of the following individuals:

Mr. C.M Gumbie: National Focal Point for the Country Report
Mr. D. Duwa: Chairman of the National Forestry Programme (NFP)
Mr. S. Zingwena: National Focal Point for the National Forestry Programme of Zimbabwe

The other contributors too numerous to mention here are listed in Table B1 in the Appendice.

FOREWORD

In response to the twelfth Regular Session of the Commission on Genetic Resources for Food and Agriculture, Zimbabwe undertook to contribute to the compilation of The State of the World's Forest Genetic Resources Report to be published in 2014. The construction of Zimbabwe's Country Report followed FAO guidelines in line with thematic areas in the sphere of forest genetic resources considered important to sustainable forest management, food security, poverty alleviation and environmental sustainability. The Report compilation and data gathering process in Zimbabwe was based on a participatory approach where key stakeholders had an input in the whole process to come up with the current state of forest genetic resources in the country.

The Report for Zimbabwe highlights the current state of forest genetic resources in the country for the ten-year period from 2002 to 2011, building upon its 2002 assessment of the forest genetic resources.

Findings in the 2002-2011 State of Forest Genetic Resources Country report for Zimbabwe indicated that the area under woodlands, bushlands, grasslands and wooded grasslands had declined to varying levels due to a number of factors, chief among them agricultural expansion and veld fires. For example in 2009 alone, close to a million hectares of land had been burnt by fire. It is also evident from the 2002 to 2011 assessment that despite the above loss, there remained a substantial area under various conservation management programmes totaling 11.83 million hectares of which 830,000 ha were under protection; 5.4 million ha under national parks and safaris while 5.6 million ha were under the Communal Lands Management Programme for Indigenous Resources (CAMPFIRE). In terms of flora, more than 1060 woody plant species, representing 82% of the woody species were found in Zimbabwe's National Botanic Gardens while the National Tree Seed Centre contained about 23000 accessions of both exotic and indigenous tree species.

Compilation of the Zimbabwe Country Report on the state of her forest genetic resources was made possible from funding by the Food and Agriculture Organisation of the United Nations (FAO). For this reason, let me thank FAO for their continued financial support to the Government of Zimbabwe by making this process a success right from its inception through to its finalisation and production stages of the Country Report. I would also like to recognise Zimbabwe Forestry Commission, and all contributors to the various thematic chapters that constitute this National State of Forest Genetic Resources Report. I am confident that the academia and research fraternity will find this publication relevant and useful in their quest for more knowledge, today, tomorrow and in the future.

Finally, I would like to acknowledge the professional commitment and approach in compiling this document, which, in one way or the other becomes a source of information needed for the enhancement of sustainable natural resources management and development.

.....

HON. F.D.C. NHEMA (MP)

Minister of Environment and Natural Resources Management

The State of Zimbabwe's Forest Genetic Resources

Background

Zimbabwe is a land locked country with an area of 39 million hectares. The country lies in the subtropics, between latitudes 15˚40'S and 22˚30'S. The country is bordered by South Africa in the south, Mozambique in the east, Zambia in the north and Botswana in the west. Based on elevation, the country is divided into the lowveld (below 800m above sea level), middleveld (800-1,200m a.s.l) and the highveld or watershed (1,200 to 1,500m a.s.l.) and the mountains and highlands of the eastern border (above 1,600m a.s.l.). The economy of Zimbabwe is largely agro-based and forestry contributes about 4% of the country's GDP and employs more than 16,000 people.

The natural forest and woodland ecosystem is classified into Flora Zambesiaca and Afromontane phyto region. The Flora Zambesiaca is the largest in area and is rich in terms of plant species diversity. The region comprise five woodland types namely, dry miombo, Mopane, Zambezi teak, Acacia and Terminalia-Combretum. The Afromontane phyto-region has four vegetation types that are based on elevation and tree species composition. Of the species found in the country, about 230 are considered endemic while about 500 have been listed as under varying degrees of threats of extinction. The plantation forest which accounts for 0.4% is all planted with exotic species of pines (*Pinus spp*.), eucalypts (*Eucalyptus spp*.) and the black wattle (*Acacia mearnsii).*

This report presents the current state of forest genetic resources in Zimbabwe, and the changes that occurred since the last report, 10 years ago. The major event that occurred during this period that has a potentially strong bearing on the state of forest genetic resources is the land reform programme. A total of 6,818,727 ha of farmland (2,740 commercial farms) were acquired by the state for the purposes of resettlement. Two farm models were designed and adopted, now commonly referred to as A1 and A2. The A1 model farms which make up 4,137,085ha (10% of total land area) are based on the village or communal concept, with shared residential and grazing areas, but separate cropping areas. The A2 farms are larger than the A1 farms and altogether make up a total of 2,681,642ha. A total of 140,698 families were resettled under the A1 model while a further 14,856 farming families were resettled under the A2 model (Ministry of Lands, Land Reform and Resettlement, 2006). From these statistics, it is estimated that the average farm size under the A2 is about 180ha.

The change in ownership and design of the new farms imply that management, conservation and utilization of forest genetic resources on the new farms will change. The forest genetic resources on all the old farms was in the past, governed by the Forest Act but under the new dispensation, it the Forest Act will continue to be applied to the A2 farms (40% of the old farms) while the A1 farms (60%) will be regulated by the Communal Lands Forest Produce Act. These two major pieces of legislation regulating the management and use of forest genetic resources are discussed elsewhere in this report.

The major threats to the sustainable conservation of forest genetic resources have in the past been cited as conversion of forest land to agriculture, wildfires, construction, climate change and invasive alien species. The conversion of forest land to agriculture perhaps presents the greatest threat to forest biodiversity conservation. The challenge posed by invasive alien tree species is only emerging now after years in which the focus was only placed on weeds of water bodies and Lantana camara on rangelands. Invasive alien tree species and shrubs were introduced as timber tree species, ornamentals as well as for use in agricultural systems (fodder, fruits and wind breaks).

Chapter 1: Current State of Forest Genetic Resources in Zimbabwe

The Current State of Diversity

Zimbabwe is characterised by a fairly large assemblage of forests and woodlands which constitutes 42% of the country's land area. Bushland and wooded grasslands cover a further 10.8% and 2.3% respectively. The plantation forest which is mostly characterised by exotic species accounts for 0.4%. The country has rich species diversity within its two major phyto-regions, namely Flora Zambesiaca and the Afromontane. The introduction of exotic tree species in the 1890s, followed by plantation development in the early 1920s and the subsequent development of genetic tree improvement programme broadened the country's exotic tree species diversity. The major species that were introduced were pines and eucalyptus species. To date, there are over 13 different pine species, 11 eucalyptus species, and 10 other exotic tree species in Zimbabwe. The current state of diversity can be understood better through a review of species composition in the phyto-regions.

The dominant natural forest ecosystems in Zimbabwe can be generally classified into Flora Zambesiaca and Afromontane phyto region. Flora Zambesiaca is the largest of the phyto chorionic regions in Zimbabwe. It is rich in terms of plant species diversity with over 8,500 species of which over 4,600 of these are endemic (White, 1983). It is composed of 5 woodland types namely, dry miombo, mopane, Zambezi teak, Acacia and Terminalia-Combretum.

The Afromontane phyto-region is confined to the eastern highlands of Zimbabwe, mainly on the windward side of mountains along the border with Mozambique, where about 740 vascular plant species are found (Shumba, 2001). It is often divided into four vegetation types by elevation. It is characterised by moist forests like the lowland subtropical forest Chirinda and other protected forests. The major species of importance are *Syzygium spp.*, *Widdringtonia nodiflora, Albizia spp., Trichilia dregeana, Lovoa swynnertonii* and *Khaya anthotheca*. Some of the most endangered species, like *Bivinia jalbertii, Milia excelsa* (syn. *Chlorophora excelsa*), *Strychnos mitis* and *Warbugia salutaris*, also occur in the lower altitudes of the Afromontane. Another moist forest, Chinyaduma, is reported to be under intense pressure from land clearing and human settlements.

Zimbabwe has a well-developed plantation forest sector covering over 155,000ha (about 0.4% of the country's total land area). Pines (Pinus spp.) cover 71% of the planted area, 13% is under eucalypts (*Eucalyptus spp.*) and 16% is under wattle (*Acacia mearnsii*). About 54% of the plantation is owned by large private companies, 42% by the State and the remainder of 4% by small private growers who include co-operatives.

Flora Zambesiaca (Woodlands) and Species Diversity

Miombo woodland

The dry Miombo woodland is the largest of the Zambeziaca phyto chorion region in Zimbabwe covering in excess of over 17 million ha. The dominant genera are the *Brachystegia* and *Julbernadia*, which although distinct are closely related. They belong to the legume family *Fabaceae* and subfamily *Caesalpinioideae* (Campbell and Frost, 1996). The number of taxa varies between 21 (White, 1983) and 28 (Chikuni, 1998). Although similarities do exist among the species, no putative hybrids have been found (Chikuni, 1998). Only eight *Brachystegia* species (*B. allenii, B. boehmii, B. glaucescens, B. manga, B. microphylla, B. spiciformis, B. torrei and B. utilis*) occur in Zimbabwe. Four of these species; *B. torrei, B. manga, B. allenii and B. microphylla* have a relatively confined distribution range within and around the country's borders.

Julbernadia globiflora is the only species of the miombo woodland in the genus *Julbernadia* which is found in Zimbabwe. There are five sub-types found within the Miombo woodland based on the dominant species. The most common species association in the miombo woodland is the *B. spiciformis* type, found in association with *J. globiflora* and *B. boehmii.* On the Kalahari sands, *B. spiciformis* is often associated with *Baikiaea plurijuga* and *Pterocarpus angolensis*. The *B. spiciformis* type is the most wide spread of the five sub types. The second type is *B. boehmii* which commonly occurs on escarpments at higher altitudes. Common tree associates under warm and drier conditions include *Afzelia quanzensis, Kirkia acuminata* and a range of *Acacia spp*.

The *B. boehmii* sub-type often merges with mopane woodlands at lower altitudes. The third type is *J. globiflora* which is adapted to wide altitudinal ranges. It is often found as pure stands, but also occurs in association with *Colophospermum mopane*, *K. acuminata* and *Sclerocarya birrea* at lower altitudes.

The fourth sub-type is *Parinari curatellifolia* occurring as pure unstratified stands on sandy soils with a high water table. It is generally believed that the whole central plateau of the country was once covered by *P. curatellifolia* which was invaded by *Brachystegia spp*. (Nyoka and Musokonyi, 2002). This woodland type is now very limited in extent and has generally been degraded to grasslands and savannah as a result of clearing and burning. *P. curatellifolia* was one of the fruit tree species that is widely consumed in periods of low food production.

The fifth sub-type is *Uapaca kirkiana* which occurs as pure stands generally situated on well-drained soils in frost-free areas. *Uapaca kirkiana* (muzhanje/mushuku) is one of the most prized indigenous fruit trees which is now exploited throughout its entire range of distribution in Zimbabwe. Although the fruit is not sold in formal markets, it is widely sold in both urban centres and along the country's highways. There is however a paucity of information on the consequences of this seemingly uncontrolled exploitation from the wild. The species was identified as a priority species for domestication by the World Agroforestry Centre (ICRAF) in Zimbabwe, Zambia, Tanzania and Malawi (Kadzere et al., 1998). Germplasm was collected from its entire range of natural distribution for domestication and subsequent genetic improvement. Although two trials were established in Zimbabwe, only one test remains at Domboshawa near Harare. Molecular studies have revealed that although most geographic populations of *Uarpaka kirkiana* are still sound (i.e. are genetically diverse), the Mapanzure population in the south-central part of the country (Masvingo district) was found to have a very narrow molecular genetic variability (Mwase et al., 2010). This population which represents the southern limit of the species' natural range of distribution is known to be severely degraded.

The ecological distribution range of miombo woodlanccd is widespread across commercial farmland, communal and resettlement areas, as well as National Parks. Although this woodland is not yet under threat due, in part to its size and also because a large proportion of it lies in areas where there were previously various forms of conservation, there are indications of marked reduction in the woodland area over the past 10 years as shown by most recent vegetation surveys. This is largely attributable to the changes brought about by the land reform programme.

Tree populations occurring in most communal areas have remained the most vulnerable. In densely populated communal areas such as Seke, the miombo woodland is either severely impoverished or nonexistent having been cleared for agriculture and fuelwood for the neighbouring urban settlements of Chitungwiza and Harare because of increasing demand for wood energy for household use. The woodland has been replaced by the pioneer *Acacia spp.*, on the exhausted soils. The miombo woodland occurs in the eastern highlands (above 1,500 metres above sea level), highveld (1,200 to 1,500m a.s.l.), middleveld (800 to 1,200m a.s.l) and to a limited extent in the lowveld (below 800m a.s.l.).

Mopane woodlands

The mopane woodlands are found in the high, middle and the lowveld of the country and cover an estimated area of 12 million hectares. *Colophospermum mopane* is the dominant species in this woodland and is the only species in the genus *Colophospermum*. It is classified in the legume family Fabaceae. Although the woodland exists in association with other major vegetation types such as miombo (SADC, Southern Africa Environment Outlook, 2008), there is restricted diversity in the tree species which form the dominant part of the woodland. *Colophospermum mopane* is described as one of the most distinctive vegetation groups, often forming pure stands. Coates-Palgrave (2002) identified two distinct kinds of mopane woodlands. When the woodland is composed of very tall trees, it is referred to as 'cathedral mopane' whereas when it exists on unfavourable conditions where the trees are stunted due to various selection pressures, the woodland is then referred to as 'scrub mopane'. Species commonly found in this woodland type include Scented thorn (*Acacia nilotica*), Baobab (*Adansonia digitata*), African blackwood (*Dalbergia melanoxylon*), Marula (*Sclerocarya birrea*) and Buffalo thorn (*Ziziphus spp*.) (Hirji, et al., 2002). *Colophospermum mopane* is of economic importance as a source of browse for both domestic and wild animals. It is also used for fuel wood, durable poles for general farm construction. Before the development of the forest plantation industry, mopane was also used for making mine props, parquet floors and rail sleepers. The species is also a host for a highly prized worm (*Imbrasia belina*), widely consumed in the country and now commercially sold in formal markets. Although this woodland type is not under threat, some natural stands are already being actively conserved.

Zambezi Teak Woodlands

The teak forests are confined to the central and western parts of the country on Kalahari sandy soils. The total area of this woodland is about 1.4million hectares. The woodland is spread across National Parks where it constitutes 568,000ha, communal lands (634,000ha), private land (343,400ha) and demarcated forest having the remainder of 439,000 hectares. The dominant species of the Zambezi teak woodland is the Zambezi teak (*Baikiaea plurijuga*) and is usually associated with Copal wood (*Guirbotia coleosperma*) and the ubiquitous Blood wood (*Pterocarpus angolensis*). The Zambezi teak woodland is of economic importance in commercial timber industry, wildlife ecosystems and catchment area protection. There are only two species in the genus *Baikiaea* namely *B. plurijuga* and *B. qhesquiereana.* Only the *B. plurijuga* exists in Zimbabwe while the later is endemic to Tanzania. Other tree species associated with the Zambezi teak woodland includes Msasa (*Brachystegia spiciformis*), *Burkea africana*, Pod mahogany (*Afzelia quanzensis*) and White syringa (*Kirkia acuminata*), wooden banana (*Entandophragma caudatum*) and *Schinziophyton rautanenii* (syn. *Ricinodendron rautanenii*).

More than half of the Zambezi woodland is under the National Parks and demarcated forests and is therefore under optimum protection from overexploitation. Controlled harvesting of timber (mostly *B. plurijuga* and *P. angolensis*) is practised in the protected forests but not the national parks. The other half of the woodland is on private and communal land. Only 15% of the Zambezi woodland (on communal lands) can be described as under some form of threat of degradation.

In the protected or demarcated forests, small blocks called Strict Natural Reserves (SNRs) were marked. These areas were established strictly for conservation with no exploitation permitted (Timberlake and Kwesha, 1994). Although this woodland sits on one of the most fragile environments (soils are highly erodible) in Zimbabwe, it probably represents the best managed woodlands in the country. Genetic variation studies using morphological nursery traits were carried out for *P. angolensis* and *C. mopane*. The studies were found to be less informative and inconclusive.

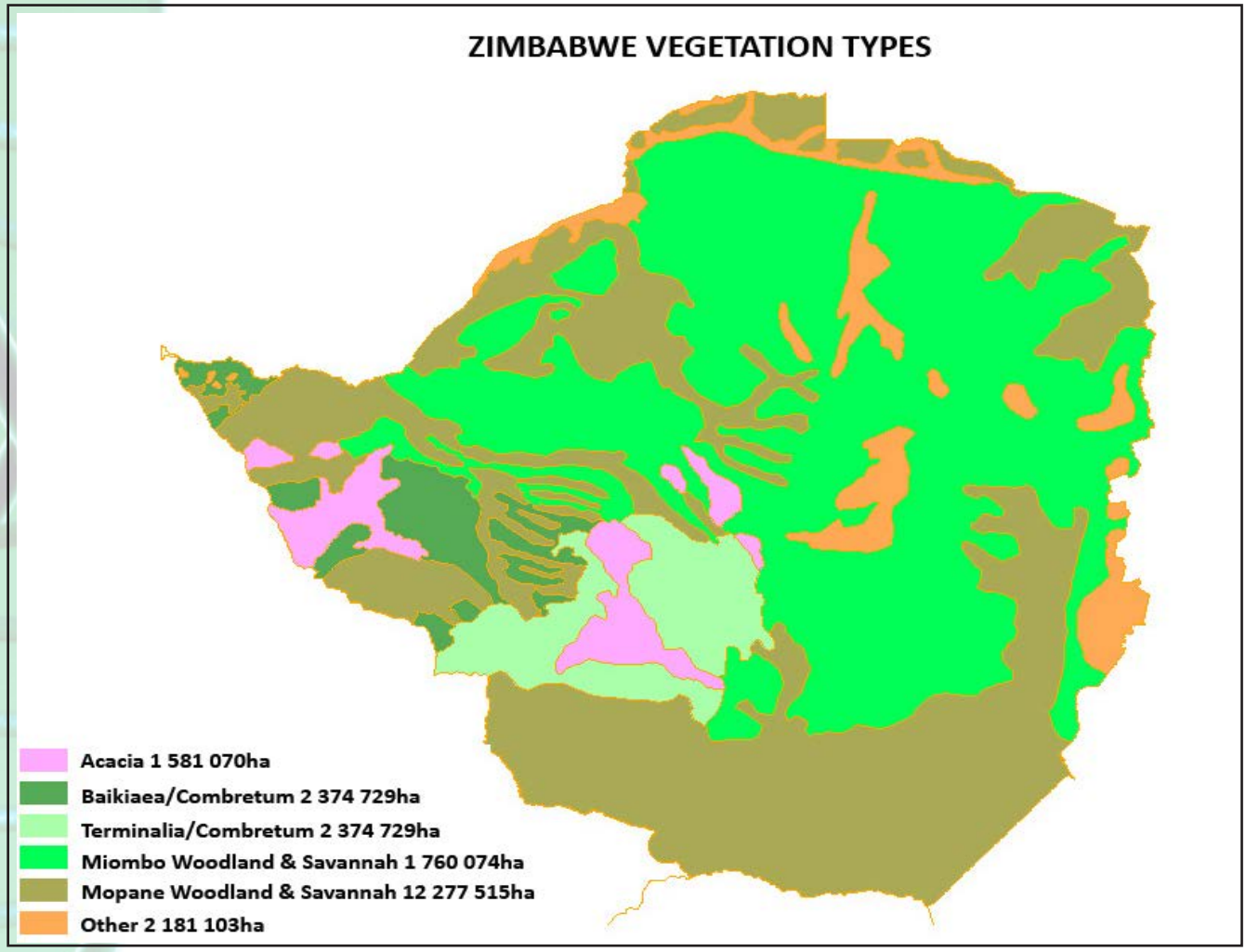

Figure 1: Zimbabwe vegetation types (Source: Zimbabwe Forestry Commission)

Acacia Woodlands

The Acacia woodland is dominated by *Acacia spp*. which includes *A. karroo, A. nilotica, A. nigrescens, A. erioloba* and *A. tortilis* on various soil types. These species are common in Zimbabwe from as low as 400m a.s.l. to over 1,600m a.s.l. They occur in river valleys, abandoned fields, and degraded areas and also in association with other important species such as *Sclerocarya birrea* and *Combretum spp.* *Faidherbia albida* is mostly a riverine species. There are 44 different taxa of Acacia which exist in Zimbabwe and of these only *Acacia chariessa* is endemic to Zimbabwe (Timberlake et al., 1999). Another, *A. rehmanniana* has its main populations in Zimbabwe while *A. eriocarpa* is confined to a small total area with a significant portion of it in Zimbabwe (Timberlake, et al, 1999). Thirty eight percent of the taxa (17 taxa) have a broad tropical distribution while 13 taxa (30%) are confined to the southern Africa region. Only one taxon is distributed within the Afromontane region with the remainder localised in the Limpopo, Zambezi and Kalahari basins (Timberlake et al, 1999).

Several Acacias have of late been the subject of intense studies in Zimbabwe. These studies have focused on their distribution, taxonomy, biology, economic value (gum arabic production), browse and fodder value, nitrogen fixation and for restoring degraded sites (Nyoka and Musokonyi, 2002). Comprehensive provenance-progeny trials were established in Zimbabwe to evaluate the genetic resources of six species, 4 of which are widespread in Africa, namely *A. nilotica, A. senegal, A. tortilis* and *Faidherbia albida*, while 2 are confined to Southern Africa, namely *A. erioloba* and *A. karroo* (Barnes and Fagg, 1995). Provenance evaluations were conducted for these species on 14 sites in western Zimbabwe (Barnes, et al, 1999) where these species are of importance to the local communities. Wide genetic variation within species on growth parameters and gum arabic production were observed (Maruzane et al., 1999; Forestry Commission Annual Report, 2010). Most *Acacia spp*. in Zimbabwe are not yet threatened by over-utilization and land clearing. There is no deliberate conservation work on *Acacia spp*. in Zimbabwe. Conservation efforts could, however be placed on those acacias with a narrow distribution range and specific habitat requirements like *A. abyssinica* and *A. erioloba* which may be affected by habitat loss.

The many species screening and provenance trials established from germplasm collected from the species' natural range of distribution have yielded useful information on provenance variation that will be useful in the design of future conservation strategies. The trials will also be useful as ex situ field gene banks. Germplasm exploration and collection were also conducted for S. birrea under a regional collaborative programme on domestication of priority indigenous fruit trees in Zimbabwe (Rukuni et al., 1998) and the southern African region by the World Agroforestry Centre (Kadzere et al., 1998). The germplasm was used to establish provenance trials in Zimbabwe, Malawi, Zambia and Tanzania. These trials have provided a wealthy of information on the extent of provenance variation in this species based on both molecular and morphological traits (Kadu et al, 2006; Chirwa et al., 2007) that will be useful in the design of future conservation strategies.

Terminalia-Combretum woodlands

The Terminalia/Combretum woodlands are dominated by *Terminalia spp*. and *Combretum spp*. In its natural state, Terminalia tends to be associated with other species such as *Sclerocarya birrea, Strychnos cocculoides, Saccharopolyspora spinosa, Piliostigma thonningii,* etc. The number of taxa in the genus *Combretum* that occur in Zimbabwe has been put at between 22 (Coates-Palgrave, 2002) and 31 (Hyde, et al., 2011) *Combretum spp*. that occur in Zimbabwe. One species (*Combretum coriifolium*, Engl. & Diels) is considered endangered while another (*C. umbricola*, Engl.) is rated as critically endangered. There are between 10 (Coates-Palgrave, 2002) and 12 species (Hyde, et al., 2011) of *Terminalia* in Zimbabwe. There is however very limited information on species diversity in these two important genera in Zimbabwe. This woodland type is often found as tree shrub combinations but it becomes dominant when it colonises burnt sites. However, this woodland type has been severely cut and most of the existing vegetation is secondary. It also tends to be the recruitment species in areas affected by elephant damage. *Terminalia sericea* and *Combretum spp*. do not have a commercial value per se and are mostly used for poles, tool handles and firewood. There is no deliberate conservation work on these species in Zimbabwe although, two Combretum spp. (*Combretum umbricola, Combretum coriifolium*) are known to be critically endangered. The remaining non-classified vegetation covers an area of 2,181,163ha.

Afromontane

The most comprehensive inventory report of the rainforests of Zimbabwe was recently carried out by Muller (2006). This section is therefore based on that report. Rainforest is extremely localised in Zimbabwe, and are found mainly on the windward slopes of mountains along the eastern border with Mozambique. The forest occurs between an altitude of 350 and 2100m with a disjunct distribution. It consists of over 350 fragments stretching in a north-south direction for approximately 250km.

The individual forests are very small and range in size from less than one hectare to a few square kilometres. There are three main centres of rainforest development, which are the Nyanga Mountains in the northern part of the eastern highlands, the Vumba Mountains in the centre and the mountains of the Chimanimani District in the south central. Smaller forests occur between these main centres and also in Chipinge District. Chirinda Forest makes up the southern end of the distribution. The total area covered by rainforest is approximately 107km^2 (less than 0.028% land area). If the steepness and undulating nature of the terrain on which forest is generally found is considered, the total area could be regarded as in the region of 120-150km^2. Where rainforest occurs, annual average rainfall is at least 1200mm, with significant precipitation (mist and rain, or rain only) during the dry season. The main environmental variables which control the species distribution and determine the species composition of the various forest types are altitude, amount of available water (especially during the dry season), and disturbance by man and, to a lesser extent, soil type, aspect and topography.

Four major forest zones are recognised based on altitude: Montane forest (above 1650m a.s.l.), submontane forest (1350 to 1650m a.s.l.), medium altitude forest (850 to 1350m) and lowland forest (350 to 850m a.s.l.). The altitudinal limits are approximate and vary considerably in accordance with aspect and relief. Using tree species composition as a criterion, (Muller, 2006) divided the two upper zones into 10 forest types. The two lower zones are best considered as one type each. There is evidence that many forests have been severely disturbed by man over several centuries which may be the reason for the difficulties in classification. The anomalies are described either as variants of the type which they most resemble or as intermediates between types where this seems appropriate.

Montane Forest zone

There are 6 montane forest types (*Syzygium masukuense* montane forest, *Afrocrania volkensii* montane forest, *Widdringtonia nodiflora* forest, *Ilex mitis-Schefflera umbellifera-Maesa lanceolata* montane forest, *Syzygium guineense* subsp. *afromontanum* montane forest and regenerating montane forest) that can be readily recognized in this zone. The combined area of this forest zone is no more than 6,120ha (Muller, 2006).

***Syzygium masukuense* montane forest**: The forest covers an area of 655ha on the Nyangani massif, between 1700 to 2050m. *Syzygium masukuense* accounts for up to two thirds or more of the total tree cover in places where the forest is least disturbed. The other common canopy trees are *Aphloia theiformis, Cassipourea malosana, Ilex mitis, Podocarpus latifolius, Prunus africana, Rapanea melanophloeos* and *Schefflera umbellifera.* Species such as *Canthium oligocarpum, Diospyros whyteana, Dovyalis lucida, Erythrococca polyandra, Pavetta umtalensis*, *Peddiea africana* and *Psychotria zombamontana* are found as scattered small trees in the sapling layer. Towards drier sites, *Syzygium masukuense* is less dominant and *Aphloia theiformis, Curtisia dentata, llex mitis, Macaranga mellifera, Maesa lanceolata, Rapanea melanophloeos and Schefflera umbellifera* more prominent. Lower down the slope the canopy is more mixed and species like Cryptocarya transvaalensis, Faurea racemosa, Olea hochstetteri, *Pterocelastrus echinatus* and *Tabernaemontana stapfiana* are more common. The canopy height is usually 10 to 12m.

***Afrocrania volkensii* montane forest:** The forest covers approximately 375ha on Nyangani mountain, where it is confined to wet boulder screes and the central portion of the high valleys, but is more extensive on mountains in the south-west of Chimanimani District. A few small patches are found in the highest part of the Banti Forest Reserve. In the canopy *Afrocrania volkensii* can be dominant (Nyangani mountain) or codominant with *Ilex mitis* and *Olea hochstetteri* (Chimanimani District). Other common tree species are *Ekebergia capensis*, *Kiggelaria africana* and *Prunus africana* while *Calpurnia aurea, Canthium pauciflorum subsp. angustifolium, Diospyros whyteana*, *Halleria lucida* and *Trimeria grandiflora* are typical of the ill-defined second layer. *Peddiea africana, Psychotriazombamontana* and *Sclerochiton harveyanus* (Chimanimani District only) dominate the shrub layer. The canopy height is sometimes up to 30m.

***Widdringtonia nodiflora* forest**: The forest is only about 40ha in extent. It occurs on the Nyanga mountains and on some mountains in the Chimanimani District, mainly between 1,700 and 2,100m. This forest consists almost exclusively of *Widdringtonia nodiflora* and occasionally specimens of *Curtisia dentata, Ilex mitis, Maesa lanceolata, Macaranga mellifera, Nuxia congesta, Rapanea melanophloeos* and *Schefflera umbellifera*. At the end of its development this forest consists of scattered *Widdringtonia nodiflora* mixed with forest edge species such as *Buddleja salviifolia, Hypericum revolutum, Myrica pilulifera, Passerina montana, Erica hexandra, Stoebe vulgaris* and others. The height of the canopy rarely exceeds 10 m.

***Ilex mitis-Schefflera umbellifera-Maesa lanceolata* montane forest**: The forest covers an area of about 695ha from about 1700m to 2100m. Dominant canopy species are *Aphloia theiformis, Curtisia dentata, Faurea racemosa, Ilex mitis, Maesa lanceolata, Podocarpus latifolius, Rapanea melanophloeos* and *Schefflera umbellifera*. Other typical or occasional trees are *Cassipourea malosana*, *Ekebergia capensis, Halleria lucida, Kiggelaria africana, Macaranga mellifera, Syzygium guineense subsp. afromontanum* and *Tabernaemontana stapfiana. Diospyros whyteana, Dovyalis lucida, Erythroxylum emarginatum, Pittosporum viridiflorum and Trimeria grandifolia* are common smaller trees. The canopy height is variable, normally between 12 and 15m, but can be up to 20m with emergent specimens of 25m.

***Syzygium guineense subsp.* afromontanum montane forest:** Covers approximately 2,420ha and the largest of the six forest types that make up this zone. The forest is found on the Nyangani massif at between 1,500 and 1,900m a.s.l. The dominant canopy tree species is *Syzygium guineense subsp. afromontanum*. Other species such as *Aphloia theiformis, Cassipourea malosana, Cryptocarya transvaalensis, Olea hochstetteri, Pterocelastrus echinatus* and *Rapanea melanophloeos* are important associate species which can become codominant or even dominant in some areas. Other widespread trees are *Apodytes dimidiata, Bersama swynnertonii, Croton sylvaticus, Ekebergia capensis*, *Ilex mitis, Kiggelaria africana* and *Nuxia congesta. Curtisia dentata, Macaranga mellifera, Maesa lanceolata and Podocarpus latifolius* are often present and, together with *Aphloia theiformis* and *Rapanea melanophloeos*, increase towards drier sites and with increasing disturbance. The sub-canopy is well developed and dominated by *Tabernaemontana stapfiana, Dovyalis lucida, Erythroxylum emarginatum, Eugenia nyassensis, Oxyanthus speciosus, Pavetta umtalensis, Rawsonia lucida, Xymalos monospora, Chionanthus foveolatus subsp. major, Ochna holstii* and *Oricia bachmannii.* The canopy height increases with decreasing altitude from about 12 to 20m, or even 25m, with emergent trees up to 30m.

Regenerating montane forest: This forest which covers about 1,935ha is the second largest of the six forest types of the montane forest zone. This forest type is common in the Nyanga and Vumba mountains where large areas of rainforest are in different stages of recovery; having been cleared in the past. All stages in between, from near- pristine *Syzygium* forest to forest which has been cleared as recently as 100 years ago, can be found. The dominant tree species is normally *Macaranga mellifera*, with *Aphloia theiformis, Maesa lanceolata* and *Schefflera umbellifera* often codominant. *Polyscias fulva* and *Allophylus abyssinica* can sometimes be fairly common, especially in the lower part of the montane belt. *Aphloia theiformis* dominates the sub-canopy, often together with *Xymalos monospora*. Most of the tree species which occur in the montane belt can be found in small numbers in regenerating forest. The canopy consists of even-aged stands of trees and can be between 15 and 20m in height with emergent specimens up to 25m.

Sub-Montane Forest zone

This forest zone lies between 1,350 to 1,650m a.s.l. and comprise four forest types: mixed sub-montane forest, Craibia brevicaudata forest, Albizia-dominated regenerating forest and the Albizia schimperiana forest (Muller, 2006). The combined of this sub-montane forest zone is covers 2,655 ha.

Mixed sub-montane forest: The forest which covers 2,130ha occurs in the Chimanimani and Vumba mountains. Although the forest generally occurs between 1,600 and 1,650m a.s.l. it reaches as high as 1,750m on the Chimanimani Mountains. The common tree species include *Cassipourea malosana, Nuxia congesta, Oricia bachmannii, Podocarpus latifolius, Rapanea melanophloeos* and *Syzygium guineense subsp. afromontanum, Cassipourea gummiflua, Chrysophyllum gorungosanum, Craibia brevicaudata subsp. baptistarum, Ficus chirindensis, F. craterostoma, F. scassellatii* and *Strombosia scheffler*i from the medium altitude zone. *Bersama swynnertonii* and *Margaritaria discoidea var. nitida* are occasional tree species which are mainly confined to this forest type. The sub-canopy is also composed of montane and medium altitude species. In a mature forest of this type species richness for trees reaches its peak for Zimbabwe. Canopy height is from 25 to 35m and emergents can reach 40m.

***Craibia brevicaudata* forest:** This is the smallest forest type in the sub-montane forest zone. It covers only about 35 ha and is only found between 1,400 and 1,600m a.s.l. The canopy consists almost entirely of *Craibia brevicaudata subsp. baptistarum*, with *Ficus chirindensis* and *F. scassellatii* as typical associates. *Cassipourea malosana, C. gummiflua, Croton sylvaticus* and the pioneer trees *Albizia schimperiana, Macaranga mellifera* and *Polyscias fulva* are occasionally present. *Craibia brevicaudata subsp. baptistarum* is also dominant in the sub-canopy, with *Dracaena steudneri, Rothmannia urcelliformis, Teclea nobilis* common and *Ritchiea albersii, Tabernaemontana stapfiana* and *Xymalos monospora* occasionally present. Canopy height is 20 to 25m, with emergent fig trees up to 35m.

***Albizia*-dominated regenerating forest**: The forest type only covers approximately 380ha. The regenerating forest changes physiognomically below 1,600m a.s.l. due to the appearance of *Albizia gummifera* and *A. schimperiana* as dominant canopy trees. The forest also occurs right through the medium altitude zone, down to about 1,000m a.s.l. *A. schimperiana* is common on drier sites and *A. gummifera* is common where there is sufficient moisture. Other typical canopy trees are *Celtis africana, Croton sylvaticus, Polyscias fulva, Rauvolfia caffra* and *Sapium ellipticum*. *Macaranga mellifera* is still very common, either in the canopy or, more often, forming a high sub-canopy immediately beneath the *Albizia crowns.* Common smaller trees include *Teclea nobilis* and *Xymalos monospora*. The canopy height of an *Albizia*-dominated forest can be up to 40m high with emergent *Albizias* up to nearly 50m.

***Albizia schimperiana* forest**: The forest is approximately 110ha in extent. This is the driest type of rainforest before miombo woodland takes over. The transition to miombo is sudden and sharp. The dominant canopy species is usually *Albizia schimperiana*. As moisture increases, *A. gummifera* becomes more common, sometimes even dominant. The other characteristic trees are *Allophylus abyssinicus, Celtis africana, Ekebergia capensis, Ficus sur, Prunus africana* and, occasionally, *Croton sylvaticus*. *Curtisia dentata, Maesa lanceolata* and *Schefflera umbellifera* can be common in the upper part of the zone. Typical lower story trees are *Dracaena steudneri, Kiggelaria africana, Ochna holstii, Pittosporum viridiflorum, Teclea nobilis, Trimeria grandifolia* and *Xymalos monospora*. Towards the drier end of this forest type, forest-edge species such as *Calodendrum capense, Erythrina lysistemon, Fagaropsis angolensis, Ficus thonningii, Olinia vanguerioides, Scolopia zeyheri, Schrebera alata* and *Terminalia gazensis* become increasingly common and can reach the canopy. Smaller trees typical of the dry end of forest development are *Bridelia micrantha, Canthium inerme, Cussonia spicata, Dais cotinifolia* and *Rhus lucida*. The canopy height can be up to 40m high with emergent *Albizias* up to nearly 50m but can be as low as 20 or 25m where the Albizias are absent.

Medium Altitude Forest zone

The forest occurs between 850 to 1350m a.s.l. Although, this regenerating forest is similar to that found in the sub-montane forest zone the major difference is the occurrence of two key species: Cordia africana and Harungana madagascariensis. This zone contains only one forest type, the medium altitude forest. The forest is approximately 1370ha. Chirinda Forest (600ha) in Chipinge District is the best example of medium altitude forest in Zimbabwe. This magnificent forest is in a near pristine state. It contains the full array of species typical of medium altitude in Zimbabwe. In Chirinda Forest, the dominant canopy species are *Chrysophyllum gorungosanum, Craibia brevicaudata subsp. baptistarum* and *Trichilia dregeana*. In other forests, in addition to these, *Newtonia buchananii* can be the dominant species, sometimes together with *Maranthes goetzeniana*. Other common canopy species are *Celtis gomphophylla, Croton sylvaticus, Diospyros abyssinica, Drypetes gerrardii, Ficus chirindensis, F. scassellatii, Khaya anthotheca (syn. K. nyasica), Lovoa swynnertonii* (only in Chirinda forest), and *Strombosia scheffleri*. The sub-canopy consists essentially of *Cassipourea malosana, Cola greenwayi, Diospyros ferrea, Drypetes gerrardii, Englerodendron magalismontanum, Heinsenia diervilleoides, Myrianthus holstii, Oricia bachmanii, Pleiocarpa pycnantha, Rawsonia lucida, Rothmannia urcelliformis, Strychnos usambarensis, Suregada procera, Trilepisium madagascariense* and *Vangueria esculenta*. *Strychnos mellodora* only occurs in Chirinda as a cub-canopy species. *Tabernaemontana ventricosa* is a common small tree or shrub typical of medium altitude and lowland forest. *Chrysophyllum viridifolium* is occasionally present, sometimes even reaching the canopy. In the Nyanga area, *Englerodendron magalismontanum is* often the dominant sub-canopy tree. The canopy height is between 50 and 55m in Chirinda Forest with emergent trees to nearly 60m but elsewhere it is 40 to 45m with emergent trees up to 50m.

Lowland Forest zone

Muller (2006) reported that very little rainforest remains in this zone and what there is sufficiently similar to describe as one type. The lowland forest covers only 490ha and lies between 350 to 850m a.s.l. The forest occurs in extremely small fragments in the Pungwe Valley and a little more than 200 ha in the Rusitu Valley. The dominant tree species in the canopy is *Newtonia buchananii*, while the other common trees are *Maranthes goetzeniana* and *Xylopia aethiopica*, with *Erythrophleum suaveolens* and *Khaya anthotheca* locally frequent. Occasional rare species are *Ficus bubu, F. exasperata, F. vallis-choudae* and *Milicia excelsa*. *Funtumia africana* often forms a high sub-canopy immediately beneath the *Newtonia crowns*. Other common sub canopy trees are *Aporrhiza nitida, Blighia unijugata, Millettia stuhlmannii, Pachystela brevipes* and *Trilepisium madagascariense*. *Uapaca lissopyrena*, an unusual tree with stilt roots, is common in wet places and along small streams. The sapling layer contains a number of small trees, the most common ones are *Aidia micrantha, Englerodendron magalismontanum, Craterispermum schweinfurthii, Dracaena mannii* and *Tarenna pavettoides subsp.* affinis. Locally abundant shrubs include *Afrosersalisia kassneri, Drypetes arguta, Rinorea convallarioides, R. ferruginea, Tabernaemontana ventricosa, Tricalysia pallens and Vepris drummondii*. Where rivers or large streams run through the forest, *Breonadia salicina, Cleistanthus apelatus, Khaya anthotheca, Mascarenhasia arborescens, Rauvolfia caffra* and *Uapaca lissopyrena* commonly occur. An occasional member of this habitat is *Syzygium owariense*. The canopy height is around 50m.

Exotic Plantations

The introduction and subsequent development of exotic tree species for industrial and domestic use began in the 1890s. The main genera that were introduced are *Pinus, Eucalyptus, Cupressus, Acacia* and a number of ornamentals. The tree breeding programme is geared towards the genetic improvement of tree species in all aspects pertaining to their end use including poles, sawn timber and pulp and paper. To date, gains in excess of 17% gain in volume were achieved in first generation selections, rising to a cumulative 38% in 2nd generation and cumulative of up to 45% in 3rd generation selections over the original wild material of *P. patula*. The other improvements were associated with reduction in the rotation age for sawn timber from over 30 to 25 years. The commercial forestry industry based on exotic trees contributes about 4% to the Gross Domestic Product.

Pine Species

There are more than two dozen species of pines that were introduced and tested in Zimbabwe. The major commercial species are *P. patula, P. elliottii, P. taeda and P. kesiya* and the minor species are *P. oocarpa, P. caribaea* and *P. tecunumanii* (syn*. P. patula ssp. tecunumanii*). The other species that were introduced and tested in Zimbabwe include *P. maximinoi, P. herrerae, P. greggii, P. merkusii, P. massoniana, P. yunnanensis, P. echinata, P. pseudostrobus, P. strobus, P. montezumae. P. michoacana, P. leiophyla. P. muricata, P. palustris, P. pinaster, P. radiata, P. roxburghii, P. ayacahuite* and *P. chiapensis*. Most of these species are now conserved in introduction plots and arboreta. In the commercially important species, diversity is maintained in breeding populations. Currently there are 12 breeding populations of *P. patula* that were constituted on the basis of general combining ability, site, generation of selection and breeding intensity (Forest genetics programme in Zimbabwe Part 11, 2007). *P. elliottii* has 13 breeding populations while *P. taeda* consists of eight breeding populations. There are five breeding populations of *P. taeda* constituted from selections that were made in Zimbabwe, Zambia, Thailand, Vietnam and the Philippines. New germplasm has over the years been introduced into the country from the south-eastern USA, Mexico and other Central American countries.

Eucalyptus Species

Eucalypts were introduced into the country to meet the demand for hardwood timber, poles and firewood (Shumba, 2001). The major commercial species are *E. grandis* and *E. cloeziana*. *E. camaldulensis, E. tereticornis* and *E. citriodora* have been used mainly in woodlots by smallholder farmers in the drier parts of the country. The germplasm of the eucalypts in Zimbabwe is considered sufficiently broad after years of sustained germplasm introduction. There are many other eucalypt species that were introduced and tested in Zimbabwe. They include *E. dunnii, E. paniculata, E. maculata, E. nitens, E. urophylla* and *E. globulus.* There are also interspecific hybrids of eucalypts that have been tested over the years. Their role in commercial forestry has still not be realised although the potential is considered to be very high. The interspecific hybrids developed are *E. grandis x E. camaldulensis* and *E. grandis x E. tereticornis* to fill the marginal areas in the country.

Exotic Acacias

Australian acacias also form an important component of exotic introductions into Zimbabwe. Two Australian species *Acacia mearnsii* and *A. melanoxylon* were introduced for the production of tannin and timber respectively. Only *A. mearnsii* became an important commercial species in Zimbabwe. The area under *Acacia mearnsii* declined from a peak of 26,000 ha to the present day 11,400ha (Nyoka, 2002). Other Australian acacia species that were evaluated in the country are *A. holosericia, A. auriculiformis, A. cowleana* and *A. tumida.*

Other Exotic Species

There are other tree species that were introduced in Zimbabwe but never became important species. These exotic tree species were introduced and tested for a range of potential uses that include ornamental, poles, timber, hedge, etc. The species include *Jacaranda mimosifolia* and the flamboyant tree that now dot the urban landscape along avenues, *Callistris spp., Cunninghamia lanceolata* and *Liquidambar ssp*. for timber, Populus spp. and Cupressus spp. for hedge. The area under *P. deltoides* has remained stagnant as the species' requirements are very narrow and restricted.

Genetic Diversity

Due to a variety of reasons, most of the genetic diversity studies have been based on morphological variation with very little use of modern methodologies such as molecular markers. Consequently, very little of the genetic variation has been elucidated at the gene level (Shumba, 2001). Due to limited financial resources, much of the past efforts were placed on quantifying between and within species variability based on morphological traits from the provenance and within-provenance studies.

Genetic variation studies based on morphological traits were conducted for indigenous fruit trees (*Uapaca kirkiana*, *Sclerocarya birrea*) and some timber tree species (*Pterocarpus angolensis* and *Colophospermum mopane)*. Significant provenance variation in tree growth (Rukuni et al., 2001; Chirwa et al., 2007), fruit size and quality (Shumba, 2001) of *U.kirkiana* were reported. Mwase et al (2010) reported on genetic variability of *Uapaca kirkiana* populations collected from Zimbabwe, Zambia, Malawi, Mozambique and Tanzania using molecular techniques. One Zimbabwean population (Mapanzure) from Masvingo fruited early, had superior height growth but had the least molecular diversity among populations from southern Africa. Kadu et al. (2006) reported on the molecular variability in *S. birrea* collected from Zimbabwe and other countries in southern and eastern Africa. The results of these studies are being used to develop optimum conservation strategies for the species as well as the envisaged breeding programmes.

Work on the genetic variation in indigenous commercial timber tree species in Zimbabwe was largely based on nursery traits. Variations in morphological traits were conducted in 17 provenances and 121 families of *P. angolensis* and 19 provenances and 154 families of *C. mopane* in 2002 (Forestry Commission, 2002 unpublished). Results have shown that north-western Zimbabwe (Fuller, Mzola and Gokwe forests) provenances of P. angolensis have bigger seeds than those from other parts of the country.

Intensive genetic studies have, however been carried in most of the exotic industrial tree species that are in the breeding programme. The studies have focussed on quantitative aspect based on morphological traits with limited molecular work (Williams et al., 1999). The breeding populations are all managed on a long term breeding and gene conservation basis.

Threatened and endangered tree species

Several species, with a fairly restricted distribution, have been identified as under moderate to severe threat of extinction. These threats were reported a decade ago (Nyoka and Musokonyi, 1999) and remain relevant today as very little was done to address the threats. The species include *Warbugia salutaris, Swynnertonia cardinea, Combretum umbricola, Combretum coriifolium, Juniperus procera, Bivinia jalbertii, Strychnos mitis, Homalium abdessammadii, Scolopia mundii, Cassia afrofistula, Ficus bubu, Ficus fischeri, Ficus ottoniifolia subsp. ulugurensis, Milicia excelsa, Morus mesozygia, Streblus usambarensis, Commiphora neglecta,* and *Turraea eylesii*. *Bivinia jalbertii* is under severe threat (Mapfumo and Mtindi,1995), as only a remnant stand of about a thousand trees of this species are now left near Ngundu where a multi-million dollar dam construction project (Tokwe-Mukosi dam) right nearby could one day seal its fate. Progress in the construction of the dam has been very slow so the expected effects of flooding have not been observed as yet.

Due to financial challenges in the past decade, very little was done to implement robust conservation programmes of the tree species that are under severe threat. This therefore remains as work do be done. Also expeditions to verify the existence or disappearance of some of the tree species that have been reported as extinct were not done due in part to financial challenges.

The prevalence of two diseases, mukwa die-back (*Fusarium oxysporum*) on *P. angolensis* and baobab sooty on *A. digitata* were reported in the last report as affecting the two species (van Wyk et al., 1993). The threat posed by the diseases remains. Also the threat posed by the scale insect, *Aspidoproctus glaber* has remained. The insect attacks a range of indigenous tree species including *Brachystegia spp.* and *J. globiflora*. There is no new information that was gathered on the extent of the damage. In the last decade it was reported that the insect had affected trees in a woodland covering over 60,000ha (Mushongahande and Mazodze, 1996). There are strong and justified fears that, unless control measures are instituted, the remnant natural Afromontane vegetation may be threatened by industrial exotic species that have become invasive. Currently, there are several exotic tree species and shrubs (*Pinus patula, Acacia mearnsii, A. melanoxylon, Populus canescens, Psidium spp.* and *Lantana camara*) that are considered serious invasive species of the natural forests and grasslands of the eastern highlands of Zimbabwe (Nyoka, 2002). Populus canescens is not only confined to the eastern highlands as it is also choking most of the rivers and dambos throughout the highveld.

Changes in Forest Cover

The proportion of total land area covered by forest has been falling significantly (Forestry Commission, December 2010). Figure 2 shows the latest woody cover map (2008) of Zimbabwe contrasted with the last woody map of 1992. The major changes that occurred is that of woodland area which declined from 53.2% to 42.3% and the expansion of cultivated land from 27.5% to 41.2%. The other significant changes were for bushland and wooded grasslands which also declined from 12.7% to 10.8% and 3.1% to 2.3% respectively. The major cause of the decline in forested/wooded area is the expansion of agriculture. The proportion of total land area covered by forest has been falling significantly, estimated to be 330,000ha per year (Forestry Commission, December 2010), compared to 70,000ha per year a few decades ago. The other causes to the decline in forest cover include population pressure in communal areas, fires, collection of non timber products for medicinal purposes, commercial timber harvesting and tobacco curing. Attempts to reduce deforestation have been made by the Forestry Commission through promulgation of the following regulations i.e. the Tobacco Wood Energy Regulations, Plantation Timber Industry Regulations, Firewood Trading Regulations, and the Movement of Timber Regulations. These regulations have not been gazetted and as a result the rate of deforestation may continue to rise.

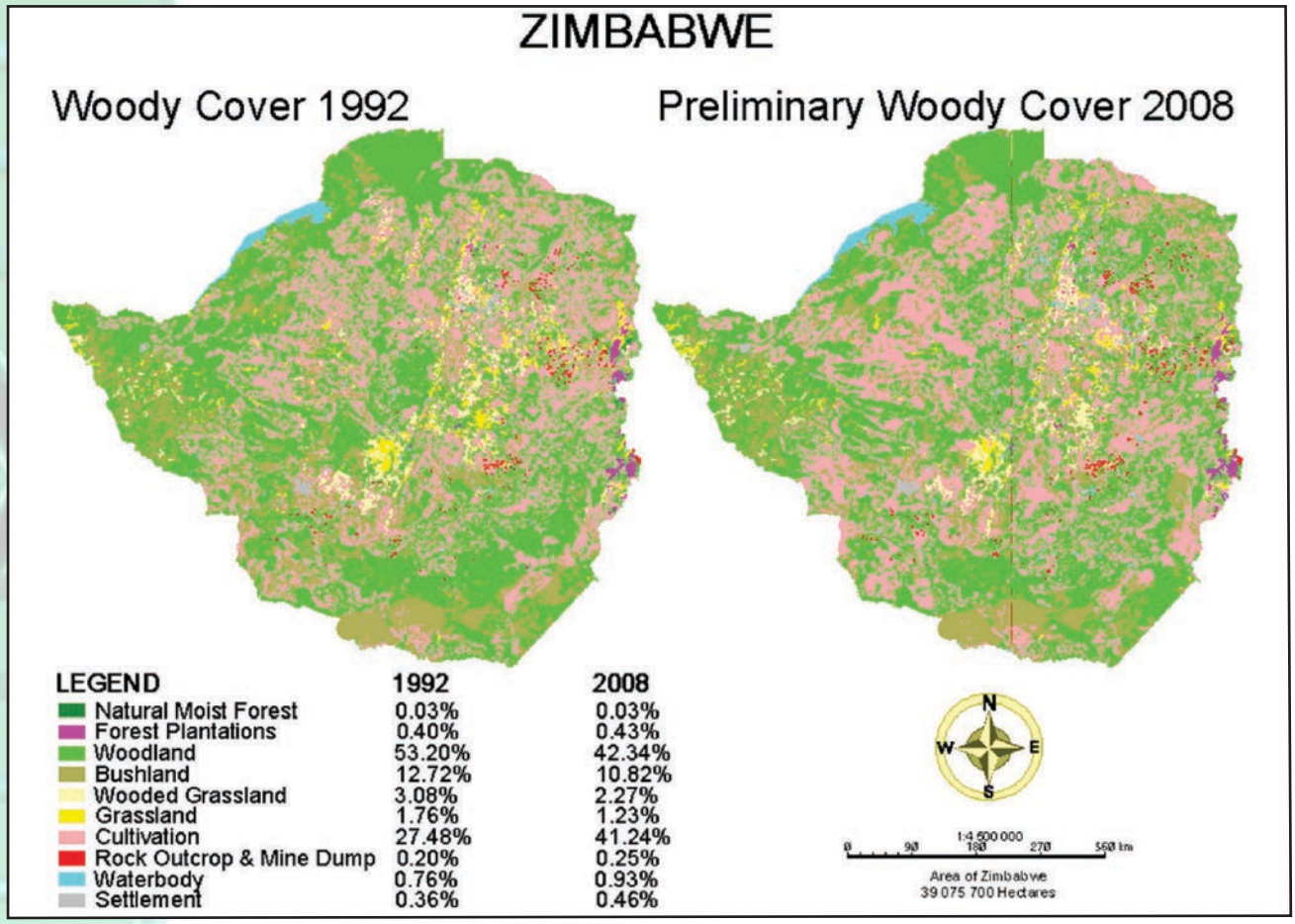

Figure 2: Woody cover maps of Zimbabwe (1992 and 2008).

Factors affecting the state of forest diversity

Over the past decade anthropogenic threats have been amongst the major threats to forest biodiversity. Climate change has also emerged as one of the leading threats to biodiversity in general. Other threats to forest diversity include wild fires, and invasive alien species.

Agricultural expansion

The opening up of forestland for agricultural expansion is the major reason for the loss of the country's forest biodiversity. It is now estimated that 330,000ha of forestland is lost to agriculture each year (Zimbabwe 4th National Biodiversity Report, 2010) compared to 70,000ha a few decades ago. Pristine miombo woodlands on the central watershed of the country are now much smaller in extent, having been cleared for cropping and grazing land. This situation is worse in the communal farming areas where 66% of the country's population lives.

Use of trees as an energy source

Natural forests and woodlands are the major source of fuelwood for rural and low income urban households who are unable to access the other sources of energy (e.g. electricity and kerosene) due to their high cost and limited availability. It is estimated that one rural household requires about 6 tonnes of fuel wood per year. Besides the daily cooking and occasional heating in winter, fuelwood is also widely used in backing clay bricks. Over the past decade, the country experienced foreign exchange shortages that resulted in shortages of kerosene (paraffin), which is widely used for cooking by low income people in urban areas. The use of firewood increased dramatically resulting in widespreading deforestation around most urban centres. The full extent of that impact has as yet to be quantified.

Infrastructural Developments

As is the case in other developing countries, Zimbabwe continues to prioritise infrastructure development for economic growth. Consequently, the rapid population growth and the related urbanisation is exerting pressure on habitats and ecosystems surrounding cities, towns and rural service centres through the provision of infrastructural services such as houses, factories and roads. This is confounded by the drive to attract foreign investment with tourism, agriculture and mining being the most lucrative sectors. Such investments result in infrastructural developments that can drive out various biological species from their habitats. For example, unless developments in the Victoria Falls area are carefully implemented, they could destroy the ecosystem on which the very existence of the tourism industry depends. Over the past decade, however, there were no significant infrastructure developments that were undertaken in the country that could potentially affect habitats.

Fire Damage

The inappropriate use of fire as a forest management tool has caused biodiversity losses in the different forests. For example, a study on the effect of fires in the Gwaai Forest Reserve showed that fires have a depressive effect on teak woodlands as they shift species' composition from *Baikiaea* and *Guibourtia* towards non commercial timber species; and from single to multi-stemmed root stocks (Calvert and Timberlake, 1992). In one single year (2009) over 945,000ha of land (forest, woodland and grassland) were burnt by wildfires (Environmental Management Agency, 2009). Between 2004 and 2010, over 867,000ha of forest land were burnt by fire in the intensively protected indigenous forests (Forestry Commission Annual Report, 2010) (Table 1.2).

Table 1.2: Area burnt in indigenous protected forests between 2004 and 2010.

Year	Number of Forests burnt	No of fires	Total Area burnt (ha)
2004	6	30	60 152
2005	11	67	260 643
2006	8	29	120 892
2007	10	40	96 337
2008	10	21	157 503
2009	6	23	91 920
2010	10	23	796 260
TOTAL	**61**	**233**	**867 067**

Source: Forestry Commission Annual Report, 2010

In the plantation sector, fires have also remained a major challenge as indicated by a cumulative 32,000 ha of plantation area burnt between 2005 and 2010 (Table 1.3). In one single year, almost 20% of the exotic plantation area was burnt by fires (Table 1.3).

Table 1.3: Fire losses for the Plantation sector between 2005 and 2010

Year	Area Burnt (ha)	Percentage loss (%)
2005	383	0.4
2006	9 732	9.3
2007	1 924	1.8
2008	2 265	2.3
2009	18 049	20.0
2010	500	0.6
TOTAL	**3 235 334.4**	**34.4**

Source: TPF -Zimbabwe Timber Industries Statistics 2005-2010

Habitat loss to alien species

Some of the exotic tree species introduced for commercial or ornamental purposes have escaped from target areas and are now replacing the original tree vegetation. Specific examples include *Acacia mearnsii* in the mist belt of eastern highlands, *Pinus patula* in the high altitude areas of eastern highlands, *Psidium spp., Populus canescens, Jacaranda mimosifolia* and *Lantana camara*. Some indigenous species such as *A. nilotica* and *Dichrostachys cinerea* are aggressive colonisers of mostly degraded lands. While their contribution to restoring sites is positive, *D. cinerea* forms thickets that are difficult to penetrate. The full extent of the impact of invasive alien woody species is still to be ascertained.

Selective Logging and Extraction

Commercial timber species found in the Zambezi teak woodlands are selectively cut on the basis of diameter (minimum 30cm) and stem form. It has been postulated that the selective removal of 'good' tree phenotype could potentially lead to genetic impoverishment of the species as superior trees are removed. However there are no long term studies that have been conducted to investigate the consequences of selective logging on the Zambezi teak woodland. In addition, selective logging affects species recruitment and dominance. For example, *Baikiaea plurijuga* tends to become the dominant species after logging in teak forests. The selective extraction of trees for various uses by local communities also leads to overexploitation. Over-exploitation of *Dalbergia melanoxylon* by wood crafters is believed to be contributing to the decline of the species. *Warburgia salutaris*, a tree reputed for its medicinal properties in the south-eastern Zimbabwe (Chipinge district), is almost extinct as a result of over harvesting. *Bivinia jalbertii*, a species that is endemic to southern Zimbabwe (Nyoni Hills, south of Chivi district) yields very durable poles but is under severe threat from overexploitation. There is also speculation that the large scale harvesting of fruit trees such as *Uapaca kirkiana* for urban markets could potentially lead to genetic impoverishment of the remnant stands as potential propagules (seeds) are removed away from their natural habitat, thus reducing the regenerative capacity of the species. What is lacking at the moment is monitoring studies to determine the consequences of uncontrolled harvesting of fruits, timber and medicinal extracts from the wild.

Elephant Damage

The impact of elephant browsing on forest biodiversity is a function of their population density. It has been reported that high elephant densities lead to shifts in plant species composition in the teak and mopane woodlands. For example, elephant damage can cause suppression of tree growth resulting in shrub and grass savannah in mopane woodlands (Anderson and Walker, 1974). In recent years, elephant damage in national parks and wildlife areas (Hwange National Park and Mana Pools area), was observed to be very high resulting in *Terminalia spp.* becoming a dominant species in sections of the teak forest.

Climate Change

During the last decade there have been significant changes in weather patterns in Zimbabwe and Southern Africa in general. Available data show that the six warmest years on record for Zimbabwe have occurred since 1987 and that four of those years were recorded after 1998 (USAID, 2010). This is consistent with all climate models that have predicted that southern Africa (including Zimbabwe) will get drier and drier as a consequence of climate change. Climate change poses serious threats to the environment. These include erratic rainfall, frequent droughts and floods which cause increased dependency on natural resources and erosion of biodiversity. Severe droughts often result is massive tree deaths leading to a change in tree species composition of forests or at worst conversion of forested areas into grasslands. The variability in climate is particularly critical for tree species whose geographic distribution is very restricted and those endemic to Zimbabwe. The species that will require monitoring in the next decade include *B. jalbertii* and *W. salutaris.*Indirect impacts of climate change can be appreciated in the shift of investment priorities by government and development organisations from natural resources management to immediate livelihood demands such as food security.

Future needs and priorities

Zimbabwe has not yet developed specific action plans on the conservation of forest genetic resources at national level. The Zimbabwe Biodiversity Action Plan of 1998 identified unmet needs in the context of the Convention on Biological Diversity (CBD) (Zimbabwe 4th National Biodiversity Report, 2010). Although progress has been made in addressing some of the unmet needs as they relate to forest genetic resources, for example, forest inventories and surveys for vegetation cover, threatened species and change in land use, a lot needs to be done in mainstreaming conservation and management in the context of forest genetic resources. Key result areas include formulation of relevant legislative frameworks, training and capacity building for relevant institutions and government departments, and improving community education, awareness on value and sustainable management of forest genetic resources, determining the genetic variability of the threatened species and those being actively exploited (for timber, fruit, medicinal, etc). Other areas which will require attention include strengthening national, regional and international collaborations on forest genetic resources management and promotion of access and benefit sharing issues with regards to forest genetic resources.

Chapter 2: The state of in situ genetic conservation

Introduction

The country's forest resources fall into natural forests, woodlands and trees on communal lands, private land, national parks and wildlife areas and in protected forest areas; and exotic forest plantations. In situ conservation of forest genetic resources in Zimbabwe is mainly practised in protected forest areas under the Forestry Act. In situ conservation of forest genetic resources is also practised in other legally protected areas (parks and wildlife) and in communal areas mainly based on traditional beliefs.

Forests and woodlands constitute 53% of land mass in Zimbabwe of which 2% is protected under the Forestry Act and a further 13% is protected under Parks and Wildlife Act. The responsibility for in situ and ex situ conservation of forest and tree biodiversity in gazetted or protected forests resides with the Forestry Commission. Outside the protected forests, the Forestry Commission uses both the Forestry Act and the Communal Lands Forest Produce Act as applicable laws in the protection, conservation and utilisation of forest resources. Furthermore, these instruments are further strengthened by a combination of traditional beliefs, local by-laws in in-situ conservation efforts in communal areas.

The Parks and Wildlife Act established in situ conservancies in designated national parks, safari and wilderness areas, sanctuaries, botanical gardens, botanical reserves and recreational parks. The main objective of establishing these protected areas is to preserve, conserve and protect wildlife and its associated forest, natural landscape, plants, and natural ecological stability of flora and fauna of Zimbabwe.

The lack of sufficient studies to understand genetic variation within and among key tree species has hampered the formulation of consistent strategies to optimise in situ conservation efforts. Moreover, the increased cases of alien invasive species, high incidences of uncontrolled or wildfires, illegal mining and continuous agricultural expansion will continue to weaken the in situ conservation efforts.

Forest Genetic Resources Inventories and Surveys

In an effort to enhance sustainable conservation and utilisation of forest genetic resources in the country, the Forestry Authority or its designated agents periodically conducts inventories and surveys to quantify exploitable forest resources. The following inventories and surveys were carried out in Zimbabwe in the past few years:

a) Large diameter tree classes that are not harvested (seed trees) for commercially exploited tree species *(Baikiaea plurijuga, Pterocarpus angolensis, Afzelia quanzensis* and *Entandrofragma caudatum* in Mafungabusi and Muzola protected forests were mapped and marked.

b) The amount of commercially exploitable timber species (*B. plurijuga, P. angolensis, Afzelia quanzensis, E. caudatum, Kirkia acuminate, Albizia antunesiana* in the districts of Nkayi, Zibagwe and Tsholotsho and in Mzola forest were determined.

c) Vegetation change detection analysis was conducted in Mudzi district based seven different classes (Mopane, *Commiphora/Combretum* and Miombo woodlands, riverine forest, cultivation, rock outcrop and water body.

d) Woody vegetation cover assessments were carried out in Mwenezi District targeting Mopane woodland Combretum woodland, cultivated land and other classes.

e) Timber enumeration survey were conducted to establish estimates of standing stock volume by species (*P. patula, P. elliottii* and *E. grandis*) and age groups in commercial plantations in Mutare district and eucalypts at Gwebi College of Agriculture.

f) Compartment boundaries of *Eucalyptus spp*. plantings in Guruve district were mapped to enhance management.

g) An inventory and collection of specimens of medicinal plants was undertaken in the five districts Bulilima, Mangwe, Matobo, Chimanimani and Chipinge. The study also determined distribution of the medicinal plants their regeneration capacity.

h) Gold panned areas in Chimanimani District were mapped and the extent of damage to local environment was also assessed.

i) Vegetation inventories were conducted in Mashonaland East province using Integrated Resource Information System.

j) Inventories of tree endemic species and those under severe threat (Red Data lists) for Zimbabwe were conducted.

Conservation of Forest Genetic Resources within and outside protected areas

Table 2.1: Protected dry forests and woodlands in Zimbabwe*

FOREST	Principally targeted tree species	Area (ha)
Chesa		14,250
Insenze Extension		8,400
Gwaai	*Baikiaea plurijuga*	144,230
Mbembesi		55,100
Gwampa	*B. plurijuga*	47,000
Sukumi		54,400
Fuller	*P. angolensis*	23,300
Kavira		28,200
Molo		2,900
Mvutu		2,100
Ungwe	*Entandrophragma caudatum*	567
Grants		2,509
Insenze		35,200
Umguza		32,200
Ngamo	*P. angolensis, G. coleosperma*	102,900
Lake Alice		39,000
Mzola	*Colophospermum mopane*	67,200
Kazuma	*B. plurijuga*	24,000
Panda-Masui		35,500
Sijarira	*C. mopane*	25,600
Umzibane	*Pterocarpus angolensis*	2,471
Mafungabusi		82,000
Mudzongwe	*E. caudatum*	1,420
Batley		2,215
TOTAL		**832,662**

*Source: Ministry of Environment and Natural Resources Management, 2010

Conservation within protected areas

Forest protected areas in Zimbabwe includes; gazetted moist and dry forests, National Parks, Safari areas, Sanctuaries, Botanical Gardens, Botanical Reserves and Recreational Parks. There are over 832,000ha of protected dry forests and woodlands are protected in Zimbabwe (Table 2.1). The protected dry forests range in size from 567ha (Ungwe forest) to 144,000ha (Gwaai forest). Each of these forests has a unique species that is principally targeted for conservation efforts. Table 2.2 shows the extent of the moist natural forests of Zimbabwe. All the moist forest (rainforests) cover just over 10,600ha. The forests vary in size from 10ha (Nyangui) to over 3,100ha (Nyazungu/Pungwe gorge). Not all the natural forests are protected by law as some are not as yet gazetted. Some of the forests are only private land, some on state land (National Parks or Forestry Commission) while others are on communal lands. The least protected are those on communal lands.

Table 2.2: Extent of natural rainforests in the eastern highlands*

Area	Extent (ha)	Percentage of total forest (%)
Nyangui	10	0.09
Kwaraguza	55	0.52
Nyafaru	165	1.55
Nyanga Block/Gleneagles	2900	27.27
Nyazengu/Pungwe Gorge	3180	29.90
Lower Pungwe Valley	35	0.33
Mtarazi Falls	260	2.44
Stapleford/Sheba (Rupere and Gorongo forests)	255	2.40
Mutare	25	0.24
Vumba North	430	4.04
Vumba South & East	545	5.12
Banti, Engwa, Chetora	305	2.87
Mudima, Nyambena, Tandai Forests	300	2.82
Gwendingwe	290	2.73
Chikukwa Communal Land	70	0.66
Mutema Communal Land	0.38	0.38
Mermaids Grotto/Glencoe	200	1.88
Chimanimani Nat. Park	190	1.79
Chimanimani Town	25	0.24
Haroni/Rusitu/Chisengu rivers	425	4.00
Upper Rusitu Valley	35	0.33
Waterfalls	60	0.56
Chipinge Tea Estates	20	0.19
Mount Selinda area (Chirinda forest)	815	7.66
Total	**10,635**	**100**

*Source: Tom Müller (2006)

The land area under the National Parks and Wildlife Management Authority is also protected and therefore provides secondary protection to the forests, woodlands and trees on these lands (Table 2.3). There are over 2.7 million ha of land under national parks ranging from 2,300ha (Victoria Falls) to 1.4 million ha in the Hwange National Park. Safari areas, recreational parks and sanctuaries cover more than 2.6 million ha which is also protected by law and therefore indirectly protects forests, woodlands and trees.

Table 2.3: Extent of protected areas under the National Parks and Wildlife Management Authority

National Park	Area (1000 Ha)
Chimanimani	17.1
Chizarira	191
Gonarezhou	505.3
Hwange	1,465.10
Kazuma Pan	31.3
Mana Pools	219.6
Matopos	42.4
Matusadona	140.7
Nyanga	47.2
Victoria Falls	2.3
Zambezi	56
Total national park area	**2,703.8**

Other Protected Areas	Area
Safari Areas	2 367.0
Recreational Parks	308.6
Botanical Reserves	7.0
Botanical Gardens	0.5
Sanctuaries	18.6
Subtotal	**2,701.7**
Total protected area	**5,403.5**

Conservation of forest tree resources outside protected areas

The use of tree resources on communal lands is governed by two pieces of legislation: the Communal Lands Act and the Communal Land Forest Produce Act. Local authorities (District Councils) usually have control over the exploitation of trees within their jurisdiction. Local people do not receive a share of the profits from the exploitation of trees but are deemed to benefit from the services rendered by these local authorities.

The Forest Act, although broad in its coverage of forest resources throughout the country; tends to be applied chiefly to protected or gazetted forests and forests/woodlands on private land (predominantly large-scale commercial farms). However, application of the Forest Act on forests on private land is less strict and to a large extent provides a self regulatory control mechanism. The Act prohibits the harvesting, injury or destruction of any indigenous trees or timber from private forests except in terms of a valid timber permit issued with the consent of the forestry authorities. On protected forests, the Act for a long time advocated the protectionist approach to conservation which did not permit neighbouring communities to derive any benefits from them. The protectionist approach has been blamed on the widespread timber poaching by the communities (Shumba, 2001).

Traditional culture as a conservation strategy

Traditional beliefs have consistently positively impacted on the conservation and management of trees and woodlands in communal areas. Zimbabwe has long tradition of nature conservation as part of its culture. Sacred trees, forests and landscapes illustrate are few examples of this unique tradition. The claims that this is a manifestation of nature worship could in future potentially reduce the effectiveness of this strategy. It is very difficult to give the exact number of sacred forests and woodlands and their extent (i.e. area) in Zimbabwe as such an exercise has not been done. There is therefore a need to determine the number and size of the sacred forests in Zimbabwe to quantify its contribution to the conservation of genetic resources.

Certain trees or whole forests are usually considered sacred and harvesting of trees in such forests is prohibited or regulated. Parinari curatellifolia is considered sacred as religious ceremonies are usually performed under the tree. The cutting down of fruit trees is in some areas prohibited by the traditional leaders as the trees are often the source of food in periods of poor crop harvests. It is therefore not uncommon to find fruit trees such as *Ziziphus mauritiana* (Zambezi valley), *Azanza garckeana* and *Strychnos cocculloides* (Gokwe district) growing on crop fields.

Ecosystem Management for Forest Genetic Resources Conservation within and outside Protected Areas

Trans-boundary Natural Resources Management Areas

Zimbabwe is a member to a number of trans-boundary natural resources management area initiatives which includes Zimbabwe-Mozambique (ZIMOZA), Zimbabwe-Zambia (TBRMA) and Great Limpopo Trans-frontier Conservation Area (GLTFCA) between Zimbabwe-South Africa-Mozambique. These trans-boundary programmes aim to improve the sustainable use of the shared natural resources.

Community Based Natural Resources Management Programs

In forests, with large populations of wildlife species, bordering communal areas, there are formal arrangements with local communities to engage in the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in which the locals benefit from utilisation of wildlife. The CAMPFIRE is a long-term programmatic approach to rural development that uses wildlife and other natural resources including forest genetic resources as a mechanism for promoting devolved rural institutions and improved governance and livelihoods. The cornerstone of CAMPFIRE is the right to manage, use, dispose of, and benefit from these local resources. The CMPFIRE approach gives a voice in natural resource management decision-making.

Management of wildlife populations

The elephant population has been reportedly increasing over the last decades at a rate of 5% per year (source) with most areas with population exceeding their carrying capacity. It has been reported that high elephant densities lead to shifts in plant species composition in the teak and mopane woodlands. For example, elephant damage can cause suppression of tree growth resulting in shrub and grass savannah in mopane woodlands (Anderson and Walker, 1974). In the Hwange National Park and Mana Pools area, elephant damage is so high that Terminalia has become a dominant species in a teak forest.

Fire Management

In 2010 over 79,000ha of forest land were destroyed by fire in protected forests (Forestry Commission Annual Report, 2010). Although the use of fire as a management tool is beneficial; its inappropriate use has caused biodiversity losses. For example, a study on the effect of fires in the Gwaai protected forest showed that fires have a depressive effect on teak woodlands as they shift species' composition from Baikiaea and Guibourtia towards non commercial timber species; and from single to multi-stemmed root stocks (Calvert and Timberlake, 1992). The full impact of the fires that burnt over 79,000ha of the protected forest land recently is still to be felt.

Activities on in situ Genetic Conservation

Commercial Timber

The harvesting of timber trees (*B. plurijuga, P. angolensis, G. coleosperma* and *A. quanzensis*) in natural forests is by selection of right size specimen. Quantities of the latter two species are considered low due to the inherent low densities of the species per unit area. *Pterocarpus angolensis* has been heavily exploited in the past, due to its being highly favoured for furniture making. There are currently seven timber concessions operating in five different forest reserves and 13 formal indigenous hardwood firms in western Zimbabwe.

Wildlife

After the establishment of the Forest Commission in 1954 wildlife production within the protected forests became one of the major activities. The production and utilisation of wildlife for ecotourism activities (consumptive and non-consumptive tourism) has gained increasing importance in protected forests during the last five decades. The forests are rich in populations of elephant, buffalo, lion, leopard and rhino and the larger and smaller antelopes. Poaching by local communities is a recurring problem. The forest authorities have also engaged communities neighbouring some of the large protected forests with arrangements similar to the CAMPFIRE.

Forestry products

Forests also provide a wide range of non-wood products and services to communities leaving within or near the forests. Studies in three protected forests firewood, thatch grass, construction poles and wild fruits were the most important products collected from the forests (Mufandaedza, 2004; Mudekwe, 2006). The sale of firewood, wild fruits, thatch grass and curios is an important economic activity for harvesters living adjacent to the forests. The Forestry Commission currently encourages the active involvement of local people in the management of the forests as a means of ensuring sustainable forest resource use. Observations are that the success of this involvement by the local people in the management of the resources is dependent on the existence of tangible benefits.

Grazing

Forests provide grazing for domestic stock, predominantly cattle. Three ways of managing domestic stock are available in protected forests. There are commercial rancher-leased cattle grazing schemes in selected forests and currently there are eight grazing leases in six protected forests. Most forests are surrounded by communal and resettlement areas and therefore domestic stockowners in these surrounding areas graze their cattle in the forests. During drought years, protected forests are used for drought relief grazing under some arrangements between cattle owners in the region and the Forestry Commission. Livestock grazing is a valuable tool that is used to reduce fuel loads in protected forests.

Criteria for in situ Genetic Conservation units

Criteria for establishing protected areas

The Forest Act sets out the criteria for establishing gazetted forest in Zimbabwe while National Parks and Wildlife Act set out the criteria for establishing protected areas in Zimbabwe. The National Parks and Wildlife Act criteria mainly targets wildlife conservation though in broad sense includes the forestry genetic resources that give habitats to wildlife.

Criteria used to establish Strict Natural Reserves

Strict Natural Reserves (SNR) were established within the protected forest reserves. They contain commercially harvestable indigenous hardwoods. The target species are those of commercial importance whose genetic integrity could potentially be altered by over exploitation. The SNRs are akin to 'witness stands' but little is known about the genetic variation of the target population. If conservation of these species is to be successful the specific genetic variation over their distribution zones needs to be investigated established to create a base for future monitoring.

Criteria used to establish Plant Red data list

The IUCN 1994 Red Data list categories were used to determine plant genetic resources that are extinct, extinct in the wild, critically endangered, endangered, vulnerable, lower risk, lower risk-near threatened, lower risk-least concern and data deficient.

Use and Transfer of Germplasm

CAMCORE Membership

The Central America and Mexico Coniferous Resources (CAMCORE) is a non-profit, international organisation which promotes the conservation and utilisation of tropical and subtropical forest tree species of Central America and Mexico for plantation development. Their primary activities include but not limited to, germplasm exploration, collection and distribution to its members for conservation, breeding and utilisation. The Forestry Commission was a member of CAMCORE up until 1999, when the organisation withdrew due to financial challenges. Today, Border Timbers a local timber company is an active member CAMCORE. The Forestry Commission benefitted immensely during their period of membership. Besides interaction and exchange of scientific ideas and materials, the organisation also acquired germplasm of *P. maximinoii, P. tecunumanii, P. greggii, P. herrerae and P. patula.*

Tree Seed Centre

The local tree seed centre was initially founded on tree seeds of commercial trees. The seed centre was then strengthened in the late 1980s by the Canadian International Development Research Centre (IDRC). The aim was to transform the tree seed centre into a regional tree seed centre. With further assistance from the Canadian International Development Agency (CIDA), the tree seed centre become a member of the SADC Tree Seed Centre Network project after the establishment of similar tree seed centres in Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania and Zambia and later South Africa.

From its highly sophisticated breeding programme of pines and eucalypts, the local tree seed centre has over the years sold tree seed into the region (South Africa and Malawi), east Africa (Uganda), South America (Colombia) and North America (USA). The Forestry Commission is not currently involved in active germplasm exchange programs for research purposes owing to unavailability of adequate resources. The table below shows the type of germplasm that is available on request or exchange.

Table 2.4: Tree germplasm that may be available on request to nationals and internationals partners

Species (scientific name)	Type of material	Available for national requests only		Available for international requests	
		Commercial	Research	Commercial	Research
P patula	Seed	Yes	No	Yes	Yes
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
P taeda	Seed	Yes	Yes	Yes	Yes
	Pollen	No	Yes	No	Yes
	Cuttings	No	Yes	No	Yes
P elliottii	Seed	Yes	Yes	Yes	Yes
	Pollen	No	Yes	No	Yes
	Cuttings	No	Yes	No	Yes
P kesiya	Seed	Yes	Yes	Yes	Yes
	Pollen	No	yes	No	yes
	Cuttings	No	yes	No	yes
P oocarpa	Seed	Yes	No	Yes	No
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
P psuedostrobus	Seed	Yes	No	Yes	No
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
P. maximinoii	Seed	Yes	Yes	Yes	Yes
	Pollen	No	Yes	No	Yes
	Cuttings	No	Yes	No	Yes
P. tecunumanii	Seed	Yes	Yes	Yes	Yes
	Pollen	Yes	No	Yes	No
	Cuttings	No	Yes	No	Yes
E. grandis	Seed	Yes	Yes	Yes	Yes
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
E. saligna	Seed	Yes	No	Yes	No
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
E. cloeziana	Seed	Yes	No	Yes	No
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
Eucalyptus Hybrids	Seed	No	No	No	No
	Pollen	No	No	No	No
	Cuttings	No	No	No	No
E camaldulensis	Seed	Yes	Yes	Yes	No
	Pollen	No	Yes	No	No
	Cuttings	No	Yes	No	No
E tereticornis	Seed	Yes	Yes	Yes	Yes
	Pollen	No	Yes	No	No
	Cuttings	No	Yes	No	No
E citriodora					
E grandis x E camaldulensis					

Priorities and major needs of in-situ forest genetic resources

The following are the priority areas of focus and investment to enhance in situ conservation of forest genetic resources in Zimbabwe.

1. There is a need to conduct comprehensive genetic studies (molecular and quantitative) on the endangered tree species to enable the development of optimum conservation strategies for the species.

2. Restoration of the membership of the Forestry Commission and its scientific staff to major cooperatives and netwconsidered if the financial position of the rest Genetic Resources Network - SAFORGEN) should be considered s the financial position of the organisation improves. This is expected to enable Zimbabwe to not only access germplasm but also allow local scientists to engage with their peers in international fora.

3. There is a need for the tree seed centre to refurbish its equipment and also expand its capacity to meet the growing needs of the region in terms of germplasm.

4. The research and development in forest trees in Zimbabwe has remained basic, relying on may now be described as inefficient approaches. There is a need to build the capacity of local scientists to enable them to use modern methods that are fast, efficient and more reliable and perhaps cost effective in the long run.

5. Agricultural expansion and mining (particularly illegal or uncontrolled gold panning) remains the greatest threat to in situ conservation efforts. Enforcement of the law to protect forests and woodlands, particular those with endangered or threatened species must be a priority.

6. Although there are now laws governing the control of invasive alien woody species, the response has perhaps been slow. The priority must be to quantify the extent of the invasion in all areas, the cost in terms control, lost environmental services, ensure that progress on control is quantified and monitored.

7. There is also a need to develop a coordinated approach to the issue of conservation as this cuts across many institutions (e.g. national parks, forest authorities, farmers and local authorities).

Chapter 3: The state of ex-situ forest genetic resources

Introduction

Ex-situ conservation entails the protection of species outside their natural habitats by removing part of the population into a new location that is managed by man. This form of conservation must be regarded as the least favourable, and an option of last resort for a number of reasons.

(a) It is very difficult to mimic species habitats given the large number of variables that define them. Thus the new environment may never equate the natural habitat.

(b) In many cases, only a few individuals (or propagules from a few plants) which may be unrepresentative of the natural population, are rescued and brought into storage or conservation.

(c) Ex-situ conservation disrupts the process of evolution as associated species are not included in the conservation exercise. Its greatest advantages are that it increases accessibility and awareness on the conserved species.

Ex-situ genetic resource management

The management of ex-situ forest genetic resources in Zimbabwe is primarily a responsibility of the public sector. Public institutions involved are the Forestry Commission, National Parks and Wildlife Management Authority (both under Ministry of Environment and Natural Resources) and National Herbarium and Botanic Garden (Department of Research and Specialist Services, Ministry of Agriculture). The Forestry Commission is by far the largest contributor, primarily focusing on ex-situ conservation of commercial timber species (eucalypts and pines, in particular). The National Parks and Wildlife Management Authority and National Herbarium and Botanic Garden specifically account for genetic conservation of indigenous species.

Tree seed banks

Establishment of tree seed banks involves the collection of genetic resources in the field in the form of seed, tissues, embryos or buds or pollen, and their subsequent storage at national centres.

Scientific principles are applied during seed collection expeditions to ensure that a population is adequately sampled and conserved. Such seed banks provide readily accessible operational plant material. Ex-situ conserved material also acts as a back-up for some segments of diversity that might otherwise be lost from anthropogenic activities.

The Tree Seed Centre of the Zimbabwe Forestry Commission currently holds over 23,000 accessions. These mainly consist of seeds of species collected from natural stands, research trials and also sourced from other tree seed centres worldwide. The accessions include over 400 provenances and introductions of exotic species, as well as indigenous tree species from seed stands, seed orchards and trials.

Information kept on the seedlots includes species name, date of collection, and such other details as collection locality, its altitude, soil type and climatic. Where applicable, growth performance data is also collected. To date, eucalypts and pines (exotics) represent the major tree species collected for ex-situ conservation. Approximately 50kg of each of the two species are exported annually as exchange material for international afforestation and research. The others germplasm conserved ex-situ is for indigenous tree species, ornamentals and fruit tree species.

Storage facilities

The tree seed is stored at the Seed Centre of the Forestry Commission in cold rooms at ±5°C for long term storage and at ±15°C for short term storage of orthodox seed. There is need to upgrade and expand storage and seed testing facilities at the Centre. The greatest challenge faced by the Tree Seed Centre in the past was the intermittent power supplies to the cold room. Seed duplication is an important issue that is currently not in place. Collaboration with the National, Regional and International Gene Banks or other relevant institutions needs to be developed in order to improve safety of storage of genetic material. Presently, field banks provide the only form of duplicate copies for ex-situ genetic material in the country, but only for selected commercial species.

Resource conservation stands

Genetic resource conservation stands are established for tree species that are threatened by over-exploitation, and whose population structure is heavily fragmented. Such species include *Chlorophora excelsa* which has a few trees left in Gonarezhou National Park, *Bivinia jalbertii* with a relic population left in the Ngundu Hills, and *Warburgia salutaris* with a heavily fragmented, relic population on Mt Chirinda. For species that do not survive outside their natural ranges, establishment of enrichment planting sites has been encouraged. In some cases, such sites are gazetted and protected as special conservation areas to ensure preservation of the species. Some 27 sites have been gazetted under the Environmental Management Act as special areas of endemism or representatives for vegetation/species types on privately owned land. These have mainly been established under the auspices of the Forestry Commission.

Botanic Gardens of National Herbarium and Botanic Garden

Ministry of Agriculture, Mechanization and Irrigation Development administers ex-situ conservation of forest genetic resources through the National Herbarium and Botanic Garden. The Garden, with an outstation in Mazowe (Mazowe Botanical Reserve) was established with the objective of building a comprehensive collection of plants found in Zimbabwe and the southern African region. At the same time, representative units for major ecosystems or vegetation types of the country were established in the garden. To date, 1,060 plant species, representing 82% of the about 1,230 woody species found in Zimbabwe, have been established in the National Botanic Garden. This collection contributes towards genetic conservation, through authentic plant identification and education afforded by easier accessibility of the species. Due to space constraints, however, the National Botanic Garden does not contribute much to the physical conservation of forest genetic resources as only a limited representative number of plants of each species can be grown. Some seed collections stored in the Herbarium storerooms are progressively being destroyed by pests due to inadequate monitoring and failure to fumigate the premises as required.

Botanic Gardens of the Parks and Wildlife Management Authority

The Nationals Parks and Wildlife Management Authority manages ex situ forest genetic resources through two botanic gardens, Ewanrigg, near Shamva (area of 286ha) and Vumba, near Mutare, (area of 242ha). The Ewanrigg garden focuses primarily on succulent species, while Vumba garden primarily focuses on rainforest woody species of the Eastern Highlands of the country.

Ex Situ Community Field Gene Banks

There are some few Non-Governmental Organisations (NGOs) that are working with communities in setting up Field Gene banks of both fruit trees and medicinal trees. They include Southern Alliance for Indigenous Resources (SAFIRE), Environment Africa and the Zimbabwe National Traditional Healers Association (ZINATHA).

Security

Although the security at the Forestry Commission's Tree Seed Centre is adequate, there are indications that the security at the National Botanic Gardens may be inadequate as the ex situ conserved trees, especially medicinal species, are frequently poached.

Constraints to sustaining ex situ collections

Ex situ collections have low demand for utilisation, hence are static. Limited resources are allocated for their conservation and protection. Some of the challenges faced by institutions involved in ex-situ conservation include a decline in financial support from the public purse. This was exacerbated by challenges country faced between 2001 and 2009. In some of the institutions involved in conservation, there are no specific budgets for ex situ maintenance of forest genetic resources and most institutions have to do with the same budget meant for other important activities. Institutions with cold storage facilities are facing challenges of power cuts. There are therefore unable to maintain the required low temperatures for long term storage. Resources permitting, it will be prudent for the institutions involved to acquire standby generators to minimise power disruptions, and consequently the integrity of the germplasm.

As the country faced economic challenges between 2001 and 2009, there was a massive exodus of trained and experienced staff to other countries, resulting in inadequate human capacity to carry out ex-situ conservation work. Activities on regeneration, characterisation and viability tests were either shelved or poorly done. This has compromised the quality and longevity of some of the ex-situ material.

Although facilities to conduct molecular studies (e.g. characterisation) are available at some institutions in Zimbabwe (University of Zimbabwe Crop Science Department, Tobacco Research Board), the high cost of contracting the work has hampered the adoption and use of these modern techniques.

An analysis was conducted to assess the extent of genetic conservation of forest tree species and other woody plant species in the country by the National Herbarium and Botanic Garden. The results were used to designate areas of different gene-ecological zones of the country, where 20-30% of woody species are included in conservation programmes. Some of the conservation has been designated on-farm (circa-situ).

Regeneration

Many of the ex situ conserved species that were not regenerated between 2001 and 2009 will require immediate regeneration in order to preserve the genetic material before it deteriorates. This will however depend on availability of funding.

Future needs and priorities

The public institutions involved in ex-situ conservation must ensure that duplicate material is also deposited at the National Gene Bank, whose mandate at present is restricted to agricultural and food crops. Collaboration with international institutions that store and distribute forest genetic resources must be strengthened. Duplicate material must always be deposited at the Millennium Gene Bank, Wakehurst, London after following all the necessary protocols on biosecurity.

In the short term there is a need to prioritise ex-situ conservation of all species listed on the National Red Data List. There is also a need for a coordinated approach to germplasm exploration and collection, among all the national institutions involved in conservation of forest genetic resources collaborating. Those institutions without adequate facilities such as cold storage facilities must urgently equip their laboratories to minimise losses.

Zimbabwe has a number of species (e.g. *Encephelatos spp*.) that are known to be extinct in the wild. There is an urgent need for the relevant institutions initiate the re-introduction into natural habitats of species that now only exist in the home gardens. Measures to protect the habitat of the other species (e.g. *Warburgia salutaris, Bivinia jalbertii* , *Chlorophora excels* and *Juniperus procera*) that are severely threatened needs urgent attention. Research must also be conducted to determine least cost propagation methods for these threatened species. There is also a need to compile information for species on the national Red Data List and publicise this to improve awareness among all the stakeholders including policy makers and the public.

Chapter 4: The State of use and Sustainable Management of Forest Genetic Resources

Introduction

Zimbabwe has an advanced participatory conservation framework on forest genetic resources based on the Community Areas Management Programme for Indigenous Resources (CAMPFIRE). CAMPFIRE is a national programme that was established with the primary purpose of helping rural communities to sustainably conserve and utilise their natural and cultural resources. CAMPFIRE is incentive driven as local communities legally gain and exercise rights of access, and use, and have the right to derive income from these resources. The communities also determine how the income is utilized. Benefits accrue from the intrinsic values of forestry resources and these benefits could be tangible or non tangible. CAMPFIRE is premised on the understanding that producer communities are an integral component of ecosystems and must therefore be at the centre of efforts to conserve forestry and other natural resources. The Programme was designed as the answer to the management of natural resource in communal lands which are communally owned and is an intervention focused on preventing a potentially chaotic situation derived from an open access regime. The programme was initiated on the ground in Nyaminyami and Guruve Districts in 1988. To date, 23 years later, 57 out of 59 Districts are running the CAMPFIRE Programme through the engagement of local communities in various natural resources management practices.

Conceptually CAMPFIRE was designed to cover all natural resources (woodlands, wildlife, water and pasture resources). However at its inception the programme focus was on assisting communities to derive benefits from the sustainable use of wildlife resources. This is because the programme was sectorally initiated and promoted by the Parks and Wildlife Management Authority. Focus on wildlife tapped into an already established international market for safari hunting operations. Admittedly today, safari hunting is still the key driver for CAMPFIRE. Safari hunting benefits from large communal areas that are close to national parks, have low density human populations and are set aside as concession areas leased for the purpose of professional hunting activities. This has indirect benefits to the conservation of forest genetic resources as the wildlife areas in communal lands present both pristine wildlife habitats and undisturbed woodlands and grasslands.

There are many communities that are not surrounded by wildlife resources who must build their futures around different approaches to natural resource use. Programmes have been initiated in this area and focus of these is on developing community enterprises based on the use of non-forest timber products. Examples of these enterprises include: - (i) craft making, (ii) indigenous fruit processing for oils and pulp, (iii) honey production, (iv) jatropha soap making, (v) herbal tea production, (vi) water bottling, (vii) community based tourism, and (viii) honey production. These enterprises are based on woody forest resources and create a monetary incentive for the conservation of the woody trees.

CAMPFIRE will continue to assist rural communities to benefit from the sustainable use of a much wider range of natural resources. The future and sustainability of the CAMPFIRE system are directly related to the skill with which the system can expand its existing opportunities and develop new business and market opportunities around a broader range of natural resources. The challenge is to develop these other opportunities, increase the flow of benefits to communities, reduce encroachment into wildlife areas and enhance the sustainability of the forest resources and other natural resources. The key driver of devolution with CAMPFIRE is the understanding that people at the local level have a better knowledge and understanding of the local ecological dynamics acquired over many years of association with their forestry resources.

This creates the basis for integrated management of the biological and physical environment around them. Decision making and management that are closer to the ecosystem level lead to greater participation, responsibility, ownership, accountability and equity. The CAMPFIRE framework therefore if properly implemented has the potential to deliver on the three objectives of the Convention on Biological diversity which are:

- To conserve biological diversity.
- The sustainable use of the components of biological diversity, and
- Fair and equitable benefit sharing arising out of the utilization of genetic resources.

Zimbabwe also has a very advanced genetic improvement programme of exotic species of pines and eucalypts. Since the mid 1980's, programmes for other indigenous species (acacias and indigenous fruit trees) and exotic multipurpose species have been initiated. These programmes concentrate on provenance and progeny testing for adaptation and growth of the species. This Chapter gives an outline of: (i) how CAMPFIRE is promoting the conservation of forest genetic resources through their sustainable use.
(ii) active national programmes on genetic improvements.

The policy and legislative framework regulating the management of forest genetic resources in Zimbabwe

There are four pieces of legislation regulating the management of forest genetic resources in the country. These include:

(i) The Environment Management Act (Chapter 20:27). This is the main Act regulating the conservation of all natural resources in the country.
(ii) The Forestry Act (Chapter 19:05) and the Communal Lands Forest Produce Act (Chapter 19:04). These mandate the Forestry Commission to manage forest genetic resources in the country and regulate its activities.
(iii) The Parks and Wildlife Act (Chapter 20:14). This provides the legal framework for the sustainable utilization of wildlife in rural areas.

There are also two policies: the National Environment Policy (NEP) and the Forest Based Land Reform Policy (FBLRP). The legislations and the policies are briefly described below.

The Environment Management Act (Chapter 20:27)

The Environment Management Act (Chapter 20:27) (EMA) is an outcome of environmental law reforms that were initiated by Government in 1992. There were three key motivations for law reform.

- The first motivation was the need to streamline more than 11 environmental laws which were administered by different government agencies with no framework for coordination amongst themselves. The laws overlapped and suffered from conflict.
- The second motivation was to develop a framework for coordinating the laws and responsibilities of the different government agencies with different mandates for conservation.
- The third motivation was to take on board provisions of the Convention on Biological Diversity (CBD).

EMA is now the principal legislation in the country but does not cover the specific legislative requirements of each environmental aspect. It constitutes building blocks for conservation in various aspects. The implication is that all other sectoral legislation is still operative but becomes ancillary legislation and has to be reviewed to meet the provisions of EMA. The law reform is significant as it has some key conservation principles and provisions that were developed and tested in the Natural Resources Act and the Parks and Wildlife Act.

These include:

- The recognition of the importance of people particularly local communities who have the right to gain access to and enjoy the benefits of participating in the conservation of the country's biodiversity.
- The right for everyone to have access to environmental information, as well as the right to participate in policy and legislative processes.
- The need for socially, environmentally and economically sustainable development.

EMA also spells out environmental rights as human rights. These include the right:

- To leave in a clean environment.
- To protect the environment for the sake of future generations.
- To effectively participate in environmental governance.

The Forest Act (Chapter 19.05) and the Communal Lands Forest Produce Act (Chapter 19.04)

The management of forestry resources in Zimbabwe is regulated by the Forest Act (Chapter 19.05), (FA) and the Communal Lands Forest Produce Act (Chapter 19.04) and the mandate falls under the Forestry Commission. The regulation of forestry resources is still dualised with the Forest Act (FA) governing the use of forestry resources on private and state land, and the Communal Lands Forest Produce Act (CLFPA) governing the use of forestry resources in communal areas. Under the Forest Act the State and commercial farmers owning land can exploit their forests in any way they want. Under CLFPA communal dwellers can only exploit forest resources for subsistence purposes. They cannot exploit it for commercial purposes. There is a strong belief that some sections of both the FA and the CLFPA run contrary to the provisions of EMA and may therefore require review so that local communities derive more access and benefits.

The Parks and Wildlife Act (Chapter 20.14)

In the 1960s, in response to the public outcry over the decimation of predatory wildlife species in commercial farming areas, the government enacted provisional legislation that allowed freehold land owners to benefit from wildlife on their property although wildlife retained its *resi nullius* status. These provisions were entrenched in the Parks and Wildlife Act of 1975 (Chapter 20:14). This Act contains provisions for giving Appropriate Authority status (AA) to the free landholder: (i) to have control over wildlife on his land, (ii) to sell the wildlife to best advantage, (iii) to retain the full benefits from the sale of the wildlife. This provision in the Act proved to be a landmark development. Devolution of "ownership" of and the responsibility to manage and benefit from wildlife was robust - from the State to the individual landholder. Benefits accruing to the farmer proved significant and motivated the farmer to invest in wildlife management. In Agro-Ecological Zones IV and V wildlife management turned out to be a more viable land use option than traditional farming practices.

Prior to independence in 1980 the provisions of the Parks and Wildlife Act benefited the freehold landowners only. The residents of communal lands did not benefit from provisions of the Parks and Wildlife Act. The Parks and Wildlife Act was amended in 1982 to accommodate the residents of communal lands. This was effected through giving the AA status to Rural District Councils. Communities are not landowners under RDCs. This saw the conception and practice of CAMPFIRE. As outlined elsewhere, CAMPFIRE has been beneficial in two respects: (i) the setting aside and maintenance of wildlife habitats which lead to the conservation of woodlands and grasslands, and (ii) putting value to woody trees with products that are used in enterprises promoting non-timber forest products.

The Policy Framework

The two main policies relevant to the forestry sector are the National Environment Policy (NEP) and the Forest Based Land Reform Policy (FBLRP). NEP has sections dealing with forestry and provides that forest specific laws should promote the participation of people who depend on them and deal with the long term sustainable use of the forests. The objective is to ensure that local communities derive economic benefits from forest resources in line with the objectives of the CAMPFIRE Programme. The FBLRP seeks to promote the participation of indigenous people in plantation owning companies. This policy also needs to be given legal force.

Institutional arrangements

There are four hierarchical levels under institutional arrangements. The producer communities at the ground level are organized either as:

(i) Resource Management Committees (RMCs) in forestry areas,
(ii) Ward Wildlife Committees (WWCs) in wildlife production areas or
(iii) Community based organizations (CBOs) in areas where communities are exploiting non-timber forest products. The RMCs, WWCs and the CBOs and their support organizations are listed below (Mazambani & Dembetembe, 2010).

There are:

- 331 RMCs facilitated by the Forestry Commission.
- 165 WWCs facilitated by Rural District Councils in the CAMPFIRE Programme (Child et al, 2003).
- 153 CBOs facilitated by the CAMPFIRE Association, Africa 2000 and SAFIRE

Above the second level, there are support organizations (NGOs and Government agencies) that facilitated the setting up and operations of the producer communities. At the third level is the national Community Based Natural Resources Management (CBNRM) forum. The Forum is the umbrella organization for support organizations facilitating the conservation activities of the producer communities. These include Government agencies (Forestry Commission, the Parks and Wildlife Management Authority, the Environment Management Agency), Rural District Councils, the Ministry of local Government, Rural and Urban Development, NGOs (e.g. CAMPFIRE Association, WWF, Action, SAFIRE etc), Academic Institutions (e.g. the Centre for Applied Social Sciences of the University of Zimbabwe). Members of the Forum are key organizations in the development of the CAMPFIRE Programme. The support services cover training communities in organisational development, financial management as well as natural resource management. Other services include research and monitoring and policy development. The Forum plays an integrative, conceptual and policy development role in the programme.

The impacts of the CAMPFIRE Programme in the conservation of forest genetic resources

Co-management of forest resources between the Forestry Commission and communities adjacent to protected forests. Some communities adjacent to protected forests in Matabeleland North, Midlands and Gokwe South (Mapfungautsi Forest) have entered into co-management arrangements with the Forestry Commission. Under this arrangement communities are: (i) organized through Resource Management Committees (RMC), and (ii) can access the forests for purposes of grazing cattle, collecting dry firewood, mushrooms and thatch grass as well as broom grass, and establishing beekeeping projects. Some community commercial activities include setting up eco-tourism projects and selling thatch grass.

However communities have no access to timber products. Observance of the conditions of the co-management arrangement is enforced by the RMCs who employ resource monitors to patrol the areas. There are 331 RMCs in communities adjacent to State forests (Mazambani and Dembetembe, 2010). Through the co-management arrangements communities protect adjacent forest from encroachment, illegal timber logging and veld fires on the basis that they derive benefits from the forests. This is significant in the conservation of forest genetic resources.

Community management of woodlands

Mazambani and Dembetembe (2010) reported that communities in communal areas organise themselves to manage woodlands in a sustainable manner. Some of the activities include:

- Rehabilitating degraded areas through planting trees and grasses.
- Protecting woodlands to promote beekeeping ventures.
- Adopting by-laws to control over-harvesting and to manage veld fires.
- Protecting of wetlands, natural springs and other sources of water.

Maintenance of wildlife habitats

Communities in CAMPFIRE, particularly those adjacent to formally protected areas are engaged in wildlife management activities through:

(i) designating and setting aside land as concession for wildlife management purposes, and
(ii) leasing the land to private safari operators who market trophy hunts on a commercial basis.

Altogether, CAMPFIRE protects an area equivalent to 56,135km^2. (Child et al., 2003). The country's formally protected areas add up to 49,700km^2. Combined, the country has doubled the area is under some form of protection for wildlife. This is significant in the sense that the protection of the wildlife habitats leads to the protection of forest genetic resources in communal areas, outside areas formally protected by statute.

Adding value to woody species in promoting food security and livelihoods

Value addition to natural resources has greatly enhanced the value of natural resources. The processing results in natural resources products of much higher value. The products include cosmetics mostly from oils extracted from tree seeds, herbal teas, jam and beverages from fruits, foods, crafts, and medicines. The key woody species and their products are listed in Table 4.1. Other species like *Colophospermum mopane, Brachystegia spiciformis* and *Burkea africana* are hosts to edible caterpillars some of which are now formally marketed. In some communities household income from these activities has increased by up to 20% (Gondo, 2006). This has been a key incentive for the communities to appreciate the value of the woody species and the need for investment in their conservation. The Southern Alliance for Indigenous Resources (SAFIRE) works with communities and its partners; Phyto-Trade Africa, Specialty Foods for Africa and the Indigenous Tea Company of Zimbabwe to secure external markets for natural products.

Table 4.1: Forest products important in food security and livelihoods.

Species	Use for food security	Use in improving livelihoods
Adansonia digitata (muuyu)	• Oil from seed used for cooking. • Young leaves used as vegetable. • Fruit eaten as dried fruit. • Fruit juice made from dry fruit powder. • Powder mixed with maize/millet porridge	• Bark string used for weaving bags and mats • Cosmetic oil from seed • Baobab flavoured yoghurt
S. birrea (Marula/mupfura)	• Fruits used for wine production. • Oil from seed used for cooking.	• Marula oil, jelly, butter. • Leaves used as cattle fodder. • Fruit relished by wildlife • Wood used for making mortar and other crafts.
Z. mauritiana (Musau)	• Fruits eaten fresh	• Masau jam, • Masau dried strips
U. kirkiana (muzhanje/mushuku)	• Fruits eaten fresh	• Fruit used in jam production • Fruit sold in informal urban markets
P. curatellifolia (muchakata/muhacha)	• Cooking oil • Fruits eaten fresh	• Cosmetic oil
Fadogia acnelata	• Herbal tea (branded Makoni Tea)	• Commercialised herbal tea
C. mopane	• Host of the edible worm (Imbrasia belina)	• Commercial sales
B. spiciformis and *J. globiflora*	• Host of Edible worms (Imbrasia ertli, Imbrasia epimethea, Gynanisa maia)	
Burkea africana (mukarati)	• Host of edible worms (Cirina forda) • Host of edible stinkbug	

Genetic improvement programmes and their implementation

History of Tree Improvement in Zimbabwe

The development of the forest plantation in Zimbabwe began soon after the colonisation of the country with introduction of exotic tree species. Extensive plantation development took place in the 1920s with cypress, pines, eucalypts and wattle. An intensive programme of provenance testing and breeding was initiated in the late 1950s. Today, Zimbabwe has a very simple but effective advanced genetic improvement programme of exotic of pines (*Pinus patula, P. taeda, P. elliottii* and *P. kesiya*) and eucalypts (*Eucalyptus grandis, E. tererticornis* and *E. camaldulensis*) that produce markets high quality germplasm locally, regionally and internationally. Since the mid 1980's, provenance testing was initiated for some important indigenous tree species (*African acacias* and fruit trees) and other exotic multipurpose species suitable for integration into agricultural systems.

Exotic species

The genetic improvement of exotic timber species for plantation development began in 1958 (Barnes, 1973). Since then, dozens of Pinus species from the south-eastern United States of America, Mexico and central America and from Asia were introduced and tested for adaptation, growth and timber qualities. The successful species include *P. patula, P. taeda, P. elliottii and P. kesiya*. The breeding objectives are to improve the yield and quality of timber (see appendix 4). The breeding populations of these species are mostly in their 3rd generation of selection.

With the economic recovery, further generation advancement which had been slowed down is envisaged. Significant gains have been made in improving the timber yield and quality of most of the species. Other *Pinus spp*. that are currently being tested with a view to deploy them in specific niches include *P. tecunumanii, P. maximinoii, P. hererrae* and *P. greggii*. Some minor *Pinus spp*. being improved through simple mass selection are *P. caribaea, P. chiapensis, P. pseudostrobus* and *P. roxburghii*. There is also a small but budding programme of interspecific hybrids of pines. The interspecific hybridization uses *P. caribaea, P. tecunumanii* and *P. oocarpa*. Besides pines, there are also advanced breeding programmes of *Eucalyptus grandis E. camaldulensis, E. cloeziana* and *E. tereticornis*. The most advanced breeding populations of *E grandis and E. camaldulensis* are in the 4th generation of selection. The minor species of eucalypts (*E. citriodora, E. nitens, E. maculata, E. microcorys, E. paniculata, E. dunnii, E. saligna*) have simple mass selection programmes. There is also a small but growing programme programme of interspecific hybrids of eucalypts involving *E. grandis x E. camaldulensis and E. grandis x E. tereticornis*.

The breeding strategies being used combine genetic improvement of desired attributes and gene conservation. Currently under the Tree Improvement programme there are 13 different pine species and 10 eucalyptus species undergoing improvement with different end uses such as pulpwood, timber and transmission poles. A total of 3,198 Plus Trees have been selected for breeding programmes and to date 1,035 provenances have been tested across a range of environments in Zimbabwe (see Appendix 3).

The National Tree Seed Centre (of the Forestry Commission) specialises in tree seed production and marketing. The centre controls 100% of the local market for improved plantation tree species and also supplies tree seed to regional (South Africa, Uganda, Malawi) and international (North and South America and Australia) markets. There are more than 160 seed orchards of the different exotic species with a combined area of over 330ha (Table 4.2). Tree seed, pollen, scions and clones used in the breeding programme have been exchange with other research organisations in the past. The Forestry Commission acquired germplasm (*P. oocarpa, P. tecunumanii, P. maximinoi*) in the form of seed and grafted clones from the Oxford Forestry Institute, University of Oxford through the assistance of the then Overseas Development Administration, ODA (now DfID) of the UK government. Some germplasm (*P. kesiya*) mostly as seed was acquired through the assistance of Danish International Development Agency (DANIDA) of the Danish government. More germplasm also in the form of seed was also sourced through the International Union of Forestry Research Organisations (IUFRO) working party of which Zimbabwe was then a member. Through the CAMCORE membership, Zimbabwe also accessed germplasm of P. herrerae, P. greggii, P. patula, P. maximinoi and P. tecunumanii. Germplasm of eucalypts was mostly sourced through the Centre for Scientific and Industrial Research Organisation (CSIRO) of the Australia and the Queensland Forestry Research Institute, Queensland, Australia. The Forestry Commission's engagement with some of the networks and associations ceased when the organisation started experiencing financial challenges. Now that the economy is on a recovery path, there will be a need for the organisation to resuscitate some of the links which remain relevant.

Table 4.2: Number of seed orchards, area and level of improvement of seed germplasm available in Zimbabwe

Species (scientific name)	Seed orchards*		
	Number	Generation**	Area (ha)
E. grandis	6	2nd and 4th	15
E. camaldulensis	17	1st,2nd ,3rd,4th	33
E. tereticornis	9	2nd,3rd	10
E. citriodora	1	1st	0.6
P. patula	26	1st and 2nd	46
P. taeda	24	1st and 2nd	33
P. elliottii	28	1st and 2nd	61
P. kesiya	17	1st and 2nd	53
P. oocarpa	7	1st	22
P. psuedostrobus	1	1st	0.7
P. maximinoii	4	1st	19
P. tecunumanii	14	1st	18
P. caribaea var. hondurensis	1	1st	0.6
P. caribaea var. bahamensis	1	1st	0.6
P. caribaea var. caribaea	1	1st	0.6
P. palustris	1	1st	0.5
P. chiapensis	4	1st	6
Pinus spp. hybrids	2		1.4
Cupressus lusitanica	1	1	0.6
TOTAL	165		336

Indigenous species

The programme for indigenous species can best be described as simple provenance testing with, in some few cases progeny evaluation. No selection for development of second generation populations has been practised on all the indigenous tree species. The species that have been tested in some replicated provenance trials are *Acacia erioloba, A. nilotica, A. karroo, A. senegal, Faidherbia albida, Uapaca kirkiana, Strychnos cocculoides, Sclerocarya birrea*). The *A. karroo* and *A. senegal* were evaluated for gum arabic production as well as for browse and fodder production. The gum of the later enters world markets while that of the former has only been traded locally. Recently 715 samples of gum arabic were collected from 15 provenances of Acacia senegal trials in Ntabazinduna and Guyu.

The programme on domestication of indigenous fruit tree species is a collaborative programme between the World agroforestry Centre (ICRAF) and some SADC countries. The species being evaluated are *Sclerocarya birrea, Uapaca kirkiana* and *Strychnos cocculoides*. Germplasm was collected in the late 1990s throughout SADC countries where the species occur and replicated trials were established in Zimbabwe, Zambia, Malawi, Mozambique and Tanzania. The local trials were however not optimally managed due to funding challenges that affected their management.

Limited studies were also conducted covering phenology of P. angolensis in natural stands in the protected forests. Also provenance variation studies using morphological nursery traits were done in *P. angolensis* and *C. mopane*. Information from these limited studies will contribute to the design of management plans and conservation strategies of these species.

Opportunities and challenges

There are a number of challenges to community based natural resources management (CBNRM) as epitomized in the form of CAMPFIRE. Some of these are outlined below.

Challenges

a) Inconsistencies in policy and legislation:

There are inconsistencies between land tenure and resource use rights. Communities in communal lands do not legally own the land which they occupy. The land owner is the State which is represented on the ground by the RDC. It is the RDC that are bestowed the Appropriate Authority (AA) status in CAMPFIRE. The problem is that although the desire in CAMPFIRE is to give the rural communities the full responsibility to manage wildlife and other natural resources at their local level, communities cannot enter into any contractual agreements involving land without the authority of the RDCs. This impairs community decision making which needs to be continuously sanctioned by the Council. Furthermore, within communal areas, land ownership is under customary tenure. There are no adequate legal provisions to safe-guard long term community investments. This militates against long term investments. Lack of security of land tenure hinters complete community access to; control and ownership of natural resources.

b) Human-Wildlife conflict:

Human wildlife conflict (HWC) is a serious challenge in the participatory conservation programmes such as CAMPFIRE and constitutes a big cost to communities and is most likely to remain so for a long time. Where the primary resource in the conservation is wildlife, strong competitive interactions between people and their livestock and wild animals and takes place where these share the same environment. The conflict affects the security and livelihoods of the semi-subsistence farmer and in turn negatively affects the interest of the communities in the programme.

c) Climate change:

Climate change is the biggest challenge to CBNRM for the foreseeable future. Many communities will have reduced capacity for cropping and livestock husbandry. They will naturally turn to natural resources for their livelihoods.

Opportunities

a) Climate change adaptation and mitigation:

The CBNRM provides the opportunities for the conservation of woodlands outside protected areas where there are severe pressures for encroachment, carbon sequestration from avoided deforestation, enhanced livelihoods, and the purchase of carbon credits.

b) Food and nutrition security:

Participatory management of natural resources through the CBNRM approach provides opportunities for production of indigenous fruits, honey and meat.

c) Biodiversity conservation and combating desertification Opportunities exist for scaling up community conservation efforts through: restoration of indigenous fodder tree species, rehabilitation of degraded areas, and improved management of land, water and wetlands.

d) Establishment of environmental sub-committees

Amendments to the Rural District Councils Act will now give RDCs full responsibility for the conservation of land and biodiversity over its jurisdiction. The councils will be required to create "Environment Subcommittee areas" with gazetted boundaries. An Environment Subcommittee (ESC) will have oversight responsibilities over the Subcommittee areas. The implication of this is that the Environment Subcommittee will become a local community institution with the legal mandate to be delegated the Appropriate Authority status for the management of natural resources including wildlife. Each Environment Subcommittee will have the responsibility for developing and implementing Local Environment Action Plans (LEAPs).

Review of the Forest Act and Communal Lands Forest Produce Act

The Forestry Commission has initiated the review of the Forest Act and the Communal Lands Forest Produce Act. This presents an opportunity for incorporating CBNRM principles and provisions in these Acts. This will legitimize and increase the focus on CBNRM initiatives in the forest sector for the benefit of enhancing community livelihoods and promoting the conservation of forest genetic resources.

Conclusion

CBNRM has the potential for promoting conservation of forest genetic resources and sustainable development in rural areas. Awareness has been carried out to make CAMPFIRE acceptable and justifiable socially, economically, environmentally and politically. At the local level this has been built in the structure of the programme in the form of Natural Resources Management Committees, CBOs, and RMCs. In terms of going forward there is the need for increasing effort in terms of scaling up activities that add value to natural resources products.

Chapter 5: The State of National Programmes, Research, Education, Training and legislation on Forest Genetic Resources

National programmes on forest genetic resources

The purpose of national forest programmes in Zimbabwe is to increase the capacity at all levels concerning the conservation, sustainable utilisation of forest genetic resources and design of equitable benefit sharing mechanisms. This includes participation of all stakeholders in forest resource conservation. Government institutions and some NGOs lead the efforts to train people at various levels. Zimbabwe has not yet established a National Programme for Forest Genetic Resources although it is embedded in the national forest programme. However, in 1987 the country prepared a National Conservation Strategy based on the World Conservation Strategy with an objective of ensuring sustainable utilisation of natural resources. Some organisations have used the document as a useful reference guide book for sustainable development in Zimbabwe.

An analysis of existing institutions and their programmes clearly shows that Zimbabwe does not have a well coordinated national programme on the management of forest genetic resources except for isolated projects implemented by Forestry Commission, Universities, other research institutions and NGOs. Although no comprehensive national programmes exist to support forest genetic resource conservation and utilization, a number of activities are undertaken to improve the overall management of forest genetic resource in the country.

Funding of public sector programmes

The funding for forest genetic resources programme in Zimbabwe averaged just over US$300,000 per annum in the last two years (2009-2010) after the hyperinflationary environment that prevailed between 2002 and 2008. There has also been indirect funding for the national programme by both the private sectors and donor organisations.

National Legislation

Zimbabwe does not have clear legal frameworks regulating forest genetic resources. There are however various legislation and regulations relevant to forest genetic resources. The Ministry of Environment and Natural Resources Management through its line departments and agencies (Forestry Commission, Environmental Management Agency, Parks and Wildlife Management Authority) is the major player in forest conservation. The principal legislation and regulations that govern the conservation and utilisation of forest genetic resources are: the *Forest Act (Chapter 19:07)*, *Environmental Management Act (Chapter 20:27)*, *Communal Land Forest Produce Act (No. 20 of 1987)* and the *Parks and Wildlife Act (PWLA) (chapter 20:14).* The other pieces of legislation that also relate to forest genetic resources include: *Traditional Leader's Act (Chapter 29:17)*, *Seeds Act: (chapter 19:13)*, *Plant Pests and Diseases Act (Chapter 19:08)* and the *Patents Act (chapter 26:03).*There are also some policies and action plans that relate to the management, conservation and utilisation forest genetic resources in Zimbabwe. There are: National Environment Policy (NEP), Forest Based Land Reform Policy (FBLRP) and Zimbabwe National Biodiversity Strategy and Action Plan (NBSAP).

Environmental Management Act (Chapter 20:27)

The Environmental Management Act (Chapter 20:27) and the National Environmental Policy were put in place for the conservation of biological and genetic resources. The Act refers to biological diversity as defined in the United Nations Convention on Biological Diversity (CBD) adopted in 1992. This Act together with the Forestry Act facilitates the control, regulation and coordination of forest resource management through the respective departments. The Environmental Management Agency is responsible for regulating and enforcing broader environmental issues, while the Department of Rural and Urban Planning give guidance to Rural District Councils in the formulation of local by-laws for forest resource conservation in communal areas. Other sectors such as agriculture and construction have both direct and indirect impacts on forest genetic resources.

Forestry Act (Chapter 19:07)

The Forest Act is the principal piece of legislation that governs the exploitation and protection of gazetted or protected (State) forests and woodlands and also forests on private land. This is achieved through the establishment of conditions for and regulation of the magnitude to which forest produce may be utilised. However, forest genetic resource conservation in the state forests have often been threatened by illegal settlers and timber poachers from neighbouring communities. To minimise the poaching some neighbouring communities are now participating in co-management (conservation and utilisation) of the forests. Private lands that have security of tenure and flexibility in the provisions of the Forest Act have contributed to good forest genetic resource conservation. The Act is less strict and provides a somewhat self- regulatory control mechanism for the management of private forest resources by owners. The Forest Act *prima facie* prohibits the destruction, injury or harvesting of any indigenous trees or timber from private forests and forest produce from any State land except with a valid timber permit. Despite some post- independence amendments, the two Acts largely retain the protectionist approach to natural resource management.

Communal Land Forest Produce Act (Chapter 19:04)

The Communal Lands Forest Produce Act (CLFPA) is the main piece of legislation that governs the exploitation and protection of forest resources in the communal areas of Zimbabwe. Although the Forest Act allows State and private land owners exploit their forests for both subsistence and for commercial purposes, the CLFPA only allows communal dwellers to exploit forest resources in their area for subsistence purposes. They cannot exploit it for commercial purposes.

Parks and Wildlife Act (Chapter 20:14)

The Parks and Wildlife Act (PWLA) has six types of protected areas in the form of national parks, safari areas, sanctuaries, botanical gardens, botanical reserves and recreational parks, each with a specific objective. The purposes of these areas include the preservation and protection of the natural landscape, scenery of wildlife and plants and the natural ecological stability of wildlife and plant communities found therein with the ultimate objective of bringing public enjoyment; education and inspiration. Human activities in these areas are prohibited except with a permit, licence or other authorisation issued by the responsible authority. In communal areas, Appropriate Authority status for wildlife is granted to Rural District Councils (RDCs) to exploit wild animals and plants on behalf of the communities they serve. The Rural District Councils Act empowers RDC to make bylaws related to the management and conservation of their indigenous resources.

Traditional Leaders Act (Chapter 29:17)

The Traditional Leaders' Act in a small way affects the management, conservation and utilisation of forest genetic resources. Part II section 5:1 of the Act states that a chief shall be responsible within his/her area for ensuring that the land and its natural resources are used and exploited in terms of the law and, in particular, controlling over-cultivation; over-grazing; the indiscriminate destruction of flora and fauna; illegal settlements; and generally preventing the degradation, abuse or misuse of land and natural resources in his/her area.

Seeds Act (Chapter 19:13)

The Seed Act was provides for the registration of sellers of seed and seed testing laboratories; regulates the importation, exportation and sale of seed; provides for the testing, certification and inspection of crop seeds. The Seed Act is used in conjunction with its enabling regulations: *Seed Regulations (1971)*, Seed (*Certification Scheme*) Notice 2000 and *Plant Breeders Rights Act, Chapter 18:26 of 1979*. The *Seed Act* is silent on forest tree seed but is specific on crops. There is scope to expand the *Seed Act* to cover forest tree seed.

Plant Pests and Diseases Act (Chapter 19:08)

The Plant Pests and Diseases Act provides for the eradication and prevention of the spread of plant pests and diseases in Zimbabwe, the prevention of the introduction into Zimbabwe of plant pests and diseases, and for matters incidental thereto. The provision of plant quarantine services is the responsibility of the Plant Protection Research Institute of the Department of Research & Specialist Services, Ministry of Agriculture. There are currently 21 entry points that control the movement of plant material into and out of the country.

Patents Act (Chapter 26:03)

The patent act of Zimbabwe prohibits patenting of life forms. No Patents have been entered into that are related to forest genetic resources.

Research

Zimbabwe has a number of research projects directly related to the management, conservation and utilisation of forest genetics resources. The major player is forestry research is the Forestry Commission through its Research & Development division. The main research projects are on breeding of industrial and non-industrial exotic and indigenous tree species. The Forestry Commission has three forest research stations (John Meikle, Muguzo and Chesa) and one satellite testing centre (Mtao). The Timber Producers Federation (TPF) actively participates in shaping the direction of forestry on industrial species. The TPF members, forestry timber companies actively participate in the research by hosting and managing some of the trials on industrial tree species on their estates while some agricultural research stations of the Ministry of Agriculture also host some of the research trials.

Besides their usual teaching activities, the universities (agroforestry tree species screening and fodder quality testing by the Departments of Crop and Animal Sciences; co-management of forests by the CASS centre, fire management and natural regeneration by the Tropical Resources Ecology Programme, all of the University of Zimbabwe) have also complemented the Forestry Commission in conducting research in forestry. There other universities in the country that are involved in teaching and field research on forest genetic resources are: National University of Science & Technology, Bindura University of Science Education, Chinhoyi University of Technology, Midlands State University and Africa University.

There have been collaborative projects involving international research organisations (ICRAF, CIFOR and IPGRI) but these were mostly scaled down during the hyperinflationary period.

There are only two institutions that are currently actively involved in laboratory work that is related to forest genetic resources and these are the Tree Seed Centre of the Forestry Commission and the Seed Services of DR&SS, Ministry of Agriculture. The two institutions are involved in tree seed testing with Seed Services acting as the reference laboratory.

The Botanic Gardens under the Ministry of Agriculture is actively involved in field work related to forest genetic resources. The National Herbarium houses dried plant specimens, including materials from other countries in Southern Africa that is used as reference material for taxonomic work. The Herbarium also identifies trees from Botswana, Zambia, Malawi and Mozambique.

Education and Training

There are several state and quasi-state colleges and universities in Zimbabwe that offer training from Diploma to MSc level in general forestry, forestry and wildlife management, wildlife and rangeland management, natural resource management, agroforestry and tropical resources ecology. Two colleges: Mushandike Natural Resources College and the Zimbabwe College of Forestry provides offer training at Diploma level; Bindura University offers training up to MSc; the National University of Science and Technology, Midlands State University, Chinhoyi University of Technology and Africa University offers training at BSc level. The Institute for Environmental Studies of the University of Zimbabwe offers an MSc programme on tropical ecology and resources.

Zimbabwe's training priorities and needs

Zimbabwe experienced a mass exodus of highly skilled and experienced professionals during the hyperinflationary period. Consequently, most positions are now filled by young scientists. There is therefore a need for support to strengthen most of the institutions through training of the young professionals to acquire higher degree qualifications. Strengthening institutions such as universities and government research centres will facilitate the development of a strong scientific base for future forest genetic resources management. There is need to put and support local scientists on exchange programme with other countries for mentorship. Where possible, scientists from other countries should also be supported to come to Zimbabwe for on-job mentorship of the local scientists. There is also a need to revamp the curriculum on forest genetic resources for colleges and universities to put it in line with modern trends.

Documentation and Dissemination

Documentation

Documentation systems have been computerized with standard formats to facilitate data exchange although currently they need revamping, after going through a period of economic decline that resulted in stagnation on investment in ICT. Zimbabwe's main challenges to improve the information management systems for forest genetic resources are lack of skilled and experienced staff, old computer hardware and software, financial resources and unreliable internet connectivity. There is therefore a need for good training in database formulation; documentation and information management.

Forest Genetic Resource awareness

Zimbabwe has developed four strategies to enhance awareness of the importance of forest genetics resources: national tree planting day – an annual event led by the State President, field days focussing on research on industrial tree species, annual exhibitions at the national and provincial agricultural shows, national radio and television programmes, and establishing demonstration plots on across the country. Conducting awareness campaigns is constrained by lack of adequate funding constraints. Besides funding, there is also a need for policy initiatives on forest genetic resource, improvement in the legislation on conservation and use of forest genetic resources and training.

Networking and Collaboration

Zimbabwe was involved in several national networks whose objective is to improve the sustainable management of forests. Zimbabwe has been involved in several networks on forest genetic resources in the past ten years. Some of the networks include, National Biodiversity Forum, National Plant Genetic Resources Committee (NPGRC), African Network for Agriculture, forestry and Natural Resources Education (ANAFE), CAMPFIRE Association of Zimbabwe and Timber Producers Federation (TPF). The other networks have all ended when the funding for their sustenance ended. They include SADC and TSCN.

Future needs and priorities

Below is a list of important needs and priorities for Zimbabwe on education, training, information exchange, documentation and legislation (Table 5.1).

Table 5.1: Identified National needs for strengthening forest genetic resources legislation

Needs	Priority level			
	Not applicable (NA)	Low (L)	Moderate (M)	High (H)
Improve forest genetic resources legislation				H
Improve reporting requirements				H
Consider sanction for non-compliance			M	
Create forest genetic resources targeted regulations				H
Improve effectiveness of forest genetic resources regulations			M	
Enhance cooperation between forest genetic resources national authorities				H
Create a permanent national commission for conservation and management of forest genetic resources		L		
Prepare targeted forest genetic resources information			M	
Prepare targeted forest genetic resources communication strategy				H
Improve access to forest genetic resources information			M	
Enhance forest genetic resources training and education				H
Improve understanding of benefits and values of forest genetic resources		L		

Chapter 6: The State of Regional and International Collaboration

Regional and International Agreements and Collaborations

Zimbabwe has played its part on the regional and international stage by participating and ratifying important conventions and treaties on forest genetic resources. Some of the conventions, treaties and agreements related to Forest Genetic Resources conservation and management that were signed include: SADC Protocol on Forestry, SADC Protocol on Wildlife and Law Enforcement, Convention on Biological Diversity (CBD), Convention on International Trade of Endangered Species (CITES), and the Cartagena Protocol on Biosafety.

SADC Protocol on Forestry

In the SADC Protocol on Forestry, Article 17 state parties should adopt national policies and implement mechanisms to ensure that access to the forest genetic resources is subject to prior informed consent and mutually agreed terms and that there is an equitable sharing of the benefits derived from the use of these resources.

SADC Protocol on Wildlife and Law Enforcement

The SADC Protocol on Wildlife and Law Enforcement compels State parties to integrate trans-boundary natural resources management thus ensuring protection of in situ forest genetic resources. Under this protocol, This has resulted six Trans Frontier Conservation Areas (TFCAs) of which Zimbabwe is party were created; Kavango-Zambezi (KAZA), Zimbabwe-Mozambique-Zambia (ZIMOZA), Greater Limpopo Transfrontier Park (GLTP), Lower Zambezi-Mana Pools, Greater Mapungubwe and Chimanimani.

Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is an international legally binding treaty whose goals are conservation of biological diversity, sustainable use of its components and fair and equitable sharing of benefits arising from genetic resources. It has resulted in formulation of regulations e.g. the SI 61 of 2009 on Access to Genetic Resources. This convention has resulted in the establishment of a national biodiversity office in the country tasked with the responsibility for coordination of work on biological diversity.

Convention on International Trade of Endangered Species (CITES)

The Convention on International Trade in Endangered Species (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of plants and wild animals does not threaten their survival. In the case of forest genetic resources, CITES ensures the sustainability of trade tree species in order to safeguard these resources for the future.

Cartagena Protocol on Biosafety

Cartagena Protocol on Biosafety aims to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. It allows countries which are Parties to apply the precautionary principle and allow developing nations to balance public health against economic benefits.

Important Networks on Forest Genetic Resources

Zimbabwe's membership to a number of organisations and networks on forest genetic resources that lapsed in the last 10 years include membership of CAMCORE, SADC-TSCN and IUFRO-GFIS. As the economy stabilises, it will be critical for Zimbabwe to reconsider rejoining important groupings such as the CAMCORE and the IUFRO which bring immense benefits to scientists working on forest tree breeding, forest management, and forest and gene conservation.

Organisations involved in Forest Genetic Resources

CIFOR: The Centre for International Forestry Research (CIFOR) carries out collaborative research on sustainable forest management and establishing models of resource sharing for protected indigenous forests.

World Agroforestry Centre: The International Centre for Research in Agroforestry (ICRAF) conducts collaborative research on tree domestication, tree germplasm conservation, tree management, integration of trees in agricultural systems (agroforestry), soil fertility improvement using green manure and carbon sequestration in agroforestry systems.

Forestry Invasive Species Network for Africa: The network shares information on forestry invasive species in Africa, their management and monitoring. It now has membership in west, east and southern Africa.

Future needs and priorities to strengthen international networks on forest genetic resources

A number of priority areas for Zimbabwe on regional and international collaboration and networking were identified.

(i) There is a need for Zimbabwe to harmonise or align some of the policies and legislation with the international conventions and treaties to which the country is a signatory.

(ii) Although the country has ratified and signed most of the regional and international treaties related to forest genetic resources, funding for most of the activities for which the country is obliged to undertake has not been adequate. While competing needs may crowd out funding for forest genetic resources, consideration should be placed on securing donor support to undertake some of the critical activities.

(iii) The private sector must also be encouraged to complement government and the donor community by supporting activities that enhance the conservation and utilisation of forest genetic resources.

Chapter 7: Access to Forest Genetic Resources and Sharing of Benefits arising from their Use

Introduction

Zimbabwe has no specific laws or policies regulating particularly the issue of access to forest genetic resources and sharing of benefits arising from their use. What exists are various sectoral policies and legislation which may be used indirectly to address the issue of access to forest genetic resources and sharing of benefits arising from their use. The absence of a comprehensive access and benefit sharing policy and legislation on forest genetic resources affects other issues like intellectual property rights. The issue of access and benefit sharing mechanism to address facilitated access, and the fair and equitable sharing of benefits arising from the use of biological resources and community knowledge has been a subject of debate since Zimbabwe ratified the Convention on Biological Diversity (CBD) and other related international instruments whose provisions allude to the need for contracting parties to come up with legislation regulating access to genetic resources, in this case forest genetic resources.

International framework regulating access to forest genetic resources and sharing of benefits

There are three major international frameworks that govern access to genetic resources (including forest) of which Zimbabwe is a signatory. They are the Convention on Biological Diversity (CBD), Trade Related Aspects of Intellectual Property Rights (TRIPS) and the Nagoya protocol.

Convention on Biological Diversity

Article 15 of the CBD vests the authority to determine access to genetic resources with national governments, subject to national legislation. Countries are permitted to set terms for access to their resources so that they gain profit from the use of their biodiversity (including forest genetic resources). The general principles of which access must be granted under article 15 include prior informed consent (PIC) and mutually agreed terms (MAT). For PIC concept to be effective, clear and adequate information on the full range of potential benefits, forms of compensation on foreseeable harm and the conditions under which access to biodiversity is granted must be available to the authority.

Trade Related Aspects of Intellectual Property Rights

The Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement requires member states to provide patent protection for any inventions, whether products or processes, in all fields of technology, provided that they are new (novel in the strict sense of the word), involve an inventive step (technically non-obvious) and are capable of industrial application.

Nagoya Protocol

The objective of this Protocol is the fair and equitable sharing of the benefits arising from the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components. Zimbabwe is in the process of ratifying the Nagoya Protocol.

Regional Agreements, Legislation and Institutional Frameworks for Biodiversity Management in Southern Africa

In order to regulate access to biological and genetic resources in the region, SADC has also developed guidelines on Access and Benefit Sharing (ABS) agreements, Legislation and Institutional Frameworks for Biodiversity Management in Southern Africa (SADC Secretariat, Gaborone, 2007). The purpose of the guidelines is to: promote best practices for fair and equitable access and sharing arrangements for sustainable biodiversity management in the region, provide tool kits for formulation of ABS legislation, and provide guidance on coherent and effective institutional frameworks on ABS. Furthermore the member countries have signed various protocols which contain elements of ABS and these include those on Forestry, Wildlife Conservation and Law Enforcement, etc.

National Legislation regulating access to forest genetic resource

Constitution of Zimbabwe

The Constitution of Zimbabwe (section 16A) clearly states that all agricultural land that is identified by the Government for whatever purpose including, but not limited to settlement for agricultural purposes, land reorganizations, forestry, environmental conservation or the utilization of wildlife or other natural resources is acquired by and vested in the State with full title therein. The Constitutional provision does address an important question related to biodiversity i.e. the question on whose right is paramount on our natural resources. By vesting the natural resource in the State, the State is in a position to distribute it equitably among its citizens thus addresses the question of access.

Forest Act

The Forest Act has no provisions on the role of communities neighbouring the protected forests or forests on private property in sustainable utilization and equitable sharing of the benefits resulting from the forests. The right to access and use are vested in the State in the case of protected forests and the land owner in the case of forests on private land.

Communal Land Forest Produce Act

This Act gives local communities limited rights to exploit the forest resources in their area for subsistence use only and not for commercial purpose. The exploitation of major forest resources within a protected area requires a permit. Proceeds from sale of forest produce from communal land or licence to exploit are given to the local authority, usually the Rural District Council.

Environmental Management Act

The Environmental Management Act provides for the conservation of and access to biological diversity and the regulation of biological and genetic resources. The Act among other things protects the indigenous property rights of local communities in respect to biological diversity and supports the integration of traditional knowledge on conservation of biological diversity with scientific knowledge. The Act also permits the enactment of regulations to control access by any person to the biological and genetic resources of Zimbabwe. The regulations will, provide for the equitable sharing of benefits arising from the technological exploitation of germplasm originating from Zimbabwe between the owner of the technology and the government.

Traditional Leaders Act

The Traditional Leadership Act vest authority with the chief in dealing with matters related to access to forest genetic resources. The Act stipulates the functions of the Chief as follows:

Ensuring that the land and its natural resources are used and exploited in terms of the law and in particular controlling over-cultivation, overgrazing, indiscriminate destruction of flora and fauna and generally preventing the degradation, abuse or misuse of land and natural resources in his/her area.

Existing National policies related to Forest Genetic resources

Forest Based Land Reform policy

This policy ensures that the forest development plans are integrated with the overall land use plans and support the development of environmental sustainable small scale industries.

National Environment policy

The policy propagates the continued development of the forest sector while at the same time balancing the economic growth with the conservation of biodiversity and the maintenance of stability and resilience of forest ecosystem.

Wildlife Based Land Reform policy

The wildlife-based land reform programme will be maintained where it is the most appropriate land use option through transfer of leases or allocation of shares.

Access to Genetic Resources and Indigenous Genetic resource-based Knowledge Regulations of 2009

The purpose of these regulations is to ensure the protection of the rights of local communities over their genetic resources; facilitate the regulation of access to genetic resources held by communities , and the sharing of benefits from use of such genetic resources; regulate harvesting, gathering, collecting on a large commercial scale genetic material; control export from Zimbabwe of any genetic material; regulate publishing, or registering a patent or other intellectual property rights in relation to any genetic material.

The regulations articulate clearly the specific extra-communal rights vested in the local authority or the indigenous community in relation to any genetic resource. These rights include the right to: harvest, gather, collect on a large commercial scale genetic material that are indigenous to local community; export from Zimbabwe any genetic material; publish, or register a patent or other intellectual property rights in relation to any genetic material indigenousto the local community concerned or any indigenous genetic resource-based knowledge.

Benefits arising out of the use of forest genetic resources

Benefits sharing can be realized in different ways. The benefits may be direct monetary payment, technology transfer, construction of infrastructure for the local community, research into local maladies, equipment, participation in monetary benefits associated with intellectual property rights, taxonomic, biochemical, ecological, horticultural and other information and data, through research results, publications and educational materials, access to collections and databases, benefits in kind, such as augmentation of national collections in the country of origin and support of community development activities training in science, in situ and ex situ conservation and management, information technology and management and administration of access and benefit-sharing, among other benefits.

Recommendations on improvement of legislation to address conservation and improve ABS of forest genetic resources

From the review of the existing law on forest genetic resources, it is evident that Zimbabwe does not have appropriate legislation regulating the access and benefit sharing of forest genetic resources. The existing legislation is mostly inadequate. For example the Forest Act and the Communal Land Forest Produce Act, the two primary pieces of legislation that directly relate to forest genetic resources have been found to be inadequate and tend to favour some sections (private land owners) of the society over others (communal dwellers) in the use of forest genetic resources. Zimbabwe will therefore need to improve the existing legislation governing access and benefit sharing or develop more specific and perhaps separate legislation regulating access to forest genetic resource since access.

Conclusion

Zimbabwe currently faces challenges in establishing harmonised policies and laws and also determining what kind of management arrangements are best related to sustainable use and equitable sharing of forest genetic resources and the benefits arising from them and how to strengthen existing institutions to govern the arrangements. The ABS regulations established under EMA have not been implemented. No institutional framework has been established two years down the line following their enactment.

Chapter 8: The Contribution of Forest Genetic Resource Management to Food security and Poverty Reduction

Introduction

Forests and woodlands play a significant role in the social and economic development of Zimbabwe. They provide a wide range of forest products and services upon which rural communities depend for their livelihoods and subsistence. The forest products include wild foods such as honey, mushrooms and fruits, medicines, fuelwood, construction poles, and browse and fodder for livestock. The forests and woodlands also provide important environmental services that include watershed protection, wildlife habitats, bio-diversity, carbon sequestration and maintenance of ecosystem functions.

A number of non-wood forest products have been commercialised and play an important role in the rural economy. While it is generally accepted that forests contribute to poverty alleviation through employment creation, income generation and meeting subsistence needs of rural communities, there are no readily available figures that show the extent of the contribution. In some parts of Zimbabwe for example, the sale of fruits from the wild, medicinal extracts, thatching grass, crafts and other products contributes over 35% of some rural households' incomes. The overall contribution of wood and non-wood forests products (NWFPs) to the national economy appears to be grossly understated due to lack of credible statistics on production and marketing of NWFPs. Furthermore, the value of environmental services such as soil and watershed protection remains to be quantified.

Food Security and poverty alleviation

Forests contribute significantly to the national economy. The commercial forestry sector contributes approximately 4% to the GDP. The plantation based industry employed an average of 14,600 between the period 2005 and 2010. The indigenous hardwood industry, which is mainly based on the indigenous hardwoods from the Zambezi teak woodlands, employs an additional 2,000 people and a significant number in the downstream furniture industry. This sector is facing raw material shortages as a result of over-harvesting in previous years.

The forestry industry provides inputs into a well-developed portfolio of further manufacturing activities that include furniture making, construction timber, flooring, packaging paper, paperboard products, and printing and publishing. There was a decline in the production of paper and paper products between 2005 and 2009, the period of hyperinflation. Production completely ceased between 2010 and 2011. In 2002 exports of forestry products were about US$20 million but in 2010 they increased to US$30.5million. Imports of forestry products are limited to paper and pulp, and small quantities of speciality woods (e.g. oak) for furniture. Thus the industry is largely self-sufficient.

The contribution of the forest sector to the national economy is grossly under-estimated as reliable statistics are not available from the informal sector. For example firewood provides over 80% of the energy used by rural households and is the major fuel for 40% of the urban population. Although there are no current statistics, 17 years ago, it was estimated that fuelwood accounted for 47% of the total energy consumed in Zimbabwe (Campbell and Mangono, 1995). Due to a decline in electricity generation this figure may have gone up for the people in urban areas. In terms of environmental services forests protect important watershed which support large irrigation dams in the country as well as many water courses that provide water to rural communities. In addition forests provide habitats for wildlife which is the major basis for the country's tourism. Tourism is the third highest foreign currency earner after agriculture and mining.

Importance of Trees and Forests in the local economy

Forests and woodland resources play a central role in rural economies and household production systems in Zimbabwe. They provide on subsistence basis a range of products that help communities meet their basic needs. These include food, plant medicines, fuelwood, construction materials and browse for livestock and wildlife. The foods include fruits, mushrooms, honey, bush meat, caterpillars and other insects, vegetables and many others. Poorer households in the communal areas depend more on forest products especially in times of critical food shortages and disasters and are more vulnerable to reduced access to these products (Matose, 1994). In Binga, one of the poorest districts in the country, poor households often survive on products from the forest including marula (Sclerocarya birrea) nuts, manketti (Schinziophyton rautanenii) nuts and baobab (Adansonia digitata) fruits. Forest resources therefore provide important safety nets for the poor which prevent them from suffering further deprivation in critical times.

The agricultural production system in rural areas is intricately linked to forest resources. Forests provide inputs in the form of browse and fodder for livestock, and leaf litter, for augmenting soil fertility. The forests also provide resources for forest-based micro-enterprises. They include furniture, wood craft and basketry. In addition, the sale of seasonal products such as fruits, caterpillars and mushrooms provides supplementary income to many households. It is estimated that over 78% of the rural households in Zimbabwe use herbal medicines at least once in a year for both humans and livestock.

Rural communities living in wildlife rich areas derive significant incomes from tourism activities especially under the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE). This is in the form of earnings from wage employment in the tourism industry or dividends paid through the Rural District Councils. There are no recent statistics on the contribution of the CAMPFIRE although there are likely to have slumped in the past 10 years due to the general economic decline. Between 1989 and 1996 the revenue retained by rural district councils (RDCs) with 'Appropriate Authority' to use wildlife exceeded US$9.3 million (Bond, 2001).

Besides cooking, fuelwood is also critical for micro-enterprises such as brick-making, beer brewing and bread making. In tobacco growing areas, firewood is used for tobacco curing. The use of firewood for curing tobacco increased in the last two years with the emergence of small to medium size tobacco growers. The challenges in the production and distribution of coal, also a result of the hyperinflation only exacerbated the problems.

Trees and Forests in relation to poverty

The key areas of the contribution of trees and forests can be categorised into subsistence support, supplementary income, and industrial activities and environmental services. Under the subsistence support, the main areas are energy provision and agriculture.

Forests and energy

Fuelwood energy is the dominant and most often, the only form of energy available to the rural poor. Fuelwood is used for cooking lighting and heating. Nationally fuelwood energy accounts for 46% of the total energy consumed in the country whilst the remainder is met from electricity, coal, kerosene and other fuels. The estimated average annual household fuelwood consumption in rural areas is about 5.6 metric tonnes although this varies depending on availability of forest and woodland resources. In areas critical wood deficits now devoid of vegetation, most households resort to using cow dung and crop residues for cooking and heating. In urban areas, 39 to 40% of the low income households use firewood for cooking and consume about 3 metric tonnes per annum. In the last three years, the price of electricity rose coupled with the shortage of paraffin resulted households reverting back to use of firewood for cooking. Most of the wood used for cooking in urban areas sourced or poached from commercial farming areas up to 100 km around the cities. Most of the wood used is from the natural woodlands and forests. Wood from planted woodlots costs 3 to 4 times more but is generally not preferred. Most of the woodlots established during the 1980s to address the fuelwood shortage are now the main source of construction timber in the rural areas with fuelwood being a minor by-product (Remme et al., 1996). Even wood from the urban block plantations established by the Forestry Commission for fuel wood supply purposes, was too expensive and had to be sold to commercial loggers for poles or pulp.

The felling of trees for firing bricks in rural areas is a major contributor to deforestation. Brick-making uses wet wood. It is estimated that about 2 metric tonnes of wood are required to fire sufficient bricks for one house (Grundy, 1993). Given the increasing demand for brick houses, this suggests that brick-making constitutes a serious threat to the existing woodland resources. However, alternatives, in the form of cement bricks exist and are growing in use. Their use depends on the price and availability of cement.

Wood fuel markets in rural areas are relatively small. Purchase of construction wood is more frequent, rising to 90% in heavily deforested areas. The pricing and availability of paraffin influences fuelwood consumption levels, with shortages and higher prices promoting greater use of firewood. Soon after the onset of the fuel shortages that began in 2001, the woodlands in urban centres quickly disappeared. The consumption of firewood in urban and rural areas was estimated at 0.46 million tonnes per year at 8.5 million tonnes per year respectively.

Although charcoal production is not a common practice in Zimbabwe, some charcoal production for rural household use has been reported in Buhera. Charcoal use in urban is a preserve of the affluent. The charcoal sold in formal markets is produced from sustainably managed wattle trees (Acacia mearnsii).

In spite of the commonly assumed link between fuelwood and deforestation, there is overwhelming evidence that deforestation in Zimbabwe is largely linked to clearance for agriculture than for fuelwood. Other than in densely populated areas e.g. urban and peri-urban centres), fuelwood collection may cause little impact to minor forest degradation due the rapid growth rates of coppices of most miombo species that are commonly used as fuelwood. For example the growth rates of Brachystegia spiciformis and Julbernadia globiflora coppices are about 3 to 4m in height and 5 to 14cm in diameter in 2 to 4 years. Overall biomass increases in dry miombo is about 53 to 72 tonnes per hectare per year. Given the fact that the wood for household cooking is generally small-sized, 5 to 15cm diameter, the natural replacement appears to cope with the extraction rates where population pressure is low.

Very few forests and woodlands, especially in the communal areas are under any form of planned management. Management tends to be confined to planted trees around the homestead, and in crop fields, gardens and planted woodlots. On-crop fields, a number of trees mostly indigenous fruit trees are left within the fields. This is also to a very large extent aided by customary practices and rules which prevent the cutting of fruit trees in many communal areas. However, in heavily deforested areas even fruit trees are cut for firewood purposes.

The rural afforestation programme which began in 1982 initially focussed on planting fast growing eucalypts to meet the then perceived shortage of fuelwood but later diversified to include woodland management of indigenous tree species. Various studies undertaken to determine the effectiveness of the tree planting programmes have revealed that the trees planted are not being used for firewood but for construction poles and homestead beautification. Lack of water, termites and damage by livestock are the major constraints to tree planting.

Sustainable Development

Non Timber Forest Products and Income generation

In order to minimize the risk, farmers also undertake a number of supplementary activities which include casual labour, beer brewing, brick-making and various artisanal activities most of which are based on forest products from woodlands and trees outside forests (Kaimowitz, 2003). Tree and woodland resources provide a safety net for most rural households particularly during the dry season and before harvest. Tree resources may also be looked at as assets that can be liquidated during difficult times as a means of diversifying crop production and income and as buffer stocks of food, browse and fodder during times of drought. The are many non-timber (wood) forest products (NTFP) that provide rural communities with supplementary cash income. The most common NTFP are wild fruits when they are in season. The most widely marketed wild fruits are *Adansonia digitata*, *Uapaca kirkiana, Ziziphus mauritiana, Azanza garckeana* and *Strychnos cocculoides* which are sold as fresh or dry fruits. Other non-timber forest products that are traded include mushrooms, caterpillars (macimbi), plant medicines, thatch grass. Although there are several kinds of caterpillars or worms that are harvested, only the mopane worm is the one that enters commercial trade in Zimbabwe and the region.

In many areas forest-based micro-enterprises dominated by furniture making, woodcraft and basketry provide income and employment to a significant number of people. A survey found that forest based micro-enterprises employed up to 12% of the people in the area. In Chibuwe, a dry area of Chipinge district, income from basketry ranked 2nd to agricultural income and contributed as much as 40% of the total household income.

Some NGOs like the Southern Alliance for Indigenous Resources (SAFIRE) and the Forestry Commission have initiated programmes on product and market development of non-timber forest products in a bid to improve the value of the forest resources and benefits that accrue to local communities. A number of new products have been developed and are now being marketed in both the domestic and export market. These include baobab and marula oil, baobab pulp, masau and marula, mazhanje jams, masau candy sticks, makoni herbal tea and Kigelia africana fruit extract. These products have potential to transform the status of the poor through significant increases in household income. A community enterprise in the dry Rushinga district produces more than 500 litres of baobab oil per month (3,000 litres over 6 months) valued at US$30,000. The raw material (baobab fruits) was purchased for about US$5,000. The processing enterprise employed seven people directly (SAFIRE, 2003). Indications are that for the many entrepreneurs venturing into value addition, these enterprises are now the main source of household income whilst for the producer communities supplying raw materials to the enterprises, income from such activities now contributes between 25 and 50% of household income.

Community-based tourism

In 1999 tourism accounted for 12.4% of GDP and was the third highest foreign currency earner after mining and agriculture. The industry however declined dramatically up to 2008 and only started picking recently. There is a growing community-based tourism sector that is closely associated with the introduction of the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE). Different forms of community based tourism have emerged since 'Appropriate Authority' to manage and utilise wildlife was devolved from the Parks and Wildlife Management Authority to the district councils. The most common forms include community-owned and run enterprises, enterprises leased from local communities and run by private operators who pay the lease fees, enterprises run by private operators outside communal lands but linked to communal areas, community owned enterprises on communal land run by community members. Currently there are nearly forty community-based enterprises that could be classified under any one of these categories. For those districts rich on wildlife, annual income has been in excess of US$2 million in the last five years.

The woodcraft and basketry industry target the tourism industry and has grown significantly. More than 3,000 people are believed to have been directly employed in the 1990s. The studies showed that the crafts consumed about 700m^3 of wood annually along the Bulawayo-Victoria Falls road compared to 5,000m^3 used by the furniture industry in the same area. Because the craft industry is heavily linked to the tourist industry, one could infer that the industry was not spared by the economic downturn that saw the decline in the tourist industry in the last decade.

Environmental services

Vegetation cover is one of the major factors that determine soil loss through erosion. Good vegetation cover intercepts raindrops and improves water infiltration into the soil. The soil protective functions of woodlands and forests occur at the level of the tree canopy, herbaceous plant cover and surface litter. Since most of woodlands are deciduous and leaf fall occurs well before the rains between July and September, it means that there is litter to intercept rain drops the soil surface level. At the same time the leaf flush which occurs between September and November provides cover that intercepts rainfall at the canopy level. Finally the dead herbaceous plant biomass, mainly from grass helps protect the soil at the onset of the rainy season. The maintenance of vegetation cover for soil protection especially in watershed areas is very critical.

Zimbabwe is a relatively dry country with an average annual rainfall across the whole country of only about 655mm. About one-third of the country receives less than 600mm rain a year on average, while only 13% gets more than 800mm. Inter-annual variability in rainfall is high, particularly in the drier areas. Mean annual runoff averages about 20.0km^3 or 7.8% of mean annual rainfall, equivalent to per capita of about 1,600m^3 per year. Annual groundwater recharge is estimated to be about 5.0km^3. Potential surface storage capacity, excluding Lake Kariba, is estimated to be 32.8km^3 with an annual potential yield of 10.5km^3 (53% of mean annual runoff). Water is also a prime source of power generation. At present, hydropower makes up 34% of total power generation in Zimbabwe and 14% of total energy use. The demand for good-quality water by all sectors will continue to increase.

The level of vegetation cover or protection in a watershed is very critical for regulating surface runoff, base flow and groundwater recharge. Given the low and seasonal nature of the rainfall in the country, maintenance of adequate vegetation cover for watershed is very critical. Unfortunately most watershed areas have been extensively deforested due to clearance for agriculture and settlement. Most of the major catchments have lost most of their original forest cover. For example the Save catchment has less than 25% of its original cover left. In fact this catchment is so heavily deforested that the major river, Save is silted and does not flow perennially anymore. The loss of watershed protection increases the vulnerability of rural populations living in these areas to drought, flooding and soil erosion. In 2002 and 2003, cyclones induced floods caused extensive damage to infrastructure in the eastern and southern areas of Zimbabwe.

As the watersheds are degrade due to deforestation and soil erosion, surface and ground water have become more scarce and livelihood tasks more difficult, time consuming and costly. In remote rural areas people are forced to rely on water from sand abstraction. Although catchment and sub-catchment councils have been established, there is still very little integration of catchment management plans into overall land use and natural resources management plans. The local authorities appear to concentrate on water management, access and use at the expense of watershed protection. The concluded land reform programme did not appear to put watershed protection as central issue in the resettlement plans.

The Zimbabwean forests and woodlands represent huge carbon stocks and continue to play a major role in carbon sequestration for which incentives or compensation could be given as an incentive for their maintenance. At present there are not many projects on carbon trade that are being implemented in the country compared to other countries in the region. As the country recovers, there will be a need to perhaps fast track these issues so that the country catches up on lost ground.

Biodiversity

The natural forests and woodlands of Zimbabwe are rich in bio-diversity and are home to more than 4,400 vascular plant species. Of these, 214 species are endemic while a number of others are near endemic. About 504 species, covering 257 genera in 84 families are known to be threatened. The family Orchidaceae (orchids) contain the largest number of threatened species (72). The main areas of endemism are the serpentine grasslands of the Great Dyke and the quartzite outcrops of the Chimanimani Mountains in the eastern part of the country. The country also has 672 bird species, 450 of which breed in Zimbabwe, though none are strictly endemic; 196 mammal species, 156 reptile species, 120 species of amphibians, 132 fish species, and still to be identified species. Zimbabwe also supports populations of 14 bird species of global conservation concern, one of which is classed as endangered, 7 as vulnerable, and the balance being classed as near-threatened in a global context. Forty-four species are classified as Specially Protected Species in terms of the 1975 Parks and Wild Life Act. Among the mammals, one species is classed internationally as being Critically Endangered (Black Rhino), two species as Endangered (African Elephant and Painted Wolf), and 8 species as Vulnerable.

Forests and Agriculture

Typically, the small scale low-input production systems of the communal and resettlement areas are based on a combination of crops and livestock. The agricultural production system is intricately linked to forest resources. Crops and livestock are highly interdependent with livestock providing draft power and manure which are critical for maintenance of the system. On the other hand, crop residues form a significant proportion of livestock feed. Two major land use components characterize this farming system, namely, arable fields and grazing areas which comprise grasslands and woodlands. The latter provide browse and fodder and medicine for livestock and contribute towards soils enrichment. Cattle are very important for draught power in crop production. In the drier parts of the western and southern part of the country, the livestock survive on browse and tree fodder for a greater part of the year.

Commercial forestry

The forest industry in Zimbabwe is largely based on the plantations that are found in the eastern part of the country where rainfall is enough to sustain tree growth. There are also small plantations near Mvuma as well as around the great dyke between Norton and Macheke. The plantations are all of exotic species of pines (Pinus patula, P. taeda and P. elliotii), eucalypts (Eucalyptus grandis) and wattle (Acacia mearnsii).

These commercial plantation industries provide wage employment directly to 13,000 people. In recent years the industry has established and expanded its partnership with small-holder farmers through the promotion and establishment of out-grower schemes especially of eucalyptus plantations. In 2002 there were more than 1,000 out-growers with an estimated plantation area of 4,000 hectares. Although most of these are from the large-scale and small-scale commercial farming areas, a sizeable number are from the communal areas. The out-grower schemes have enabled the farmers to diversify their sources of income and to create employment opportunities. The major limitation to expansion of the out-grower scheme is insufficient land. Most of the farmers in the communal areas do not have adequate land to produce both food crops and plant trees on an economically viable scale. The opportunities for significant poverty reduction are limited to those with adequate land. Research on interspecific hybrids of both pines and eucalypts has slowed down in much of the last 10 years due to inadequate funding.

The indigenous hardwood timber industry is concentrated on the Zambezi teak woodlands which occur in Kalahari sands in the western part of the country. The main commercial species are *Baikiaea plurijuga* and *Pterocarpus angolensis*, whilst other species include Afzelia quanzensis, *Entandrophragma caudatum* and *Guibortia coleosperma.* The timber is mainly used for furniture, parquet flooring and veneer. Commercial harvesting of hardwoods has also declined over the years from 44,000m^3 in 1990 to 22,000m^3 in 1996 and 20,000m^3 in 2002. In districts (parts of Tsholotsho and Nkayi districts) that are resource endowed, revenue from timber now accounts for up to 30% of total household income for local communities. Teak coppices well but from stumps that are less than 20cm in diameter making this an impractical management tool for sawlog production. Mukwa regeneration is very problematic. Selective felling of older trees has not significantly improved the situation. Thus there has been little regeneration and replacement and the tree population is declining. Mukwa is often affected by the die-back disease that is caused by the fungus *Fusarium oxysporum* (Pierce, 1986). Mukwa growth is relatively faster than that of teak. The major areas where commercial harvesting of mukwa and teak is taking place are the State forests, and communal areas in Tsholotsho, Nkayi, Lupane and Gokwe Districts.

Local communities living around reserved forests and other protected areas generally have no guaranteed access to the forest resources even for subsistence use. They may however be granted permits on an individual basis, for harvesting specific products such as firewood, thatch grass collection or grazing their livestock. In recent years the Forestry Commission has attempted to improve the involvement of local communities in the collaborative management of reserved forests through the resource sharing scheme. Under this arrangement which is being undertaken in the Mafungabusi Forest Reserve, communities have access and use rights limited to some forest products (timber and wildlife are excluded) that are agreed upon. The Forestry Commission essentially retains ownership and control of the forest and basically defines what cannot be done by communities in the forest. However for the agreed forest products (broom grass, thatch grass, mushrooms and honey) the local community are fully involved in the development and implementation of management and harvesting plans, definition of benefit sharing mechanisms through their own institutional arrangements. Whilst the results of the pilot have been positive and have indicated the possibility of giving a greater management in the communal areas, very few of the forests areas are under any formal management. The exception is Tsholotsho District, where the two main production forests, Pumula and Mpindo blocks have very good management plans. Mpindo forest is the only natural forest that has been certified by SGS under the Forest Stewardship Council (FSC) guidelines as being sustainably managed. The lack of management of the rest of the forests poses a serious threat to the forests and to the hardwood industry that depends on them.

Conclusion and Recommendations

Forests and woodlands are directly and indirectly linked to rural livelihood and production systems in Zimbabwe. The level of dependency on forests and forest products and services for subsistence of the rural poor is very high. The supplementary income from forest based micro-enterprise enterprises using both wood and non-wood forest products is very important for diversifying income sources and increasing disposable incomes for many rural poor. There is strong evidence that value addition and commercialisation of NTFPs (NWFPs) significantly increases incomes for rural communities and has potential to create wealth and take those involve in value adding out of poverty. These benefits could be increased substantially for communities living around protected forests and national parks if they were granted increased access to these resources and they in turn use them within the frame work of their conservation objectives. The potential of increasing the contribution of commercial forestry to poverty alleviation in the plantation sector exists although expansion of the plantations area is limited by lack of funding and other competing land use systems. The contribution of natural hardwoods could be significantly improved in the long term through improved resource management to increase supply in the areas that were over-harvested. The environmental services and functions of forests are critical for food production and security especially in as far as they provide a production base for agriculture through soil protection and improvement of water conservation. Watershed protection is particularly critical given the erratic nature of rainfall in the country and the dependence on ground water and dams of most rural communities.

There are a number of measures that need to be adopted to achieve forest-based poverty reduction. These strategies are aimed at addressing improving local community access to forest resources, increasing the forest resource base and value addition to improve the contribution of the forests towards meeting the need of the poor. This however requires that forests and tree resources management be integrated with other land uses systems such as agriculture and livestock production.

The specific recommendations are:

- Improve access to forest resources through improved land and tree tenure
- Strengthen local management of natural forests and woodlands through development and implementation of management plans. This should include resolving the institutional conflicts and clarification of roles between RDCs and traditional leaders and central government agencies.
- Strengthen local institutions and institutional arrangements to ensure benefits from the forests are captured at community level
- Support value addition of NWFPs and wood products at community level
- Promote out-grower schemes in commercial plantation forestry
- Integrate forests and woodlands into land use plans that take into account the inter-linkages between forests, agricultural, watershed protection and bio-diversity conservation.
- Grant local communities access to and management rights of protected forest areas and national parks to ensure that they benefit local communities. This could involve paying a proportion of the revenue generated from these forest areas to local authorities in which they occur as compensation.
- Establish partnerships between communities and the private sector especially in eco-tourism and timber harvesting.
- Develop and implementing simple and accessible mechanisms for compensating local communities for global services of forests.
- Review and update forest policies and laws to align them with current practice and thinking.
- Integrate forest resources management in newly resettled areas
- Build capacity of local communities in natural forests management and entrepreneurship.

Appendices

Appendix 1: Nodulation and chromosome number of Zimbabwe Acacia spp.

Taxon	Nodules	Chromosome number and specimen location
F. albida	√	26 (Sudan1)
A. abyssinica	√	52 (Chimanimani)
A. adenocalyx	No	
A. amythethophylla	√	26 (Sudan1)
A. arenaria	√	
A. ataxacantha	√	26 , 52 , 104
A. borleae	√	
A. burkei	√	
A. caffra	√	26 (Natal)
A. chariessa	√	
A. eriocarpa	N/A	
A. erioloba	√*	26 , 52 (Nyamandhlovu)
A. erubescens	√	
A. exuvialis	√	
A. fleckii	√	
A. galpinii	√	40 (Matopos)
A. gerrardii	√	52 (Sudan)
A. goetzei	√	
A. grandicornuta	√	
A. hebeclada var. chlobiensis	N/A	
A. hebeclada var. Hebeclada	√	208 (N. Pretoria)
A. hereroensis	√	
A. karroo	√	52 (Bulawayo)
A. kirkii	√	52 (Zaire)
A. luederitzii	√	
A. mellifera	√	26 (ssp. Mellifera Sudan1)
A. nebrownii	√	26 (N. Transvaal)
A. nilotica	√	52
A. pentagona	No	
A. permixta	√	
A. polyacantha	√	26 (Zambia)
A. rehmanniana	√	52 (Matopos)
A. robusta var. clavigera	√	
A. robusta	√	52 (N. Pretoria)
A. schweinfurthii	No	26 (Sudan1)
A. senegal var. leiorhachis	√	
A. senegal var. rostrata	√	
A. sieberiana	√	104 (Marondera)
A. stuhlmannii	√	
A. tortilis var. heteracantha	√	52 (Tuli)
A. tortilis var. spirocarpa	√	52 (Birchenough)
A. welwitschii	√	
A. xanthophloea	√	52

1Elamin (1972) * suggested to be aberrant; does not normally nodulate.
N/A data not available. Adapted from Timberlake et al (1999).

Appendix 2: Value and use of important species at national level

Species name	Value code	Present, Future or potential										
		ti	po	wo	nw	pu	fo	fd	sh	ag	co	am	xx
Faidherbia albida	1		√	√				√		√	√		
Acacia erioloba	1							√					
Acacia karroo	2		√	√	√			√					
Acacia nilotica	2							√					
Afzelia quanzensis	1	√											√
Andostyachis johnsonii	2		√										√
Baikiaea plurijuga	1	√	√	√									√
Bivinia jalbertii	2		√	√									
Colophospermum mopane	1		√	√				√					√
Entandophragma caudatum	1												√
Guibortia coleosperma	1	√											√
Kirkia acuminata	3												√
Milicia excelsa	2	√											√
Pterocarpus angolensis	1	√											
Schinziophyton rautanenii	2												√
Sclerocarya birrea	1						√		√				√
Strychnos cocculoides	1		√				√						
Strychnos mitis	2												√
Uapaca kirkiana	1						√						
Warburgia salutaris	2				√								
Ziziphus mauritiana	1						√						

Utilization

ag agroforestry systems
am amenity, aesthetic, ethical values
co soil and water conservation
nw non wood products (gums, resins, medicines, dyes, tannins, etc.)
fo Food
fd fodder
po posts, poles, roundwood
pu pulp
sh shade, shelter
ti timber production
wo fuelwood, charcoal
xx Other

Value code

1 = Species of current socio-economic importance and already in breeding programmes or anticipated to be included in breeding programmes
2 = Species with clear potential or future value
3 = Species of unknown value given present knowledge and technology

Appendix 3: Number of Plus Trees and Genetic Tests in the breeding programme

Species		Plus trees*	Provenance trials		Progenies trials		Clonal testing and development			
Scientific name	Native - N exotic - E	No.	No. of trials	No. of prov.	No. of trials	No. of families	No. of tests	No. of clones tested	No. of clones selected	No. of clones used
P. patula	E	463	4	130	2	4				
P. elliottii	E	335			1	35			2	
P. taeda	E	263								
P. tecunumanii	E	83	9	269						
P. oocarpa	E	36	1	18	1	12			5	
P. kesiya	E	124	4	39	2	30			16	
P. caribaea	E	390	2	27						
P. chiapensis	E	72	3	7						
P. psuedostrobus	E	8								
P. maximinoii	E	18								
P. greggii	E	4	4	83						
P. herrerae	E									
P. radiata	E	42								
P. palustris	E	10								
P. leoiphylla	E	5								
P. montezumae	E	10								
C. lusitanica	E	32								
P. roxburghii	E	32								
P. pringlei	E	5								
Pinus spp. hybrids	E	84			3	127				
Cupressus lustanica	E									
Eucalyptus grandis	E	624	5	189	7	199				
E. camaldulensis	E	143	4	167					95	
E. tereticornis	E	146	4	70					35	
E. citriodora	E	28	1						3	
E. nitens	E	40	2	12						
E. maculata	E	4								
E. microcorys	E	14								
E. paniculata	E	29								
E. dunnii	E	9	1	4				9		
E. saligna	E	30	1	20						
E. pilularis	E	1								
E. crebra	E	5								
E. botryoides	E	2								
E. sideoxylon	E	1								
E. propinqua	E	2								
E. grandis x E. tereticornis	E	8			1	21	2	52		
E. grandis x E. camaldulensis	E	14			2	39	4	52		
TOTAL		3198	45	1035	19	467	6	113	156	

Appendix 4: List of tree species that are conserved in tree seed banks

Species	Species origin	purpose
Pinus patula	Exotic	timber
P. taeda	Exotic	timber
P. elliottii	Exotic	timber
P. tecunumanii	Exotic	timber
P. maximinoii	Exotic	timber
P. oocarpa	Exotic	timber
Pinus spp.	Exotic	timber
Eucalyptus grandis	Exotic	Poles
E. tereticornis	Exotic	poles
E. camaldulensis	Exotic	poles
Eucalyptus spp. (8)	Exotic	poles
Cupressus spp (2)	Exotic	poles
Acacia erioloba	Indigenous	browse
A.karroo	Indigenous	Gum arabic
A.nilotica	Indigenous	browse
A.senegal var. senegal	exotic	Gum arabic
A.tortilis	Indigenous	Soil fertility and reclamation
A.abbyssinica	Indigenous	protection
Faidherbia albida	Indigenous	Soil fertility, fodder
Acacia mearnsii	Exotic	Tannin bark
Acacia melanoxylon	Exotic	Furniture
Sclerocarya birrea	Indigenous	fruit
Pterocrapus angolensis	indigenous	Furniture
Baikia plurijuga	Indigenous	Furniture
Colophosperma mopane	Indigenous	Furniture
Widdringtonia nodiflora	Indigenous	
Juniperus procera	Indigenous	
Sesbania sesban	Indigenous	
Sesbania glandiflora	Indigenous	
Adansonia digitata	Indigenous	
Milicia excelsa	indigenous	Protection
Bivinia jalbertii	indigenous	Protection
Guibortia coleosperma	indigenous	Furniture

Appendix 5: Breeding objectives for the different exotic tree species in the breeding programme

Species	Origin	Breeding objective					
	Native (N) or exotic (E)	Timber	Pulpwood	Energy	MP*	NWFP**	Other
Pinus patula	E	√	√	N/A	N/A	N/A	N/A
P. elliottii	E	√	√	N/A	√	N/A	N/A
Pinus taeda	E	√	√	N/A	N/A	N/A	N/A
P. tecunumanii	E	√	√	N/A	N/A	N/A	N/A
P. oocarpa	E	√	√	N/A	N/A	N/A	N/A
P. kesiya	E	√	√	N/A	N/A	N/A	N/A
P. caribaea	E	√	√	N/A	√	N/A	N/A
P. chiapensis	E	√	√	N/A	N/A	N/A	N/A
P. psuedostrobus	E	√	√	N/A	√	N/A	N/A
P. maximinoii	E	√	√	N/A	N/A	N/A	N/A
P. roxburghii	E	√	√	N/A	√	N/A	N/A
P. greggii	E	√	√	N/A	N/A	N/A	N/A
P. herrerae	E	√	√	N/A	N/A	N/A	N/A
Cupressus lustanica	E	√		N/A	√	N/A	N/A
Eucalyptus grandis	E	√	√	√	√	N/A	N/A
E. camaldulensis	E	N/A	N/A	√	√	N/A	N/A
E. tereticonis	E	N/A	N/A	√	√	N/A	N/A
E. citriodora	E	√	N/A	√	√	N/A	N/A
E. nitens	E		√	N/A	N/A	√	N/A
E. maculata	E	√	N/A	N/A	√	N/A	N/A
E. microcorys	E	√	N/A	N/A	N/A	N/A	N/A
E. paniculata	E	N/A	N/A	N/A	√	N/A	N/A
E. dunnii	E	N/A	N/A	√	√	N/A	N/A
E. saligna	E	√	N/A	N/A	√	N/A	N/A

*MP: Multipurpose tree improvement program
N/A : Not applicable
**NWFP: Non-wood forest product
√: Specific use

Source: The Forest Genetics Programme in Zimbabwe: Part II

Appendix 6: Availability of germplasm from the breeding programme of pines and eucalypts

Species	Type of material	Available for national requests only		Available for international requests	
		Commercial	Research	Commercial	Research
E. camaldulensis	Seed	√	√	√	√
	Pollen	N/A	N/A	N/A	N/A
	Cuttings		√	N/A	N/A
E. tereticonis	Seed	√	√	√	√
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	√	N/A	N/A
E. citriodora	seed	√	N/A	N/A	N/A
E. grandis x *E. camaldulensis*	Seed	√	√	N/A	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	√	N/A	N/A
E. grandis x *E. tereticonis*	Seed	√	√	N/A	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	√	N/A	N/A
P. patula	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
P. taeda	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
P. elliottii	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
P. oocarpa	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
P. psuedostrobus	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
P. maximinoii	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
P. tecunumanii	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
E. grandis	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
E. saligna	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
E. cloeziana	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A
Eucalyptus Hybrids	Seed	√	N/A	√	N/A
	Pollen	N/A	N/A	N/A	N/A
	Cuttings	N/A	N/A	N/A	N/A

√ = Available on request, N/A not available

Appendix 7: The state of national involvement in forest genetic resources networks.

Network	Main Functions	Benefits	Current State
National Biodiversity Forum	Co-ordinate National Biodiversity Programme	Conservation of Forest Biodiversity	On going
National Plant Genetic Resources Committee (NPGRC)	To provide advice on plant genetic resource activities and recommend policies and legislative frameworks to the government of Zimbabwe	Steering national programmes	On going++
Beekeepers Association of Zimbabwe	Coordinate bee keeping activities for sustainable honey production	Forest conservation Poverty alleviation Food security	On going
CAMPFIRE Association of Zimbabwe	Conservation of natural resources and benefit sharing at the community level	Sustainable management of natural resources	On going
Timber Producers Federation (TPF)	Coordinates activities of timber producers for sustainable management of forests	Sustainable forest management	On going
African Network for Agriculture, forestry and Natural Resources Education (ANAFE)	Collaboration and networking of agriculture and forestry training. Universities and agriculture/ forestry colleges are members.	Funding for Research Networking Training in agroforestry	Ongoing

Appendix 8: List of Contributors to the Report

NAME	INSTITUTION
Gotore. T .Mr	Forestry Commission
Gwande. K. Mr	Environment Africa
Mapaura. A. Mr	National Herbarium
Matanga. N. Mrs	Zimbabwe College of Forestry
Muchichwa. J. Mr	Forestry Commission
Mutete. P. Mr	Forestry Commission
Nyahuye. A. Ms	Environment Management Agency
Smith. M. Mr	Timber Producers Federation
Randeni T. Mr	Forestry Commission

References

Barnes RD (2001). The African acacias: A thorny subject. Southern African Forestry Journal. 190: 9-18.

Barnes RD, Marunda CT, Maruzane D and Zirobwa M (1999). African Acacias: Genetic Evaluation: Phase II. Final Report of FRP/DFID Forestry Research Scheme R6550. Oxford Forestry Institute and the Zimbabwe Forestry Commission, 49p.

Coates Palgrave K. (revised and updated by Meg Coates Palgrave) (2002). Trees of Southern Africa. 3rd edition. Struik, South Africa

Campbell B. (eds) (1996). The Miombo in Transition: Woodlands and Welfare in Africa. Centre for International Forestry Research. Bogor, Indonesia.

Child B, Jones B, Mazambani D, Mlalazi A and H. Moinuddin (2003). Final Evaluation Report: Zimbabwe Natural Resources Management Programme-USAID, Zimbabwe Strategic Objective No. 1. CAMPFIRE Communal Areas Management for Indigenous resources. Unpublished report, USAID, Harare.

Chikuni A (1998). A taxonomic study of Brachystegia Benth. (Caesalpinioideae-Leguminosae) Oxford Forestry Institute. Department of Plant Sciences. University of Oxford.

Chirwa PW, Bwanali RJ, Meke G, Sagona W, Munthali CRY and Mwabumba L (2007). Growth and phenology of a three- to four-year-old Sclerocarya birrea international provenance trial in Malawi. Southern Hemisphere Forestry Journal, Volume 69, (1): 49 – 54.

Colding J. (2002). Southern African Plant Red data List. SABONET, Report 14.

Forestry Commission Annual Report (2010). Zimbabwe Forestry Commission, Harare Zimbabwe , pp. 19

Gondo, P. (2006). Benefit Driven Natural Resource Management in Zimbabwe. A Case Study of Decentralized Natural Resources Management at Community Level. SAFIRE, Harare.

Hirji R, Johnson P, Maro P and T Matiza-Chiuta (2002). Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa. SADC, IUCN, SARDC. World Bank, Maseru/Harare/Washington DC.

Hyde MA, Wursten BT and Ballings P. (2011). Flora of Zimbabwe: Checklist: Combretaceae]. http://www.zimbabweflora.co.zw/speciesdata/utilities/utility-display-checklist.php?family_id=59. Accessed on 19 December 2011.

Kadzere I, Chilanga TG, Ramadhani T, Lungu S, Malembo LN, Rukuni D, Simwanza PP, Rarieya M and Maghembe, JA. (1998). Choice of priority indigenous fruits for domestication in southern Africa: summary of case studies in Malawi, Tanzania, Zambia and Zimbabwe.
In: Selecting Indigenous Trees for Domestication in Southern Africa: Priority Setting with Farmers in Malawi, Tanzania, Zambia and Zimbabwe. Maghembe JA, Simons AJ Kwesiga F and Rarieya M (eds). ICRAF, Nairobi, Kenya. 1-15.

Kadu CAC, Imbuga M, Jamnadass R and Dawson IK (2006). Genetic management of indigenous fruit trees in southern Africa: A case study of Sclerocarya birrea based on nuclear and chloroplast variation. South African Journal of Botany 72: 421–427.

Mapfumo P and Mtindi K (1995). Zimbabwe Country Report to the FAO International Technical Conference on Plant Genetic Resources. Leipig.

Maruzane D MacGregor J and Mukwekwerere M (1999). The role of African Acacias in communal area framing systems in Zimbabwe. Final Socio-economic report (incorporating reports by JEM Arnold and J. Coppen), Oxford Forestry Institute, UK and the Zimbabwe Forestry Commission. FRP R6550

Mazambani D and Dembetembe P (2010). Community Based Natural resource Management Stock taking Assessment. Zimbabwe Profile. USAID, Washington.

Müller T (2006). The Distribution, Classification and Conservation of Rainforests in Eastern Zimbabwe. Occasional Publications in Biodiversity No. 19. Biodiversity Foundation for Africa P.O. Box FM 730, Famona, Bulawayo, Zimbabwe. 32p

Mwase WF, Akinnifesi FK, Stedje B, Kwapata MB and Bjørnstad Å, (2010). Genetic diversity within and among southern African provenances of Uapaca kirkiana Müell. Årg using morphological and AFLP markers NEW FORESTS, 40 (3): 383-399, DOI: 10.1007/s11056-010-9206-z

National Herbarium and Botanic Garden (2011). National Herbarium & Botanic Garden Database, DR & SS, Harare, Zimbabwe.

Nyoka BI, Akinnifesi FK, Tembo C and SA Mng'omba Growth and fruit yield of Sclerocarya birrea in Malawi. Unpublished. 15p

Nyoka BI (2002). The Status of Invasive Alien Forest Trees Species in Southern Africa. Forest Genetic Resources No. 30: 11-14.

Nyoka BI and Musokonyi C (2002). State of Forest genetic Resources: FAO. Harare

Rukuni D, Maruzane D, Zirobwa M and Shumba EM (2001). Provenance variation in a Sclerocarya birrea provenance trial ten weeks after planting at Enyandeni in Zimbabwe. The newsletter of the SADC tree seed centre network p. 5-8

Rukuni D, Kadzere I, Marunda C, Nyoka BI, Moyo S, Mabiza R, Mavi S, Kwaramba J and Kuwaza C (1998). Identification of priority indigenous fruits for domestication by farmers in Zimbabwe. In: Selecting Indigenous Fruit Trees for Domestication in Southern Africa: Priority setting with Farmers in Malawi, Tanzania, Zambia and Zimbabwe. Maghembe, J.A., Simons A.J. Kwesiga, F. and Rarieya, M. (editors). ICRAF, Nairobi. Pp 72-93.

SADC, SARDC, IUCN and UNEP (2008). Southern Africa Environment Outlook, Gaborone/Harare/Nairobi

Shumba E (2001). Biodiversity and Planning Support Programme: Zimbabwe Case Study. Paper prepared for an international workshop on "Integration of Biodiversity in National Forestry Planning Programme" held in CIFOR Headquarters, Bogor, Indonesia on 13-16 August 2001

Taylor RD (2006). Case study (communal Areas Management Programme for Indigenous resources), Zimbabwe. USAID-FRAME Paper. USAID, Washington.

Timberlake J, Fagg C and Barnes RD (1999). Field Guide to the Acacias of Zimbabwe. CBC Publishing, Harare, Zimbabwe.

Timberlake J (1994). Changes in the extent of moist forest patches in the Eastern Highlands: Case studies based on aerial photographs. Forest Research Paper No. 7. Forestry Commission, Harare.

Timberlake J and Kwesha D (1994). Vegetation mapping; Woody plants; Maps; Zimbabwe

USAID (2010). Community Based Natural Resources Management: Stocktaking Assessments, Zimbabwe Profile.

Van Wyk M, Campbell BM, Calvert GM and Pierce GD (1993). Mukwa dieback in the State Forests of Western Zimbabwe, pp. In Pierce, GD and Gumbo D (eds.) The Ecology and management of Indigenous Forests in Southern Africa. Proceedings of an International Symposium, Victoria Falls, Zimbabwe, 27-29 July 1997, 382-401

White F (1983). The Vegetation Map of Africa: Descriptive memoir for UNESCO/AETFAT/UNSO vegetation map of Africa. Natural resources Research No.20 UNESCO, Paris

Williams CG, Barnes RD and BI Nyoka (1999): Embryonic Genetic Load for a neotropical Conifer, Pinus patula; Schiede & Deppe. Journal of Heredity, 90: 394-398.

Zimbabwe Fourth National Report to the Convention on Biological Diversity (2010) Ministry of Environment and Natural Resources Management, Zimbabwe.