A FOREST RESEARCH STRATEGY FOR NAMIBIA (2011–2015)

MINISTRY OF AGRICULTURE, WATER AND FORESTRY

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Research in an era of sustainable economic development, biodiversity conservation and climate change

Ministry of Agriculture, Water and Forestry

EXECUTIVE SUMMARY

The forest research strategy document was formulated to address issues associated with sustainable forest management (SFM), chiefly the key drivers of deforestation and forest degradation, and core SFM issues such as natural and artificial regeneration (tree planting) of commercially exploited species. Linked to these is also the issue of value-addition to forest products, which is currently performing below its potential. In fact, more forest products could be brought to the market and contribute directly to rural development. Furthermore, Namibia has made strides in community-based forest reserves, the management of which requires improved technical skills and appropriate organisational development at both national and community levels. In all these, it is recognised that the protection, management and use of forest ecosystems to provide commercial products and also vital ecosystem services such as carbon sequestration, require a comprehensive monitoring, reporting and verification system of the forest resources. To address these issues, the strategy document has identified seven strategic forest research areas listed herein as follows:

i. Vegetation (forest and rangeland) monitoring programme
ii. Forest products (value-added) research
iii. Ecological studies
iv. Growth and yield studies
v. Silvicultural research
vi. Economic, policy and sociological research
vii. Management of information

The seven strategic forest research areas have been described, including their justification, associated strategic objectives, indicative actions and associated results. Out of the seven areas, a priority list of research topics that can be viewed as constituting a research programme portfolio has been suggested:

i. Understanding the drivers of deforestation and forest degradation – Justification for a monitoring programme
ii. Growth and yield of forest resources
iii. Developing or applying technologies to improve natural and artificial regeneration
iv. Forest products (value-added) research
v. Economic and social aspects of SFM, including issues of governance
vi. Management of data and information

Recognising that the identification and definition of research problems and even actions are not enough to achieve objectives, the document includes an implementation strategy with these key elements:

i. Redefining roles within forest research and management divisions
ii. Forging strategic partnerships with other institutions
iii. Managing the research process – identification; proposal writing; execution; analysis of data; peer review; publication
iv. Developing programme performance indicators
v. Supporting forest researchers
vi. Introducing a Performance Management System
vii. Implementing a Monitoring and Evaluation System
viii. Fund-raising for research and development
ix. Acknowledging the personnel implications of the research strategy

Mindful of the current personnel constraints of the Division Forest Research, it is stressed that the Directorate of Forestry develops and facilitates partnerships and also provides the necessary support to the research processes, including support to individual researchers. In this regard, the strategy recommends that the priority research areas are initiated in phases over a period of 24 months from the time the research programme is launched. During that period, the Directorate of Forestry and particularly the Division Forest Research should pursue its personnel recruitment targets so that most of its established posts are filled in line with the strategy.

FOREWORD

The Forest Research Strategy derives its mandate from the Forest Policies of 1992 and 2001, the Forest Act of 2001 and more recently, the current Strategic Plan of the Ministry of Agriculture, Water and Forestry (2008–2012). The Ministry's Strategy has seven focal areas, with forest management falling under the sixth of those, namely, that of Sustainable Natural Resources Management. The Research Science and Technology Act of 2004 is of further strategic interest as it gives special focus to research and development. All research components of government must be affiliated to this Act and espouse and contribute to its policies.

Developments in the forestry sector are now in the second decade after the formulation of the first strategic plan of 1996. While significant gains have been made regarding institutional development, capacity building and the proclamation of community forest reserves, a renewed research focus and effort is needed to help realise Namibia's objective as a nation to use her natural resources for meaningful economic development. In this regard, the rapid increase in the number of community forest reserves has raised expectations on the part of the public as to the economic opportunities associated with their proclamation. In addition, the government has through MAWF given a new policy direction to promote bush utilisation; tree planting; commercialisation of various forest products; and orchard development. Despite the environmental limitations of a dry country such as Namibia, the policy direction gives scope for research to improve the management of trees, woodlots and forests and to add value to already known products and also bring new products to the market. Evidence of such possibilities is suggested by the commercial potential of oils from marula, sour plum, and gums from *Commiphora* species. Orchard developments have also given impetus to tree growing by communities and individuals and are likely to generate research in tree growing at an unprecedented scale in Namibia.

Cognisant of its responsibility to monitor Namibia's environment and advise her people and government, the Directorate of Forestry, through its unit for mapping, remote sensing and GIS, is well placed in conjunction with other government agencies, to offer environmental monitoring services. These will greatly help in Namibia's efforts in climate change adaptation and mitigation, particularly in agricultural production systems that could be heavily affected by changing climatic conditions or extreme swings in weather conditions in the short term.

This document gives a new focus to forest research in Namibia and, mindful of the fact that Namibia's human resources are still scarce and not found in one institution, it calls for a deliberate formation of strategic and functional partnerships among institutions to conduct collaborative research. Furthermore, it requires a management of performance and a support system for researchers to enable the sub-sector to show results and attract scarce research funding.

The conservation of Namibia's forest species and ecosystems is dependent on the generation and management of research information, resulting in an improved technical understanding and the translation of this knowledge into relevant and responsible forest management recommendations. Thus, the impacts of this current investment of the Ministry in forest research will be extensive and enduring, and ultimately contribute to the development objectives of the nation.

Mr Andrew Ndishishi
Permanent Secretary
Ministry of Agriculture, Water and Forestry

June 2011

Aspects of forestry. Clockwise from top left: forest inventory planning; wood products; controlled burning; propagation of trees from seed; taking measurements for a forest inventory; *Eucalyptus* plantation.

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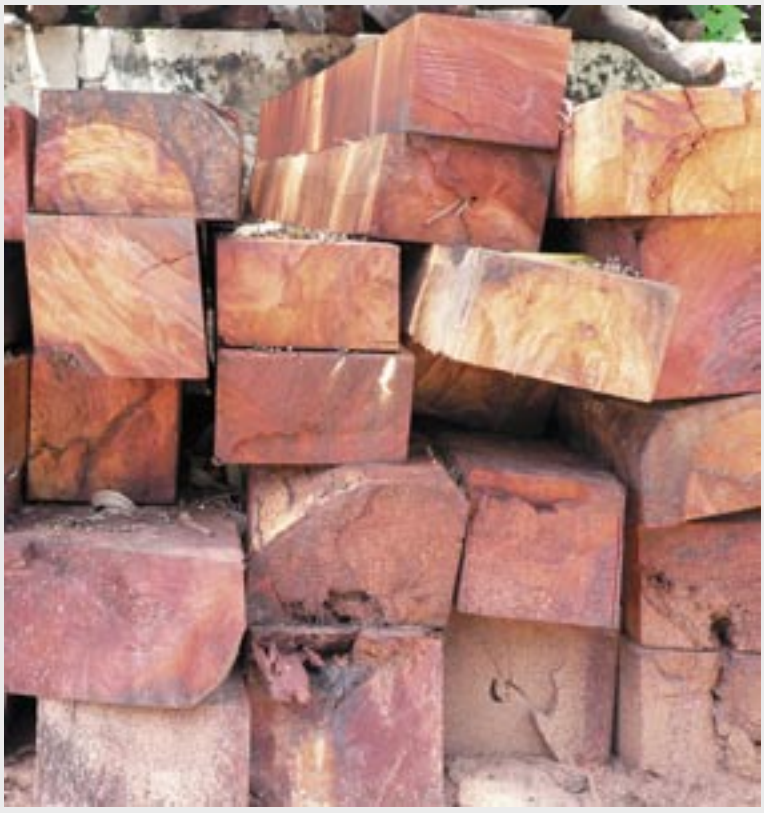

Aspects of forestry.
Clockwise from top left: storage of seeds; deforestation; orchard; wood products; herbarium specimen; timber harvesting; honey products.

1. INTRODUCTION

1.1 Background, justification and structure of the document

The Forest Research Strategy document represents a new attempt to address the issues that are relevant to the management and use of forest resources but viewed from a research perspective, and in which research is regarded as an essential tool to address issues, problems and challenges that stand in the way of sustainable forest management. There is a tacit acknowledgement that research and technological development are crucial to the sustainable management of Namibia's forest and woodland resources, particularly in the context of today's socio-economic conditions. It is also worth remembering that besides natural disturbances, it is the socio-economic, political and demographic characteristics of Namibia that are the origins of the main drivers of change in forest conditions, and if not checked, lead to deforestation, degradation and permanent loss of forest cover.

The document therefore gives an overview of the history of forest research and management in Namibia. It briefly describes the key problems in Namibia today that warrant a series of co-ordinated, medium- to long-term actions that form the core of strategic research areas. The strategic research areas are designed to address both the technical research aspects of managing forest and woodland resources, and value-addition to contribute to the development objectives of the country. Recognising that the forestry sector is often affected by policies and actions (collectively known as 'drivers') that originate from outside the sector, due priority has been given to revealing and defining the main drivers of deforestation and forest degradation. This is meant to highlight areas where national policy actions can be positively designed to counteract the key drivers that are detrimental to the survival of ecologically and economically important forest resources.

Each strategic research area is described and the rationale for its choice is provided, together with suggested possible, relevant actions and the results that could be expected. From the seven strategic areas, a priority set of research actions is proposed and also presented in a results-based framework, which is meant as an input to the production of an action plan as a logical consequence of the exercise.

An important section that follows the strategic research areas is that of the implementation mechanism. This section argues for a redefinition of roles within the Directorate of Forestry to support the Division Forest Research; advocates for the creation of functional and result-oriented partnerships with relevant institutions; calls for the deliberate management of the research process; and recommends direct support to researchers by way of advisory services, mentoring and others. Furthermore, it suggests the serious application of a performance management system from the level of programme down to individual researchers. Finally, a monitoring and evaluation framework is recommended for the research programme and it is proposed that the entire programme be evaluated at least once every five years. The next subsection provides a brief overview of the history of forest research and management in Namibia.

1.2 History of forest management and research in Namibia

Evidence from the literature suggests that the activities that would constitute forest management from the colonial era were mainly the regulation of commercial harvesting permits for *Pterocarpus angolensis* (kiaat) and the establishment of species trials based in Okahandja and Grootfontein Forest Stations by the German Administration. It appears that there were no major efforts at that time to understand the regeneration characteristics of the main commercial species. As such, there are virtually no silvicultural guidelines on the management of the natural forests, particularly with regard to stand treatments and regulations to aid natural regeneration that would have included the management or deliberate use of fire. The species trials that were attempted, basically concentrated on *Casuarina*, *Eucalyptus* and *Prosopis*, and a number of ornamental species for planting in the cities and around farm dwellings.

However, the coming of the South African Administration saw the advent of a more classical approach to the management of natural forests and the establishment of fire trials. The realisation that fire is an important ecological phenomenon in the structure and function of the dry woodlands of the Kalahari Sands and Miombo is important for their sustainable management. This is based on observations that fire can be used as a mechanism for renewing range quality if it is used to burn off moribund grass. Fire enhances the availability of ash (potash) that is important for the rapid regeneration of the grass and herbaceous understory of the dry woodlands and provides the rationale behind 'shifting cultivation'. In addition, natural fires can also serve as an efficient breaker of physical dormancy in the hard-coated seeds of fire-adapted taxa such as those within the family Fabaceae (e.g. *Acacia*) and others. However, its ecological effects on vegetation are dependent upon many factors such as timing; weather conditions; fuel load; and frequency. The issue of fire will be discussed more fully in the section under research issues and priorities. In addition to trying to understand the function of Namibia's natural forests, there were attempts to establish *Eucalyptus* species trials that were inherited by Namibia at Independence in 1990. It is noteworthy that at Independence, the dry woodlands were not under any systematic management, other than the mere exploitation of kiaat (*P. angolensis*), Zambezi teak (*Baikiaea plurijuga*), and false mopane (*Guibourtia coleosperma*). Furthermore, it is surprising that there were no proclaimed forest reserves for purposes of protection or the application of strict rules or practice of sustainable forest management, despite the promulgations of the Forest Act of 1968 and the Forest Conservation Ordinance of 1925 before it. However, those two pieces of legislation enabled the listing of species for total protection and were used to regulate commercial harvesting in what is today known as the Caprivi, Kavango and Otjozondjupa Regions of Namibia.

A renewed focus on forest management came soon after Namibia's Independence in 1990, when a devoted Directorate was created with two divisions for management and research, supported by regional and field offices. This was soon followed by the first-ever promulgated Forest Policy of 1992 to be followed later by a 10-year Strategic Plan in 1996 and new Forest Act in 2001. These new policy and strategic directions are elaborated in another section with specific commentary on the role they have played to promote research in forestry.

1.3 Forest resources of Namibia

The forests of Namibia, also described as dry, semi-open to open woodlands, occur mainly in the deep aoelian Kalahari sands, in the north-central and north-eastern parts of the country. The dominant tree species in the Kalahari Sands Woodlands, which are also distributed in Angola, northern Botswana, Zambia and Zimbabwe belong, like in the dry Miombo Woodlands, to the subfamily Caesalpinioideae. The '*caesalpiniod*' species typical of these ecosystems are *Baikiaea plurijuga*, *Burkea africana*, *Guibourtia coleosperma* and *Colophospermum mopane*. Species such as *Pterocarpus angolensis*, *Sclerocarya birrea*, *Terminalia sericea* and *Schinziophyton rautanenii* are also important. The woodlands that cover about 20 % of Namibia's surface area are contiguous with more open *Acacia-Combretum* Savannas, which occupy 66 % of the total land cover, about 830,000 km^2. It is also important to note that dry woodland formations also occur in Central and West Africa to the north of the moist Guineao-Congolian moist tropical forests and also to the east and south of the Congo Basin. The largest such formation is the dry Miombo Woodlands that cover much of Angola, the southern DRC, most of Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. Like the Kalahari Sands Woodlands of southern Africa, the Miombo is also dominated by species belonging to the subfamily Caesalpinioideae. However, the Miombo is typified by different caesalpinioid tree species within the genera *Brachystegia*, *Julbernadia* and *Isoberlinia*.

An issue that is often the subject of interesting discussion is the justification of the classification of the dry woodlands as forests. The FAO system of classification or definition of what constitutes a forest uses the criteria of mean height; crown cover; and minimum area for its definition. With that in mind, a general definition of what constitutes a forest is a stand of a minimum size of 0.5 ha, a minimum height of 5 m and a crown cover of 15 % or more. In the most recent discussions pertaining to reducing emissions (of greenhouse gases) from deforestation and forest degradation (REDD+), a country wishing to manage its woody vegetation cover can adopt and declare its own minimum threshold as to what it considers a forest. As an extension to this discussion, an inventory of Namibia's woodlands conducted between 1999 and 2002 has yielded data on mean heights; stand density; merchantable timber volumes; total biomass; and also the incidence and distribution of some important, indigenous fruit tree species.

Commercially, the timber species that have been exploited from the dry woodlands have been mainly restricted to kiaat (*Pterocarpus angolensis*), which also occurs in the Miombo, and *Baikiaea plurijuga*, which is confined to the Kalahari Sands Woodlands. To a limited extent, *Guibourtia coleosperma* has also been exploited to manufacture specialised furniture. However, the economic value of these forests should not be restricted to timber. For instance, they have tremendous habitat value for Namibia's wildlife and tourism industries and they provide valuable wood for local construction and energy requirements, most of which is not formally traded or accounted for. In addition, these woodlands harbour fruit- and nut-bearing tree species of which *Sclerocarya birrea* (marula), *Schinziophyton rautanenii* (mangetti, mugongo), *Berchemia discolor* (bird plum) and species of *Strychnos* (monkey orange) are well known. A number of medicinal plants such as *Harpagophytum procumbens* and *H. zeyheri* (devil's claw) are also found in these woodlands, and also in the adjoining open savanna and desert environments.

1.4 Existing forest resource data

This subsection presents examples of data that came out of a national inventory programme conducted between 1999 and 2002, in what was the first ever effort at a national inventory under the Namibia Forestry Strategic Plan of 1996. During the exercise, only tree species of diameters exceeding 5 cm were tallied and anything lower was considered as regeneration. The volumes quoted herein refer to the tree trunk and branches with associated twigs and in addition only above ground biomass values were estimated. For students of classical forestry, some data on diameter distributions plotted for one region (Figure 1) and tabulated for another (Table 1) are provided. In general, the Caprivi Region supports the greatest height growth, followed by Kavango and Ohangwena Regions. However, those differences in height among the three regions are not statistically significant.

The Caprivi Region of the north-east, which receives between 650 to 1000 mm of rainfall, is relatively well-forested compared to other regions. It had an average of 87 trees per hectare and 21 m^3 tree volume per hectare. As one will note, the average number of trees and the total volume per hectare is lower than areas that on average receive less rainfall. The most probable explanation is that most of the land in Caprivi is in the flood-plains with low densities of trees per hectare. However, in areas of deep Kalahari sands or sandy loams, such as the state forest reserve, tree densities are much higher. The average number of stems per hectare is therefore reduced and skewed by the much lower densities in the relatively open areas. The forests have key timber species such as *Pterocarpus angolensis*, *Guibourtia coleosperma*, *Burkea africana* and *Baikiaea plurijuga*.

In the Kavango Region, where the bulk of the forests are on deep Kalahari sands, and which receives an average rainfall of about 600 mm per annum, estimates of 125 trees per hectare and 35 m^3 tree volume per hectare were recorded. Again, key timber species including *Pterocarpus angolensis*, *Guibourtia coleosperma*, *Burkea africana* and *Baikiaea plurijuga* can be found in the region.

The Ohangwena Region, which like Kavango has deep Kalahari sands and receives about 550 mm of rainfall per annum, had high tree densities estimated at 164 trees per hectare and volumes of 27 m^3. Key timber tree species are *Pterocarpus angolensis*, *Guibourtia coleosperma*, *Burkea africana* and *Baikiaea plurijuga*.

The Oshikoto Region that on the other hand receives about 400 mm of rainfall is relatively well-forested with an estimated 129 trees per hectare and volumes of 11 m^3 per hectare. The forests harbour important timber tree species such as *Guibourtia coleosperma* and *Pterocarpus angolensis*.

In the Otjozondjupa Region, which receives about 500 mm of rainfall per annum, stand densities of 101 trees per hectare were recorded but with much lower stand volumes of 4.22 m^3 per hectare. Important timber tree species such as *Pterocarpus angolensis* can be found in the region.

In the Omusati Region, which receives about 350 mm of rainfall per annum, only sparse forest cover is supported, with an average of 32.6 trees per hectare and volumes of only 3.2 m^3 per hectare. Even though no commercially important timber tree species can be found in this region, it nonetheless has stands of mopane (*Colophospermum mopane*) that have traditionally supplied communities with construction wood and energy.

The Oshana Region, which receives about 400 mm of rainfall per annum, is also a poorly forested region with an estimated 23 trees per hectare and 1 m^3 tree volume per hectare. While no important timber tree species can be found in this region, it has groves of naturally occurring fruit tree species such as jackal-berry (*Diospyros mespiliformis*), which survive on the fringes of temporarily flooded pans (oshanas). In addition, it has relatively big specimens of marula (*Sclerocarya birrea*) and bird plum (*Berchemia discolor*) trees, which are two other important fruit tree species in Namibia.

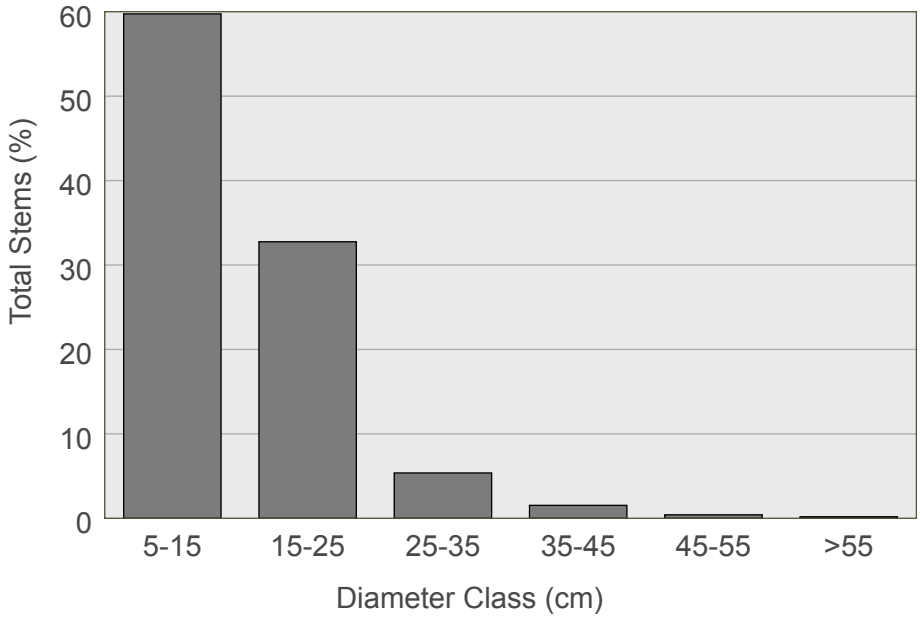

Figure 1. Diameter distribution of stems by species in the Oshikoto Region of Namibia. The bulk of the stems were found in small diameter classes.
Source: Directorate of Forestry, Namibia

Other regions (Khomas, Karas, Hardap, Erongo and Omaheke) were not inventoried due to their much lower forest cover. However, plans are underway to inventory these regions to determine their resource potential, since their woody vegetation provides key fodder for livestock and wildlife and also plays an important ecological role.

Table 1. Diameter distribution of stems by species in the Oshana Region of Namibia.
Source: Directorate of Forestry, Namibia

Species	Diameter class, in cm (1000 stems)								Total	% of total
	5 -15	15-25	25-35	35-45	45-55	55-65	75-85	115-125		
Acacia erioloba				5					5	0.1
Acacia nilotica	475		69						544	16.8
Colophospermum mopane	1,347	328	24	31		3			1,732	53.6
Combretum apiculatum (apiculatum)		95							95	2.9
Combretum zeyheri	19	57							76	2.3
Commiphora angolensis		115	29						144	4.5
Diospyros mespiliformis		95			3			11	109	3.4
Sclerocarya birrea	29	29	24	24		21	21		147	4.6
Terminalia prunioides	190								190	5.9
Terminalia sericea	144	19	5						168	5.2
Unknown1					24				24	9.7
Total	2,204	738	150	59	27	24	21	11	3,234	
% of total	68.1	22.8	4.7	1.8	0.8	0.8	0.7	0.3		100

1.5 Policy and legislative framework for forestry development in Namibia

Introduction

Forests, by virtue of their direct economic value through harvesting of tangible and tradable products and their provision of environmental goods and services, both for the national and global good, often require political intervention in both their exploitation and protection. By extension, policy and financial support for forest research to improve management for production and to maintain or enhance the ecological or environmental functions of forests are matters of both private and public interest. In drafting this research strategy, reference is made to existing public policy and legislative frameworks as the basis for the forest sector to seek public support and official funding for research. The current Namibia Forestry Strategic Plan, from which this forest research strategy derives its origins, has a recent history from Namibia's Independence in 1990. In view of the cross-border distribution of forest ecosystems, a regional context for the development of Namibia's forestry sector is provided. A brief description of post-Independence policies, pieces of legislation and plans, with an indications as to their direct or indirect bearing on the research strategy is also provided.

The Regional Context: SADC Protocol on Forestry and the SADC Forestry Strategy

The SADC Protocol on Forestry (2002) remains the direct and over-arching policy framework for future forestry collaboration amongst Member States in the region. The Protocol states guiding principles on how to co-operate in protecting, managing and utilising forests to meet regional and national objectives. Article 4 (g) refers explicitly to matters relating to Reducing Emissions from Deforestation and Forest Degradation (REDD).

Significantly, the Protocol on Forestry, just like most policies in SADC, also subscribes to multilateral environmental agreements such as the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCC), the United Nations Convention to Combat Desertification (UNCCD) and the United Nations Forum on Forests (UNFF).

A summary of the guiding principles in Article 4 of the Protocol states, *inter alia*, that Member States will i) reserve the right of countries to use forest resources for their own socio-economic and environmental needs; ii) uphold the principles of sustainable forest management; iii) support sustainable use with appropriate policies and legislation; iv) recognise their responsibility to protect, manage and where necessary, restore degraded forest ecosystems; v) use the precautionary principle in the protection and management of forests, where there is insufficient scientific information; and vi) seek, reveal, anticipate and mitigate deforestation and degradation.

Specifically, forest-related research is clearly supported in the Protocol in Articles 19 to 21, which refer to capacity building and public awareness, research and development, reporting and information exchange.

The SADC Forestry Strategy (2010) has the vision within SADC of a "*vibrant and evolving forest sector that contributes significantly to rural development, poverty reduction and, industrial progress, while retaining the vital ecosystem services of forests such as, water supply, climate change mitigation, and protecting biological diversity*". Its mission is to "*facilitate co-operation among member states to promote the active protection, management and sustainable use of forest resources, through sound policy guidance, the application of requisite skills and the best available technology, in order to enjoy the multiple benefits of forests in perpetuity*."

The strategy is operationalised through eight strategic programme areas that include: i) climate change mitigation and adaptation; ii) protection of key catchment forests; iii) community-based forest management; iv) forestry and poverty reduction; v) enhanced trade within SADC; vi) cross-border co-operation in

fire management and management of trans-boundary forest ecosystems; vii) forest assessment and management of a regional database; and viii) capacity improvement in SADC.

Policies in Namibia

It is crucial that forest research draws its mandate from official government policies and plans and uses these to maintain public interest in its quest for knowledge to aid the management and protection of the vital services and functions provided by forest or woodland ecosystems in Namibia. In that regard, forest research in Namibia today is underpinned by some key policy documents of which the Namibia Forest Policy Statement of 1992 is the first in post-Independent Namibia. This was followed by the Namibia Forestry Strategic Plan of 1996; Forestry Development Policy of 2001; and the Forest Act of 2001. It is significant that the seventh and ninth strategic objectives of the Forest Policy of 1992 directly refer to the importance of forest research and underline the need to provide information for management and to provide baseline data on forest resources. The Namibia Forestry Strategic Plan of 1996 is a document that brought focus to developments in what is today's forestry sector. In a way, and more than any other policy document, it has shaped the current programmes of the forestry sector and has directly and indirectly influenced the research agenda. Its guiding themes were production, protection and participation. To implement the Strategic Plan, four main areas, namely Capacity Building; Environmental Forestry; Community Level Management of Natural Forests; and Farm Forestry were chosen. Of these four areas, it is the first three that were significantly funded. In fact, the recognition of community participation that has led to the rapid proclamation of community forest reserves underpinned by supportive legislation and the massive resources that went into formal training, thanks to funding mainly by Finland and other donors, stemmed from the Strategic Plan. The present demand for research to support community level management of natural forests has its origins in this Strategic Plan. The Plan also clearly articulated the importance of forest ecosystems in biodiversity conservation, carbon sequestration and as reservoirs of plant-based products with known and potential values. It is noteworthy that in 2001 a new Forest Act, the development of which was virtually concurrent with the Strategic Plan of 1996, was promulgated and it was crucial to the official proclamation of today's officially gazetted Community Forest Reserves. In 2008, a new strategic focus for forestry was developed as part of the overall Strategic Plan for the Ministry of Agriculture, Water and Forestry (2008–2012). The Ministry's Strategy has seven focal areas in which forest management falls under the sixth of those, namely, that of Sustainable Natural Resources Management. The major result areas are stated as:

- Improved and integrated natural resources management
- Coping mechanisms in place for addressing adverse effects of climate change on production (including global warming, floods, droughts and 'veld' fires)
- Reduced negative human and animal impact on environment health (including pollution and waste management

The outputs envisaged under this strategic focus area have been stated in a logical framework matrix format and the role of research and development to facilitate the achievement of objectives is recognised in the strategic plan.

The above policy documents and strategies, strengthened by the Forest Act of 2001, have reinforced the need for production, protection and participation. This is consistent with one of Namibia's overall development policy positions that favours the sustainable use of natural resources within marine, freshwater and terrestrial ecosystems. The sustainable use concept and practice has significant resonance with the classic forest production concept of 'sustained yield management,' which has its roots in plantation forestry and aims to supply a steady and predictable quantity of fibre for commercial use. In Namibia today, the management of the dry woodlands, with their limited resource base, requires the application of sustainable use much more than sustained yield. This is because the former recognises the limitations on a naturally occurring resource base and suggests that harvestable quantities must be constrained and restricted by an amount that allows the resource to still produce or renew itself. Under a "sustained yield system" there is a much greater room for increasing the resource base through planting or a treatment that enhances regeneration and growth to ensure predictable levels of supply.

1.6 Challenges in managing Namibia's dry forests

The challenges of managing the dry forests and woodlands are many and varied depending on one's perspective and professional orientation. For purposes of this document, a few challenges that can directly impinge upon management efforts are described.

The dry conditions in Namibia tend to limit growth and yield of forest products, in a manner quite different from much wetter countries in southern Africa. Increasing demands by rural populations for land and wood products therefore exert pressure on an already constrained system. The threat of climate change, with predicted vulnerability to droughts, will most likely require adaptation strategies that may have high cost implications for Namibia. The need for research and technology to increase production; develop tradable products and sustainably use the biological capital in the dry woodlands is probably the greatest challenge that the forestry sector in Namibia faces today.

Since Namibia, like any other natural resource based economy, would like to use her natural resources to develop, there is pressure to use resources and at times this may require a careful balancing between protection of forests for purely ecological functions and the need for direct economic uses of the same resources. In general, maintaining forests for their protective functions tends to restrict use and is politically difficult to sell in a developing country.

As is fairly typical of the dry woodlands of southern Africa, only a few species are targeted for commercial exploitation. In view of demand that outstrips supply for both local industry and export markets and partly as one of the few revenue sources in the rural areas, there is generally a tendency toward overexploitation, often to the detriment of those few commercial species. The story of kiaat in Namibia is a good example.

Linked to the above point is that since most of the woodlands are communally owned and given the history of licensed commercial logging as the predominant form of management in the past, with no tradition for active stand management, Namibia's woodlands have suffered what is typically described as the "tragedy of the commons". Essentially common ownership and unregulated access without proper recognised rights of local people, has inadvertently fuelled a tendency to "mine out" available merchantable timber with no due regard or responsibility regarding regeneration for future harvesting.

The dry conditions of Namibia's woodlands are associated with relatively slow growth rates and poor regeneration, particularly in the nutrient-poor deep Kalahari sands. In technical terms, one can say that the rate of recruitment of smaller trees to larger size classes suitable for harvesting is relatively slow and is probably a disincentive to public and private investment in their active management.

A natural and anthropogenic phenomenon in the dry woodlands is the use of fire. It is used frequently as a land preparation and range management tool. In addition, a number of wildfires escape from land preparation burns into the woodlands, causing significant damage to grazing, thatch grass and natural regeneration if the timing is not right and if frequency exceeds the adaptation thresholds of dry woodland systems. While there is an appreciation of fire as a land management tool, to date, there is insufficient understanding on its deliberate, controlled and productive use to achieve land management objectives, particularly in farmed landscapes, and hence negligible application.

Technologies that could lead to the utilisation of a broader range of species may exist elsewhere in the world but these have not been adopted or harnessed for local use. For example, species such as red syringa (*Burkea africana*) can be utilised if there is improved sawing technology that can yield wood for applications such as flooring. Even more interesting technologies exist to make reconstituted wood products such as fibre and wafer boards, over which high quality veneer can be bonded to produce high quality wood-based panels for both local and export markets. Hence, the barriers to technology transfer is one challenge that Namibia must gear itself to overcome.

This document presupposes an effort by the government to develop and recruit suitably qualified personnel to implement the research programme. However, the reality on the ground is that Namibia does not have adequate numbers of appropriately qualified researchers to implement this strategy; hence deliberate efforts to overcome skills shortages must be made. Even where such skills exist, these are often scattered over several institutions and in that regard, encouraging institutions and people to collaborate is another challenge that research will face.

Given the above challenges, it follows that the current outputs from research are inadequate to enhance our understanding of how the woodlands function, of which natural regeneration of species and yields of other products are important. So far, there are virtually no stand treatment procedures that are formally recommended for the management of key species under pressure of harvesting. Research will also help produce technologies that can facilitate the development of new products (both wood and non-wood), enable the sustainable use of other species and help to alleviate rural poverty.

1.7 Opportunities for doing research in Namibia

Despite the formidable challenges that have been described, Namibia as a country has features and circumstances that should be interesting to a curious scientific mind. Given that independent Namibia has had a relatively short period of academic and research pursuit, there are tremendous opportunities for her to develop dryland forest scientists of repute. Some of the opportunities have to do with the issues listed below:

- High levels of endemism, which should be exciting to any researcher
- Problems such as bush encroachment, the solutions of which are immediately applicable to a recognised problem
- An arid environment that calls for research in adaptation and tolerance to sustained periods of stress
- A policy environment, that seems quite supportive of natural resource research in underpinning social and economic development
- Room for novelty due to the uniqueness of the environment and its flora

While some would view Namibia's status as the most arid country in sub-Saharan Africa as somewhat of a dubious distinction, it nonetheless provides a unique physical environment in which some of its animals and plants have evolved unique traits to survive in its harsh conditions. That in itself provides unique opportunities for aspiring scientists to study the survival strategies of its plant and animal life. For example, the wide distribution of camel thorn (*Acacia erioloba*) from Namibia's wettest north-eastern region of Caprivi down through the Kalahari and Namib Deserts to the Orange River, is a study in plant adaptation along an environmental gradient. The natural regeneration of tree species in the deep Kalahari sands and their adaptation to both fire and herbivory are other interesting arenas for both the discerning scientific mind and the keen observer of natural phenomena. In summary, the plants and their environments can provide the 'budding scientist' with plenty of room to bring new and exciting information to the world of science; in other words, novelty.

The government's policy that has led to the proclamation of several community forest reserves in the last decade has brought new demand for technologies generated by research to both increase and sustainably utilise the "biological capital" of Namibia's forests and woodlands. It is an opportunity for research to inform policy and practice. This is because as new technologies are developed or adopted for management, the likelihood for their uptake is high because the community owners have asked for them in the first place. The community forest reserves provide a good platform for the development of a very strong science-policy-development interface.

One can also say that the policy environment for research to promote added value to forest and tree products and sustainable use is quite strong and supportive in Namibia today. This is evident in policy statements in the forestry sector and also in the foresty-related development objectives in the current

National Development Plan (NDP 3). There is also a strong demand by government for research that promotes the sustainable use of indigenous woody species that have become locally invasive, forming patches of impenetrable thickets inaccessible to livestock. Furthermore, the strong policy push by government is a great opportunity for forest research to claim its place in the development of Namibia and provide incentives for government to allocate funding for the development of scientists, support for technology development and facilitate the adoption of technologies available from elsewhere.

1.8 Current research infrastructure

The current structure of the Directorate of Forestry includes the Division Forest Research. The Division is composed of two subdivisions. Subdivision Research Programmes and Stations makes provision for five Forester Level (minimum qualification of a 4-year Bachelor's degree, but preferably MSc degrees) posts at the Research Headquarters in Okahandja (National Forestry Research Centre – NFRC), with one post decentralised to Hamoye Forestry Research Station. The NFRC is headed by a Chief Forester Level Position, who also manages three field stations, namely Hamoye (Kavango); Kanovlei (Otjozondupa); and Ngoma (Caprivi). Of interest is that NFRC has a Tree Seed Centre with cold storage facilities and a laboratory that is used for seed testing and other laboratory-based experiments. In Hamoye, work on species trials and propagation methods have been on-going, but unfortunately it is located in a 'frost pocket' that leads to near total mortality during every winter. It produces good quality seedlings that are sold at the Regional Forestry Office in Rundu, which is relatively frost-free. Kanovlei Forestry Research Station runs a burning trial, but was largely responsible in the recent past for testing the use of truncheons to vegetatively propagate *Pterocarpus angolensis*, later abandoned for lack of rooting. This station is ideally situated adjoining both State Forest and Community Forest areas, with fairly pristine stands of dry woodlands. Ngoma Forestry Research Station was transferred to the Directorate of Forestry in 2003. It has an impressive plantation establishment trial using mainly *Eucalyptus*, which has yielded interesting results that could be analysed.

The second subdivision below the Deputy Director, who is the head of the Division Forest Research, is Subdivision Policy, Planning and Information, which includes the National Remote Sensing Centre and the National Forestry Inventory. In addition to the Chief Forester, provision has been made on the establishment for nine Forester Level Positions. The levels of qualification of current incumbents within the Research System are one PhD; seven Masters; two Honours; and four Bachelors. Bearing in mind the focal areas of the research strategy, the current establishment, if all the posts are filled, will have over ten members of staff with a minimum of a B.Sc. degree. This would be sufficient for it to run a credible research programme and particularly if the Directorate of Forestry forms strategic partnerships already described in order to seriously pursue the research agenda.

The budget allocated to the Division Forest Research in the 2009-2010 Financial Year, excluding salaries, was four million Namibia Dollars (N$ 4 million) for the recurrent budget and a development budget of just under three million Namibia Dollars (N$ 3 million). The recurrent budget is largely allocated to the running and maintenance of the research programmes and facilities and the Development Budget normally goes into construction and purchase of capital goods. The total budget, including salaries, is just over one million US Dollars. However, it is not clear how much of the recurrent budget goes directly to fund research projects. The fact that the Directorate of Forestry is a single cost centre without clear delimitations in the financial system to manage funds at a divisional or subdivisional level, makes analysis of expenditure fairly difficult. Annex I describes the main research projects in existence during the preparation of this document.

A significant development that should positively affect the Directorate of Forestry is a decision by the Ministry of Agriculture, Water and Forestry, to merge the Directorate of Forestry with the National Botanical Research Institute (NBRI). This should add more skilled staff, and will also have implications on the structure of the Division Forest Research, especially in the areas of common interest, such as vegetation monitoring, the National Tree Seed Centre, value-addition and aspects of applied botanical research.

2. RESEARCH ISSUES, PROBLEMS, KEY STRATEGIC RESEARCH AREAS AND PROGRAMME PRIORITIES

2.1 Introduction

Having discussed the challenges that impinge upon forest research and management efforts in Namibia, this section provides a synthesis of facts and views to produce a set of problems or issues that the forest research programme seeks to address. Thereafter, the section introduces a set of strategic research areas that are deemed relevant to address the research problems or issues. Each strategic research area or theme is defined, its rationale given, together with possible actions and results that could be expected.

At the end of the section, a few research priorities and the relevant strategic research areas meant to address them are presented in what is termed a results-based matrix.

2.2 Problems and issues as justification for the research agenda

As reflected in subsection 1.5, which presents the key challenges to managing forests and woodland resources, these challenges also help define what research questions could arise and spur actions within a research programme that could help achieve sustainable forest management. The key issues and problems that research should address, include the following:

a) Understanding the direct and underlying drivers of deforestation and degradation
b) Poor levels of natural regeneration in commercially exploited species
c) Limited success in tree growing under artificial regeneration systems
d) Inadequate data on growth and yield on species of interest
e) Inadequate efforts and products from value-added processing of wood and non-wood products
f) Inadequate numbers of skilled researchers in the forest sector
g) Problems associated with governance systems and structures in key programmes such as the community forest management programme

The ***drivers of deforestation and forest degradation*** affect the commercial and ecological functions of forest and woodland ecosystems in quite significant ways. For example, they often lead to severe degradation, which directly affects ecosystem functions but also retards regeneration of tangible forest products. Deforestation, if not followed by regeneration either naturally or by planting or seeding, will often see the permanent loss of forest cover; a phenomenon described as conversion. These drivers are also important globally because as forest cover is lost, so too the ability to mitigate ever-increasing emissions of carbon dioxide to the atmosphere is compromised. It is logical to state that the monitoring of forest cover and its changes, and also identifying and understanding the key drivers that underpin such cover changes, constitute a legitimate research area. In general, one can describe direct drivers such as harvesting of wood for energy and domestic construction and also indirect or underlying drivers, which in this case, could be high power tariffs and high taxes on natural gas (alternative energy sources).

Technology to overcome ***problems of regeneration*** is another issue with its peculiar problems. It is in fact a classic forest management issue in which research has played a traditional role in the regeneration of species that are commercially exploited. In Namibia, the key timber species such as *Pterocarpus angolensis* and *Baikiaea plurijuga* do not regenerate readily, particularly *P. angolensis* in the dry Kalahari sands. In addition to the obvious environmental limitation, not enough is understood as to which conditions favour their regeneration. This has made it difficult to prescribe ways to treat natural stands. In addition to poor natural regeneration, the species do not flourish in tree nurseries. For example, *P. angolensis* normally develops a tap-root system for a few years before it starts to grow in height and during those years, the shoot grows but dies back every year, until the root system is well established. This makes it all the more important to find ways in which natural stands can be treated to enhance natural regeneration. Clearly ways to improve natural and artificial regeneration are problem areas worthy of research.

Poor and inadequate data on growth and yield is yet another problem or issue that hinders science-based management planning of forest resources. In this regard, we are referring to both timber and non-timber forest products. With the rapid growth of community forest reserves in Namibia and the commercialisation of products such as marula and sour plum (*Ximenia*) oils and others, growth and yield of various products could help in resource management plans and yield predictions. This information, in turn, could form the basis of sustainable use strategies and also resource enhancement technologies.

Given the dry conditions and low levels of growth and regeneration, one would expect Namibia to invest in value-addition technologies to maximise the economic gains from timber and non-timber resources. However, one identified problem is that ***Namibia is neither adequately utilising existing technologies, nor developing new ones to enable a fuller use of her scarce resources***. Research in favour of value-added processing or manufacturing is a crucial research area identified in this document.

Other aspects of research that are often overlooked in favour of classical approaches in forest research are issues of governance; economic analysis of management practices; or the economic effects of certain cultural practices such as the use of fire, elite capture and so on. Governance systems and structures are particularly relevant under the current community based forest management programme.

The following subsection presents a set of seven strategic research areas, which are deemed relevant to the issues or problems described in this subsection. Indeed, this section together with the next section on the implementation mechanism, are at the core of this Forest Research Strategy. The problem of inadequate numbers of skilled researchers is dealt with in Section 3, which is about the development of an implementation mechanism.

2.3 Strategic research areas: Definitions, justification, relevant actions and possible results

In this subsection, based largely on views expressed by Namibian stakeholders, some strategic research areas are described. In so doing, each strategic area is justified and relevant strategic objectives are proposed for each. As a further interpretation of the proposed strategic objectives, relevant key actions are provided together with sets of results that could be expected to flow from the recommended actions. The suggested actions and the proposed expected results are not meant to be prescriptive, but nonetheless provide some direction as to what should be done under each strategic area of focus. The strategic research areas are as follows:

- Vegetation (forest and rangeland) monitoring programme
- Forest products (value-added) research
- Ecological studies
- Growth and yield studies
- Silvicultural research
- Economic, policy and sociological research
- Management of information

To implement the research programme along the lines of the strategic research areas listed here, an implementation mechanism is proposed in the next section of the document. Together with Section 2, they form the core of Namibia's Forest Research Strategy.

2.3.1 Vegetation (forest and rangeland) monitoring programme

Rationale

Namibia has a constitutional provision that calls for the sustainable use of her natural resources for economic and ecological benefits that are important to the country and also to the international community, who shares her vision of environmental management and conservation of the environment and its biological diversity. Namibia is also cognisant of her status as the driest country in sub-Saharan Africa and, in that regard, also her vulnerability should long-term changes in climate result in increasing aridity and episodic events associated with extreme weather conditions. Because of these, the Directorate of Forestry with its GIS and Remote Sensing facility and its history of land and vegetation mapping, is uniquely suited to be an institution that could offer monitoring services at sub-national and national levels. Some of the key factors of change that should be monitored are the drivers of deforestation and forest degradation, which if not checked would render research and technological development ineffective since they erode and reduce the resource-base upon which this research strategy is built. In Namibia, some of the direct drivers include agricultural expansion; fuelwood harvesting; and overgrazing. Another significant phenomenon and driver that Namibia has to continuously contend with is the high incidence of wild fires, the frequencies of which seem to be on the increase. Under this strategic area, monitoring services will continue to be offered and specifically used for purposes of creating awareness as to the impacts of the direct and indirect drivers of deforestation and forest degradation. With respect to fire, one would need to advocate for its use, influence cultural tendencies and attract much needed resources for its management.

Given the crucial nature of Namibia's physical environment for nature-based tourism and livestock management, both of which are important for the economy, an ecological monitoring function is not a mere scientific curiosity but a principal, core duty that the Directorate of Forestry should offer in the national interest. It is also crucial for Namibia to adopt climate change adaptation policies and practices that are informed by a nationally supported monitoring system.

Strategic objective

The strategic objective for this function is to provide information on the status and changes of Namibia's vegetation cover on an annual basis and enable the design of remedial and or adaptation measures in response to the observed changes.

The monitoring function will be implemented in collaboration with the Ministry of Environment and Tourism, the Polytechnic of Namibia, the National Botanical Research Institute, and also the Directorate of Agricultural Research and Training and the Directorate of Resource Management of the Ministry of Agriculture, Water and Forestry.

Guidelines to key actions

The main coverage of the Vegetation Monitoring Programme may include, but will not be restricted to the key actions enumerated below:

- Mapping of all forest/woodland cover, rangelands and Protected Area Network of Namibia
- Monitoring to detect changes in cover such as degradation and rate of conversion (identifying and mapping high risk areas)
- Monitoring fires, including seasonal variation, timing, severity and extent
- Supporting the monitoring of episodic events such as floods, pests and diseases, in conjunction with other institutions.

Expected results or result areas

The outputs and results of the function described here would include:

- Periodic maps on the status and changes in vegetation cover in Namibia in communal and private land as an input into forest, livestock and rangeland management policies
- Annual fire maps showing heavily affected areas to be used to influence land management policies involving the use of fire
- The status and distribution of vegetation cover in protected areas, which in turn will be used to regulate stocking rates, particularly of large herbivores in Namibia's Protected Areas and Communal Area Conservancies

2.3.2 Forest products (value-added) research

Rationale

As stated earlier, one expects Namibia's dry conditions to motivate a strictly sustainable use-oriented resource management and high levels of value-addition to make the most of the scarce renewable natural resources. The truth is that some potential exists, but the country has not single-mindedly pursued a value-added research and development focus for its wood and non-wood products.

It is nonetheless encouraging that some products such as fruit, oil-producing nuts and other non-wood products that have been used traditionally are now finding their way into the formal market and if developed further, could help created much needed rural incomes. Some of these products include juice and oil from *Sclerocarya birrea* (marula), which is the subject of a burgeoning international market. Devil's claw (*Harpagophytum* spp.) has been in the regional and international markets for decades. Most recently, natural gums from *Commiphora wildii* in Namibia's north-western desert have found their way into the cosmetic industry. This is not so surprising because the genus *Commiphora* belongs to the Myrr

family (Burseraceae) of plants that have been used for centuries in the perfume industry. It should be noted that the value of Namibia's forests for timber, confined to no more than three slow-growing species (*Pterocarpus angolensis*, *Baikiaea plurijuga* and *Guibourtia coleosperma*), ranks lower than the other uses, when compared to the situation in the forest-rich countries to its north. Namibia has another interesting and huge challenge to economically utilise species of bush that have encroached mainly commercial livestock-dominated, private farms. The phenomenon, known as 'bush encroachment', in which taxa such as *Acacia mellifera* var. *detinens*, *Dichrostachys cinerea*, and *Terminalia prunioides* are the key culprits, is of much interest in Namibia since it limits the economic use of encroached lands. As such, the sustainable use of such bush has the double advantage of providing a product and also improving or increasing range available for the livestock industry. Current efforts to use such species to provide electricity and the potential for the manufacture of reconstituted wood products are exciting and must be purposefully augmented by research efforts.

Strategic objective

The research challenge is for Namibia to economically and sustainably utilise its tree species, bearing in mind her status as a dry country in which growing conditions are limiting and resources are relatively scarce, hence requiring the need to extract maximum economic value.

The strategic objective is to promote research that adds economic value to the wood and non-wood forest resources of Namibia.

Guidelines to key actions

The key actions relevant to the objective would include:

- Revealing, through research, the properties and potential uses of wood species available in Namibia
- Providing information on the distribution and abundance of species of economic potential, both wood and non-wood
- Collaborating with other institutions to conduct research that adds value to Namibia's forest resources and develops new products for the market
- Analysing patterns of wood consumption

Expected results or result areas

The key research results or outputs could include:

- A booklet describing the wood properties and potential uses of Namibia's wood species
- A report on the manufacturing and quality characteristics of reconstituted wood products (made from encroaching bush and other abundant species) such as boards, panels.
- A compilation of the properties of oils from Namibia's species such as marula (*Sclerocarya birrea*), mangetti (*Schinziophyton rautanenii*), sour plum (*Ximenia* spp.) and false mopane (*Guibourtia coleosperma*)
- A report on the processing and packaging of fruit such as bird plum (*Berchemia discolor*)
- A report on the properties of gums and resins from Namibia and their potential for commercialisation
- Abundance, distribution of key species and products and management status, including response to commercial harvesting
- Documentation of the effects of large-scale bush utilisation on range species diversity
- Report on trends in wood consumption and their implications for energy policies and deforestation
- Contributing to the formulation of a processing/marketing strategy for forest products

2.3.3 Ecological studies on Namibia's forest/woodland ecosystems

Rationale

The field of forest ecology is very broad indeed. In the Namibian context, it is attempted to define and describe the aspects of forest ecology that are in line with development aspirations contained in the current Strategic Plan for the Ministry of Agriculture, Water and Forestry and the Third National Development Plan (NDP 3). The two documents stress the need for Namibia to use her natural resource base in a sustainable manner.

As a start, this strategic area is directly linked to the first one, i.e. providing information on the status and dynamics of Namibia's woody vegetation cover by way of monitoring, hence mapping of forest cover and forest cover changes. Associated inventories of biomass and merchantable wood volumes provide the baseline data against which the monitoring of change is possible. In Namibia, phenomena such as bush encroachment, in which a finite number of species are involved, and their particular response to fire and harvesting should be further studied. In addition, the regeneration characteristics of key timber species, particularly flowering phenology and seed yields are important environmentally sensitive traits worth investigating. The biology of invasive alien plant species, which is now well recognised as a problem in a number of southern African countries, is also worthy of investigation.

Of these, bush encroachment as a form of invasiveness is a serious problem in Namibia since huge swathes of rangeland have been rendered unproductive. Several attempts to control such local invasiveness of indigenous species have proved to be expensive and no economically feasible method of control has been discovered. So far, a number of hypotheses on why and how the phenomenon has developed have been put forward. It seems plausible that a combination of factors do aid the encroachment. These are:

- The substitution of browsers by grazers (predominantly cattle in the *Acacia-Combretum* dominated savannas)
- Over-grazing, which degrades range conditions, reduces the population of perennial grasses and paves the way for the emergence of woody vegetation
- The exclusion of fire over extended periods of time

The above hypotheses should be tested by forestry in conjunction with range scientists, alongside efforts to sustainably utilise the encroaching bush for benefits such as Forest Stewardship Council (FSC) Certified Charcoal, generation of electricity and the manufacture of reconstituted boards and panels.

The fire ecology of key tree species and indeed the response of Namibia's forests and woodlands to different fire regimes is another area of research in which Namibia has potential to generate useful information. Already, the country has capacity to monitor fires using Geographical Information Systems (GIS) technology and also has a history of implementing fire trials in natural stands. The two approaches can be used at both local and broader scales to investigate the long-term effects of fire on a number of vegetation variables.

In existing and future state and community forest reserves, where harvesting of timber and poles are permitted, the responses of stands and individual species to harvesting operations is a legitimate area for long-term investigation. Examples of such response studies include rate of natural regeneration; species diversity; diameter growth in residual stands; and recruitment to higher diameter classes.

Strategic objective

The strategic objective is to understand how natural forests and woodlands function and how they respond to applied treatments and by so doing, aid in the regeneration of key species, the safe and productive use of fire, and slowing down the rate of bush encroachment.

Guidelines to key actions

The key research actions could include:

- Mapping and inventory of specific forest areas or blocks
- Conducting trials on range treatment techniques to reduce bush encroachment
- Setting up long-term fire trials nested within broader, region-wide fire monitoring regimes
- Setting up studies of the invasion biology of key invasive species such as *Prosopis*
- Setting up post-harvest trial plots to observe regeneration and growth responses of residual stands

Expected results or result areas

The key results that could be expected from such studies are:

- Inventory data on expected biomass yields (carbon removals from the atmosphere) and information to be used in setting harvesting limits
- Technologies or practices that reduce bush encroachment after de-bushing operations and to prevent bush encroachment in high-risk areas
- Flowering calendars for all key species to enable the collection of superior tree germplasm
- Improved understanding of the fire adaptation of key species and ecosystems and the recommendation of burning regimes
- Development of harvesting regimes for all types of forest products

2.3.4 Growth and yield studies

Rationale

Growth and yield is a classic forest research issue that is found in the forest research portfolios of all national programmes. However, with a number of wood and non-wood products that have commercial potential, Namibia has the challenge that growth and yield data and predictive models necessary for the management of her natural forests have not been generated. The exploitation of key timber producing species such as *Pterocarpus angolensis*, *Baikiaea plurijuga* and *Guibourtia coleosperma*, has occurred for over 100 years. Hence, one would expect an existing wealth of information regarding their growth in natural stands. In addition, stand treatment practices to enhance the regeneration and performance in artificial plantings should be available. Unfortunately, this is not the case and basic growth models are yet to be developed.

In addition to classical growth models, information on yields of non-wood products such as fruit and nuts predicted on the basis of climatic data is not easily available. The current interest in marula and sour plum (*Ximenia*) oils makes this an interesting and applied research topic. Ideally, plots for growth and yield modelling should be established in the key forested regions stratified by rainfall regimes and soil types. Such plots could be part of a national network of permanent sample plots used in the long-term monitoring of forest cover or could also be established outside such a framework, particularly for some of the fruit trees that may have clumped distributions. In plots with timber species, the use of dendrometers to monitor growth should be applied. The data yielded could then be presented according to site quality, which would have been the basis of stratification. Biomass equations can then be generated by site indices.

Another interesting species to be considered for growth modelling is false mopane (*Guibourtia coleosperma*), which has a relatively short and often convoluted trunk. It would be of interest to model the growth and examine differences in its stem form as influenced by stand density.

Besides growth of indigenous tree species, growth and yield modelling in plantation species is applicable in Namibia, particularly the provenances of *Eucalyptus camaldulensis* and its hybrids; some of which have already been tested in Namibia. Information can be collected from existing trials and used to generate cumulative annual increment curves and provide material for the training of local researchers in growth modelling. The same can be used to draw up guidelines for the development of woodlots.

Strategic objective

The strategic objective is to generate growth and yield data and information on key species of ecological and economical importance to enable the design of management decisions aimed at their protection and sustainable use.

Expected results or result areas

The results from growth and yield models described herein could be in the form of, but not restricted to:

- Species specific allometric equations for biomass yields (includes woodlot species, data will also be useful in forest carbon accounting)
- Protocols and equations for the estimation of biomass from satellite images and aerial photography (Application of Remote Sensing (RS) and GIS techniques in forestry research)
- Distribution data for selected species and information on their conservation status
- Design of rotational periods between harvests
- Predictions of yields of fruit and nuts from particular species
- Form factors for species such as *Guibourtia coleosperma*

2.3.5 Silvicultural research

Rationale

The dry environments of Namibia are both a challenge and opportunity in the growing of trees, particularly under artificial regeneration schemes. The development of value-added products such as pharmaceuticals (devil's claw and *Hoodia*) and essential oils such as *Commiphora*, have raised significant interest in artificial regeneration of commercial quantities and qualities of the species themselves. Research that promotes artificial regeneration and also enhances growth under natural conditions is essentially applied and immediately can provide value for money.

Currently, marula has attracted sufficient interest and the Directorate of Forestry has already invested in field trials using grafted propagules. In addition, the Ministry of Agriculture, Water and Forestry has initiated a campaign to promote orchards under its Directorate of Forestry. The fencing industry also needs species that can be grown in woodlots and feed the local demand, which is currently met by supplies from South Africa.

Bearing in mind the long, dry season and high rates of evapo-transpiration, water use efficiency and drought-hardiness or -tolerance are traits that are crucial in planting materials destined for growing in Namibia. Today, plants imported from South Africa are not necessarily selected for tolerance to drought or frost; to the extent that they tend to require high volumes of water during establishment. A number of species, if not matched to site, may suffer from heavy bouts of frost. A number of nursery-based studies at the NFRC are needed to recommend provenances or material for planting. Studies in seedling physiology to support artificial and natural regeneration are important, and in this regard, issues such as drought- and salinity-tolerance; root/shoot ratios; and efficiency in nutrient uptake are legitimate areas of scientific inquiry.

Since a number of traits discussed here and many others are under varying degrees of genetic control, selection and breeding for such traits is therefore a must in Namibia. This is a research area that has much promise not only for Namibia but other dry countries in southern Africa.

Strategic objective

The strategic objective is to conduct research to develop planting materials that are suited or adapted to Namibia's dry climate.

Guidelines to key actions

The key actions to achieve the objectives include:

- Applying stand treatment techniques or guidelines, e.g. i) coppice systems for mopane; ii) thinning regimes for *Baikiaea plurijuga* and *Terminalia sericea*; iii) enrichment planting with selected species; and iv) natural regeneration treatments
- Establishing replicated species trials at a number of sites with different conditions and the recording of growth variables that can be statistically analysed
- Testing different planting techniques to improve root establishment and moisture retention
- Conducting germination trials, including dormancy-breaking techniques for key species of interest
- Identify phenotypically superior individuals for purposes of selection and tree improvement. Where applicable, use molecular markers for the rapid characterisation of desired genotypes
- Improving vegetative propagation techniques, particularly on marula and other indigenous fruit trees such as sour plum (*Ximenia* spp.), monkey orange (*Strychnos* spp.) and mangetti (*Schinziophyton rautanenii*) – cuttings, grafting and micro-propagation

Expected results or result areas

The key results that can be expected from the above actions are as follows:

- Silvicultural stand treatment guidelines to improve stand quality and regeneration
- Improved nursery practices that increase the survival rate of out-planted materials
- Species-specific recommendations on planting and tending technologies that enhance the quick establishment and long-term survival of plantings
- Planting protocols for orchards, woodlots and plantations
- Protocols for grafting and other forms of vegetative propagation (including micro-propagation) of key fruit tree species
- An *in situ* gene bank/clonal orchards of superior provenances of commercially planted species
- Commercially viable plantations of economically important species

2.3.6 Economic, policy and sociological research

Rationale

Policy and economic studies are important aspects of any research programme since they provide an important interface between scientific research and the translation of scientific facts or findings into policy and the crucial transformation that is otherwise known as technological change. Policies in turn, influence the allocation of resources to research and development.

In Namibia, for example, the attitude of the government to combat bush encroachment is premised purely on the fact that bush encroachment limits the optimal or potential economic use of existing rangelands for a crucial and well-known livestock industry. On the other hand, however, the economic effect of frequent wild fires has not been sufficiently illustrated to influence major land management policies and cultural practices and to enforce enacted laws. There is therefore a clear need to show the economic losses attributed to fire so that the organs of central and local governments can adopt policies that support the safe use of fire as a tool in land management.

In addition to the above example, all new technologies and forest management practices should be subjected to cost-benefit analyses or economic evaluations.

Coupled with economic studies, are those related to policy and social developments. For example, Namibia after promulgating the Forest Act of 2001 has seen the proclamation of several community forest reserves under its provisions. To date, a number of the community forest reserves are still evolving their governance structures and experimenting with management models that communities have not used before. It is an opportune moment for the Directorate of Forestry to commission a study to evaluate the governance of the Forest Management Committees that have been created to run the reserves. In that regard, the issues of organisational structures; representation; allocation of roles; financial reporting and benefit sharing are researchable topics.

One area that is normally ignored is the adoption, transfer and domestication of technology that adds value to forest products. It is often hindered by the poor flow of information to policy-makers and also policies or systems that give little or no incentives for the private sector to import or invest in new technologies. Forest researchers, policy analysts and economists should therefore collaborate, as a matter of strategic importance in order to promote the active adoption of existing technologies, particularly those that enable value-added processing and manufacturing.

Strategic objective

The strategic objective is to understand the economic, policy and sociological aspects of forest management and apply them to the management and utilisation of forest products for Namibia's development.

Guidelines to key actions

The key actions involve the commissioning of policy, economic and social studies that support forest management and utilisation.

Expected results or result areas

The expected results are indicated as follows:

- Data and information paper on economic losses due to wild and uncontrolled fires
- Improvements in the governance structures and systems of community forest reserves
- Economic valuation reports on existing and potential technologies for the management and processing of forest products
- Study of community – fire interaction and attitudes

2.3.7 Management of information

Rationale

Any research programme dealing with the management of a resource such as forests should collect, analyse and store data and information, in a manner that creates and adds to ''institutional memory'', and acts as a resource for managers and researchers. While there is an existing database populated with forest inventory data and a GIS database at the NRSC, they are not optimally designed to enable easy access of data and information, over which access rights by the general public is permissible.

In addition to databases, the Division Forest Research should insist that all experiments have electronic files detailing their objectives; designs; inception of programme; expenditure; and so on, and which are regularly updated. Furthermore, all experimental plantings such as plantations and woodlots must have compartment/plot registers that have the history of their establishment, treatments and dates and future plans, including tentative results.

As a key contribution to the body of knowledge available to the public, the database should also be populated with monographs on the key tree species and other economically important or iconic plants of Namibia. The monographs should contain information such as taxonomy; distribution; abundance; phenology; artificial regeneration techniques; properties; existing and potential uses.

Strategic objective

The strategic objective is to build a knowledge management system that serves research and development needs and maintains key 'institutional memory' for future use or applications.

Key results or result areas

- Database of Forestry Inventory Data
- Stand Treatment Registers (for all managed natural/planted stands
- Electronic Register of projects under the research programme
- Consolidation of forestry data and information, including repatriation
- Production of monographs on main, economically important tree species

2.4 Priority research actions: Links to research problems/issues and strategic research areas

Table 2. Research priorities and indicative actions

RESEARCH ISSUE/ PROBLEM	INDICATIVE ACTIONS	INDICATIVE RESULTS/OUTPUTS	RELEVANT STRATEGIC RESEARCH AREA
1. To understand the drivers of deforestation and forest degradation	I. Commission a study on the drivers of deforestation and forest degradation (D & D) II. Relate the study to emissions of atmospheric CO^2 III. Indicate the major policy factors that encourage D & D IV. Identify policy changes needed to reduce D & D V. Establish and implement a Vegetation (Forest and Rangeland) Monitoring system VI. Continue with the current fire monitoring programme VII. Develop a system to monitor the drivers of D & D	• Report and national agreement on the drivers of D & D • Policy changes in the land-use and other sectors to reduce D & D • Reduced fire incidences and severity • Forest and rangeland status reports • Climate change adaptation policies	Vegetation (Forest and Rangeland) Monitoring Programme
2. To improve natural and artificial regeneration of forest/woodland habitats and/or for key tree spp.	I. Establish trial plots in natural stands II. Conduct stand treatment trials to encourage natural regeneration III. Improve grafting technology for key commercial species (e.g. marula, *Ximenia*, *Strychnos*) IV. Establish clonal orchards (for the same species above) from superior mother trees V. Collect seed from clones and test them for quality attributes VI. Conduct nursery-based research to improve field survival of out-planted seedlings VII. Conduct seed technology studies (viability; dormancy; longevity; storage conditions; pre-germination treatments)	• Improved treatment techniques for natural regeneration • A national network of Permanent Sample Plots • Improved grafting technology of key species • Viable clonal material for selection and breeding programmes • Improved (more productive) germplasm • Increased survival of out-planted seedlings • Patented varieties	Ecological studies Silvicultural studies Growth and Yield

3. To increase levels of value-added forest products in the market	I. Conduct studies on wood properties of key species II. Identify and collaborate with a laboratory for the testing of various oils III. Commission analytical work to produce a report on the main gums and resins from the woodlands of Namibia IV. Investigate technologies to make reconstituted wood products from local woody species, including technologies that enable the use of small size woody materials	• More value-added products in the market • Report on the properties of key products	Forest Products (value-added) research
4. Inadequate data on growth and yield on key species	I. Set up permanent and temporary sample plots II. Refine current allometric equations to estimate stem volumes III. Develop schemes to monitor yields in non-timber products such as fruit; e.g. marula, sour and bird plums IV. Train staff in measurements and analysis of data	• Species specific allometric equations • Information on both above and below ground biomass in Namibia's forests and woodlands • Yield prediction tables for non-timber products	Growth and Yield Modelling Vegetation (forest and rangeland) monitoring programme
5. Poor understanding/ application of economic and social principles in forest research and management Weak governance structures for managing community forest reserves	I. Develop methodology to quantify the economic impacts on the drivers of D & D II. Assess the economic impacts of wildfires in Namibia III. Conduct a study on the functionality of current Forest Management Committees, of the Community Forestry Programme IV. Policy studies on the drivers of D & D	• Report on economic impacts of e.g. fire and selected drivers of D & D • Improved governance models for community forest reserves	Economic, policy and sociological research programme
6. Management of data and information	I. Establish a forestry database for inventory data, projects and stand registers II. Provide an information service to the public (publications)	• Functional and preferably interactive database • Reports based on the database	All strategic research areas

3. IMPLEMENTATION MECHANISM FOR THE RESEARCH STRATEGY

This section represents the processes and mechanisms by which the strategic objectives will be realised. While it is focused on a number of institutional issues that are important in any natural resource management programme, it has also considered Namibia's unique circumstances. In that regard, it has proposed certain actions meant to develop and support scientists wishing to advance their professional careers in forestry-related disciplines. The main components of the implementation mechanism are:

- Redefinition of roles within the Divisions of Forest Research and Forest Management
- Forging strategic partnerships with other institutions
- Management of the research process – identification, proposal writing, execution, analysis of data, peer review, publication
- Programme performance indicators
- Support to forest researchers
- Performance Management System
- Monitoring and Evaluation System
- Fund-raising for research and development
- Personnel implications of the research strategy

3.1 Redefinition of roles in the Directorate of Forestry

Rationale

The many issues to be tackled under the forest research agenda would surely overwhelm the existing research staff unless some critical areas are addressed, beginning with the redefinition of roles within the Directorate. Hence, to take on the new agenda, the Directorate of Forestry should see how to reorganise itself to adopt it. As already mentioned, a useful starting point is to redefine the roles of some key staff members of the Directorate, regardless of whether they fall under the Division Forest Research or not. The process of redefinition, which would be internal to the Directorate, will however not be enough to address the research agenda and the Directorate will still need to look outside itself to enlist the support of other organisations. The issue that is termed "strategic partnerships" is described subsequent to this sub-section.

Chief Forester positions

Division Forest Management

It is suggested that the redefinition of roles should start at the level of Chief Forestry Officers responsible for both geographic and thematic subdivisions. For instance, all Chief Foresters managing the Forestry Regions should be required to offer more support to the research division than is currently the case.

As such, they should be expected and required to observe and analyse the forest management challenges in their regions and in conjunction with the research division help in the early formulation of research questions, based on their field perspectives.

Once a research project has been initiated or developed in the field they should, by virtue of their proximity to field stations and plots, ensure that the same are protected. This may entail having a deliberate community outreach programme that explains the importance of research, and where feasible, establish collaborative participation of local communities in such research.

Chief Foresters should ensure that the layout of all new plantings in the field such as orchards and woodlots, have the input of the research division so that they can yield data that can be subjected to

statistical analysis. The plantings in Onankali, Iiyeke, Siya, Kaisosi and the current Tree Planting Project in the north-central are relevant in this regard.

Furthermore, these officials are responsible to ensure that all plantings have specific physical and electronic records indicating details such as establishment techniques (pre-planting and post-planting treatments); growth data; pests; diseases; and other types of information.

Division Forest Research

In view of the state of forest research in Namibia, coupled with the number of aspiring scientists interested in the area, the current terms of reference for the job of Chief Forester within the Division Forest Research should be modified. There is a need to refocus on certain aspects related to the performance of research staff and in the management of the research process that is also described in this section. The suggested improvements are listed as follows:

- Establish and run demonstration on-station and field-based research trials or projects
- Assume coaching responsibilities for young researchers recruited into the division
- Design individual mentorship programmes for individual scientists
- Facilitate the functioning of a Forest Research Advisory Committee
- Chair a team in the division that guides specific research processes, e.g. data capture and analysis

3.2 Management of the research process

Rationale and actions

The Division Forest Research should institute what is hereby described as the management of the research process. While the definition of such a process can vary, for purposes of this document, the process should include

- Publishing research priorities on a biennial basis and sharing this with the Directorate and partners and other stakeholders
- Creating a system to ensure that all research proposals that are designed to yield quantitative data have appropriate statistical designs/analytical models
- Creating and facilitating the functioning of research working groups or teams such as :
    - Growth and yield modelling/management planning
    - Ecological monitoring, modelling (e.g. climate change vulnerability) and associated field studies
    - Silviculture
    - Forest Products
- Forming and developing a Forest Research Advisory Committee whose functions will be to:
    - Advise on and recommend a research agenda to the Director of Forestry and the Permanent Secretary, for approval
    - Liaise with the National Commission on Research, Science and Technology in Namibia, or relevant interim body
    - Internally review the general direction of the research programme and the quality of individual projects
    - Provide specialist mentoring, if possible
    - Nominate individual researchers and research projects for due recognition and reward
    - Advocate for research funding

3.3. Support to researchers

Rationale

A refreshing observation is that the staff of the Division Forest Research, though young, are quite enthusiastic about their work and have great potential to become formidable scientists in their own right. What they need is both research funding and a concerted effort by the Directorate and its partners to support their work in several ways that are briefly described here. It is conceivable that five years from the launch of this research strategy, some elements of support listed and described here will no longer be necessary. However, the current group of researchers would greatly benefit from the advice and constructive criticism of a formally appointed Forest Research Advisory Committee, the individual members of which could also serve as leaders of research working groups as mentioned in the preceding subsection. The young scientists should be initiated into forest research by deliberate mentoring; structured training sessions; and offered opportunities to present their findings.

Support structures

Forest Research Advisory Committee

The Division Forest Research should facilitate the function of the Forest Research Advisory Committee to offer technical advice to junior staff members as already described in Section 3.2. The Committee should meet at least twice a year. However, some members could also have direct support roles to individual researchers.

Mentorship

The mentorship programme is proposed here as a mechanism to enable researchers to intellectually interact with a senior colleague on matters pertaining to research. For instance, a newly recruited researcher, who may have just attained an M.Sc. degree should, upon assumption of duty, be linked to a senior scientist, preferably in the natural sciences, for at least the first two years of their career. The senior scientists need not be employed by the Directorate of Forestry but may be researchers or academics in the natural resources or natural sciences fields. What the mentors should offer should include their own experiences in the application of scientific methods; experimental designs; formulation of hypotheses; new approaches to scientific investigation; scientific writing; skills in observation; and issues regarding the translation of scientific findings into policy advocacy communication pieces.

Training programmes

The Division Forest Research, in conjunction with the Division of Agricultural Training in the Ministry, should routinely do a yearly audit of existing skills; a process that should be linked to or derived from the annual performance appraisal, which is anticipated to soon become an official requirement within the Public Service of Namibia. The audit should be guided by the different skills set that is required by the research programme; those required of managers, researchers, research technicians and field hands. Based on the audit, the kind of training courses that could be offered are:

- Use of new statistical software
- Experimental design and analysis
- Use of specialised equipment, e.g. a PCR Machine
- Tree identification
- Ecological techniques
- Sampling of forest populations
- Resource assessment techniques – use of LIDAR, Quickbird
- Scientific reporting
- Leadership training

Opportunities for presentation of research findings

The idea is that the Division Forest Research should, with appropriate partners and institutions, organise platforms or fora to give opportunities to researchers to present their work. In the process, the same platform can be used to recognise important contributions to science and publicise the work, as part of the reward system for scientists.

3.4 Strategic partnerships

Rationale

As already stated, the Division Forest Research and the entire Directorate of Forestry can only address the research agenda sufficiently if the participation of scientific talent and experience from within and outside the Directorate are enlisted. Indications are that several academic and natural resource management institutions in Namibia are keen to collaborate and share the human resources and facilities that are scattered in various institutions. To make that happen, collaborating institutions should design memoranda of understanding to guide their relationships and their work. Special consideration should be given to issues such as the sharing of credit under collaborative arrangements, which if not handled sensitively, can impede and derail the spirit of collaboration.

The Directorate of Forestry through the Division Forest Research should form and facilitate strategic partnerships along the lines tabulated below.

Table 3. Strategic partnerships for forest related research

Collaborating institutions		Subject matter
1	Polytechnic of Namibia UNAM – Ogongo Campus UNAM – Multidisciplinary Research Centre (MRC)	Growth and yield modelling Long-term stand treatment trials
2	UNAM – Multidisciplinary Research Centre	Economic, policy, social studies
3	National Botanical Research Institute (NBRI) Directorate of Scientific Services (MET) Directorate of Environmental Affairs (MET) Desert Research Foundation of Namibia (DRFN) Namibia Nature Foundation (NNF) Southern African Science Service Centre for Climate Change and Adapted Land-use (SASSCAL)	Ecological/Vegetation Monitoring Climate change modelling Biodiversity monitoring
4	UNAM – Food Science Department Polytechnic of Namibia CRIAA Indigenous Plant Task Team (IPTT) NBRI	Forest products/value-added research (Natural products; wood panels; energy generation)

There are also a number of ***local partners*** such as the Namibia Agronomic Board, Etosha Ecological Institute (EEI), and the Millennium Challenge Account, Namibia Chapter (MCA).

Regional and international partners could include UN Agencies (FAO; UNDP; GEF); SADC initiatives; International Agroforestry Centre (ICRAF); International Union of Forest Research Organizations (IUFRO); Centre for International Forest Research (CIFOR); World Wide Fund for Nature (WWF); Forestry Faculties of Universities; and the Centre for Scientific and Industrial Research (CSIR) of South Africa.

In conjunction with teaching and research institutions, the Directorate of Forestry, should run a well-orchestrated ***student internship programme***. In this regard, students should be attached to ongoing research and development projects, during which they should be systematically introduced to both the 'joys' and 'rigours' of scientific investigation and reporting. Every year, full reports and abstracts should be submitted to the head of the Division Forest Research for joint evaluation with partner institutions.

The issue of developing and driving functional partnerships is crucial to the realisation of the research strategy. It may be necessary to have a liaison officer to co-ordinate the strategic partnership function.

3.5 Programme performance indicators

Rationale and key actions

The Division Forest Research should prepare research programmes that clearly state the key priorities and implementation modalities to be executed over periods of three to five year funding cycles. The same research programmes should be vetted by the proposed Forest Research Advisory Committee, who should recommend these for funding within and from outside government. Upon approval, the research programmes should be further shared with the top management of the Ministry for purposes of funding, and also to the National Commission on Research, Science and Technology in the Ministry of Education and other collaborating partners. The main features in the research programme should be the key objectives; expected results; indicators of progress; and eventual achievement of end results or outcomes. This subsection is closely linked to the next because the programme objectives, results and indicators are the foundations upon which the research programme must base a new performance management system for the Division.

3.6 Performance management system

Rationale and key actions

Based on programme outputs and indicators, as stated in the preceding subsection, the implementation of the programme should then be divided into subdivisional down to individual responsibilities. This will necessarily cascade from the Deputy Director of Forest Research to Chief Foresters to Team Leaders and individual researchers.

To institute a performance management system, the Division will need to specify subdivisional targets and indicators of achievement, divide these into individual workplans, and use the other support systems already described in this section to achieve the programme objectives. Based on subdivisional and individual workplans, the Deputy Director of Forest Research will set clear standards of individual performance, upon which researchers will be rewarded and recognised. Reward systems could be in the form of:

- Access to innovation grants
- Recognition for papers accepted for publication
- Recognition for management responsibilities – management of performance
- Conference grants
- Promotion to higher ranks within the Division
- Nomination to go for further studies/short-term fellowships

3.7 Monitoring and evaluation system

Rationale and key actions

The purpose of a monitoring and evaluation (M and E) system or framework is to encourage efficient and transparent management of resources and assist programmes to keep track of progress towards achieving periodic and strategic objectives. The framework can be drafted as a combination of 'process ' and 'product/result' indicators. In addition, a programme should also develop milestones that can serve as interim indicators towards the achievement of already defined end-results or outcomes. To this end, the Division Forest Research will:

- Design an M and E system as a management tool to measure accomplishments
- Require the mandatory use of the logical framework as applicable for all projects
- Conduct structured, biannual project reviews
- Subject itself to mandatory internal and external evaluation of all research projects/programmes
- Institute and complete performance appraisal of all staff on an annual basis, including periodic continuous assessments between annual appraisals
- Facilitate the mandatory evaluation of the entire Research Programme every three to five years

3.8 Funding sources for research

Besides the availability of appropriately qualified human resources and a well-defined strategy, fundraising for research is arguably one of the top three crucial factors in achieving programme objectives. The strategy will primarily depend on direct government funding but for it to be in a position to respond quickly to emerging issues and remain reasonably versatile in a rapidly changing world, additional funding sources are needed. It is however important to note that to get government funding, the research strategy should publicise and otherwise promote its relevance to national development and sustainability objectives.

To date, funding sources typically include:

- Government funding, through line-Ministry allocations
- Government funding, through a body like the proposed National Commission on Research, Science and Technology
- Partnership with local academic/research institutions to unlock additional sources of locally and internationally available funding
- Individual competitive grants
- Private funding (philanthropic, endowments)
- Private funding (industry)

In addition to the above, the Division Forestry Research should recruit skills appropriate to the strategy, which it must use to actively and creatively source additional funds from within and outside government sources. For a small research organisation, such as the current Division Forest Research, it is crucial to maintain key strategic partnerships, particularly those with research and academic institutions. Donors tend to particularly like joint proposals involving students and institutions in partnership. Hence, a well-organised and publicised student internship programme, run by the Ministry under the Directorate of Forestry, is an important mechanism for attracting both government and external funds.

Some sources of International Funds worth investigating are listed below:

The International Foundation for Science: This is a foundation based in Sweden that awards research grants mainly to young researchers in environment and natural resources. It has awarded several such grants to young researchers and particularly encourages African scholars to apply.

Global Environmental Facility: The GEF may consider funding environmental monitoring programmes, provided that the research proposal shows strong linkages to biodiversity conservation, combating of desertification and/or land degradation, or climate change adaptation.

UN Agencies such as FAO, UNEP: The FAO may fund applied research that supports Sustainable Forest Management, particularly if the research project is part of a larger National Forestry Programme.

EU Budget line for Tropical Forestry: This is a budget line that is not commonly accessed by many African countries but it is potentially a good source of funding for applied research.

The Southern African Science Service Centre for Climate Change and Adapted Land-use (SASSCAL): The centre, which will be co-ordinated from Namibia, is an initiative involving five southern African countries, with funding from the Federal Republic of Germany. The MAWF has been designated by Cabinet as the lead implementer for Namibia. SASSCAL should be a natural partner for the Division Forest Research, given its relevant thematic areas of specially forestry, biodiversity and climate change.

The Millennium Challenge Account (MCA) – Namibia: The MCA has a component dealing with the development and commercialisation of products from Namibia's indigenous natural resources.

3.9 The personnel implications of the research strategy

In view of the strategic research areas and the priority actions already suggested, an even cursory look at the current staffing suggests that the Division Forest Research is significantly understaffed. A priority issue for which minimum additional staff will be required is the Vegetation (Forest and Rangeland) Monitoring Programme. A Remote Sensing and GIS Laboratory, an Inventory Unit and an existing satellite-based fire monitoring programme already exists. The ecological and silvicultural aspects of research appear to be catered for by young but bright prospects, who with support described under Section 3, will be able to function effectively within a relatively short time. However, specialist skills under silviculture such as physiology and breeding are still lacking. Skills in other areas such as understanding the drivers of deforestation and forest degradation and quantifying their impacts, researching the socio-economic and governance issues associated with the forestry sector, and supporting value-addition to forest products through resource-based research must be acquired.

The Directorate of Forestry should therefore do its best to recruit additional research staff using the strategic objectives and priorities to guide its search for the requisite skills. This will be an appropriate approach when recruiting to fill posts in the proposed new structure of the Division Forest Research.

At the moment, it will have to rely on a few partnerships with key institutions, beginning with the National Botanical Research Institute, and others such as departments at the University and Polytechnic to establish the priority research programmes within the first 18 to 24 months from the official launch of the Strategy.

The Directorate should also convene a donor meeting to publicise the Strategy and seek support for its implementation. In view of the currency of such concepts such as reduced emissions from deforestation and forest degradation (REDD+), a number of donors could fund a study on the drivers already discussed. Governance is also another area that could find funding because of its policy linkages that interest a number of development partners.

In the action planning stage, the Division Forestry Research should develop a clear and feasible, phased initiation and implementation of priority research issues over a 24 to 30 month period. During this period it should endeavour to recruit staff to fill the essential positions, as guided by its staff establishment. In doing this, support from the top management of the Ministry of Agriculture, Water and Forestry and the Ministry of Education, Directorate of Research, Science and Technology, must be sought.

4. ANNEXES

Annex I. Comments on existing research projects

Fire monitoring/Fire scar mapping

The current satellite- (MODIS) based fire monitoring programme is interesting, both from technical and practical viewpoints. It yields data that can be used to estimate incidence and extent of fires. These research products can be used to create public awareness and change or influence current policies and cultural practices regarding fire use. The same data can also be used to estimate Namibia's contributions to atmospheric emissions of greenhouse gases, particularly carbon dioxide from biomass fires.

The beauty of the system also lies in the fact that it can i) monitor fires in real time; ii) can map fire scars; iii) large areas can be covered as it is satellite-based; iv) yields data on burns over a whole season and one can group fire scars according to the time of the season (early, mid-season and late-season periods); and v) the burnt areas once clearly mapped can be assessed later to observe the effects of the fires on vegetation, albeit historically.

Some of the drawbacks of satellite-based fire monitoring systems are that i) the analysis of burns is based on historical data over which one has no control as opposed to experimental data; ii) the satellite systems do not measure local weather conditions prior to and after a burn; and iii) the timing of burns depend on the fire causes rather than the observer.

Makambu fire trial

The Makambu Fire Trial, which has been in existence for decades, was established during the South African Colonial Administration in Namibia. Although abandoned just before Independence, the trial has subsequently been rehabilitated and is running to date. Burning treatments (five burning regimes, including control) are randomised over a block of indigenous Kalahari Sands Woodlands in the Kavango Region. It essentially applies different burning regimes, on an annual basis, and monitors their effects on several vegetation characteristics such as species diversity, diameter and height growth. Usually, the plots are given treatments (control burns) every year at the same time and the timing does not depend on, for example, end of the last rainy season, soil moisture/dryness index and prevailing winds. The data yielded from it are interesting and the experiment has been running for a long period of time. However, except in carefully managed natural stands, the results achieved from the trial may have limited application in the wider landscape since the burns cover limited areas as opposed to the fire scar monitoring programme (described above) that can track fire spread over huge landscapes. Despite these limitations, the data yielded so far could be applied to relatively small sizes of managed blocks of natural forests.

The comments on the two types of fire projects suggest that the two could be designed to support each other. This would most probably enable the results of burns at Makambu to apply to a wider landscape over which the satellite monitoring system has been applied. This can be done in several ways listed here:

The Makambu Trial could modify the onset of its annual burns to correspond to variables such as i) end of the last rainy season; and ii) soil dryness index. It could also ensure that before burning, variables such as air temperature; fuel load (e.g. grass biomass/ha; stem density); and wind speeds should be recorded.

The advantage of this is that the conditions of burn could be matched with uncontrolled fires that would have been observed from the satellite images. This would essentially enable comparisons of the effects of fires on vegetation; one from a controlled space with known micro-climatic conditions, and the other

over a much larger landscape. The point is that the two fire projects need each other and their deliberate collaboration is clearly in their interests.

Another issue is that from an experimental point of view, the history of the Makambu area is relatively well-known compared to other natural forests in Namibia. It does not seem to have attracted the interest of local communities, who may see it suitable for conversion to other uses. It also carries the main Kalahari Sands timber species. As such, it would be an ideal place to establish long-term growth and yield modelling experimental plots on these species. This means that the Makambu site could be included in any future national forest cover monitoring scheme, which is already an identified strategic research topic.

Mopane management trial

The Mopane Management Trial, which has been running for over a decade, is another experiment that is definitely of interest to the community forestry programme of the Directorate, and particularly in the Oshana and Omusati Regions, where mopane is heavily harvested for energy, construction and fencing. The experiment was essentially a series of treatments involving the removal and retention of multiple shoots (from a common stool or stump) at different levels of intensity and frequency. For example, one treatment involved the removal of all shoots except the leading one, which is allowed to grow into a main stem and each year emerging side shoots or coppices are removed.

In research terms, the design of the project makes it difficult to analyse statistically and make conclusive statements, despite many years of data collection. Notwithstanding the design fault, the long-term observations can justify some measure of legitimacy to trends that may be showing up. Ideally, the treatments that could be recommended should have a combined response of mopane to maintain the main stem, a permanent tree cover, and also produce side shoots of dropper sizes that can be harvested at acceptable time intervals (every two years or so). Without pre-empting the final analysis, which will be performed on the 2010 data, there is reason to believe that one of the treatments will meet the criteria suggested here. After the analysis, the experiment should be stopped at the current site at the DAPP Centre in Outapi. However, a simpler design that can be analysed can be initiated at the Ogongo College Game Ranch and also as on-farm trials in which farmers can be co-implementers.

Marula propagation

This project is related to an earlier version that was an attempt to grow marula provenances in the north-central to observe their performance in the field. Poor survival of those plantings, particularly in Onankali, appears to have reduced the interest of the Division Forest Research at the time. However, it now seems that there is renewed interest in the propagation of this species.

Given the growing commercial importance of marula oil and fruit, this is a very timely project that the Division Forest Research should take quite seriously, since it is best placed to be a key leader in the propagation of the species. The current marula propagation project is focused on the grafting of scion material from superior mother (female) trees onto locally grown root stocks. The successful grafts are then out-planted in the field in replicated formats and growth data (survival and growth) are recorded.

Observations in the field (Oshana and Omusati Regions), where the grafts were out-planted, show mixed results in terms of field establishment and performance of the plantings. In one planting near Iiyeke in Oshana Region, the planted grafts were not regularly watered by members of the community, employed specifically to water and protect the plants from browsing livestock, but who were nonetheless drawing monthly salaries.

All in all, this is a project that should continue, using the same and additional sites, but with modifications as suggested here:

- There should be a high intensity selection process by a qualified geneticist across the north-central (including Tsumeb and Otavi Mountains), Kavango and Caprivi Regions to get a large collection of scion material for clonal banks. The clonal banks should be established in the three regions.
- More scion material should be collected from mother trees that have been chosen or identified by local farmers, as was done with the first lot of graftings.
- A specially fitted grafting shed (misting chambers) should be constructed in the north-central.
- New field layouts with sufficient numbers of individuals per clone should be planned.
- The planting technique in the field should follow the example set by the Tree Planting Project in the north-central in order to improve field survival.
- Watering amounts should be precise and the same for all.
- Observations should carry on as usual but analysis should be supported by a rigorous statistical model.

Eucalyptus trial woodlots

During field work for the forestry strategy, only three sites planted with *Eucalyptus* were visited. These were Iiyeke in Oshana Region, Siya in Kavango Region and Ngoma in Caprivi Region. Particularly Siya and Ngoma are of interest since they are relatively recent plantings; with Siya planted by the now-disbanded Development Brigade Service and Ngoma by the former government parastatal company, Amalgamated Commercial Holdings (AMCOM). Of these two, only Ngoma was officially handed over to the Division Forest Research, while the Siya plantings that include other species, is under the Division Forest Management. These plantings, however, are quite important from a research point of view since they are planted over areas large enough to enable meaningful survival and growth data of provenances under test. Land preparation records are still available unlike for the older plantings in Onankali in Oshikoto and even Hamoye in Kavango. In addition, information regarding the treatments applied from planting are available for Siya and Ngoma as the individuals who helped to establish these plantings can still be accessed in Namibia. Furthermore, the Siya and Ngoma plantings have since they were planted showed some phenomenal growth rates, particularly those raised from improved and certified seed. If *E. camaldulensis* seed lot number 17297 from Australia is added, which was tested in Okashana in Oshikoto Region, interesting conclusions can be drawn as to the potential performance of *Eucalyptus* in formal woodlots in Namibia.

Although still able to provide data on total growth since planting, the weakness, however, lies in the fact that the plantings were not laid out in a strictly experimental design. Furthermore, there were no deliberate attempts to record growth performance such as survival; diameter; and height growth, which would have made it possible to compute mean annual increments that could later be extended to various sites around the country. The lack of measurements is surely a lost opportunity in that regard.

Despite the loss of data, the *Eucalyptus* plantings have and will still yield useful data. The Siya plot offers an opportunity to demonstrate growth of *Eucalyptus* as a pole-producing species in Kavango. So far, only one inventory measurement was recently conducted in 2010. In addition, the Rundu Office has been applying cool fires during the late winter to clear litter and it is interesting to see whether this affects growth in any way. It is already obvious that some form of bark injury occurs, but the trees seem to be adapting by growing new layers of bark and exfoliating the fire-damaged layers.

The Ngoma plantation covers more than 50 hectares, and is composed of different age classes. Based on these various age classes, at least annual growth rates and total volumes per hectare can be estimated, also related to stand age. Despite the lack of systematic data, there are nonetheless two very interesting observations from this planting. One is a compartment solely planted with bulked seed collected from Onankali, which has not seen any form of genetic improvement in the more than 20 years since the stand

was established. The majority of the stems in over four hectares of planting have crooked or sinuous stems. It is probably one of the best examples to show that one can and should collect and select for stem straightness if the objective is pole-production. It also suggests a very strong case for inbreeding depression portrayed in poor stem form. All in all, some interesting research experiments can be derived from the 'crooked stem' plot. Another interesting observation is the phenomenal growth of individuals grown from seed of a hybrid of *E. camaldulensis* and *E. grandis*. The growth is significantly higher than those of open-pollinated individuals. The results of the inventory done in 2010 should illustrate the differences in growth that have been observed.

So far, there is sufficient data and information that can be used to generate technical guidelines for the establishment and tending of *Eucalyptus* woodlots. For example, the Directorate of Forestry could publish a woodlot development manual that could specify maximum area per wood lot permitted; site preparation; stand establishment and tending practices; rotation age for pole and timber; and coppicing guidelines, amongst other aspects.

Tree planting/Orchards

The orchard trials, which include species such as *Ziziphus mauritiana*, *Annona senegalensis* and *Mangifera indica* are interesting and provide opportunities to do on-farm collaborative research with local farmers. There is need to consider including several aspects in future trial designs (soil amendments; watering regimes; 'hardening-off' of seedlings before planting out) and planting layouts should also be experimental so that results can be analysed and recommendations based on scientific evidence. The whole area of on-farm research is particularly recommended for Hamoye, which lies in a frost-prone valley that has for years frustrated attempts to establish viable on-station research plots with a number of species, including *Eucalpytus* spp.

As stated earlier all fruit tree trials, whether on research plots run by the Directorate of Forestry or on-farm with communities, should have experimental layouts and the minimum recommended replications.

Annex II. Training needs assessments – A summary

The strategic planning process also included a quick assessment of the most obvious training needs for three levels of staff, namely managerial – technical (from Chief Forester level upwards); research staff (with professional B.Sc. and/or M.Sc. qualifications); and technicians (Diploma and below).

Respondents were asked to respond to a semi-structured questionnaire that required them to state their skills against a set that was listed in the questionnaire. The respondents were also given the opportunity to suggest the type and level of specialised training they thought was important for their job. The table summarises the general recommended types of training (short courses) that should be offered to the specified three levels of research staff. Obviously, these are generalisations because some members of staff already have some of the skills.

It is furthermore recommended that a comprehensive Training Needs Assessment be conducted by a specialist in order to evaluate the overall needs according to the establishment of the Division Forest Research, as well as the individual capacity development requirements of each staff member. A masterplan for training over the longer term, including needs for both qualifying training and short course training, could thus be developed and could guide allocation of funding and prioritisation of critical training needs.

Table 4. Summary of training needs for the Directorate of Forestry: Division of Forest Research

Managers
Recommended training: • Performance management, performance appraisals, with concepts of Monitoring and Evaluation • Designing and managing demonstration experiments • Leading scientific teams • General analysis and interpretation of quantitative data • Coaching and mentoring of colleagues • Proposal writing and fund-raising for research • Understanding the policy/science interface
Researchers
Recommended training: • Formulation of testable hypotheses • Writing of scientific proposals • Theory and practical methods of experimental designs and analysis • Sampling forest populations and estimations of population means • Writing of scientific reports • Presentation skills
Technicians
Recommended training • Layout of experiments, simple computation of summary statistics • Field sampling (systematic and random transects, placing sample plots) • Examining and describing site conditions (soils, aspects, slope, etc.) • Basic soil analysis (pH, OM, conductivity) • Basic laboratory techniques (for lab-based technicians, e.g. National Tree Seed Centre) • Recording and maintaining plot/stand/compartment registers – treatments, observations, any major changes

Annex III. Research concepts

To launch the Forest Research Strategy and attract the necessary resources to do forest research, a series of research concepts are proposed here. At least half of the concepts should have been developed into full proposals and funded, two years after the launch of the Strategy. Several funding sources have been cited in Section 3.8. These should be seriously pursued starting from in-country resources to initiate the process. A suggested list of projects that should attract funding, is given and briefly described in this section.

Research topics

Understanding the drivers of deforestation and forest degradation. This is the basis for establishing a national vegetation (forest and rangeland) monitoring programme.

Resource assessment. This falls under the monitoring programme and involves the application of remote sensing techniques like Quickbird, LIDAR and aerial photographs for volume assessments; detecting vegetation (forest and rangeland) degradation; establishment of field plots to assess proportion of below ground biomass in major vegetation cover types.

Regeneration studies. The application of silvilcultural principles to stimulate natural regeneration; artificial regeneration studies; and tree improvement.

Example: Genetic improvement and propagation of two key indigenous fruit trees in Namibia: *Sclerocarya birrea* and *Ximenia caffra*/*X. americana*.

- Selection of superior mother trees
- Establishment of state-of-the-art grafting facilities in the north-central
- Replicated clonal trials in the north-central, Kavango and Caprivi Regions
- Eventual establishment of clonal orchards and genebanks
- Identification of molecular markers in superior trees/provenances

Growth and yield studies. Involves growth and yield modelling on key timber and fruit tree species, and establishment of temporary and permanent sample plots.

Resource-based research to support development of forest products. Working in close collaboration with other stakeholders, the following could be considered: Commissioning a study on the feasibility of reconstituted wood products from abundant bush species; and investigating new uses of available species. It should also include identifying analytical laboratory facilities as partners for natural products research in Namibia.

Socio-economic studies. Economic analysis on the effect of wildfires; study on governance structures for community forest reserves and various aspects of the timber trade.

Management of data and information. Setting up a database on all projects and providing an information service to the public, e.g. by preparing species monographs (starting with ten popular trees of Namibia).

1. DIRECTORATE OF FORESTRY, TOP MANAGEMENT: OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES	WAYS TO IMPROVE RESEARCH WORK	STAKEHOLDERS
Opportunities • Good will from government • Clear supportive policy statements • An officially mandated Division Forest Research • Physical infrastructure; HQ, Field stations etc. • Climate change modelling • Forest genetic resources that can be investigated, e.g. *Hoodia* and marula • Could supply key information services to managers, e.g. indicators for sector performance **Key Challenges** • Inadequate researchers/inadequate technical capacity/limited research mind-sets • High expectations from Forest Management • Including and increasing the number of forestry courses into natural resource curricula of tertiary institutions • No devoted funds for forest research • No clear science/policy interface • Unsustainable land-use practices (cultural practices such as fire use, slash and burn) • Aridity of the Namibian environment **Key Research Issues/Priorities** • Indigenous fruit, nuts, oils – contribute to value-addition research through resource assessment, incidence and distribution • Artificial regeneration techniques (seed and vegetative methods), coppice management • Seed technology – storage, seed treatment (breaking dormancy) • Harvesting cycles/guidelines on forest products (timber and non-timber) • Management of exotic plantations • Fire management • Economic analysis of operations, e.g. fire suppression • Production and dissemination of information; e.g. species monographs • Monitoring and supply of baseline data on forest resources • Bush encroachment and bush utilisation • Tree improvement work – breeding, genetics	• Devoted budget • Key research skills training • Post-graduate scholarships • Provide a forum for scientific reporting • Partnerships with research and academic institutions • Management of the performance	• Policy-makers • Farmers • Tertiary institutions • Agricultural extension • Forest product users • Agricultural research

2. DIRECTORATE OF FORESTRY: INVENTORY UNIT: OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES	WAYS TO IMPROVE RESEARCH WORK	STAKEHOLDERS
Current Role/Opportunities • Interest from academic institutions on growth and yield data/plots • Demand for management advice by communities • Currently supplies inventory information for all community forests • Populating and managing a forest resource database **Key Challenges** • Low number of researchers • No devoted funds for forest research • Unsustainable land-use practices (cultural practices such as fire use, slash and burn etc.) • Shortage of skills in biometrics, economics and genetics **Key Research Issues/Priorities** • Provision of data on carbon stocks (could include underground biomass) • Information on growth and yield of key tree species • Stand treatment techniques for community forest reserves • Application of remote sensing techniques to estimate biomass • Wood utilisation studies • Development and use of forest resource databases	• Improved dissemination of available data (Research is both supply and demand driven)	• Forest management • Communities • Academic institutions

3. DIRECTORATE OF FORESTRY: NRSC: OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES	WAYS TO IMPROVE RESEARCH WORK	STAKEHOLDERS
Current Role • Boundary mapping of community forest reserves • Fire mapping • Customised thematic maps **Opportunities** • Climate change work offers new opportunities for RS/GIS applications • Use aerial photography **Key Challenges** • Funding • Workload • Bureaucracy • Inadequate use of available data (collected but not analysed and used) **Key Research Issues/Priorities** • Could play a role in detecting/monitoring effects of climate change on natural resources • Climate change modelling • Monitoring land/forest degradation • Fire monitoring/fire ecology/monitoring the ecological impacts of wild fires • Long-term forest cover monitoring (use of FAO/FRA framework)	• Devoted budget • Post-graduate scholarships • Provide a forum for scientific reporting	• Forest Management • Policy-makers • Farmers • Tertiary institutions

4. DIRECTORATE OF FORESTRY: OKAHANDJA: OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES	WAYS TO IMPROVE RESEARCH WORK	STAKEHOLDERS
Current Role/Opportunities • Demand for growth and yield data • Demand for support to livelihood improvements; e.g. orchard development • Calls for bush utilisation **Key Challenges** • Insufficient facilities, poor maintenance and repair services due to bureaucratic 'bottlenecks' • Aridity of the environment affects experiments – low survival, high maintenance costs • Conversion of forest land to other uses • No forum for sharing and reporting on research work • No clear research agenda, no clear annual workplan • No devoted research funding • No library facilities, no statistical software **Key Research Issues/Priorities** • Vegetative propagation techniques • Nursery studies – stress tolerance • Orchard development – planting, tending • Wood science studies – properties and uses • Growth and yield • Recovery of stands after harvesting, regeneration of key species • Plant/Forest products: value-added products • Seed technology • Ecology - Invasion biology, fire ecology • Forest cover monitoring – cover changes, degradation • Bush utilisation	• Building research teams • Channel funds through less bureaucratic organisations • Targeted skills training workshops • Linkages to SASSCAL • Mentoring of young researchers • Introduction to forestry for researchers without forestry background • Provision of a statistical package • Forum for reporting scientific findings and discussions of topical issues	• Forest Management • Policy-makers • Farmers • Tertiary institutions

5.	DIRECTORATE OF FORESTRY: DIVISION FOREST MANAGEMENT (FIELD): EXPECTATIONS, OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES

Expectations

- Data on growth and yield of key species
- Propagation of key timber species, such as kiaat
- Harvesting guidelines for all forest products
- Involvement of research in all field operations (demand or supply driven?)
- Matching species/provenances to sites
- Proper documentation of research protocols, regular and mandatory publishing of results, monographs

Opportunities

- Involvement in Orchard/Woodlot Development
- Propagation work with fruit trees to facilitate early fruiting

Key Challenges

- Population pressure to community forests – threat of conversion
- Overexploitation of forest products – poles, droppers, timber
- Aridity of the environment affects experiments – low survival, high maintenance costs
- Some community forests are small and scattered (in the east), boundary issues around them, weak Forest Management Committees, their sustainability
- Problems of income diversification from community forests

Key Research Issues/Priorities

- Orchard/Woodlot development
- Forest resource monitoring – data on distribution, yields, quality and harvesting guidelines
- Long-term forest cover monitoring
- Post-harvest recovery of forest stands
- Climate change – monitoring to detect responses to CC, vulnerability etc.
- Management plans for *Eucalyptus* stands
- Propagation of key timber species
- An assessment on the functions of Forest Management Committees (power relations, benefit-sharing models)
- Drought-tolerance

6. TERTIARY INSTITUTIONS: EXPECTATIONS, OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES	WAYS TO IMPROVE RESEARCH WORK
Expectations • Clear research focus • Collaborative mechanisms and arrangements • Support for Integrated Land Management • Resource assessment – stocking, distribution • Focus on species of economic importance, including species monographs • Growth and yield data • Active use and publication of available data • Knowledge management • Active forum for reporting **Key Research Issues/Priorities** • Vegetation mapping • Forest products utilisation research = value-addition, incl. reconstituted forest products • Regeneration studies – artificial and natural • Growth and yield modelling for timber and non-timber forest products • Social research, e.g. an assessment of the effectiveness of the community forestry model (achievement of policy objectives, conditions for success, technology adoption, their governance functions) • Diseases and pests of key fruit and nut species, e.g. dwarf mistletoes on marula • Support to bee-keeping • Information dissemination – available data, species monographs	**Other strategic Issues** • Carefully laid out permanent sample plots • Long-term commitment • Data security: long-term storage of data, protection of plots • Outsourcing of research to appropriately qualified institutions, e.g. technology studies • Career paths for researchers • A system of knowledge management

7.	NON-GOVERNMENTAL ORGANISATIONS: EXPECTATIONS, OPPORTUNITIES, CHALLENGES, KEY RESEARCH ISSUES/PRIORITIES

Expectations

- The Division Forest Research should set the scene – set clear priorities and supply the appropriate skills for the job
- There should be stronger links between research and the Community Forestry Programme – harvesting guidelines for key products based on appropriate and not outdated data
- Post-harvest inventories
- Active publicity on what information and data are available (supply-driven research)

Key Challenges

- Use of outdated data to make management decisions, such as 'allowable cuts'
- Inadequate capacity to promote and supervise compliance with the principles of sustainable forest management (SFM)
- Available data are not widely publicised to facilitate their analysis and use
- Limited research capacity
- Limited collaboration amongst institutions
- Limited research even in tertiary institutions
- Potential researchers often end up in management (promotional) posts
- Predicted land-use changes with regard to climate change

Opportunities

- Interest in bush utilisation
- Livelihoods focus in the policies of government
- Increasing recognition of the contributions of forests in climate change adaptation
- The focus on Indigenous Natural Products by the MCA-Namibia
- Opportunity for forestry to cover rangeland monitoring

Annex V. The structure of the Division Forest Research in the Directorate of Forestry

The Division Forest Research in the Directorate of Forestry is headed by a Deputy Director. On its current establishment, the Division makes provision for an adequate number of Forester Level (minimum qualification of a four-year B.Sc. degree, but preferably M.Sc. degrees) positions. The division is further subdivided into the National Forestry Research Centre in Okahandja (Subdivision Research Programmes and Stations) and the National Remote Sensing Centre, together with National Forest Inventory, which constitute the Subdivision Policy, Planning and Information. Both subdivisions have a national operational mandate. These subdivisions are headed by Chief Forester level positions. There are currently three field stations on the divisional structure, namely Hamoye Forestry Research Station (Kavango); Kanovlei Forestry Research Station (Otjozondupa); and Ngoma Forestry Research Station (Caprivi) .

The current levels of formal qualification within in the Division Forest Research below the Deputy Director (current incumbent holds a Ph.D.), include one Doctorate degree, six M.Sc. degrees, three Honours degrees and three four-years B.Sc. degrees. This current staff establishment, if all the posts are filled, would be sufficient for the division to run a credible research programme and particularly if the Directorate of Forestry forms those strategic partnerships already described in order to seriously pursue the research agenda.

A significant development that could positively affect the Directorate of Forestry is a decision by the Ministry of Agriculture, Water and Forestry, to integrate the National Botanical Research Institute (NBRI) within the Directorate of Forestry. This should add more skilled staff, and will also have implications on the structure of Division Forest Research, especially in the aspects of common interests such as vegetation monitoring, the National Tree Seed Centre and aspects of applied botanical research. Without pre-empting the decision of the Ministry regarding this new structure, it would be useful if reference is made to the Forest Research Strategy as an input to provide guidance to the merger. In that regard, the following issues could be considered:

- Rationalise the core functions of each of the organisations before the merger to ensure that forestry and botanical services concentrate on their core competencies. An expert evaluation team could do this;
- Merging the sub-units, from the two institutions that have similar remits (e.g. the National Tree Seed Centre with the National Plant Genetic Resources Centre);
- Create officially mandated, specialised teams to tackle the focal areas in the Forest Research Strategy;
- Ensure that staff establishment of the Division Forest Research is harmonised with that of NBRI or vice versa, so that functions, positions and benefits are not lost in the merger; and
- With the merger of the two, rationalise on the current distribution of field offices.

Annex VI. Action Plan

Introduction

Upon the specific request of stakeholders, and through a series of consultative meetings involving divisional staff, this Action Plan was directly derived from the Forest Research Strategy, which identified the seven strategic research areas listed below:

i. Forest and rangeland monitoring programme
ii. Forest products (value-added) research
iii. Ecological studies
iv. Growth and yield studies
v. Silvicultural research
vi. Economic, policy and sociological research
vii. Management of information

Choice of priority actions or topics from the strategic research areas

The justification or rationale for each of the strategic research areas, their corresponding strategic objectives and indicative actions have, been described in the main strategy document. However, it was deemed necessary to chose priority areas and topics that could form the research programme portfolio of the Division Forest Research for a period of five years. The topics are:

i. Understanding the drivers of deforestation and forest degradation – Justification for a monitoring programme
ii. Growth and yield of various products
iii. Developing or applying technologies to improve natural and artificial regeneration
iv. Forest products (value-added) research
v. Economic and social aspects of SFM, including issues of governance
vi. Management of data and information

The Action Plans are designed to be implemented over a five-year time period. However, in line with government budgeting, one-year work plans will be developed to show what actions will be initiated or concluded in any particular financial year. Milestones will be used to show the timing of actions and expected periods for outputs or outcomes to be realised over the implementation period.

Consolidating the suggested implementation mechanisms

To achieve results or outcomes related to the above priority topics, the strategy document has described a set of actions that constitute the implementation mechanism for the Forest Research Strategy. These included:

i. Redefinition of roles within the Divisions Forest Research and Forest Management
ii. Forging strategic partnerships with other institutions
iii. Management of the research process – identification, proposal writing, execution, analysis of data, peer review, publication
iv. Programme Performance Indicators
v. Support to forest researchers
vi. Performance Management System
vii. Monitoring and Evaluation System
viii. Fund-raising for research and development
ix. The personnel implications of the research strategy

The nine elements of the implementation mechanism have been consolidated into four main actions listed below:

i. New roles and the resource implications of implementing the research strategy
ii. Strategic partnerships and fund-raising
iii. Management of the research process (including support to forest researchers)
iv. Performance Management at programme, team and individual levels

Together with the priority topics, the four consolidated elements of the implementation mechanism are presented as objectives within the proposed Action Plan, supported by logical framework tables, with outputs and indicators. This is because the Division Forest Research should show in its progress report that it is providing the necessary support to achieve the stated and desired research outputs and outcomes.

Converting priority areas into actionable objectives

In order to give focus to the Forest Research Strategy, a set of priority topics were identified. These priorities are described in Section 2.4. In the Action Plan, these priority issues have been converted into problem or objective statements from which relevant actions, outputs, outcomes and indicators have been developed. The objectives are:

i. A functional vegetation (forest and rangeland) monitoring system in place
ii. Adequate data on growth and yield on key tree species provided
iii. Natural regeneration of selected species improved/Selected tree species are artificially regenerated
iv. Additional value-added products in the market (local and international)
v. A functional structure for the management of the research process in place/Performance management system in place for individual researchers/Monitoring and evaluation system established

Table 1. Understanding the drivers of deforestation and degradation						
Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
1. To understand the drivers of deforestation and forest degradation (D & D)	1.1 Identify and describe the main drivers of D & D, distinguishing between direct and underlying drivers 1 1.2 Commission study to identify and describe socio-economic factors that underpin the key drivers of D & D	Reports and policy recommendations on mitigation and adaptation	Penetration effectiveness (%)	Head NFRC		200,000
	1.3 Map and monitor D & D i. Land cover mapping ii. Land cover change detection and monitoring	D & D updates	Updates to user requirements (rating)	Head NFRC		400,000
	1.4 Describe and map main carbon sinks and sources in relation to the woodlands of Namibia	Wildfire Carbon Emissions Data Forest Carbon Storage Data	To (internal, technical) accuracy target (average % all sets)	Head NFI		200,000
	1.5 Establish and implement a GIS-based forest advisory service	GIS-based forest advisory service	Responsiveness rating (%) Delivery to agreed deadlines (average %) compliance	Head NRSC		350,000

Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
	1.6 Expand the fire monitoring and management programme					100,000
	i. Monitor, map and analyse fire events	Burned Area maps and analyses Fire Risk Advice (Based on fire danger rating maps from AMESD)	Maps: To internal accuracy target (%) Analysis: To user requirements (%) Advice: Responsiveness rating by user(s) (%)	Head NRSC		
	ii. Assess and integrate existing fire monitoring trials in Kavango (Makambu) and Kanovlei [1]			Head NFRC		
	iii. Develop protocols for prescribed burning	Prescribed burning practice recommendations	Technical excellence Reception	Head NRSC		
	iv. Commission study to assess the direct and indirect economic impacts, as well as the ecological impacts of wildfires in a selected region of Namibia – A case study for policy advocacy	Report and recommendations	Penetration effectiveness (%)	DD/DoP		

[1] Existing fire trials, protocol needs revision

Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
	1.7 Describe bush encroachment and likely effects of bush harvesting on ground water recharge, habitat quality and carbon sink relation [2]	Compilation on best practices for bush control, including clearing and aftercare, ecologically sound uses of bush	Technical excellence Reception (Quality of response)	Head NBRI/ NFRC		200,000
	i. Monitoring of bush-cleared areas					
	ii. Determining best practices for bush clearing, keeping habitat quality in mind	Maps of encroached areas – species, severity				
	iii. Monitoring ground water recharge – comparison cleared/un-cleared land (and different variations)	Reports on bush-groundwater relations				
	iv. Estimate carbon sequestration under bush encroachment and its implications	Carbon density maps				
	1.8 Describe the distribution and effects of invasive alien plants in Namibia and recommend management measures	Management recommendations	Technical excellence Integration success rating (%) Reception	Head NFRC/ NBRI		

[2] To link up with PoN, Pasture Science, NBRI, Geohydrology, international partners (e.g. SASSCAL)

Table 2. Growth and yield data for various forest products						
Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
2. To provide adequate data on growth and yield for key tree species	2.1 Establish a network of permanent and temporary sample plots i. Select sample sites ii. Draw up sampling protocols	Key Tree Species Sampling Scheme Growth and Yield Models/Info	To (agreed) user specifications (%) To internal accuracy target (%)	Head NFI	June 2012	55,000
	2.2 Conduct participatory CF inventories	PCFI reports	To within approved Standard Error target range (%)	Head NFI		300,000

Table 3. Technologies to improve natural and artificial regeneration						
Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
3.a To improve natural regeneration of selected species	3.1 Draw up trial protocol: variables/ parameters/measurement	Species regeneration research standards	% Compliance with research technical checklist/project	Head NFRC		
	3.2 Establish trial plots in natural stands	Reforestation practice guidelines	Penetration	Head NFRC		56,000

Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
3.b To artificially regenerate selected tree species	3.3 Introduce improved grafting and other vegetative propagation technologies for key commercial species	Afforestation and Reforestation Guidelines	Technical excellence Usefulness	Head NFRC		500,000
	3.4 Select phenotypically superior mother trees from the wild (for selected traits) and undertake genetic improvement of selected taxa through tree breeding					100,000
	3.5 Establish clonal orchards (for the same species above) from superior mother trees (at least 30 individuals per clone)					810,000
	3.6 Collect seeds from clones and test them for traits and quality attributes under open and controlled pollination					
	3.7 Conduct nursery based research to improve field survival of out-planted seedlings i. Design survival (root shoot ratios; root development; hardening off; root pruning etc) experiments	Nursery-based research standards	Technical excellence	Head NFRC		80,000
	3.8 Conduct seed technology studies (viability; dormancy; longevity; storage conditions; pre-germination treatments)	Seed manual	Technical excellence	Head NFRC		80,000

Table 4. Additional value-added products in the market						
Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
4. To support the development of value-added forest products	4.1 Conduct a project to improve the quality hence marketability of Namibia Wood Crafts i. Conduct studies on wood properties of key species	Feasibility study report	Usefulness	Head NFRC	June 2012	410,000
	4.2 Investigate technologies to make reconstituted wood products from local woody species and technologies that enable the use of small size woody materials	Reports	Technical excellence	NFRC NBRI		200,000
	4.3 Explore new commercial uses for local species i. Commission study on wood properties – physical and biological/chemical ii. Conduct resource (raw material) and product market surveys	Forest product research advice	Compliance with user prioritised programme	NFRC NBRI		200,000
	4.4 Commission analytical work to produce a report on the main oils, gums and resins from the woodlands of Namibia	Report	Technical excellence	NFRC NBRI		815,000

Table 5: An appropriate mechanism to implement the forest research programme						
Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
5.a To improve management of the research process	5.1 Provide structure for management of the research process and establish support to researchers					
	i. Establish a research advisory committee	Committee with clear ToRs	Extent of improvement in quality of research design and delivery of results	Director, DD: Research	July 2011	75,000
	ii. Create and facilitate the functioning of research working groups	Technical recommendations	Penetration/ uptake of recommendations	DD: Research	Oct 2011	90,000
	iii. Publish standards for the preparation of research protocols (e.g. from proposal to analysis)	A manual or handbook	Technical excellence		July 2012	7,500
	iv. Establish a mentorship programme (Senior scientists)	Mentorship programme	Success rating		Oct 2012	515,000
	v. Training: Identify training needs and recommend staff for training, e.g. scientific writing, statistical analysis	Training plan for all staff	Compliance with plan		June 2012	63,000
	vi. Keeping up with current issues – journal subscriptions	Journals in library	At least 2 forestry related journals in Library		Oct 2011	50,000
	vii. Affiliation to regional and international forestry organisations	MOUs	Two MOUs		Feb 2012	173,000

Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
	5.2 Management of data and information					
	i. Establish/maintain a forestry database; inventory data, projects and stand registers	Functional database with electronic registers of all projects	Technical excellence	DD: Forest Research	June 2012	150,000
	ii. Provide an information service to the public (publications)	Science-based advisory service	User satisfaction		June 2012	775,000
	iii. Consolidate literature resources, setting up a FR archive	Archive established; Functional archive	% historical data/information available		Jan 2012	
	iv. Implement FR knowledge management system	FR knowledge management practice	Information accessibility to the agreed spectrum and criteria		2013	388,000
	v. Establish a forestry research society/ club for foresters	Relevant society identified/established	% staff membership		Dec 2011	
	vi. Present research findings to an appropriate forum	Research papers	Compliance with internal publication development schedule		Aug 2011	173,000

Objective	Project/sub-action/milestone	Output	Indicator (target)	Leader	Schedule	Budget N$
5.b To introduce a Performance Management System for individual researchers	5.3 Performance management system in place			Director, DD: Research	Nov 2011	350,000
	i. Set clear standards of individual performance	Official assessment reports	% of targets achieved			
	ii. Specify subdivisional targets and indicators of achievement		Commendations			
	iii. Set reward system	Guidelines for promotion and other rewards	Recommend-ations for capacity improvement			
5.c To establish a Monitoring and Evaluation System (including Key Programme Performance Indicators)	5.4 Monitoring and Evaluation System established	M&E Framework with Key Performance Indicators (KPIs) published and distributed to key research partners	M&E reports available at set periods	Director	Dec 2012	208,00
	i. Design an M&E policy/guidelines and programme to the Advisory Committee					
	ii. Identify the key indicators for the overall research programme					
	iii. Present the programme to the Advisory Committee		Technical excellence			
	iv. Identify and train an M & E Coordinator					256,000
	v. Conduct bi-annual project reviews					
	vi. Schedule periodic overall programme Evaluations		Evaluation scores or rating of the research programme at acceptable level			

MINISTRY OF AGRICULTURE, WATER AND FORESTRY