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**Ministry of Environment, Natural Resources and Physical
Development**

**Higher Council for Environment and Natural Resources
(HCENR)**

National Biodiversity Strategy and Action Plan 2015 -2020



Government of Republic of Sudan

Ministry of Environment, Natural Resources and Physical Development

Foreword

Sudan is a country of a great diversity of plants, animals, forests, wildlife and habitats within diverse environmental systems making it endowed with flora and fauna. Biodiversity provides the basis for livelihood and sustainable social and economic development; and safeguards ecological safety and food security.

Sudan is a Party to the Convention on Biological Diversity (CBD), which calls upon all Parties to develop and update in a timely manner national biodiversity strategy and action plan for conservation and sustainable use of biological diversity. Accordingly, Sudan developed the first National Biodiversity and Action Plan in 2002. The present document on National Biodiversity Strategy and Action Plan, which developed in a consultative process, provides the framework for taking actions by the different stakeholders in biodiversity, including the people themselves, for achieving the three objectives of the CBD, namely conservation of biodiversity, sustainable use of its components, and fair and equitable sharing of benefits arising out of their use and to fulfill the global Biodiversity Vision, of living in harmony with nature.

This document identified the strategic goals, and priority areas and actions for biodiversity conservation. These strategic goals, objectives and actions set by the updated NBSAP call for education, training and increasing awareness, among the people, on the value of biodiversity, and understanding of the importance of maintaining biodiversity and why it is crucial that biodiversity components are used in a sustainable manner, to ensure a change in human behavior and attitudes those result in loss of biodiversity and to ensure active participation in the implementation of the strategy and action plan. Furthermore, strengthening of the legislations and polices, increasing efforts in conserving and using biodiversity in a sustainable manner have been incorporated in the strategy as priorities.

I would like to take this opportunity to thank all those who were involved in the development of this Strategy. The challenge is to take the necessary further steps towards the implementation of the strategy and priority actions and to achieve its objectives. I therefore, request all the actors involved in the national biodiversity strategy to make their efforts for fulfilling it. We look forward for further cooperation and collaboration among all the stakeholders at all levels including national and international in implementing the NBSAP.

H. E. Hassan Abdelgadir Hilal
Minister
August, 2015



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Government of Republic of Sudan
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Development
Higher Council for Environment and Natural Resources

Preface

This National Biodiversity Strategy and Action Plan (NBSAP) is a key planning tool for conservation of the country's biodiversity and for fulfilling the commitments of Sudan towards the international obligations.

The strategy and priority actions take into account the national policies, strategies and comprehensive plans. It also takes into consideration the national priority needs in terms of conservation, sustainable use of its components and equitable sharing of benefits. The strategy will be implemented in collaboration and partnership with all relevant stakeholders.

Funding is a major challenge in this regard. While the national government role is major in providing necessary financial resources, all stakeholders have to be as creative and active as possible to obtain funding from different internal and external sources for implementing the different proposed actions.

Our great appreciation should go to the late Professor El Wakeel who has the incitation role in the development of the this strategy, put in place the road map on which others go and the solid base without it this document may not be in hands. I would like to thank project team for their dedication and hard work to complete this task in time.

I wish also to express my great appreciation to the Global Environment Facility and United Nation Development Program for financial support.

Nadia Hassan Omer
Acting Secretary General
August, 2015



Government of Republic of Sudan
Ministry of Environment, Natural Resources and Physical Development
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Acknowledgement

The National Biodiversity Strategy and Action Plan is a framework, based on the national priorities and capacities taking into account the global targets included in the Strategic Plan of Action 2011-2020. Its aims to integrate Sudan obligations under the Convention on Biological Diversity into national development and sectoral planning framework through a renewed and participative biodiversity planning and strategizing process, in manner that is in line with the global guidance contained in CBD 2011-2020 Strategic Plan.

The document provides a comprehensive review on the status of the country's biodiversity, threats and causes of biodiversity loss in Sudan, describes strategic goals, priority areas and actions and the enabling environment for implementation of NBSAP. It also outlines the financing and implementation arrangement, identifies Strengths, gaps and priority needs in national capacities and technologies for biodiversity management.

The updated NBSAP is the output of the valuable contributions of key stakeholders from different sectors. I would like to appreciate all efforts and inputs made by all government agencies, civil society, NGOs private sectors and individual experts, who contribute in different ways in the preparation of this document. My grateful thanks are to everyone who provided his valuable comments and suggestions.

I would like to put on record the great efforts and input made by the late professor Ahmed Suliman EL Wakeel who devoted himself to this work until the last moments of his life. I also acknowledge the efforts and valuable input made by the former manger professor Mirghani Osman Iboaf.

My sincere thanks are extended to H.E. Minister of Environment Hassan Abdelgadir Hilal and to Under Secretary of the ministry of Environment and GEF operational Focal Point Dr. Babiker Abdalla for their follow up and continuous support.

Successful completion of this work would not have been possible without the assistant, support and cooperation of the staff of the Higher Council for Environment and Natural Resources; I would like to extend my sincere appreciation to all of them.

Finally, I would like to express my sincere appreciation to the Global Environment Facility and United Nations Development Program for their financial support to prepare the NBSAP.


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Acronyms and Abbreviations

AEPS	Agriculture Economic and Planning Section
ARC	Agricultural Research Corporation
ARP	Agricultural Revival Program
APGRC	Agricultural Plant Genetic Resources Conservation and Research Centre
CBD	Convention on Biological Diversity
CBS	Central Bank of Sudan
CBS	Central Bank of Sudan
CBOs	Community-Based Organizations
CGIAR	Consultative Group on International Agricultural Research
CWR	Crop Wild Relatives
EDMoA	Extension Department, Ministry of Agriculture
FAO	Food and Agriculture Organization of the United Nations
FED	Forestry Extension Department
FFDU	Forestry Faculties and Departments at Universities
FNC	Forests National Corporation
FPTUA	Farmers and Pastoralists Trade Unions and Association
FRC/ARC	The Forest Research Centre –Agriculture Research Council
GEF-UN	Global Environmental Facility
GIS	Geographical Information Systems
GMO	Genetically Modified Organism
GRU	Genetic Resources Unit
HCENR	Higher Council for Environment and Natural Resources
NCSP	National Council for Strategic Planning
NRC	National Research Center
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LUURSA	Land Use Unit and Remote Sensing Administration
MENRPD	Ministry for Environment, Natural Resources and Physical Development
MOAI	Ministry of Agriculture and Forestry
MoCI	Ministry of Culture and Information
MoE	Ministry of Education
MoFNE	Ministry of Finance and National Economy
MoHESR	Ministry of Higher Education and Scientific Research
MoI	Ministry of Industry
MoL	Ministry of Labor
MoJ	Ministry of Justice
MoM	Ministry of Minerals
MoLFR	Ministry of Livestock , Fisheries and Rangelands
MoTW	Ministry of Tourism and wildlife
MoWRE	Ministry of Water Resources and Electricity
NBSAP	National Biodiversity Strategy and Action Plan
NAPA	National Adaptation Program of Action
NDDCU	National Drought and Desertification Control Unit

NGOs	Non-Governmental Organizations
NTA	The Native or Tribal Administration
NTSC	National Tree Seed Centre
PERSGA	Regional Organization for Environment Protection of Red Sea and Gulf of Aden.
PGR	Plant Genetic Resources
PGR/ARC	Plant Genetic Resources Unit of the Agricultural Research Corporation
PGRFA	Plant Genetic Resources for Food and Agriculture
REDD	Reducing Emissions from Deforestation and Forest Degradation
RPGD	Range and Pasture General Directorate
SECS	Sudanese Environment Conservation Society
SSFS	Sudanese Social Forestry Society
SSMO	Sudanese Standards and Metrology Organization.
TMRFAD	Traditional and Mechanized Rain-fed Agriculture Departments
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNCCD	United Nations Convention on Combating Desertification
UNFCCC	United Nations Framework Convention on Climate Change
WCGA	Wildlife Conservation General Administration
WRC	Wildlife Research Corporation

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Executive Summary

The National Biodiversity Strategy and Action Plan to Support the Implementation of the CBD 2011-2020 Strategic Plan in Sudan is a project supported by the Global Environment Facility (GEF) with partnership of the United Nations Development Program (UNDP), and the Ministry of Finance and National Economy (Sudan). It is being implemented by the Higher Council for Environment and Natural Resources (HCENR) in Sudan. Its objective is to integrate Sudan obligations under the Convention on Biological Diversity (CBD) into national development and sectoral planning framework through a renewed and participative biodiversity planning and strategizing process, in a manner that is in line with the global guidance contained in CBD 2015-2020 Strategic Plan in Republic of Sudan. The present document, which is an updated NBSAP for the one issued in 2000, and intended to cover the coming period up to 2020 in Sudan, is one of the results of this project and the renewed participative process initiated by it for biodiversity planning and strategizing in the country. The overall objective of the first NBSAP (2000-2010) was to conserve and enhance biological diversity for the prosperity and development of the Sudan. Although some progress has been witnessed in Sudan for conservation and sustainable use of some components of biodiversity, the implementation of the NBSAP (2000) has not been as effective and satisfactory as it should be..

As a party to the Convention on Biological Diversity (CBD), Sudan has to adhere to its three objectives: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

The updated NBSAP is a framework, based on the national priorities and capacities and taking into account the global targets included in the Strategic Plan of Action 2011-2020. It also takes into account the national policies, strategies and comprehensive plans, including the 25 years strategy (2002-2027), the five years plan (2012-2016) and the five years program for economic reform (2015-2019), which are all featured by working towards combating the deterioration of resources and conservation of genetic resources, as well as upgrading living standards for the limited income inhabitants, and reducing poverty severity at family and society levels while building their capacities towards the climate change. This is in addition to some sectoral policies and strategic action plans such as the forestry policy (2006), which supports the conservation of biodiversity and its sustainable use, and provides clear guidelines for rehabilitation and raising of awareness of communities on the importance of forest resources, the wildlife policy (2014), which encourages establishment of new protected areas, and the strategic action plan of range and pasture plants in semi-desert and low rain savannah, which aims at strengthening the communities capacities towards climate change, as well as the

national investment plan for the agricultural sector (2012), which aims at supporting the natural resources sector in order to ensure its regeneration and sustainability, as well as the paper on poverty combating and population policy.

The development of this document has been preceded by a number of processes that tackled three important elements; stocktaking of biodiversity and related aspects in the country and setting of national targets, evaluating the impacts of climate change on the biodiversity and economic valuation of ecosystems and biodiversity. The objective of the updated NBSAP is to integrate Sudan obligations under the Convention on Biological Diversity into national development and sectoral planning framework through a renewed and participative biodiversity planning and strategizing process, in manner that is in line with the global guidance contained in CBD 2011-2020 Strategic Plan.

This NBSAP document is arranged into eight chapters included in three parts followed by the references and appendices. The first part is a background which comprises the first chapter on geography and environment of Sudan, the second chapter on state of biodiversity, the third chapter on issues related to biodiversity conservation and sustainable use and the fourth chapter on threats and causes of loss of biodiversity. The second part covers the strategy and action plan, which are presented in two chapters: chapter five on the strategy and chapter six on the detailed action plan. The third part is on the implementation and financing, which are dealt with in chapter seven on the enabling environment for the implementation of the NBSAP and chapter eight on financing aspects and implementation mechanisms.

In chapter one the geography and environments of Sudan are introduced. Sudan is endowed with a wide range of ecosystems and species diversity. The ecological zones extend over a wide range from the desert in the extreme north to the savannah in the south. This diverse environment exposes the country's flora and fauna to a number of threats caused by natural factors as well as human activities.

In the second chapter the state of biodiversity in Sudan is reviewed and updated. Its value and contribution to the national socio-economic development is highlighted. The chapter covered the known components of biodiversity, which includes plant agrobiodiversity, forests, range plants and livestock diversity, terrestrial, marine and inland waters, wildlife ecosystems.

The third chapter covers some the recently emerging issues related to biodiversity conservation and its sustainable use and management. It includes an evaluation of the state of the emerging problem of the invasive alien species , the impact of climate change on biodiversity and the modern trends and techniques of biotechnology that are

expected to contribute positively or negatively to the state of the biodiversity in the country, including the biosafety arrangements. The economic valuation of ecosystems and biodiversity and its integration in the process of development has been taken into account through a set of suggested actions such as training of relevant civil servants and stakeholders in transforming biodiversity components into items of monetary value and taking biological resources as vehicles for rural development within the strategy for poverty alleviation.

The fourth chapter addresses the threats and causes of biodiversity loss in Sudan. They could be outlined into threats due to environmental changes or those due to socio-economic factors. Drought spells, rainfall fluctuations, floods and rise in temperature are specific environmental factors. Expansion in agricultural activities, the land tenure system and the consequent land fragmentation, the implementation of industrial and other development projects and other production activities have had eroding effect on the genetic diversity of indigenous biota. Unrest conditions and civil strife in a number of regions have led groups of populations to move from their local areas and consequently resulted in destruction of natural habitats for different flora and fauna in the country. Burning of trees and forests by different groups during these civil conflicts has resulted directly in removal of tree cover, deforestation and loss of indigenous species. Popular wide scale gold mining is widely spread. Devastating mining practices have led to deforestation and loss of some indigenous species. Poverty is one of the biggest indirect threats to forest biological diversity. The majority of the population in Sudan lives in dry and vulnerable areas, depending entirely on the already fragile natural resources for their livelihood. Also covered in this chapter are a number of specific threats affecting the different components of biodiversity.

The fifth chapter includes the strategy, which consists of the guiding principles, vision, mission, strategic goals and national targets. The vision is "sustainable use of natural resources of Sudan, where biodiversity is valued, conserved, restored and sustainably used to maintain ecosystem services, sustain health and deliver benefits essential for all people of Sudan, and hence contributing to the economic and social development in the country". The mission is essentially aiming at taking necessary measures to ensure conservation and restoration of all biodiversity components and maintenance of different ecosystem services through effective policy, legislative, financial, administrative and technical actions. The national targets are based on the global strategic goals, in order to address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society, reduce the direct pressures on biodiversity and promote sustainable use, improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity, enhance the benefits to all from

biodiversity and ecosystem services and enhance implementation through participatory planning, knowledge management and capacity building.

The sixth chapter includes the national action plan, which covers a number of proposed actions that are primarily set in order to address under each of the biodiversity components a number of thematic areas, which are education, training and awareness, policies, legislations, conservation and sustainable use. The necessary actions are tied to each of the national targets, each of which is detailed into specific component target(s) under the corresponding Aichi Target for each of the biodiversity components, in addition to biotechnology and biosafety as well as to management of the invasive alien species and the impacts of climate change on the biodiversity.

The seventh chapter addresses the enabling environment for implementation of the NBSAP, which includes those national strategies, policies and plans that are associated with biodiversity in the country. The enabling environment includes also the international agreements and instruments of relevance to biodiversity and to which Sudan is a party such as those on desertification, climate change, plant genetic resources for food and agriculture, access to genetic resources and sharing of benefits arising from their utilization, and wetlands.

The eighth chapter deals with the implementation mechanisms and financing of the NBSAP. It deals with assessment of capacity building needs, identification of technologies required for the implementation of the NBSAP, monitoring and evaluation strategy, awareness and communication strategy, and resources mobilization. The implementation of the NBSAP is a national State responsibility through the different agencies and institutions at national and sub-national levels in addition to different stakeholders including the private sector and civil society organizations. Both government and society have to be aware of their responsibilities towards this NBSAP and act effectively to implement it. Funding is a major challenge in this regard. While the national government role is major in providing necessary financial resources, all stakeholders have to be as creative and active as possible to obtain funding from different internal and external sources for implementing the different proposed actions. A Technical Committee composed of a group of experts in Biodiversity is also proposed to work closely with and under HCENR to develop policies and review work plans and advise on biodiversity issues.

Partition

Part I: Background

Chapter 1

1. Introduction

The National Biodiversity Planning to Support the Implementation of the CBD 2011-2020 Strategic Plan in Sudan is a project supported by the Global Environment Facility (GEF) with Partnership of the United Nations Development Program (UNDP), and the Ministry of Finance and National Economy (Sudan). It is being implemented by the Higher Council for Environment and Natural Resources (HCENR) in Sudan. Its duration is two years (2013-2015). The project objective is to integrate Sudan obligations under the Convention on Biological Diversity (CBD) into national development and sectoral planning framework through a *renewed and participative biodiversity planning and strategizing process, in a manner that is in line with the global guidance* contained in CBD 2011-2020 Strategic Plan in Republic of Sudan.

1.1 Sudan Geography and Environment

Sudan is a vast country with an area of 1.8 million km². It lies between latitudes 10° and 22° N and longitudes 22° to 38° E. Its landscape consists primarily of gently sloping plain, with the exception of Jebel Marra, Massif Red Sea Hills, and Nuba Mountains. Mean annual temperatures vary between 26°C and 32°C across the country. The northern part is almost desert and semi desert with average annual temperatures around 30°C and average annual rainfall about 150 mm/year. The central area is semi-desert to savannah with average annual temperatures that are around 27° C, and rainfall averaging to about 200 mm/year. Rainfall, which supports the great majority agricultural activity, is erratic and varies significantly from the northern to southern ranges of the country. Sudan can be ecologically divided into five vegetation zones according to rainfall patterns from North to South. These are:

- i. Desert: (0-75 millimeters of precipitation)
- ii. Semi-desert: (75-300 mm)
- iii. Low rainfall savannah on clay and sand: (300-800 mm)
- iv. High rainfall savannah (800-1500 mm)
- v. Mountain Vegetation: (300-1000 mm)

Sudan is endowed with a wide range of ecosystems and species diversity. The ecological zones extend over a wide range from the desert in the extreme north to the savannah. According to the recently published, Land Cover Atlas of Sudan, FAO (2012), Forests together with Rangeland represent 35.6% of the total country area (Table 1 and Figure 1). Sudan is rich in biodiversity within diverse environmental systems making it endowed with flora and fauna which are being subjected to a number of threats as a result of natural factors and human activities.

Table 1.1: Sudan Land Cover Classes in Hectares

Land Cover Class	Area (Ha)	%
Agriculture in terrestrial and aquatic/regularly flooded land	23,710,025	12.6
Trees closed-to-sparse in terrestrial and aquatic/regularly flooded land	18,733,182	10
Shrubs closed-to-sparse in terrestrial and aquatic/regularly flooded land	22,231,327	11.8
Herbaceous closed-to-sparse in terrestrial and aquatic/regularly flooded land	25,982,720	13.8
Urban areas	730,331	0.4
Bare Rocks and Soil and/or Other Unconsolidated Material(s)	95,277,727	50.7
Seasonal/perennial, natural/ artificial water bodies	1,290,000	0.7
Total Sudan area	187,955,312	100

Source: FAO, 2012: Land Cover Atlas of Sudan

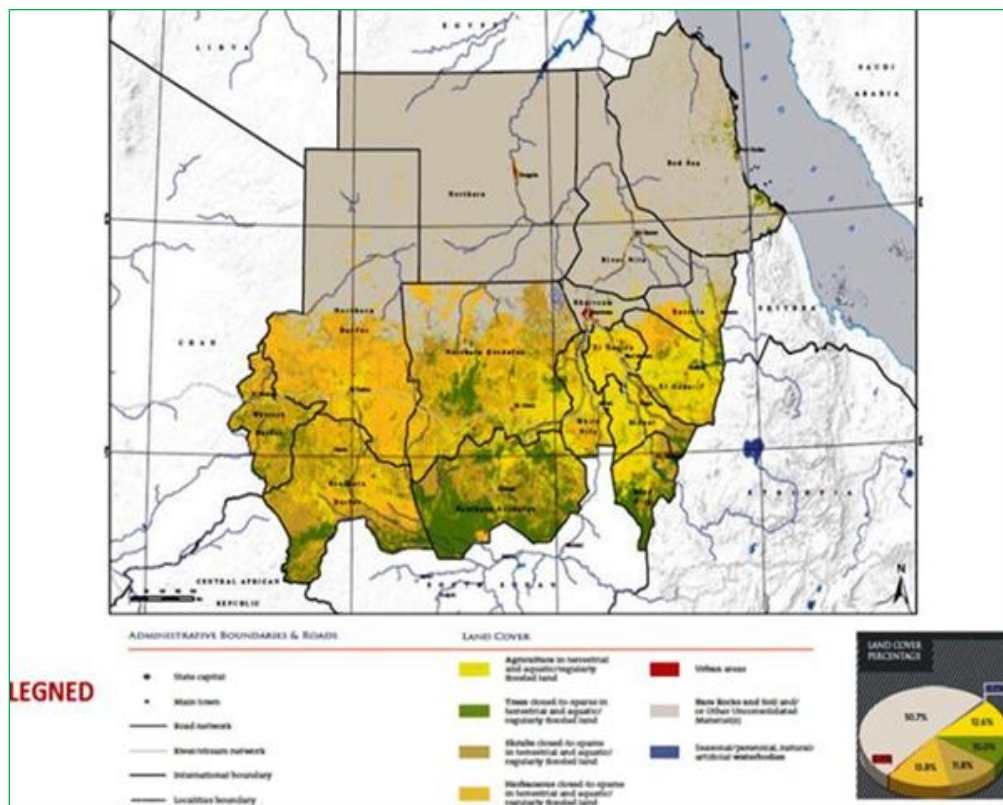


Figure (1.1): Sudan Land Cover

1.2 Rationale

Sudan is a party to the Convention on Biological Diversity (CBD), which has three objectives: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. Accordingly, Sudan has developed and endorsed a National Biodiversity Strategy and Action plan (NBSAP) through a national process initiated in 1999 and completed by 2000. The vision of the NBSAP (2000) was given as “Conservation of diversity and related indigenous knowledge for sustainable national development of Sudan”. The overall objective of it was to conserve and enhance biological diversity for the prosperity and development of the Sudan through actions to achieve the specific objectives of biodiversity conservation, sustainable use, promotion of awareness, creation of enabling environment and complying with and benefiting from regional and international agreements and mechanisms. Actions proposed in the NBSAP (2000) to attain those objectives covered a number of major areas of action that included conservation, use, documentation, training, education and extension, institutional arrangements and legislative arrangements. The plan envisaged future sustainable development plans to take into consideration the conservation of the natural environment and its constituent biological, ethnic and cultural diversity.

The Strategic Plan for Biodiversity 2011-2020, which was adopted by the Tenth Conference of Parties to the CBD (COP 10) in 2010 states "Biological Diversity underpins ecosystem functioning and the provision of ecosystem services essential for human well-being". It provides food security, human health, the provision of clean air and water; it contributes to local livelihoods, and economic development, and is essential for the achievement of the Millennium Development Goals, including poverty reduction". This understanding provides basis for keeping reviewing status of progress with regard to implementation of necessary global, regional and national interventions associated with biodiversity including to what extent that biodiversity issues have been mainstreamed in the development policies and plans at global, regional and national levels.

Although some progress has been witnessed in Sudan for conservation and sustainable use of some components of biodiversity, the implementation of the NBSAP (2000) has not been as effective and satisfactory as should be. It is hindered by a number of factors and prevailing conditions including the weak capacities in terms of human resources and infrastructures that was due to a number of reasons on top of which was the lack of necessary policies and legislations.

In general, the assessment of available capacities for conservation, management and monitoring of biodiversity in Sudan has revealed a number of gaps and constraints that have to be removed in order to enable efficient monitoring, conservation, management and sustainable utilization of biodiversity in Sudan.

The NBSAP (2000) formed a baseline document for policies in Sudan with regard to the conservation and sustainable utilization of biodiversity. However, more detailed and focused policies are required when it comes to the implementation of the different aspects of the NBSAP. Lack of effective comprehensive environmental and natural resources

policy, and lack of legislative framework that deals with land use in an integrated way are clear examples in this regard.

The present biodiversity related legislation is either regulatory or penalty legislation, which is sector based. There is no national legislation on access to genetic resources and aspects of sharing of benefits arising from their utilization. However, the Interim National Constitution of Sudan (2005) contains articles considered as relevant to the realm of environment and natural resources as indicated by a number of articles among which is Article 11. (1), which states that "the people of the Sudan shall have the right to a clean and diverse environment; the State and the citizens have the duty to preserve and promote the country's biodiversity".

Qualified full-time personnel seem to be either lacking or inadequate in different aspects of biodiversity monitoring and conservation. The shortage of taxonomists in the country could not be overlooked. Number of scientists and technicians, who are trained mainly on conservation of genetic resources, is limited to some units such as the Agricultural Plant Genetic Resources Conservation and Research Centre of the Agricultural Research Corporation (APGRC/ARC).

In spite of the fact that a number of institutions are concerned in a way or another with matters of biodiversity conservation, monitoring and use, the specialized units on such area are very limited. The only plant gene bank at present is in the ARC with limited facilities. No national herbarium or zoological garden is found in the country. There is no central authority for the overall management and conservation of the wetlands ecosystems. The already established institutions are suffering from limited funding and shortage or lack of equipment and/or buildings. Except the Dinder National Park, Jebel Aldair and Marine Parks most protected areas are not well managed due to lack of facilities, shortage of personnel and sometimes insecurity. Most, if not all, Game Reserves and Sanctuaries have not been taken care of since their proclamation. There are no institutes with research programmes dedicated mainly to aquatic ecosystems are found in the country. Although concerns are being shown by some bodies on matters related to access to genetic resources and benefit sharing, there are no specific institutions that are totally responsible for handling such matters.

There is a lack of sustained harmonized efforts between and within the different institutions, groups and individuals engaged in matters of biodiversity conservation and use. Coordination is as well lacking with other bodies, which could be indirectly related to the issue. However, one can note that the Higher Council for Environment and Natural Resources (HCENR) has playing to some extent a significant role in attempting to fill this gap during the last years through the projects it has been executing on biodiversity. Still, HCENR can play a major role in this regard provided that its capacities are strengthened in a way enabling it to fully fulfill the terms of reference and structures provided for in the Environment Conservation Act of 2001 including as well those more detailed in the NBSAP (2000).

Existing information associated with biodiversity in Sudan is not extensively published or easily accessed. Access to the available information within the different institutions active

in this area is hindered by lacking or insufficiency of information and database systems at institutional and national levels. However, it is interesting to note the progress achieved by the PGR Unit / ARC in this regard by establishing an electronic gene bank documentation system including passport data on existing PGR collections, which are uploaded and made available on the internet through a regional data portal for Eastern Africa Plant Genetic Resources Network (EAPGREN). However, one of the components of the national planning for Biodiversity project is to establish Biodiversity Clearing House mechanism (CHM) which is now under process.

There is virtual absence of syllabi related to conservation of biodiversity in the general education curricula, and little, if any, in the higher education curricula. As a result of that, awareness in this regard seems to be only limited to some of the experts and interested people.

Globally, most Parties to the CBD identify a lack of financial, human and technical resources as limiting their implementation of the Convention. Technology transfer under the Convention has been very limited. Insufficient scientific information for policy and decision making is a further obstacle for the implementation of the Convention. As a result to that, the diversity of genes, species and ecosystems continues to decline, as the pressures on biodiversity remain constant or increase in intensity mainly, as a result of human actions. Therefore, the COP10, which convened in Japan in October 2010, has adopted Strategic Plan for Biodiversity 2011-2020, with specific targets known as Aichi Targets. The purpose of the Strategic Plan for Biodiversity 2011-2020 is to promote effective implementation of the Convention through a strategic approach, comprising a shared vision, a mission, and strategic goals and targets known as “the Aichi Biodiversity Targets”. The COP10 urged Parties and other Governments, with the support of intergovernmental and other organizations, as appropriate, to implement the Strategic Plan for Biodiversity 2011-2020 and in particular to "develop national and regional targets, using the Strategic Plan and its Aichi Targets, as a flexible framework, in accordance with national priorities and capacities and taking into account both the global targets and the status and trends of biological diversity in the country, and the resources provided through the strategy for resource mobilization, with a view to contributing to collective global efforts to reach the global targets, and report thereon to the Conference of the Parties at its eleventh meeting".

As a result of this project, the present document includes an updated NBSAP for the coming period up to 2020 as framework, based on the national priorities and capacities and taking into account the global targets included in the Strategic Plan of Action 2011-2020. The development of this document has been preceded by a number of processes that tackled three important elements; stocktaking of biodiversity and related aspects in the country and setting of national targets, impacts of climate change on the biodiversity and economic valuation of ecosystems and biodiversity. This updated NBSAP has, therefore, been developed in light of the findings of these three preceding processes.

Chapter 2

2. State of Biodiversity

In this chapter the state of biodiversity in Sudan is reviewed and updated. Its value and contribution to the national socio-economic development is highlighted. In addition to the known components of biodiversity, this chapter includes an evaluation of the state of emerging problem of Invasive Alien Species and the modern trends and techniques of biotechnology that are expected to contribute positively or negatively to the state of biodiversity in the country.

2.1. Plant Agro-Biodiversity

Sudan is considered as part of the centres of origin and / or diversity for some of the cultivated crops such as sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), okra (*Abelmoschus esculentus*), melons (*Cucumis melo*), sesame (*Sesamum indicum*) and dry dates (*Phoenix dactylopera*). It is also a secondary centre of diversity for others such as hot pepper (*Capsicum spp.*) and Roselle (*Hibiscus sabdariffa*). Wild relatives of different crops are also known growing in the country. These include wild relatives for crops such as sorghum, pearl millet, rice, okra, watermelon, melon and sesame. Globally, Sudan is part of the East African Region of crop genetic diversity, which is one of eight global centers of diversity of cultivated plants. Local cultivars from old introduced germplasm for other crops such as maize, faba bean, cowpea and chickpea, are still existing and being utilized by some farmers. A number of crop species might have originated in Sudan, where the wild ancestors and relatives exist. Among those are sorghum, pearl millet, sesame, okra and melons. Cereal crops grown in Sudan include sorghum, pearl millet, wheat, maize, rice, finger millet and barley.

The Sudan's flora includes the three wild sorghums believed to be the progenitors of cultivated sorghum viz *S. aethiopicum*, *S. verticilliflorum*, and *S. arundinaceum*. It is the home of *S. sudanense* (Sudan grass) which attained international importance for forage. At present variability among traditional farmers' varieties is still observable in different regions of the country. Western Sudan is believed to be a part of the West African centre of origin for pearl millet. About 18 wild species of *Pennisetum* are reported in the country. Genetic resources of this crop in Sudan include a variety of landraces/farmers' varieties grown mainly in Darfur and Kordofan regions.

Recent collection missions for maize (*Zea mays*) showed remarkable variation in cob size, and seed colour. Old landraces of wheat (*Triticum aestivum*) in the northern region seems to be completely eroded as not a single wheat accession was collected during a multi-species collection mission carried out in the Northern state in 2005 and only two accessions were collected from the River Nile state in 2008.

Rice (*Oryza sativa*), although grown on a limited scale, it is one of the food crops used in Sudan. It is well known that the wild red seeded rice (*O. punctata*) is found in Darfur region of western Sudan, where it is still collected and consumed by the people.

The grain legumes constitute important food crops in Sudan. Several species are grown in the country including summer-adapted and winter-adapted species. The summer-adapted

species include cowpea, pigeon pea and hyacinth bean. Some other legumes are grown on a very limited scale of which the bambara groundnut is the most important. The main winter-adapted crops include faba bean, field bean, chickpea, lentils, lupin, and pea.

Cowpea (*Vigna unguiculata*) is among the most important summer adapted food grain legumes in Sudan. It is believed to be introduced from West Africa to the western parts of Sudan. This has resulted in a considerable diversity of cowpea types especially in Kordofan region of western Sudan. Other summer-adapted legumes grown in Sudan include pigeon pea (*Cajanus cajan*) and hyacinth bean (*Lablab purperius*) both of which are cultivated depending on old cultivars. Recent collection mission in 2005 to the Northern state resulted in collecting a number of pigeon pea and hyacinth bean accessions from farmers' fields, with the latter showing a remarkable variation in seed colour and size. Bambara groundnut (*Vigna subterranea*) is a minor leguminous crop in western Sudan. It is grown mainly in the northern part of south Kordofan state, the eastern and southern parts of Darfur and Blue Nile states. It is believed to be introduced there by immigrants from West Africa and still grown on limited scale. Cultivars grown are mixtures of several different lines originated from the original early introductions, which are clearly variable in seed size and colour as observed by collection missions to North Kordofan, South Kordofan and Blue Nile states in 2004 and 2005.

Faba bean (*Vicia faba.*) is the major winter-adapted cultivated legume grown in Sudan. It is grown in the Northern and Darfur regions. The Northern region produces 90% of the total country produce from this crop. It is an important food crop in the Sudan especially in the urban areas. The varieties grown by farmers are primarily landraces named after locality of production such as Aliab, Zeidab and Agabat. Faba bean in Darfur is produced mainly on the upper terraces of Jebel Marra and northern parts of the region where the climatic conditions are suitable for production of this crop. Varieties grown there are mainly local cultivars introduced from the Northern region. Variation observed in a recent collection mission from Northern state in 2005 was on seed size and colour. Chickpea is mainly produced in the River Nile state. It is also cultivated on the upper terraces of Jebel Marra Mountain and the northern parts in Darfur region, as well as some areas of Gadarif state in eastern Sudan. Cultivars grown by farmers are landraces known as Beladi. Although a number of improved cultivars were released to farmers, farmers still cultivate their local landraces.

Other winter-adapted legumes include haricot bean (*Phaseolus vulgaris*), and lupin (*Lupinus ulbus*). Old introduced cultivars from these crops are still grown by farmers in Sudan although a number of improved cultivars were released to farmers.

The most important oil crops grown in Sudan are sesame and groundnut. In the recent years the country witnessed expansion in production areas allotted for growing sunflower.

Germplasm collecting efforts exerted so far have resulted in collection of sesame (*Sesamum spp.*) germplasm from areas in eastern, western and central Sudan. The sesame germplasm collected included both cultivated and wild material with different characters especially for seed colour. Groundnut (*Arachis hypogea*) is another important oil crop grown in central, eastern and western regions of Sudan. It is mainly produced for its seed

oil, which is important food oil in Sudan. Farmers' varieties previously grown were of the runner type locally known as “Abu Hibailat”, which is believed to be available at present only in some remote and isolated areas, with a high risk of disappearance. Fortunately, some few accessions were collected from the traditional runner type from South Kordofan state in 2004. Groundnut material collected so far showed a considerable variation in growth habit, seed size and colour.

Several plant species are used in Sudan as fibre producing plants. More than 30 species indigenous to Sudan are used for fibre production. Many of them grow in the wild, and the most widely used is perhaps the Doum palm (*Hyphaene the baica*). The most important fibre crop cultivated in Sudan is cotton (*Gossypium spp.*) and to much lesser extent Kenaf and sisal are worthy of mention. The growing of cotton crop in Sudan dated back to a period before the Christian era.



A number of vegetables are grown in Sudan such as okra, onion, tomato, potato, peppers, eggplant, melons, watermelon, pumpkins, squash, sweet potato, radish, jewsmallow, purselane, rocket and chard.

Okra (*Abelmoschus esculentus*) is the most traditional popular vegetable in Sudan, where both cultivated and wild types of okra are known. Some of the wild types belong to the cultivated species *A. esculentus* and others belong to other species such as *A. ficulneus*. Recent studies on okra collection of genetic resources revealed that the species *A. caillei* (West African okra) is possibly grown in Sudan. Farmers depend almost completely on the use and production of landraces, which in many cases are designated names relevant to the localities where they are usually produced. Recent collection efforts and characterization studies resulted in collection of indigenous okra genetic resources with variable plant and fruit characters.

Tomato (*Lycopersicon esculentum*) is among the most important vegetables in Sudan, where it is used for salad and paste. It is an introduced vegetable, and old introduced

cultivars have been observed to still exist in some parts of the country especially in the Northern, Kordofan and Darfur states.

Peppers (*Capsicum spp.*) that are either hot or sweet are popular in Sudan. They are mainly used as spice or green vegetable in salad. Hot pepper was introduced to Sudan since a long time. Variable local cultivars are well known in the country, and in western Sudan some unique and distinct local cultivars are very famous. A recent study in 2001 has revealed that both species of hot pepper, *C. frutescens* and *C. chinense*, are believed to be grown in Sudan.

Among the most important cucurbits grown in Sudan are melon (*Cucumis melo*) and watermelon (*Citrullus lanatus*). Melons are believed to have originated in eastern Africa including Sudan. Four cultivated types of melons are grown in Sudan; sweet melon (*C. melocantalupensis*), snake melon (*C. meloflexuosus*), a salad melon known locally as (Tibish), and a melon type used for its edible seeds known locally as (Seinat). True wild melons known locally as (Humaid) and belongs to the group *C. meloagrestis* grows in central, northern and western parts of Sudan. Watermelon used for production of seeds is a major crop in western Sudan, where variable landraces of watermelon are grown. Wild relatives of watermelon could also be found in Sudan. One of them is the wild species *C. colocynthis* (bitter apple), which grows extensively in the Northern region. Remarkable variation has been observed in the local genetic resources of watermelon especially in fruit shape and size, pulp colour and taste, and seed size and colour.

Several fruit producing species are grown in Sudan. Some of them are ancient in the country while others were introduced not long time ago. The most well-known fruit producing species in Sudan include date palm, banana, guava, citrus fruit trees and mango.

Date palm (*Phoenix dactylifera*) is believed to be cultivated in the northern Sudan and upper Nubia since 3200 BC. Dry date cultivars might have originated in Southern Egypt and Northern Sudan. Different local and old cultivars and seedling races are known in the country.

Mango (*Mangifera indica*) is believed to be introduced into Sudan from India via Egypt. About 57 cultivars of mango are reported existing in Sudan. Main areas of Mango production extends along the main Nile banks in northern Sudan, and Blue Nile banks in central Sudan.

The most important citrus fruit trees grown in Sudan are sweet orange (*Citrus sinensis*), grapefruit (*Citrus paradise*) and lime (*Citrus aurantifolia*). Such different types of citrus trees are grown in different parts of the country, of which the northern, eastern, western and central regions are the most important. Cultivars of citrus grown are absolutely introduced old varieties.

An old type of cultivars, which is Dwarf Cavendish, is the type of banana used to be produced in Sudan for long time since early twentieth century. However, some new cultivars have been evaluated and released recently to farmers.

In Sudan there are some plants species that exist in wild form and used traditionally for their food, fodder, fiber, oil or medicinal properties, but not yet have been adopted in

large-scale agriculture. They may have the potential to contribute to food security, nutrition, health, income generation and environmental services. These species have been neglected or underutilized due to a variety of reasons. Some are economical and some are cultural. These plants include species such as *Brachiaria obtusiflora*, known locally as "Um chirr", *Cassia obtusiflora* known locally as "kawal", *Echinochloa colona*, locally known as "difra", *Oryza punctata* known as "roz el wadi", and *Sonchus* spp. known locally as "moleita". Some of these species have the potential for more wide spread use, and hence promotion for food security and agricultural diversification. Some indigenous tree species in Sudan are also known to produce edible fruits used by the local inhabitants. More than ten species could be named in this regard such as *Hyphaenethebaica*, *Borassus aethiopicum*, *Ziziphus spina-christi*, *Tamarindus indica*, *Grewia mucronata*, *Balanites aegyptiaca*.

2.2. Forest biodiversity

Sudan's forests are important sources of food, timber, firewood, and habitat. They provide fodder for livestock, marketable non-wood products such as honey, gum Arabic, tubers and roots, wildlife, and medicinal plants. Furthermore, they play a major role for the sustainability of the traditional smallholder agricultural systems and provide protection for a variety of genetic resources of plants, animals and ecosystems.

Based on the Africover assessment, the Forests National Corporation (FNC) estimates that, after secession of South Sudan, forests cover constitutes about 11.6% of the total country area and the annual deforestation is 2.4%.

Sudan forests encompass diverse forestry tree/shrub species. There are some 535 tree species in Sudan 25 of which are exotic. It was stated that there are 184 species of shrubs including 33 exotics. Unique areas of special vegetation species are found in the Red Sea Coast, along River Nile and Mountains.

A survey by the FNC in 2002 revealed that a number of indigenous trees and shrubs are either on the verge of extinction, with the remaining species confined to limited locations, or are seriously threatened. About 241 tree or shrub species showed marked retreat in their distribution and/or regeneration as a result of climatic conditions and/or their intensive removal for fuel, fodder and round wood, or for land clearance for cultivation. A number of ministerial decrees have been issued to ban the cutting of endangered tree species such as *Hyphae nethebaica*, *Balanites aegyptiaca*, *Dalbergia melanoxylon* etc.

The arid and semi-arid areas, especially of western Sudan, are very rich with a large number of indigenous tree species. The area is regarded as hot spot of climate change. In these areas drought, conflicts, desertification, deforestation, shifting cultivation, overgrazing, soil degradation and other practices weakened the eco-system, making it more vulnerable. As a result, several species are endangered and this can have serious impacts on forest biodiversity. List of natural tree species known and their uses is shown in the table below.

Table 2.1: Some important indigenous forest species and their uses

Use	Tree Species
Timber & building materials	<i>Acacia nilotica, Albizia aylemeri, Alanthus excels, Balanites aegyptiaca, Borassus aethiopium, Burkea africana, Cassia siamea, Celtis integrofolia, Cordia africana, Grateva adansonii, Dalbergia sissso, Dalbergia melonoxylon, Daniellia oliveri, Deterium microcarpium, Kigelia Africana</i>
Non-timber species	<i>Acacia nioltica, Adansonia digitata, Balanites aegyptiaca, Borassus aethiopium, Cordia africana, Diospyrus mespiliformis, Grewiatenax, Ficus sycamorus, Hyphaene thebaca, Gardenia lutea, Tamarindus indica, Prosopis africana, Sclerocarya birrea, Terminalia brownie, Moringa oleifera, Ximmenia American</i>
Medicinal uses	<i>Salvadora persica, Acacia polyacantha, Adansonia digitata, Cissus quadrangularis, Cordia inensis, Crateva adansonii, Cymbogogon citrates, Tamarindus indica, Stereospermum kunthianum, Albizia anthelemintica, Faedharbia albida,, Fagonia cretica, Grewia villosa, Hydнора abssica, Psidium guajava, Sterculia setigera</i>
Fodder	<i>Balanites aegyptiaca, Ficus sycamorus, Ziziphus spina-christi, Faedherbia albida, Acacia Senegal, Acacia mellifera, Stereospermum kunthianum, Comertum aculetum, Maerua crassifolia, Cadaba grandulosa, Buhinia rufcens</i>
Bee Fodder and beehives	<i>Acacia seyal, Acacia seiberana, Dalbergia melonoxylon, Anogeissus leiocarpus, Adenium hongum, Lanea fruticosa, Combertum glutinosum, Boswellia papyrifera, Sterculia setigera, Acacia polyacantha, Sclerocaria birrea, Khaya senegalensis, Albizia amara, Tamarindus indica, Adansonia digitat, Pilostigma spp</i>

Source: Bashir A. El Tahir et al., 2001, USAID-Sudan (ISP), 2012.

2.3. Status of range plants and livestock biodiversity

2.3.1. Range plants biodiversity

The forestry and rangelands of Sudan support about 105.4 million heads of cattle, sheep, goats, and camels mostly under pastoral and small agro-pastoral systems in the traditional rain-lands, and a wide range of wildlife species.

Major portion of rangelands encompasses different ecological zones extending from desert and semi-desert in the north to low and high rainfall savannah to the south border. However nearly 80% of all rangelands are located in semi-desert and low rainfall savannah ecological zones that characterized by variable and unpredictable rainfall. The rangelands of importance to traditional livestock raising are confined to the semi-desert, low rainfall savannah, and the northern fringes of the high rainfall areas. In the semi-desert the plant cover is a mixture of grasses and herbaceous plants intermingled with *Acacia* trees and shrubs representing the main grazing areas for camel and sheep. Two areas of pure grassland form a distinct feature of this rangeland type; namely, the Butana plains (grassland on clay) and Baja area (grassland on sand). The Low rainfall savannah

on clay and sand have a plant cover of a mixture of *Acacia spp*, shrubs and a number of herbaceous plants.

The gizzu vegetation is an example of unique range plants. It is a group of plants, which grow in desert areas after the scarce rainfall which rarely, falls in the desert. The nomads seek the gizzu as highly desirable nutritious winter grazing. The gizzu disappeared from the desert areas during the drought periods for more than 20 years. However, during the last few years, the gizzu appeared in vast areas of the desert in Darfur.

Recently taxonomists reported that *Dactyloctenium aegyptium* (Abu Assabi) had shown some changes in its morphological features such as number of fingers (three fingers instead of five). The rangelands ecosystem contain a number of herbaceous and woody plants most of which are of value to pastoralists .Many of the natural range plants are of great value to rural inhabitants especially during periods of food scarcity. Table 2.2 illustrates grazing plant species and their uses other than grazing value.

Table 2.2: Grazing plant species and their uses other than grazing value

Grasses	D	A	S	R	Uses
<i>Cymbopogon proximus</i>		*			Aromatic, Medicinal.
<i>Echinochloa colona</i>			*		Food.
<i>Ceratotheca sesamoides</i>		*			Food.
<i>Citrullus colosynthis</i>		*			Invading – medicinal.
<i>Cyperus rotundus</i>		*			Livestock Feed, Smoke.
<i>Hibiscus spp</i>		*			Feed, Food.
<i>Ocimum americanum</i>			*		Invading, aromatic.
<i>Ctenium somalense</i>					Hand crafts.
<i>C .proximus</i>		*			Aromatic, Medicinal.
<i>Echinochloa colonum</i>		*			Food.
<i>Lasiurus hirsutus</i>		*			Sand stabilizer.
<i>Oryza barthii</i>		*			Food.
<i>Oryza punctata</i>		*			Food.
<i>Oxytenanthera abyssinica</i>			*		Sticks, Building material.
<i>Panicum turgidum</i>		*			Sand stabilizer.
<i>Pennisetum pedicellatum</i>		*			Building material.
<i>Sorghum ethiopianum</i>			*		Building material.
Herbs					
<i>Cassia obtusiflora(kawal)</i>					used as traditional food flavoretc
<i>Cerotocheca sesamoides</i>		*			Food.
<i>Colocynthis cirtullus</i>		*			Invading, Medicinal.
<i>Colocynthis vulgaris</i>		*			Food.
<i>Commicarpus africanus</i>		*			Food.
<i>Cyperus conglonieratus</i>		*			Smoke.
<i>Datura innoxia</i>		*			Medicinal
<i>Ocimum americanum</i>		*			Aromatic.

<i>Portulaca oleraceae</i>		*			Food.
<i>Sonchus oleraceus (moleita)</i>					used as fresh salad

Source RPGD (2013): working paper on: on Role of Natural Forage Plants Diversity in Pastoral and Agro-pastoral communities Livelihoods

Loss of diversity of these range plants is being experienced at an alarming rate; no specified data is available on estimates of the proportion of number of range plants endangered per specific ecological zone. however there are thirteen (13) valuable herbaceous plant species were reported as decreases in Semi Desert and Low Rainfall Savannah ecological zones include: *Blepharis linariifolia*, *Chrosophora brochidiana* (Argassy), *B. edulis (siha)*, *Aristida palmosa*, *A.paposa* Byad, *A.mutablis*, *A.mutablis*, *Panicum turgidum*, *Cenchrus Species*, *Eragrostis temula*, *Andropogon gyanus* (Abu rakhees), *Schenfoldia gracilis* and. *Ischaemumis haemoidis*, *Dismodium dichotomum*. Four (4) forage range plants species threatened where they are much localized (around wadies).

RPGD (2013) reported that in the Semi Desert Grassland on clay during 12 years period (2000-2013) there are six range plant species were not encountered in many areas in Butana. Four forage range plants species threatened where they are very localized (around wadies), the area is invaded by four (4) unpalatable plants species. Also RPGD reported that in the Low Rainfall woodland savannah on sand (West Kordofan) during 20 years period (1992-2013) there was a change in the plant species composition where five (5) grass species were not encountered (dry season) and one decreased, sixteen (16) of the herbs were not encountered while one increased and another decreased, six of the fodder trees and shrubs decreased and two increased.

2.3.2. Livestock diversity

Sudan is endowed with large and diverse of domesticated livestock species, There are different types and breeds of livestock, the majority of which is raised by tribal groups. These include cattle, sheep, goats and camels. Other domesticated local types of animals include horses, donkeys, pigs and poultry. Livestock population is estimated as 43.1 million of Sudan Tropical Livestock Unit (TLU)) in (2013), distributed all over the country were camels in the north, small ruminants extend all through the country cattle in the middle to south per capita increased southwards.

2.3.2.1. Cattle

Cattle of the Sudan are descendants of the *Bos indicus* (Zebu). These are well adapted to the tropical environment because of their high degree of heat tolerance, partial resistance to tick and many tick-borne diseases and other diseases, as well as their low nutritional requirements, because of their small size, low metabolic rate and possibly more efficient digestion at low feeding levels. The productivity of milk is generally low. They are late maturing both physiologically and sexually. Cattle in the Sudan are generally classified into the following:

- i. Zebu that includes two main types in central and western Sudan. Those are the Kenana and the Butana of the central Sudan and the Baggara of the western Sudan. Baggara cattle found in Greater Kordofan and Greater Darfur alone form over 41% of cattle population in Sudan. The rest consists of a number of types including Kenana, Butana, white Nile, a mixture of Baggara with other types, Nuba cattle, Foga cattle and Airshai.(of The Kenana, Butana and Baggara cattle represent 15.3, 8.7 and 22.6% of the total cattle population of the country, respectively). Both the Kenana and the Butana are considered dairy breeds because of their high potential of milk production, while Baggara type is used for meat production for local consumption as well as for export.
- ii. The Kenana type is mainly found on the western bank of the Blue Nile area extending from Sinnar to Upper Nile and between the Blue Nile and the White Nile. They are steel-grey in color. The Butana type is reddish in color, resembles the Kenana in size and productivity, and dwells mainly in the Butana plateau in a triangle of River Atbara, Blue Nile and the River Nile. The Baggara cattle are considered small sized animals of various coat colors. They are found mainly in the western region of the country.

Other types of northern Sudan Zebu cattle include Ayrashai (of eastern Sudan), White Nile cattle, Fuga or Dar El Reeh cattle of the North Kordofan, and the Nuba Mountain cattle. Cross-bred cattle are also found namely Friesian crossed with Kenana or Butana.



2.3.2.2. Sheep

The sheep of the Sudan belongs to what is called the Sudan Desert Sheep. It is a large animal with excellent meat and carcass characteristics. It is an export animal and live-weights of 65-77 kg can be achieved. A number of ecotypes and tribal types exist. The Kababish, Meidob, Hammar, Bija, Dubasi, Asghar, Wateesh are known in the northern, western and central Sudan. Garaj types of sheep are found in the states bordering the Republic of South Sudan and have genetic material from Nilotic sheep.

2.3.2.3. Goats

There are a number of goat breeds in Sudan including;

- i. The Black Nubian Goat is the predominant type existing in the country. It is a milk breed, large relatively long-legged with pendulous ears. It is commonly found in

central Sudan. The Nubian goat represents 50% of the goat population in the country. Weights of up to 40 kg were recorded.

- ii. The Desert goat (17% of the population), with long-legs, dark brown in color, is raised by the nomadic tribes of Baggara and Kababish, in the semi-desert regions.
- iii. The Nilotic goat, with black or white or both colors, is found predominantly south of latitude 12° and represents 30% of the goat population of the country.
- iv. The mountain goats, which have short legs, grey or brown in color, and represent 3% of the goat population.

A number of exotic breeds of goats have been imported into the country. Toggenburg, Anglo-Nubian, Saaneen (temperate breeds) and Damascus (Middle East) are to be mentioned. The Anglo-Nubian is a British cross-breed from the indigenous Nubian goats. Saaneen proved to be an adequate breed. Crosses with selected indigenous Nubian goats produced milk yield as high as 4.5 kg/day.

2.3.2.4. Camels

Two major types of the one-humped camel (*Camelus dromedarius*) exist in the Sudan; the slender riding camels, and the heavy-built pack or baggage camel. The riding camels are slender and include (a) the Anafi (Shukri), found in Kassala state, and (b) the Bishari, owned by the Bija, and Hadandawa, stronger than the Anafi and an excellent race camel, also found in Gedarif and Red Sea states. The pack or baggage type, is a heavier animal and constitutes 90% of the total camel population, and is widely, distributed in the desert and semi-desert regions. This type includes (a) Rashaidi, which is a strong, short-legged animal raised by the Rashaida in the Red Sea and Kassala states, (b) Arab camel makes up the majority of camels raised by Hadandawa, Beni Amir and Amara, and the large sized is raised by Shukria and Bataheen, (c) the Kababish distributed west of the Nile and raised by the Kababish, Hawawir and Kawahla in Kordofan region, and this is the largest in size of the baggage types in the country, and (d) the Gharbawi (western), which is mainly found in Darfur states.

2.3.2.5. Equines

2.3.2.5. 1. Horses

Two groups of horses are recognized in the Sudan:

- a. Arabian type: this is raised specifically in Northern and Southern Darfur states and in Kordofan states. This type has a light brown color, some are white in color
- b. Dongolawi type: found in north and central Sudan and Northern Darfur states. The color varies from brown to dark brown.

Both above types are of medium size. Crossing with exotic breeds of horses (mainly English breeds) is practiced in Khartoum, Nyala and El Fashir and excellent hybrids are now recognized as race horses.

2.3.2.5. 2. Donkeys

Typical pack donkeys, carrying local names such as Mackady, Dongolawi and Darawy, are found almost everywhere in the country. The Dongolawi type is a high, fast animal used for riding.

2.3.2.5. 3.Pigs

Indigenous breeds of pigs are raised by the Maban tribes in the Upper Nile State in restricted areas and in limited numbers. Pigs are also found in small numbers in pockets of the Nuba Mountains.

2.3.2.5. 4.Poultry

The local beladi fowl (*Gallus gallus*) is well adapted in the backyard system everywhere in the country. It is a small bird, supporting families in rural areas with eggs.

2.4. Status of biodiversity of wildlife, marine and inland waters ecosystems

Sudan has a diverse and broad spectrum of ecosystems extending from the terrestrial ecosystems that includes the desert, the semi-desert, mountain, the short and tall grass savannah, to the marine, coastal and inland waters ecosystems. Each is characterized and known to harboring a wide variety of wildlife species. This report has been updated to accommodate the new political map of Sudan and the newly arising issues affecting biodiversity.

2.4.1. Wildlife

The wildlife occurs in protected areas and in fragmented habitats outside protected areas in desert, semi-desert, low rainfall savannah woodland, high rainfall savannah woodland and marine ecosystems. The number of many species has either noticeably declined or disappeared from many of their former habitats. The populations of the red-fronted gazelle, Dama gazelle, Barbary sheep, Nubian ibex and lion have declined to critical levels and the number of endangered species is increasing. Sudd, flooded grassland, mountain vegetation and the equatorial forest have been lost from Sudan's ecosystem after the separation of South Sudan together with their flagship species including the Rhino, Okapi, Chimpanzee, Zebra, the White-eared kob, the Nile lechwe, the Mongala Gazelle, Beisaoryx, the Mountain reedbuck, Guenther's Dikdik, Blue duiker, Lesser Kudu, Bongo, Sitatunga, Grant's Gazelle, the giant forest hog, the Shoebill stork and the Giant Bushbuck.

2.4.1.1. Mammals

Before the separation of South Sudan, there used to be twelve mammalian orders represented in the Sudan in 2011. Further studies are needed after the separation of South Sudan. Big mammals like buffalo, lion, roan antelope and elands are hosted in Dinder and Radom National Parks. The population of some species has declined to critical levels. Three hippos could only be seen south to Alrosseries dam in Blue Nile state. Elephants became rainy seasons' migrants. A herd of 4 to 8 individuals visited Dinder National Parks and a big herd visited Radom National Park. Most species belong to carnivore (cats, canes and foxes). Dorcas gazelle, Red fronted gazelle are found in many localities, while Damma gazelle is believed to be found in Wadi Hawar Park. Dorcas, which was considered the most abundant species, is threatened by habitat fragmentation and poaching. Recent surveys indicated that density of Dorcas ranged between 0.007 and 0.1 km² in areas used to have the largest populations.

The Red Sea hills host the Nubian ibex (*Capra nubiance*) and klipspringer (*Oreo tragus*). Mountains (jebels) of Northern Darfur such as Medob, and Jebel Hassania of the River Nile state and Jebel Elba of the Red Sea state are hosting the Barbary sheep (*Ammotraguslervia*). The greater kudu is still in Jebel Mara and Jeble El Dair and some Nuba mountains. Extant mammals and reptiles formerly or presently reported *in situ* are 71 species of one of which (Tiang) is critically endangered locally, three (Addax, Slender-horned gazelle, Addra Gazelle) are critically endangered globally and four (Soemmerring's gazelle, Lewel Hartebeest, Tora Hartebeest, Scimitar-horned Oryx) are extinct locally. There is also wildlife *ex situ*, mainly Dorcas gazelle, in 22 farms. There are also 51 specieses reptiles

2.4.1.2. Birds

About 927 bird species are known to be found in Sudan. Further studies are needed also. Fresh Wetlands, coastal habitats, lakes created by dams such as Sinnar, Roseries, Khashm el Girba and Marowe, are sites of resident and migratory birds.

Most of the work was done in the central states, particularly Sinnar State, Blue Nile state, Khartoum state as well as the Red Sea state. There is also scattered work in Greater Kordofan, Greater Darfur, the Northern state, the River Nile state, Gedarif state and Kassala state. The work on birds covered most species in Sudan and there is a new record about one species (Capped wheatear) in central Darfur. There are 230 species of Forest Birds of which one (Sao' Tome (Newton's) Fiscal is critically endangered. There are also 129 species of Water birds of which one (Sociable Lapwing) is critically endangered.

Raptors are also well recorded in ecosystems of Sudan as 40 species. They were intensively and extensively surveyed in Sinnar state and the Eastern states, particularly the Red Sea state. Many raptors are endangered such as the Egyptian vulture, white-backed vulture, and the hooded vulture.

2.4.1.3. Reptiles

About 90 Species of reptiles were recorded. Snakes and lizards are the most abounded group, the most famous ones are crocodiles, which are hosted at Lake Nubia and few are found in Dinder National Park pools. African Python is widely distributed and African Spur tortoises are found in Kassala and Red Sea areas. No recent records from North Kordofan and Darfur. Two marine turtles have nesting ground in Mukkawar Island in Dungonab National Park. Many species of Dab and lizards are present. The most famous are Monitor lizard and Eyed dab lizard (*Uromastyx ocellata*).

2.4.1. 4 Others

Other fauna like amphibians, insects and other invertebrates are important and are hosted in protected areas.

2.4.2. Inland waters

The term "Inland Waters" denotes all aquatic systems that are not part of the marine system i.e. seas and oceans. The term embraces different types of water bodies and is not restricted to freshwater bodies only. Within this context inland waters could be classified into two categories running waters "Lotic" or Non-running water "Lentic".

The Nile River System is the main lotic system in Sudan. Its main axis runs for about 1700 km within the borders of Sudan. The system is made of the Blue Nile, the White Nile and the seasonal rivers such as Atbra, Dinder and Rahad. The Nile System in the Sudan is a mosaic of contrasting combinations: long and short; fast and slow; permanent and seasonal; Azrag and Abyed; silty and clear; infested and weed-free and dammed and free flowing. Other non-Nilotic lotic waters also exist and are represented by seasonal water courses (Wadis/Khors) such as Khor Baraka, K. El Gash, K. Abu Habil, Wadi El Mugaddam, W. Kaja, W. Nyla and others.

The biodiversity in inland waters in Sudan is characterized by the following:

i. Limited locations and distribution

With the severance of Southern Sudan, the area of inland waters has shrunk significantly. Vast and ecologically valuable areas such as the “Sudd” are no longer within Sudanese borders. Almost all inland waters are confined to the narrow strip of the Nile River system in Sudan, except a few lakes in western Sudan.

ii. Aquatic macrophytes

Aquatic macrophytes have always been regarded as nuisance, useless organisms and at the best cases, they have always been neglected. This attitude has been reflected in the fact that the aquatic macrophytes of the Sudan have received little scientific attention, almost no attempt to utilize and of course, no policy to conserve.

iii. Taxonomy

The taxonomy of the aquatic fauna and flora is neither accurate nor complete. Not all inland waters have been surveyed.

2.4.3. Coastal and marine ecosystems

The Sudanese coastline of the Red Sea is about 750 km long, including bays and inlets. Typical feature of the coast are costal lagoons and sheltered bays (marsas) that form natural harbours and fish landing places. Several of these lagoons are fringed by mangroves. Sea grass beds are frequently found in the shallow waters of marsas, and in the lagoons, between the coast and the reefs. These features contain a spectacular biological diversity of ecosystems and species that require considerable efforts for conservation.

2.4.3.1. Mangroves

Avicennia marina was the only mangrove species found in the Sudanese coast during a recent survey (PERSGA, 2004). Mangroves are distributed along the Sudanese coast from Mohammed Qol north of Port Sudan to Shabarango-Gafud south of Suakin. Mangrove lagoons and channels are occupied by numerous fish species including many commercially important species. The leaves and shade zones provide additional habitat.

The mangrove fauna includes true residents that spend their entire life cycle in mangroves (e.g. *Aphanius dispar*, *Gerres oyena* and some gobiids), closely associated species that are found there as juveniles (e.g. *Acanthopagrus berda*, *Chanos chanos*, *Crenidens crenidens*, *Hypoatherina temminckii*, *Leiognathus equulus*, *Terapon jarbua*, *Pomadasys commersonni* and some mugilid species), and loosely associated species that are occasional visitors seeking food or shelter (e.g. *Silago sihama*, *Thryx sabaelama*)

(PERSGA/GEF 2004b). In addition to marine organisms, mangroves are used as a food source by terrestrial vertebrates and as a roosting and nesting site by many species of birds.



2.4.3.2. Corals and coral communities

The Sudanese coast is characterized by the extreme diversity of its reefs compared to the rest of the Red Sea. The primary coral reef habitats are barrier reefs, fringing reefs, isolated patch reefs, and one oceanic atoll (Sanganeb).

The assessment of the condition of Sudan's coral reefs showed that average live coral cover on reefs in less than 10 m depth ranged from 5–75%. Healthy colonies of framework corals were observed below 10 m. Algal film was the dominant substrate cover in water less than 10 m deep and was attributed to a thermal event. Live coral cover ranged from 5–60%, with dead coral cover higher than 1% noted at only five sites (Nasr and Al-Sheikh, 2000; PERSGA/GEF 2003b).

Assessment of coral reefs in the Dugonab Bay and Mukawwar Island MPA showed major differences in the health of coral communities between parts of the MPA. The coverage of living coral was generally greatest within Dugonab Bay (PERSGA, 2006). Dugonab Bay is the home for the pearl oyster (*Pinctadamargaritifera*).

2.4.3.3. Sea-grass

Although sea-grass beds are widely distributed in sheltered shallow water and bays of the Sudanese Red Sea coast, only Dugonab Bay and Mukkawar Island MPA was extensively surveyed. The survey showed that it included at least seven species of sea grasses (*Thalassia* sp., *Thalassodendron* sp., *Halophilastipulacea*, *H. ovalis*, *Halodule uninervis*, *Cymodocea* sp. and *Enhalus* sp.). The total area of sea-grass estimated from Landsat 7ETM image is 11.68 km². The extensive sea-grass beds are a nationally and regionally important feature of the Dugonab Bay–Mukawwar Island area, particularly given the probably substantial population of globally endangered dugong found here (PERSGA/GEF, 2004).

2.4.3.5. Fishes and elasmobranches

The Dungonab Bay and Mukawwar Island MPA is significant for the conservation of fish diversity in Sudan. Major differences exist between the inside and outside of Dungonab Bay in the communities of butterfly fish (family *Chaetodontidae*) and angelfish (family *Pomacanthidae*)

Communities inside Dungonab Bay closely resemble communities from the southern Red Sea, while communities outside the Bay are similar to communities from the north-central Red Sea. The basis of this pronounced difference in community structure is likely to be differences in water quality, temperature, and turbidity (PERSGA, 2006). Additionally, the Dungonab Bay–Mukawwar Island MPA is also well known for its aggregations of whale sharks (*Rhyncodontypus*) and manta rays (*Manta birostris*) during summer (PERSGA/GEF 2004f).

Groupers were more abundant in Sudan in comparison to other sites in the Red Sea, with more than 20 groupers recorded in over half of 20-minute timed swims (PERSGA/ GEF 2003b). Parrotfish (family *Scaridae*) are important consumers of algae on coral reefs and contribute to coral dynamics and habitat formation (BELLWOOD et al. 2003). Their conservation is, therefore, important for the maintenance of coral reef ecosystems.

Assessment of fishes in Mukawwar Island and Dungonab Bay MPA prior to the MPA declaration in 2005 (PERSGA/GEF 2004f) showed that large groupers (family *Serranidae*) were rare and Nagil (*Plectropomus spp.*) over 30 cm in length were rarely observed, suggesting a high fishing pressure on these species.

Regionally important populations of sharks are known to occupy the waters off the coast of Sudan, and are a very important attraction for the marine tourism trade. Hammerhead sharks are known to occur around Sanganeb Atoll and around many of the reefs of Dungonab Park in winter, but very few were observed during the recent survey.

2.4.3.6. Marine turtles

The eastern shore of Mukawwar Island is a turtle nesting site of regional and possibly international significance. There is no deliberate capture of turtles within the MPA (PERSGA/GEF 2004f).

Green turtles nest all year at the following key nesting sites: Seil Ada Kebir Island, Suakin Archipelago and Mukawwar Island. Hawksbill turtles, on the other hand, nest during March- July at the following key nesting sites: Mukawwar Island, Seil Ada Kebir and Suakin Archipelago. Key foraging sites for Hawksbill include all fringing and barrier reefs.

All species of marine turtle are globally endangered and are CITES- listed. The eastern shore of Mukkawar Island is one of the two or three most important turtle nesting sites in the entire Red Sea region. This important site merits immediate protection, and the application of a rigorous monitoring program.

2.4.3. 7 Marine mammals

Three species of marine mammals (cetaceans) are present in the Sudanese waters including the Spinner dolphin (*Stenellalon girostris*), the common dolphin (*Delphinus delphis*) and the Bottle-nosed Dolphin (*Tursiops truncates*). It appears to show that the

cetacean population of the Sudan seems to be strong and is not under much pressure at the moment. The Bottle-nosed Dolphins appear to be breeding well and seems to cope being around the many vessels along the coast.

Like the shark species the cetacea are apex predators in the park and as such will be an indicator of the state of the health of the park, so their needs will need to be considered in the long term planning of the park.

Dugong occurs in the Mukawwar Island and Dungonab Bay MPA. The population there may be the most important remaining on the coast of Africa. However, numbers have declined sharply in recent years. The cause is most likely accidental capture in fixed fishing nets. Two species of dolphin occur in the MPA (PERSGA/GEF 2004f).

2.4.3. 8.Seabirds

The whole area of Dungonab Bay and Mukawwar Island MPA is internationally recognized as an Important Bird Area (IBA). Breeding seabird species include: *Sterna bengalensis*, *Sterna repressa*, *Sterna anaethetus*, *Larushemprichii* and *Larusheucophthalmus* (PERSGA, 2006).

Suakin Archipelago, which is an unprotected area, is also an important bird area including the following breeding seabird species: *Sterna bergii*, *Sterna bengalensis*, *Sterna repressa*, *Sterna anaethetus*, *Anousstolidus*, *Sula leucoaster* and *Larushemprichii* (PERSGA, 2006).

2.4.3. 9.Marine plankton

Very few studies have been carried out on plankton in the Sudanese Red Sea although currently some post graduate studies are being carried out. Previous investigations included studies in planktonic populations in Port Sudan coastal area (EL Hag *et.al.*, 1989) and studies in coastal plankton fauna of the Sudanese Red Sea (Nasr, 1980).

2.4.4. Bees

Morphological studies on populations of native honey bees in Sudan showed more than one subspecies. El-Sarraget *al.* (1992) mentioned two subspecies of honeybees in Sudan. The first, *Apis mellifera sudanensis* Nov sub sp, a small honeybee distributed all over Sudan between latitudes 3°N and 16 20°N. The other *Apis mellifera nubica* Ruttner, exists along the borders of Ethiopia and Uganda. The morphometric studies carried to differentiate honey bee populations showed more than one subspecies. It has been estimated that there are about 200,000 honey bee hives in Sudan, and 50,000 beekeepers. About 99% of them are traditional beekeepers and 1% using modern beekeeping technology (El-Sarrag *etal.*, 1988).

The protein structure, physicochemical properties and mineral composition of *Apis mellifera* honey of different floral origin, commercialized in several states of Sudan were studied (Mohammed and Babiker, 2009). Recent study provided information related to geographical and botanical origin of honey based on honey protein (Mohammed and Azim, 2012). Honey samples from five floral sources: *Ziziphus sp.*, *Helianthus annuus*, *Acacia nilotica*, *Acacia seyal*, and *Azadarichtha indica* were studied. *Ziziphus sp.*, *Helianthus annuus*, *Acacia seyal* and *Azadarichtha indica* honeys were 100% correctly

classified, and *Acacia nilotica* honey was 66.67% correctly classified (Mohammed and Babiker, 2010).

There is an urgent need for more studies and information to assist in developing policies for conservation of the native honeybees in Sudan.

Chapter 3

3. Issues related to biodiversity

There are some issues related to biodiversity conservation, sustainable use and management, which are addressed in this chapter. They include modern biotechnology, biosafety, invasive alien species, climate change and economic valuation of ecosystems and biodiversity.

3.1. Biotechnology aspects related to conservation and use of biodiversity

Biotechnology is a set of techniques that utilize biological systems or their derivatives to create, improve or modify living organisms for specific use. It could contribute to conservation and sustainable use of biodiversity. Advances in modern biotechnology could lead to crop and livestock improvement through genetic engineering. However, genetically modified organisms could result in some environmental, safety and health risks as well as loss in biodiversity. The risks associated with modern biotechnology should be prevented or at least minimized through corresponding development and implementation of adequate framework for biosafety.

3.1.1. Agricultural biotechnology

In Sudan, there are several biotechnology laboratories supporting agricultural research and working towards solving problems facing priority crops including through enhancing the conservation and use of agro-biodiversity. Mainly, the Agricultural Research Corporation (ARC) and research institutions such as the National Center for Research (NCR) are the leading institutions in the biotechnology research. The Commission for Biotechnology and Genetic Engineering, which is one of the institutions of the NCR, is the focal point in Sudan for the International Center for Genetic Engineering and Biotechnology (ICGEB) in Trieste, Italy. The number of laboratories dealing with biotechnology research is increasing; most of them belong to research institutions or academia.

In Sudan, several Bio-techniques have been adopted to improve and preserve plants and crops. Most existing techniques are plant cell and tissue culture and DNA molecular makers.

3.1.1.1. Plant Cell and tissue culture

This is the aseptic culture of plant protoplasts, cells, tissues or organs under conditions which lead to cell multiplication or regeneration of organs or whole plants. Tissue culture proved to be very successful in Sudan. It can also be used for conservation and storage of genetic resources for crops with special importance or those threatened by distinction.

The major programs in Sudan on plant tissue culture can be summarized in the following:

- i. Improvement of economic crops such as tomato, potatoes, elite Sudanese wheat, elite Sudanese sorghum landraces, elite Sudanese sesame genotypes, banana and ginger using callus production and regeneration technology.
- ii. Production of valuable secondary metabolites through callus or root suspension culture in species such as *Vernonia amygdalina*, *Moringa oleifera*, *Proboscidea parviflora*, *Azadirachta indica*, *Striga hermonthica* and *Solanum dubium*.

- iii. Micropropagation of important economic and endangered plants in Sudan such as grape vine, cotton, tomato, sesame pineapple, , strawberry , banana, "mukheit" (*Boscia senegalensis*), abanous(ebony) tree (*Cyperus esculentus*), gum tree "hashab" (*Acacia senegal*), ginger, rose, date palm , *Salvadora persica*, bamboos.
- iv. Production of virus free citrus plants (sweet orange and grapefruit) by the use of shoot tip grafting for virus elimination.
- v. In vitro mutation breeding through which a banana variety named Albeely was officially released in 2004.
- vi. Production of double haploids through which two doubled haploid wheat varieties were released in 2004.

Potato Seed production is being initiated at Shambat Research Station of the Agricultural Research Corporation with the aim to establish national seed system. Potato germplasm was obtained from the International Potato Center (CIP).

3.1.1.2. DNA Molecular Markers

DNA-based techniques have been used successfully in marker assisted breeding, diagnostics, and in assessment of genetic diversity of several crop species and wild types. Work on assessment of functional diversity among crop landraces and improved cultivars is ongoing in order to select the genotypes that show high tolerance to both a biotic and biotic stresses. The common DNA marker techniques used are DNA sequencing, Random Amplified Fragment Length Polymorphism (RAPD), PCR-RFLP, Inter-Simple Sequence Repeats (ISSR), and microsatellites (SSRs). The use of chloroplast DNA (cpDNA) in diversity analysis started recently in the Commission for Biotechnology and Genetic Engineering, NCR. Each of these techniques has its characteristics, genome coverage, discrimination, speed, cost, reproducibility and scoring.

Marker Assisted Selection (MAS) has been efficiently used for desired characters such as tolerance to biotic and a biotic stresses, including the following:

- i. Released *Striga* resistant sorghum (*Sorghum bicolor* L.) lines recently in 2012.
- ii. Development of sesame lines that are resistant to bacterial wilt, which is an ongoing research.
- iii. Development of white-seeded sesame lines, a character which is highly desired in industry and hence have very high prices compared to colored sesame seeds, which is an ongoing research.
- iv. Selection for drought tolerant sorghum through crossing of elite lines with cultivars possessing Stay green QTLs which is an on-going research.

The Agricultural Research Corporation had several collaboration projects with regional and international institutions and organizations in the period 2003-2009. The projects implemented the MAS for the production of stress tolerant crops. The obtained data can be used in the national breeding programs.

A number of activities have also been conducted in order to assess the genetic diversity through molecular characterization among genetic resources of different crops in Sudan such as sorghum (*Sorghum bicolor*), and sesame (*Sesamum indicum*), pearl millet (*Pennisetum glaucum*), rice (*Oryza sativa* L.), onion, wheat (*Triticum aestivum* L.), watermelon (*Citrullus spp.*, banana (*Musa pp.*).

Additionally, some of the natural populations of plants of both terrestrial and wetlands that are enriching the biodiversity of the country and have economic and environmental importance are investigated for their genetic diversity using the above mentioned techniques. Some of the species studied are classified as neglected, vulnerable or endangered such as *Sclercarya birrea*, *Combretum hartmannianum*, *Terminalia laxiflora*, *Salix murielli*, *Salix subserrata*, *Acacia senegal* and *Khaya senegalensis*.

3.1.2. Microbial industrial biotechnology

Sudan is known for its microbial wealth, and the scientific research in this field is focusing on enhancing the use of the microbes from Sudanese sources. Recently, most of the research dealing with microbial diversity and identification considers applying molecular DNA markers techniques for more confirmation besides the classical classification.

Research on yeast strains isolated from Sudanese sources as from local fermented food and beverages is intended to solve economic and nutritional problems. The production of biofuel using several yeast strains isolated from Sudanese genetic resources proved to produce ethanol from both molasses, which is a sugarcane by-product, and sweet sorghum substrate. Yeast isolated from traditional fermented food and beverages proved to be very efficient as bakery yeast according to the commercial standards, with the advantage of tolerating high temperatures more than the yeast introduced from other countries. Some of the identified yeasts strains are under the process for registration as patent of the Commission for Biotechnology and Genetic Engineering and NCR of Sudan.

There is exploitation of microorganisms as bioreactors for the production of citric acid, xanthan gum, alginate, amylase enzyme, bioactive compounds and others. Production of industrial enzyme, antibacterial and antifungal materials from soils also carried in some laboratories. Identification of microorganisms that can produce enzymes that are environmental friendly which can substitute the use of chemicals for safe dehairing of leather is on-going research. This work can help in solving serious health and environmental pollution problems caused by the tanneries in Sudan.

Molecular epidemiology of *Salmonella* in Sudan, and molecular detection and sequence-based phylogenetic analysis of cucurbit viruses are also on-going research.

Work on *Rhizobium* biotechnology in Sudan started in 1960 in some universities and research centers by using broth cultures in some pot experiments. The excellent results of those experiments encouraged the research on the local materials to be used as bacterial carriers. Nile silt with the addition of some organic and inorganic substances and other carriers such as charcoal were also examined. A biological nitrogen fixation (BNF) laboratory for bacterial inoculums production was constructed in 1992 in the Environment and Natural Resources Research Institute (ENRRI) of the NCR with the financial support of UNEP. Via thorough research and experimentation, *Rhizobium* inoculums production was realized in the Biofertilization Department of ENRRI production unit absolutely. Now it approached the commercial level and knowledge and use of *Rhizobium* biofertilizer are now spread among farmers and agricultural companies throughout the country. The institute has been awarded the republican presidential prize – first grade, as a reward for this achievement. The product is now registered and protected by the Intellectual Property authorities.

Researchers in Sudan University of Science and Technology (College of Agricultural Studies) Isolated *Rhizobium* strains from groundnut rhizosphere as symbiotic nitrogen fixers from two locations in Sudan ; Western Sudan (Obeid and Kadugli), Central Sudan (Wad Medani, and Rahad). The isolates were tested for infectivity and efficiency in fixing nitrogen with two cultivars of groundnut; Ashford and Barberton. The indigenous strains were highly infective and occupied more than 90% of the tested nodules when compared with the introduced strains from Hawaii (TAL 309, they have isolated three *Thiobacillus spp.* strains from Shambat soils which were tested under laboratory conditions for efficiency in oxidizing sulfur for future use in reclamation of salt affected soils, isolated *Azotobacter spp.* as associative nitrogen fixers in the rhizosphere of non-legumes from Shambat soils, and isolated Mycorrhiza from the rhizosphere of 3 crops of economic importance in Sudan; date palm, alfalfa, and sugar cane. The isolates were further tested under greenhouse and field conditions with corn and sorghum and groundnuts.

Bio fertilization Department carries research on the use of non-symbiotic nitrogen fixing, phosphate and potassium solubilizing bacteria as well. Many strains proved good potential for increasing yield and improving quality. Many local materials have been tested as bacterial carriers in order to produce good quality inoculants. This work is still at the experimentation level.

Sudan also initiated research on the domain of bioremediation since toxic substances interfere with the wellbeing and livelihood of soil microbes, hence disturbing elements cycles. Several studies are being carried out to assess the effects of some pesticide and oil contamination on soil microbes and on the other hand to microbial degraders for such xenobiotics. Promising isolates are obtained for the degradation of Amistar, Oxyfluorfen, Thiram, Benomyl and crude oil, and heavy metals. Main Institutions working in this field are the Environment and Natural Resources Research Institute, Commission for Biotechnology and Genetic Engineering, Central Laboratory, Department of Botany in the (University of Khartoum, and some others.

3.1.3. Animal biotechnology

Biotechnology was first applied in vaccine production in 1930. Through vaccination programs vaccines were produced locally for immunization of animal populations against contagious and infectious diseases. Bacterial vaccines such as Anthrax spore vaccine, *haemorrhagic septicaemia* vaccine and black leg vaccine, and viral vaccines such as rabies vaccine, new castle vaccine and PPR vaccine, are produced in the Sudan by the Central Veterinary Research Laboratory, Soba. There is ongoing work to produce additional vaccines against parasitic infections. The production of Rinder pest vaccines was stopped due to eradication program.

Schistosomiasis is an endemic disease in Sudan. Recombinant DNA vaccines are now being produced against viral and parasitic diseases. These studies were conducted at the Faculty of Veterinary Medicine, University of Khartoum, Sudan in collaboration with the Department of Medical Helminthology, Pasteur Institute, France.

The Ministry of Livestock, Fisheries and Rangelands, established the National Artificial Insemination Center in 1976. Subsequently, semen collection, evaluation and insemination

of synchronized cows were made possible locally through importation of good quality semen. Currently, there is an ongoing research for artificial insemination project to improve the genetic makeup and productivity of the Sudanese Nubian goats. The International Atomic Energy Agency (IAEA) funds this project. The embryo transfer (ET) was started in 1983 in bovine. Successful delivery of a full term calf from ET was reported in 1984, Gezira University Farm.

Researcher at the College of agricultural Studies, Sudan University of Science and Technology used DNA marker for estimation of genetic diversity in Sudanese (Autochthonous) cattle, carried phenotypic and genotypic characterization of Fuga cattle of Western Sudan, and phenotypic and genotypic characterization of Kababish, Shanabla and Nialawy camels, and molecular identification of some Sudanese, Qatari and some African camel types and subtypes using microsatellite techniques.

3.1.4 Molecular studies on Bees

Recently, very limited studies analyzed the genetic diversity of honey bee in Sudan using mitochondrial DNA analysis and the microsatellites DNA markers. Managed and wild honey bee populations in Sudan had been studied using SSR and *mt* DNA markers.

3.2. Biosafety arrangements

The enactment of the biosafety National Law (2010) came as a culmination of the main components for the establishment of an effective national system of biosafety in the Sudan in order to properly dealing with operations and activities related to handling and trading in genetically modified organisms (GMOs) and their products. The issuance of this law has been preceded by the preparation and issuance of the national framework for biosafety in 2005, which is a basic document prepared to set out the major policies and principles of biosafety in Sudan including the objectives and regulatory framework and administrative arrangements as well as issues related to risk assessment and management, and to the participation of the public. The preparation and issuance of the national framework and the national law after Sudan acceded to the Cartagena Protocol on Biosafety in the year 2005 are all important steps in the process of the implementation of this Protocol. Thus, these documents are the three main pillars of what could be called a national system of biosafety in Sudan, and must be strictly applied in order to achieve the objectives for which these documents were issued

3.3. Invasive Alien Species (IAS)

The significance of the IAS issue was evoked by Article 8 (h) of the CBD stating the problems of alien species. IAS are considered as a global issue that requires international cooperation and actions. There are several conventions, international and regional agreements, guidelines and codes of conduct to deal with IAS.

The prominent IAS that cause damage across the country ecosystems include, but not limited to, plant crops and animal pests, parasites and disease, undesirable plant species, weeds etc. Such as mesquite (*Prosopis juliflora*), broom rape (*Orobanche crenata*), the date palm white scale (*Parlatoria blanchardii*) and the green pit scale (*Asterolecanium*

phoenicis), fruitflies (*Ceratitis capitata*, *C. cosyra*, *Bactrocera cucurbitae* and *B. Invadens*). etc.

3.3.1. The state of IAS plants

A range of invasive alien plant, insect and animal species exist in Sudan, which have been introduced accidentally or deliberately for various purposes. Some of the alien invasive species include multipurpose trees, which were brought in to provide some benefits such as combating desertification. Unfortunately, the benefits come at the expense of costs often harmful to native species and ecosystems, because some of these invasive species degrade biodiversity by replacing indigenous species and bringing significant habitat transformation and changes in vegetation which in turn increases the cost of biodiversity conservation, these IAS could be summarized in the following:

□ *Prosopis juliflora* (Mesquite)

This is an alien invasive woody species introduced in the Sudan in the thirties of last century from South Africa and Egypt to conserve soils subject to wind erosion in eastern Sudan. Moreover, introductions were made into various places in western and central Sudan. The tree was planted in shelterbelts around farms, irrigated schemes and along the Nile. The seeds are spread by the ruminants in the feces. Dense stands of Mesquite are found in Gash and Tokar Deltas, in the Kareb landscapes areas where it invades it puts an end to all endemic trees and shrubs (Wood and browse species) such as *Acacia tortilis*, *Acacia raddiana* and others Ediris (014). The plant constitutes a threat to agriculture, biodiversity and may lead to deterioration of natural vegetation and pastures and thus jeopardize the livelihood of a large proportion of the population, particularly, where livestock raisers and subsistent farming are the main avenues for income generation.

Control efforts: Manual and mechanical means of eradication were attempted. Eradication programs, using both mechanical and manual methods for uprooting mesquite initiated by the federal ministry of agriculture since 1995 in New Halfa, and Zeidab irrigated schemes with little success. Food for Work, was run by Oxfam to mechanical control in Tokar delta, infested land Mesquite pods were swapped for sorghum to reduce seed bank. However, because of high cost eradication was incomplete and due to poor follow-up, a significant proportion of the cleared area is re-infested.

□ *Eichhornia crassipes* (Water hyacinth)

Box: Invasive Alien Species

They are species whose introduction and/or spread outside their natural ecosystems threaten biological diversity. They occur in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. They are characterized by rapid reproduction and growth, high dispersal ability, phenotypic plasticity, and ability to survive in a wide range of environmental conditions. The IAS are causing three types of damage; damage to ecosystems, damage to human safety and damage to agriculture, forestry and fisheries.

Water hyacinth is a highly invasive species and has a tendency to cover and choke major waterways and lake surfaces, which can have numerous detrimental ecological, biological diversity, fisheries, hydroelectric, transportation, and economic results.

Control efforts : Control of Water hyacinth was first carried out by applying the herbicide (2-4, D) In 1979 biological control of Water hyacinth using two weevil insects *Neochetina eichhorniae* and *Neochetina bruchi*. The adults produce characteristic feeding scars on the leaves and petioles. In the larval stage, the insect tunnels into the petioles and the crown of the plant. This feeding results in biotic stress, reduced flowers and seeds, and less vigorous growth (Abdelmoti, 2012)

❑ ***Jatropha curcas (jatropha)***

The State of Sinnar is planning to use some of the lands within the protected areas of Dinder National Park for growing jatropha (*Jatropha curcas*) for production of biodiesel. This plant has been reported to be an eminent threat to biodiversity of rangeland, agricultural and forests ecosystems. It can become a noxious weed because of its tolerance to harsh conditions. It can easily colonize large areas thus displacing and replacing native species. Transforming natural protected areas into agricultural production system is disastrous to the wildlife biodiversity in the region.

❑ ***Cannabis sativa (hashish)***

South Darfur has been plagued by influx of hashish (*Cannabis sativa*) farmers during the rainy season and all efforts to control that activity has been hampered by the inaccessibility of the roads during the rainy season. Farming does not only disturb the natural balance and exclude other natural vegetation from large areas but also adversely affect wildlife.

❑ ***Acanthospermum hispidum* (Horab hawsa)**

As an alien (toxic) invasive plant was claimed to be brought by Umbararo livestock from west Africa, it invaded Wadi Kaga (Geniena), Wadi Nyala and all livestock watering sources surroundings also spread to North and west Kordofan States, were invaded causing complete smothering and suppression of grasses and other desirable herbs on that rangelands.

Control efforts: 1962 in Gazala Gawazet Animal Production and Range Research Station, as a measure of control and prevention 12 ex-closures (20m.x20m.) Were established to exclude the grazing animals and adequately confine the invasive and the endemic grazing plants. The desirable plants will find the chance to complete their life cycles reaching seed setting state, hence free competition in the absence of selective grazing occurs. Donkeys were found to eat the seeds (biological control).

❑ ***Xanthium brasiliicum (Ramtok)***

It colonizes moist sites along the flood plains of the seasonal water canals in the Butana plain, the Gash and Tokar Deltas and the central clay plain. Where it invades it suppresses the endemic desirable grazing plants. The Young leaves often picked by small ruminants.

It is an undesirable grazing troublesome to small ruminants; the seeds cling to the wool and hair causing injuries and wounds. Its invasion in the range area is not wide

□ ***Forsetia longisiliqua (Dahayan)***

This an annual endemic undesirable herb found in the rangelands of the Semi- desert and the northern fringes of the Low Rainfall Savanna on sand and light clays. It invades overgrazed and dislurbed vegetation forming pure stand. When the herb is dry, the above ground part is moved by wind force as means of dissemination, not forming serious problem. At the end of the dry season the seeds and dry stems provide a bite to small ruminants.

□ ***Sida cordifolia (Nyada)***

Sida cordifolia is an annual herb invading the overgrazed rangelands particularly in the wet seasons grazing areas of the Baggara of Kordofan and Darfur regions on loose and compacted red sands (Nagaa or Hamaraya). Overgrazed and disturbed sacrifice areas of the villages and livestock watering sites are ideal for its invasion and dominance suppressing other plants establishment. Recently it is observed that ruminants concentrate on eating the seeds readily. Settlements inhabitants' use the plant stems as (local building fences) and energy source. In Abuzabed area the seeds are collected and fed to small ruminants kept at the households premises, showing good health.

□ ***Cassia memosoides (Sakarnaba):***

An annual undesirable species (Legume) forming pockets in the sandy soil of the Baggara Repeating Pattern, special area in the Low Rainfall Savanna. Before the flowering it is eaten by the livestock or lightly grazes the tender leaves .At maturity the stems become woody and avoided by animals. The stems are used for local temporary buildings by pastoralists and agro-pastoralists. The species is not causing hazard.

□ ***Leucas urticifolia (Um gulot)***

This is an annual undesirable herbaceous increase in degraded range areas of the Red Sea and the Butana clay plain. During good rainy season the species becomes ephemeral and vanishes before the other desirable species reach maturity stage.

□ ***Ocimum basilicum and Ocimum americanum (Reihanspp.)***

This is an annual undesirable aromatic herb, occurs in pockets in light and heavy clay soils and in moist sites. It does not grow in homogeneous stand of desirable range species.

□ ***Cassia tora (Kawal)***

An annual undesirable woody shrub grows in both sandy and clay soils. It forms pure stands. The leaves when fermented produce a stuff used by humans in the rural areas as an appetizer. It spreads in disturbed areas.

□ ***Calotropis procera (Ushar)***

An invader shrub that densely grows on externally degraded sand soil near settlements in Kordofan as well as distributed light clay soils. Shepherds in Kordofan State cut the shrub and keep it to dry saying that the dry leaves and flowers are well eaten and they control sheep internal parasites.

3.3.2. The State alien invasive parasitic weeds

□ *Orobanche crenata*

Production of faba bean is threatened by the root parasitic weed *Orobanche crenata*. The parasite is a recent introduction into Sudan and was first reported in 2000/2001 on an area of about 2 hectare at Ed Debiba in Merowe governorate in northern Sudan. It was speculated that the parasite seeds were introduced, involuntarily, as contaminants of faba bean seeds from Egypt. The parasite attacks several other legumes including lentil and chickpea. Several surveys indicated that parasite had spread into a stretch of about 160 km along the Nile including El Selaim basin. The infested area in the Northern state was about 9% of the total area (33.6 thousand ha) under faba bean. In the River Nile State the parasite was reported from 99 sites. In both States infestation varied from light to heavy. The parasite was probably introduced in the 1990s when increased urbanization and market demands led to importation of faba bean from neighboring countries. The high quality and high price of some of the introduced varieties enticed farmers to grow them locally. The parasite, unnoticed, multiplied, naturalized and has become a problem. Spread of *Orobanche* species, as is the case with many invasive alien weeds, occurs through dispersal. It is characterized by wide spread, its biology, reproduction, the nature of its association with its host, its debilitating effects, and a series of malpractices are:

1. *Eradication*: Hand-pulled *Orobanche* spikes are piled in the fields, thrown into the river or onto adjoining roads. Fields were normally grazed immediately after harvest and crop residues were used as animal feed. Land is limited, and mono-cropping of faba bean is the predominant practice; individual holdings are small, 0.5-4 ha, farm equipment including tractors and threshers are in short supply and are in common use.
2. *Seed transportation*: faba bean seeds from infested fields are transported over long distances and used for seeding.

Control: Like other root parasitic weeds no single measure provides effective control and an integrated approach comprising preventive, cultural, biological and chemical methods needs to be adopted. Control of the parasites is further compounded by existence of hosts from among wild plant species. Apart from faba bean, chickpea and lentil the parasite is found growing on *Malva parviflora*, a common weed in northern Sudan, and on *Euphorbia* species.

□ *Orobanche ramosa* (haluak)

Is an alien invasive parasitic weed on tomato distributed in Sudan from Wadi Halfa in the Northern State, Dongola, through Khartoum up to Damazin in Blue Nile State with an expected distribution along River Atbara and White Nile.

3.3.3. The State alien invasive insects

With the modernization of agriculture coupled with the rapid movement of global trade during the last decades, new species of insects were accidentally introduced to the country. Unfortunately, most of these insects are potentially harmful species, hence imposing serious threats to agriculture and/or natural resources.

□ *Parlatoria blanchardii* (Scale insect of date palm):

Two species of scale insects were reported on date palm in Sudan (Satti, 2011), the date palm white scale (*Parlatoria blanchardii*) it seemed to be introduced earlier and distributed in all date palm growing areas particularly in the Northern and Kordofan States. *P. blanchardii* was a major pest of date palm in northern and central Sudan during the second half of the 20th century, but currently its importance seems to be declined.

Control: The long history occurrence of the pest in that region seemed to enhance gradual buildup of certain indigenous natural enemies attacking the pest. It appears from observations that predators dominated by the larvae of lacewing *Chrysoperla* species, are among the main bio agents combating the white scales.

□ *Asterolecanium phoenicis* (green pit scale of date palm).

the green pit scale (*A. phoenicis*), though newly introduced, is now surpassing the former species in its population densities and damage inflicted on date palm trees and fruits. This pest is found infesting date palms especially in Asia like Iran and some neighboring countries, but now is distributed in other regions including certain African countries (Libya and Sudan). Within few years following its discovery in Algolid in northern Sudan (1985), the pest was spreading along large stretches to south and north of the original point, causing severe infestation and complete drying of the plant leaflets. More than one million trees were said to be infested, recording very high yield losses. Yield of an individual tree was reduced due to infestation from 40kg to only 15kg in an average.

Control: In an attempt to eradicate the pest during 1990s, quarantine regulations and pruning of infested leaves followed by chemical sprayings were the main control measures adopted. These measures mitigated the damage for a while, but neither succeeded to eradicate the pest nor stopped its progress to new areas. Consequently, the first appearance of the pest in Khartoum State was in 2011. Since *A. phoenicis* is under natural control in its original places, biological control through importation of suitable natural enemies can be attempted (Abbas and El Nasr, 1992; Elhassan, 2007).

□ *Ceratitis capitata* (Fruit fly):

About 950 species of fruit fly in 150 genera were recorded in Africa, most of them are native but some were exotics. However, among species thought to be of African origin are *Ceratitis capitata* and *Ceratitis cosyra*. The former species is one of the old fruit flies in Sudan, detected earlier in mid of the 20th century. This pest was firstly reported from northern Sudan where it shows its dominant abundance till now. Though *C. capitata* was said to be originated in sub-Saharan Africa, it was suspected to be introduced to that area

of the country largely from the Mediterranean region through Egypt, where it ranks among economically most destructive fruit pests.

❑ ***Ceratitis cosyra* (Fruit fly)**

Ceratitis cosyra was recently introduced, showing its dominant prevalence in central (particularly in Sinnar and Blue Nile States) and Kordofan regions as a serious pest of mango fruits (Ahmed, 2001; Ibrahim, 2006).

❑ ***Bactrocera cucurbitae* and *B. invadens* (Fruit fly):**

The genus *Bactrocera* (ca. 500 species) forms a very large group of highly destructive pests, native to Asia and also in Australia and Pacific region. Four invasive species of these (viz., *Bactrocera cucurbitae*, *B. invadens*, *B. latifrons* and *B. zonata*) were accidentally invaded Africa at different periods, and now spreading in a number of countries. Among such pests, two species (*B. cucurbitae* and *B. invadens*) were introduced recently into Sudan. They cause extensive damage to cucurbits and fruit trees, respectively. The extents of damage on cucurbits by *B. cucurbitae* vary between 30- 100% depending on crop species and the season. On the other hand, *B. invadens* is spreading very fast and now almost recorded from all parts of the country in eastern, central, western and northern regions. Evidences reported from some African countries including the Sudan showed that *B. invadens* is largely displacing other fruit fly species like *C. capitata* and *C. cosyra* in infestation of some fruits like mangoes. Thus, in Sinnar area of central Sudan, the prevailing fruit flies which dominated by *B. invadens* were reported to cause 80% damage on mango fruits. Consequently, in the 2007 the problems of fruit flies was aggravated to the extent that these pests were listed among the major national pests receiving considerable attention in control by the Plant Protection Directorate of the Ministry of Agriculture (Ahmed, 2001; Dhillon *et al.*, 2005; Ibrahim, 2006; Gassmallah *et al.*, 2008; Mohamed and Ali, 2008, and De Mayer *et al.*, 2009).

❑ ***Tomato leaf miner* (*Tuta absoluta*):**

It is a devastating insect pest with strong preference for tomatoes. It can also attack the aerial parts of potato, eggplant, pepino (*Solanum muricatum*), tobacco and solanaceous weeds. Its larvae prefer leaves, stems, buds or calyx to tomato fruit. It originates in South America where it is considered a key pest since 1980s. After its detection in Spain in 2006, it spread quickly to other European, North African and Mediterranean countries. It may be a trans boundary pest that spreads rapidly by trade pathways or naturally. It is found all the year round in greenhouses and in locations with mild winters. In Sudan, a severe outbreak of this was reported for the first time on tomato grown in greenhouses at Khartoum state in June 2010 (Mohamed *et al.*, 2012). In surveys conducted in tomato fields at Khartoum and Gezira states during February –May 2011 severe pest infestation were observed. The pest was also reported in the Red Sea and North Kordofan states in tomato grown in both greenhouses and open fields.

The severity of infestation in most of the surveyed fields ranged between 80- 100%. In December 2010, the loss in tomato yield as result of the pest infestation in the greenhouses at Khartoum state was reported to be as high as 76%. The rapid spread of this insect pest

and its high level of infestation have raised the alarm to the potential risk to tomato, eggplant and potato production in Sudan.

3.3.4. IAS Management Issues

Plant Protection Directorate of Ministry of Agriculture and Irrigation is sole Directorate responsible of control both national and local pests including migratory pests. It manages and supervises the plant quarantine stations all over the country, and approves imported chemicals. Together with States protection departments all efforts are integrated to combat plant alien invasive pests and diseases through Plant Quarantine Services and regulations. Other efforts and initiatives were carried out by government's institutions, NOGs and programs in Sudan, to eradicate or control of alien invasive such as mesquite. However, because of high cost and complexity of the problem, most of the efforts were not successful or sustainable. In 1995 the government approved a bill on mesquite management.

Although IAS are found in many parts of the Sudan causing enormous problems in the ecosystems and the economy, very limited studies are available on their impacts and control. ARC research results in that chemical control indicated that the herbicides Triclopyr and Clopyralid applied as aqueous sprays to foliage or in diesel formulations to the stem base displayed excellent activity against the weed.

3.3.5. Policy and legislation on management of IAS:

- ☒ There is no national policy and legislation on the management of IAS in Sudan, although issues of IAS are covered in sectoral policies and legislations.
- ☒ The Plant Quarantine Acts prevents the importation, culturing, distribution and selling of any plant forms without an official permit from the Plant Protection Directorate. The existence of a wider range of IAS in Sudan indicates that enforcement of the Act is weak probably due to weak border control and poor quarantine measures.
- ☒ Information on IAS often scattered and incomplete and does not contribute to decision making regarding actions to be taken.
- ☒ Education and public awareness programs of the risks associated with the introduction of IAS, including mitigation measures, are not in place.
- ☒ In 1996, the government approved a bill on mesquite management. The tree is to be eradicated where it constitutes a threat to agriculture or biodiversity and preserved in areas threatened by desertification.
- ☒ There are a number of obstacles to effective adoption strategy for managing IAS, which we here group into four categories these include:
 - ***The policy environment within which are operating is fragmented and weak.*** Because of the range of pathways through which Invasive alien species (IAS) might enter a country, and the many social, economic and biological impacts they can have, effective IAS management must adopt a broad multi-sectoral approach. No relevant policies, laws and regulations, and the institutional and operational responsibilities for addressing IAS issues are scattered between different ministries, hindering a coordinated approach and often delaying appropriate action.

- ***The critical information required by the different stakeholders is not available.*** Include: inadequate communication between the different parties. A fragmented policy environment actually demands a high degree of communication, between government, the private sector and NGOs working in the field. The necessary information may not exist; where the lists of weeds present do exist, there is increasing relevant information, but due to lack of capacity, it is often not accessible.
- ***The implementation of prevention and control programs is slow or inadequate.*** The capacity and resources to research and develop solutions may be lacking, and environmental problems that are less visible tend to be given lower priority, due to a lack of awareness and appreciation of their gravity. Many invasive species also provide benefits to some stakeholders, and difficulties in evaluating the costs and benefits, and resolving conflicts of interest, can further delay appropriate action.
- ***Capacity is lacking.*** Effective IAS management requires institutional, human and physical resources that are often unavailable. The multi-sectoral nature of the problem means that although some of the necessary capacity may be available, shortage of capacity. In recent decades the capacity to undertake biological control has greatly increased, and while it still needs strengthening, the lack of capacity in other areas means that this important management method is hindered.

3.4. Impact of climate change on biodiversity

Being an African country, Sudan is very vulnerable to climate change, as Africa is one of the most vulnerable regions in the world to climate change mainly due to poverty, lack of access to knowledge and a high dependence on natural resources and rain-fed agriculture.

During the process of updating the NBSAP, a national Climate Change Working Group has been established to undertake a rapid assessment of biodiversity and climate change interface in the Sudan, in line with the guidance of the CBD. The tasks of the working group involved generating climate related information and response options to enable Sudan prepare for managing its biodiversity and ecosystems in a changing climate. The study on biodiversity and climate change aims to develop a better understanding on consequences of the impacts of climate change and the role that the biodiversity and ecosystems play in climate change mitigation and adaptation. However the study recommended development of National Strategic Framework for Climate Change and biodiversity conservation (*Protection, conservation and sustainable management of natural & man made habitats and biological resources*) contribute effectively to climate change mitigation through carbon sequestration, carbon stock conservation and carbon stock enhancement. It also contributes to climate change adaptation through enhancing the biodiversity service and benefits to the livelihoods of dependent communities. With the following objectives:

- Protection, conservation and sustainable management of natural and unique ecosystems such as riverine forests, mountains and marine ecosystems
- Ecological corridors to conserve terrestrial biodiversity
- Valuation of ecosystem services and their contribution in the local and national economy
- Cleaner and renewable energy
- Address Driver of Deforestation
- Enhancement of Investments in A/R and protected areas and ecosystem services
- Control of invasive alien species spreading resulted from land degradation

3.5. Economic valuation of ecosystems and biodiversity

Biological resources provide a wide range of products including food, fuel, shelter, medicines, fibers, construction materials, fodder, forage and pasture, as well as, providing ecosystem services which deliver the essential support for human settlement and economic activity. These services and products provided by the ecosystems are of value, especially, to poor people. Thus, the loss of biodiversity and the degradation of natural resources impact first and foremost the vulnerable viz. poor and women. Hence, the conservation of biological resources and their diversity has a high economic value because it is maintaining the supply of all these goods and services and assures basic and continued support to human economic activities.

The economic benefits associated with biodiversity are high, proving a strong economic justification for biodiversity conservation. Gum belt of North Kordofan State in Sudan was selected to demonstrate the economic valuation of the agro- biodiversity ecosystem. The agro-ecosystem of the belt accommodates around one fifth of the population of the Sudan and two thirds of its livestock population. It also acts as a natural barrier protecting more than 40% of the total area of country from desert encroachment. That ecosystem also provides the site for irrigated, mechanized and traditional rain-fed agriculture, forestry and animal production. The analysis indicated that the agro-biodiversity ecosystem of the gum belt has a very significant economic value, in terms of its contribution to GDP, income and employment. It provides additional services. The results of cost-benefit analysis (CBA) revealed a number of key issues, which were not adequately captured in normal economic-financial evaluation methods used in the country. First, the value of land and water, major triggers of resources for conflict in the area were not estimated and were given zero value. Second, the CBA shows sets of the opportunity cost of forest trees represented by acacia trees per year which disregards its foregone value during its 24 years life-span producing gum Arabic. The agro-biodiversity ecosystem of the belt area supports rich biodiversity resources including dry season grazing land, crop production land, livestock, mammals, game animals, etc. The continued transformation of forest and grazing lands into farmland led to loss of livelihood and biodiversity resources in the agro-biodiversity ecosystem of the belt area and resulted in environmental degradation. Therefore, the economic valuation attempts to capture the true cost estimates of the agro-biodiversity ecosystem resources to come out with sustainable use of the natural resources base among potential alternative uses.

The economics and valuation of ecosystems and biodiversity and integration in the process of development is becoming an important priority. In the current Sudan's National Biodiversity Strategy (NBSAP) economic concern of biodiversity has taken into account through a set of actions. Suggested actions include: training of relevant civil servants and stakeholders in transforming biodiversity components into items of monetary value, encourage universities to incorporate biodiversity economic accounting in their curricula, and taking biological resources as a means for rural development and strategy for poverty alleviation.

Chapter 4

4. Threats and causes of biodiversity loss in Sudan

A number of factors pose pressures and threats on the genetic diversity of different biodiversity components in Sudan including natural and human factors. They could be outlined into threats due to environmental changes or those due to socio-economic factors. Drought spells, rain fluctuations, floods and rise in temperatures are specific environmental factors. Expansion in agricultural, industrial and other production activities have had eroding effect on the genetic diversity of indigenous biota. Unrest conditions and civil strifes in a number of regions have led groups of populations to move from their local areas and consequently resulted in destruction of natural habitats for different flora and fauna in the country. The following are general threats causing loss of different components of biodiversity as a whole, as well as other threats specific to each of these components:

4.1. General Threats

4.1.1. Environmental degradation and Climate extremes

Loss of farmers' varieties and complete failure of crops such as sorghum and pearl millet have resulted as consequences of the drought spells and fluctuations in rains that have been hitting the country since the 1980s. On opposite the country has been witnessing periods of heavy rains and floods at more frequent rates since the 1990s resulting in complete damage and devastation of crops grown on the banks of the Nile and other rivers. A striking example was the destruction of many banana plantations in Kassala state in eastern Sudan due to the over-flooding of the seasonal Gash River in 2003.

The repeated droughts of the 1970s, 1980s and 1990s has also resulted in disappearance of a large number of trees in the country. In rain-fed sector, particularly in western Sudan, the longer-term drop in precipitation has promoted desertification and reduced forest cover and increased the level of deforestation.

The unreliable nature of rainfall, together with its concentration in short growing seasons, heightens the loss of range plants diversity as well. Drought conditions, which result in reduction of available pasture and drinking water, also threat livestock survival. The drought disaster of 1984 is a case in point. The Foja breed of cattle, which was until 1984 an important animal in north Kordofan, has been eliminated from the area. Remnants of the breed now exist in an enclave in western Kordofan, far away from their traditional home.

4.1.2. Socio-political factors

Those factors lead to changes in human activities including those related directly or indirectly to biodiversity. For example, the land tenure system and the consequent land fragmentation have forced farmers in the Northern region to shift to high yielding varieties or to crops with low input cost and high revenues. A good example of such situation is the extensive shift to production of date palm in the Northern region in areas

that used to be cultivated by annual food crops in the past. The migration of inhabitants from rural areas to cities and big towns due to economic factors, and the consequent abandoning of farming and shifting to other jobs, have been negatively affecting the original components agro biodiversity used to be utilized and conserved by these people. The civil war, which continued for more than twenty years in southern Sudan, has negatively affected the diversity of plant crops in that area.

Burning of trees and forests by different groups has resulted directly in removal of tree cover, deforestation and loss of indigenous species. The large numbers of people in displaced camps exploited forest resources at unsustainable levels to satisfy their fuel needs. This put more pressure on the resources and further threatened biodiversity.

Civil Wars have blocked the traditional and well established livestock routes as well as entailed pressure on grazing lands hence affecting animal health and survival.

Poverty is one of the biggest indirect threats to forest biological diversity. The majority of the population in Sudan lives in dry areas, depending entirely on natural resources for their livelihood. This excessive pressure on fragile natural resource has negatively affected resources biodiversity. Due to the lack of income sources and alternative affordable energy sources in the rural areas, the most common and frequently utilized energy and cash sources are fuel wood and charcoal coming from the removal of the preferred native species.

The rangelands are the most vulnerable to climate variability and climate change, this vulnerability further exacerbated by misuse and mismanagement of the land resource resulting in decreased amount of feed produced and exposing pastoralists to conditions of poverty and food insecurity. At the same time the resources users are far from adopting practices that conserve their resources. According to National Adaptation Program of Action (NAPA) in Sudan (2007) the groups that are the most vulnerable to climate risks are traditional rain-fed farmers and pastoralists, and especially affecting pastoral communities' livelihoods. The most vulnerable are the pastoralist and agro-pastoralists of western, central, and eastern Sudan.

4.1.2.1. Expansion in civil construction and economic activities

At present several developmental activities are taking place in the country, which might affect the biodiversity. The investments in agriculture, petroleum industry and mining in different parts of the country have blocked the traditional and well established grazing routes as well as entailed pressure on grazing lands hence affecting animal health. Some tribes have been forced to leave to other parts of the country to find safety. The effect of such distant migration movement is the need to establish another transhumant strategy in the new and alien grazing environment.

Vast areas of rangelands were shifted to several investment activities such as sugar industry in White Nile State, petroleum explorations in Kordofan states, and mining in Butana area and other states. In addition to reduction of land area, spreads of drain waters resulting from these activities and that are highly contaminated may affect plants and causing death to livestock in some cases.

Popular wide scale gold mining is widely spread. Devastating mining practices have led to deforestation and loss of some indigenous species. Traditional miners just look for

gold anywhere. Large camps are scattered in almost all states of Sudan with a major concentration in River Nile and North Kordofan states. Their impact on biodiversity is overlooked. The traditional miners look for gold in *khors* that, literally, are tributaries of river Nile ecosystems. They use simple tools and heavy machines to dig or scrap the soil. It is worth mentioning that the *khors* are the only habitat types that harbour vegetation in the desert and semi-desert ecosystems. In the low and high rainfall savannah, woodland ecosystems watersheds of the *khors* support thick forests. Altogether, these constitute important habitats for diverse species. In addition to habitat destruction, both intensive and extensive poaching is taking place. Numerous birds were reported dead, particularly sand grouse, when they drink the poisoned liquid medium. This will ultimately affect the predator-prey food chain.

Pollution from industrial, agricultural, mining, oil exploration and other urban sources is a threat to the inland waters and the organisms living within near or associated with. Sewage effluents and excessive fertilizers could cause eutrophication leading to disturbance of the natural species balance.

Giant irrigation canals for Rahad and Kenana Agricultural project lie close to the boundary of the Dinder National Park and could, therefore, have negative impacts on the biodiversity within the park.

4.1.2.2. Land cultivation activities and related practices

Expansion of both rain-fed and irrigated farming has occurred at the expense of rangelands and woodlands, giving insufficient consideration to the importance of these genetic resources. The expansion of mechanized agriculture in central Sudan has occurred at the direct expense of natural forests. Large amounts of woodland have been cleared in the development of mechanized rain-fed farming in the eastern, central states, and South Kordofan state. Farmers used to select the outstanding strains of crops within their fields for future cultivation. They tend to do that on the basis of their knowledge on the surrounding environments and crops. Such selection practice results in the dominance of some genotypes at the expense of others. Due to drought, farmers of pearl millet in western Sudan tend to select early maturing varieties rather than the medium and late maturing ones providing a good example for the effect of such practice on the diversity of crops.

Crop yields increased through practicing good husbandry techniques including weed control. However implementation of diversifications and rotation of the crop in the irrigated schemes, and the continued expansion in intensive irrigated and rain-fed agricultural production have been accompanied by serious weed problems. Therefore, weed control is one of the most important practices in the central Sudan, where 29 herbaceous fodder plant species are controlled as weeds.

4.1.2.3. Biotic factors

Pests and diseases that attack crops usually have damaging results on the genetic variability within the crops. They exert selection pressures on such crops leading to extinction of those susceptible strains of cultivated species. In Sudan, as it is everywhere, a number of pests are known to attack crops, in addition to a number of

fungal, bacterial and viral diseases. Quarantine measures are not effective enough to restrict the introduction of new pests and diseases. A number of examples could be cited for damages being caused by destructive pest and disease causal agents leaked into the country due to the weak quarantine measures. Insects and other pests may damage dormant seeds in the soil resulting into declined species diversity in rangelands.

Diseases of potential economic importance to livestock include Rinder pest, *Haemorrhagic septicaemia*, Contagious Bovine *Pleuro-pneumonia*, Black quarter, Anthrax, *Trypanosomiasis*, Foot and Mouth, Tuberculosis, Brucellosis, Helminthiasis, Sheep Pox, Heart Water and internal parasites. The livestock disease problem is complicated by the vast area of the country and the fact that it is bordered by seven countries. Biting insects are common during the wet season in the southern parts of the low rainfall savannah and the high rainfall savannah of southern border along states, forcing pastoralists to move with their herds to drier areas, areas with sandy soils and higher ground where conditions are not conducive to the multiplication of the biting insects, but those acts as epidemic disease carriers.

4.2. Specific Threats

4.2.1. Threats to plant agro-biodiversity

The modern agriculture is specifically threatening the plant agro-biodiversity. It is characterized by the use of advanced improved cultivars in a mono-cropping system of agriculture, which is a phenomenon that takes place in Sudan at present. Many improved high yielding varieties are being released and / or introduced for different crops such as sorghum, pearl millet, sesame, some vegetables and some fruits. This occurs at the expense of indigenous landraces and farmers' varieties as well as old cultivars. Several new varieties have been released by the ARC during the last ten years between 2003 and 2013, which will definitely have adverse effect on the local genetic resources of crops.

4.2.2. Threats to forest biodiversity

Several factors threaten specifically forestry biodiversity in Sudan. They can be summarized into the following:

- Intensification of traditional rain-fed shifting cultivation
- Shifting cultivation and unsustainable cultural practices such as horizontal expansion and reduction of fallow periods is one of the greatest threat facing forests in the dry areas and in traditional rain-fed agriculture. It is one of the main causes of deforestation and loss of forest cover.
- Pastoralist impacts: wildfires and tree browsing: The annual burning practiced by pastoral-groups has a major impact on tree cover. Another issue is the growth of animal population and the use of foliage for camel fodder. Some slow-growing species such as mangrove forests in Red Sea state have been devastated by camel browsing.

4.2.3. Threats to biodiversity in rangelands

Loss of diversity of the range plants is being experienced at an alarming rate. Immense changes occurred within the different vegetation zones compared with the 1958 base line survey (Harrison and Jackson, 1958). Specific factors contributing to these changes include:

- Seasonal wildfire out-breaks: Increased wildfire hazard is associated with low humidity, high fuel loads and the presence of moving grazers. Annual wildfires are common and spread rapidly due to northeast winds and flat terrain. This is the case in central, western and southern Sudan. Repeated fires occur if the hot dry weather continues due to late rains forming a serious threat to rangelands and resulting in the consumption of 10-30% of the standing dry forage in different ecological zones, loss of seeds and erosion of the fire unresisting species. However, fires statistics are lacking except for limited incidents
- Grazing selectivity and over-grazing: Due to the present pattern of rangeland utilization, some highly palatable forage plant species decrease. For example grazing selectivity is among the reasons of threat to *Chrosophora brochidiana*, which livestock prefer its flowers and twigs preventing the plant to complete its life cycle. Conversely unpalatable ones become increasers and dominant. Also livestock mobility (broader grazing) entails

occurrence of invader species. As a result of the continuously growing size of livestock overgrazing has resulted in many parts of the semi-desert and savannah. The reason is over stocking of livestock, distribution of water sources and the amount of available vegetation. Blockage of livestock routes during the wet season results also in overgrazing.

- Seed collection: Methods of the traditional range seeds collections from natural rangelands lead to the soil erosion, land degradation and seed loss as most collectors harvest the whole plants.

4.2.4. Farm animal biodiversity

Diversity in farm animals of Sudan is threatened due to a number of reasons. Some of them are specific to farm animal diversity include:

- Animal movement leading to breed mixing: In the drought year 1984, about 90% of cattle and 50% of sheep in Kordofan region were lost. Drought hit again in 1990 but the losses were far less. The nomads have been able to cope with the adverse effects using the lessons learnt from the previous drought. A new system of management has evolved. Herders simply moved south and as far south as Bahr El Arab on the Northern border of Bahr El Ghazal State of newly born South Sudan country. This movement brought the danger of exposing the zebu northern cattle types to crossing with the southern Sanja southern types. Desert sheep are also under the threat of crossing with the southern types. The mixing of animals also exposes them to diseases.
- Extreme climate events: In the semi-desert of northern Sudan threats faced by livestock are in fact part of the harsh conditions to which the livelihood of the population is subjected. Geographically semi-desert and savannah zones are stretched across Sudan state boundaries from west to east.
- Feed Availability: A high rate of mortality prevails, particularly among young stock; especially during periods of feed deficits when females are subjected to nutritional stress with the result that milk yield becomes low and no longer meets young animal requirements. Some sources estimate that the overall mortality due to diseases and mal-nutrition is as high as 15% of adult and 25% of young stock. Drought periods result in higher rates of mortality (World Bank, 1993).
- Availability of Livestock Water: Livestock water is a limitation during the dry season, particularly in areas underlain by basement complex rocks (non-water bearing rocks) as is the case of Butana, Hamar District, Baja and eastern Darfur. All these areas are important grazing lands where pastoralism is a major economic activity. Most pastoralists utilize these areas as wet season grazing land and move out before the surface water in natural ponds and dugouts is exhausted. In places boreholes have been drilled through cracks in the Basement Complex rocks and they furnish a limited source of water.

4.2.5. Threats to biodiversity of wildlife and protected areas

Numerous specific threats face biodiversity *in situ*, both in protected areas and outside protected areas, caused by unclear wildlife policy and weakness in awareness and education programs. Examples of these threats are the following:

- ❖ Livestock overgrazing, poaching, hunting, shooting and extractive activities. Livestock trespassing can be felt in the Dinder National Park. Most traditional grazing land around the park, which is also wet season habitat for the migratory ungulates, has been depleted.
- ❖ Fragmented wildlife habitats: thereby reducing chances of wildlife survival and genetic diversity. Livestock compete with some wildlife species for food. Events of disease transmission like Rinder pest and Anthrax, from livestock to wildlife, took place many times and the reverse is possible particularly the Avian Flu. Livestock herders cut the branches of the ever-green *Balanites aegyptiaca* to feed their animals towards the end of the dry season when forage become scarce. They, together with honey collectors, burn about 30% of the park area annually. Technological developments like wind mills, power lines and dumping sites of waste products kill large numbers of the migratory soaring birds by electrocution, direct collision and poisoning, respectively. These affect biodiversity in many ways. Diseases and electricity increase wildlife mortality; the felling of *Balanites aegyptiaca* threatens its very existence, which will affect marabou stork that mainly roosts on it; although it could be attractive to some wildlife species like Guinea fowl and larger ungulates, the burning depletes the vegetation cover of the small mammals as well as affecting colonies of honey bees.
- ❖ Poaching is widely spread in protected areas and in other fragmented habitats that still contain pockets of wildlife. The sociable lapwing, which comes from Kazakhstan and spends winter in Sinnar and the White Nile states, is being hunted at its stop-over places in the Middle East. Mesquite, an invasive species, started to increase in the sociable lapwing wintering habitat in Sinnar. Intermittent droughts prevent the bird from attending the wintering sites in Sudan. Because of the increasing popularity of falconry, most falcons are hunted and smuggled. The practice of falconry itself could be a major threat to the critically endangered Arabian Bustard and other game birds. Populations of larger animals and game birds inside parks and outside them are considerably reduced, sometimes reaching the brink of extinction, due to poaching.

The shooting emerges as one of the major threats facing the endangered migratory vultures. Many of these vultures are satellite-tagged in Eurasia in order to determine their migratory routes and the wintering home ranges in Africa. The migratory vultures usually congregate in slaughter houses' dumping sites and sometimes remain in close proximity to livestock herds where they scavenge the dead animals. As firearms are prevalent among livestock herders and some villagers, the vultures with strange objects attached on them are attractive for the shooting. Oftentimes, the shot vultures are ultimately taken to the security for investigation. It is believed that these birds are used for spying. Hence; many satellite-tagged vultures wintering in Sudan are shot in Butana, South Kordofan and Darfur.

4.2.6. Threats to Biodiversity of In-land Waters

The inland natural biota of Sudan is facing many threats specific to them. These could be listed as below:

- Attitude and perception: The aquatic macrophytes of the Sudan have received little scientific attention, almost no attempt to utilize and no policy to conserve. The biota of many inland waters has not been studied, in particular those which are non-Nilotic.
- Legal status: None of the aquatic flora and fauna has a national protection status.
- Overexploitation: This threat is particularly befalling the fish communities through excessive uncontrolled fishing and the use of illegal fishing methods.
- Alien species: Although the only documented case of invading species is that of the alien water hyacinth (*Eichhornia crassipes*) which has outnumbered and almost excluded the native Nile cabbage (*Pistia stratiotes*) in the upper stretches of the White Nile, the phenomenon could not be ignored as it could be repeated with another native organism in a different inland water system.
- Change in water regime: The change from lotic to Lentic waters usually occurs when a dam is built and a reservoir is formed. This could lead to the proliferation of certain species at the expense (causing dwindling or extinction) of other species.

4.2.7. Threats to biodiversity of marine ecosystem

Marine ecosystem is facing a number of threats specific to this system that could be listed as below:

- Unfortunately, many of the threats identified in the State of Marine Environment Report (PERSGA, 2006) still exist namely increases in coastal development and tourism pressure, the threats from roving fishers seeking higher-level predators (such as grouper and sharks) and disrespecting territorial boundaries (e.g. Berkes and others 2006). Insufficient technical and management capacity continues to exist in Sudan.
- There is severe over-fishing for sea cucumbers in the vicinity of Dungonab Bay where sea cucumbers have been fished out from many shallow areas forcing divers to travel further and exploit deeper waters (PERSGA/GEF 2004f). Similarly, the molluscs *Trochus* spp., *Strombus* spp., *Lambis* spp., and *Murex* spp. have been severely fished. Most individuals of these species observed in the wild are small and occur at low densities (PERSGA/GEF 2004f).
- The majority of mangrove stands are affected, at various levels of severity, by camel grazing, felling and limb cutting. Current levels and types of use within the Parks appear, with only a few exceptions, to be causing little damage. The few exceptions include: a declining dugong population due to the use of fixed nets in sea-grass areas and on migration routes; heavy overfishing of some areas and some groups; unsustainable targeting of important breeding aggregations of some fishes in addition to those impacts associated with tourism activities namely anchor damage (African Park Foundation, 2006).

A number of 'natural' impacts were also observed, including the effects of coral bleaching, diseases, sediments, boring sponges, corallivorous snails (*Drupella* sp.), and the Crown-of-Thorns starfish (*Acantha sterplancii*) (African Park Foundation, 2006).

4.2.8. Threats to Bees

Honey bee diversity is under threat due to anthropogenic factors among other factors including the use of pesticides and the replacement of local colonies to recover colony losses. There is also introduction of non-native species. The two non-native honeybees in Sudan are the European (Italian and Carniolan) bees and the Asian bees (*A. florea*). The repeated introduction of the non-native species is a threat to genetic makeup of the native honey bee populations in Sudan. Invasion by non-native species results in introgression through mating in different regions.

Part II: The Strategy and Action Plan

Chapter 5

5. The Strategy

Sudan's National Biodiversity Strategy (NBS) will serve as the guide for conserving biological diversity of the country. The Strategy has taken into account several factors including, the current status of biodiversity in the country, threats to biodiversity and actions needed for ensuring the conservation and sustainable use. NBS contains the vision, mission, guiding principles, and strategic goals followed by a set of necessary actions to achieve each goal. Following are the vision, mission, guiding principles, and strategic goals which have been set as a basis for preparing this National Biodiversity Strategy:

5.1 Strategic Goals

The global 20 Aichi Biodiversity Targets were selected and used as Sudan national strategic goals. The main components of NBSAP include plant, forestry, range, farm animal, wildlife, marine and in-land waters biodiversity and biotechnology and bio-safety. Considering each component circumstances, specific and realistic component targets corresponding to global targets were set. Proposed actions are based upon these component targets.

5.2 Vision

Sustainable use of natural resources of Sudan, where biodiversity is valued, conserved, restored and sustainably used to maintain ecosystem services, and to achieve economic and social development in the country.

5.3 Mission

Taking the necessary measures to ensure conservation and restoration of all biodiversity components and maintenance of different ecosystems services through

- Establish a policy and effective legislative, financial, administrative and technical actions, to combat threats to biodiversity.
- Integrate the conservation and sustainable use of biodiversity into the country's policies and programs and
- Deliver fair and equitable sharing of benefits arising from its use.

5.4 Guiding Principles

- i. The people of the Sudan shall have clean, healthy and diverse environment and the State shall not pursue any policy, or take or permit any action, which may adversely affect the existence of any species of animal or vegetable life, their natural or adopted habitat
- ii. Biological diversity is a heritage of the nation and is a natural capital for the country that has full sovereign rights over it.

- iii. Biodiversity conservation and sustainable use are investments for the present and future generations, and the socio-economic development cannot be achieved without the sustainable management of the biological resources and ecological systems.
- iv. Conservation of biodiversity is a responsibility of the government and society in Sudan and must be based on scientific information, knowledge of local communities and ecological principles.
- v. Benefits arising from the use of biodiversity must be shared fairly and equitably between all parties including the local communities, whose contributions to conservation and rights of sustainable utilization of biological resources must be fully recognized.

5.5 National Strategic Goals and Targets

The global 20 Aichi Biodiversity Targets were selected and used as Sudan national targets to achieve the specified strategic goals (Box1). The main biodiversity components and related issues covered by the NBSAP include agricultural plant, forestry, range, farm animal, wildlife, marine and in-land waters biodiversity, biotechnology and bio-safety as well as alien invasive species. Considering each component circumstances, specific and realistic national component targets corresponding to global Aichi targets were set.

Box 1: National Strategic Goals

1. Strategic Goal A:

Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

Proposed actions are based upon these component targets.

2. Strategic Goal B:

Reduce the direct pressures on biodiversity and promote sustainable

Chapter 6

6. National Action Plan for Conservation of Biodiversity

As proposed by the Strategic Plan for Biodiversity 2011-2020, the National Biodiversity Strategy and Action Plan (NBSAP) should address the pressures on biodiversity and must be integrated into broader policies, strategies, programs, and actions.

3. Strategic Goal C:

Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.

1. Strategic Goal D:
Enhance the benefits to all from biodiversity and ecosystem services. The National Action Plan is organized under the global strategic goals. The national targets are inspired by the Aichi Biodiversity Targets and the management and capacity building.

necessary actions are tied to each of the national targets and the corresponding Aichi Target. The Action plan for conservation of biodiversity is arranged into national targets and actions pertaining to the biodiversity components consisting of plant agro-biodiversity, forestry biodiversity, rangeland biodiversity, livestock biodiversity, wildlife, marine and inland waters biodiversity, as well as actions related to biotechnology and biosafety issues, Management of Invasive Alien Species, and impacts of Climate Change on Biodiversity.

The development and adoption of this updated NBSAP is part of a process for Sudan as a party to the CBD to fulfill its obligation under Aichi Target 17, which states "By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan".

Outline plans for the implementation of the actions related to each of the components are given in Appendices 1,2,3,4,5 and 6, where the proposed actions are arranged in a thematic manner under the following themes :

- i. Education, awareness, and training.
- ii. Legislation.
- iii. Policies.
- iv. Conservation.
- v. Sustainable use.

6.1 Plant Agro-biodiversity Action Plan

Aichi Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Component Target: Promotion and strengthening of public

1. Establishing awareness campaigns and activities through organization of different fora targeting key target audiences,
2. Media training and awareness activities for putting messages about crop diversity in the public eye.
3. Production of awareness materials on the values of plant agro-biodiversity and its importance for food security and sustainable agricultural development.
4. Implement a specialized training program on CHM.

Implementing agencies for this set of actions include Ministry of Agriculture, Ministry of Environment, HCENR, Ministry of Culture and Information, Ministry of Education , Plant Genetic Resources Unit of the Agricultural Research Corporation (PGR Unit /ARC).

Aichi Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Component Target: Integration of plant agro-biodiversity values and programmes into the national development strategies and planning processes by 2018 at the latest.

Actions proposed:

1. Integrating the issues related to agro-biodiversity conservation and sustainable use into the 25 year national strategy (2002-2026) within the remaining period of this strategy.
2. Development and adoption of a national policy and strategic action plan for the conservation and sustainable use of agro-biodiversity as part of the national policies and strategies for economic and social development.
3. To train civil servants in transforming biodiversity components into items of monetary value.
4. To encourage universities to incorporate biodiversity economic accounting in their curricula.

Implementing agencies: include National Council for Strategic Planning, Ministry of Agriculture, Ministry of Environment, Agricultural Research Corporation, Ministry of Finance and National Economy, The Central Bank of Sudan and Universities.

Aichi Target 7: *By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.*

Component Target: Sustainable management and development of agricultural sector in a manner ensuring *in-situ* and on-farm conservation of plant agro-biodiversity as well as participation of local communities in related processes and activities, by 2020.

Actions proposed:

1. Initiation of activities for *in-situ* on-farm conservation of plant genetic resources for food and agriculture (PGRFA) in close collaboration with local farmers and communities.
2. Development of agricultural policy that is based on the sustainability of resources.
3. Consideration of how production, economic incentives and other policies, as well as agricultural extension and research services might facilitate and encourage the on-farm management and improvement of PGRFA.
4. Identification of appropriate farmers' varieties/landraces for multiplication and/or developing new breeding populations that incorporate specific traits into locally adapted materials.
5. Adoption of adequate policies to support diversified production systems, including the use of multi-line varieties as an option for improvement of agricultural production while maintaining diversity;
6. Application of crop rotation in traditional rain-fed cultivation on both clay and sand soils.
7. Extending formal and sustainable agricultural extension programs into the rain-fed sector
8. Conduct and strengthening research on the problems of shifting cultivation and traditional farming systems.
9. Consider integrating the conservation and management of PGRFA, particularly the crop wild relatives (CWR) and wild food plants, in land-use plans in the biodiversity hotspots.
10. Considering developing one national harmonized programme for biodiversity conservation and management, combating desertification and addressing the issues of climate change.

Implementing agencies: are *Ministry of Agriculture, Agricultural Research Corporation and Ministry of Environment.*

Aichi Target 13: *By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.*

Component Target: Conservation of PGRFA (through different measures including building necessary capacities, and development and implementation of a national strategic action plan for the conservation of genetic resources for food and agriculture in Sudan, by 2020 at the latest.

Actions proposed:

1. Taking necessary legislative and administrative measures to implement the international instruments related to conservation and sustainable use of plant agrobiodiversity such as the CBD and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) to which Sudan is a party
2. Taking necessary legislative and administrative measures to ensure that conservation of PGRFA is a national concern that has to be conducted by governmental institutions and under public domain.
3. Issuance of a national legislation on plant genetic resources (PGR).
4. Development and implementation a national strategic action plan for the conservation of plant genetic resources for food and agriculture in Sudan.
5. Establishment, strengthening and provision of necessary physical, human and financial capacities as well as building necessary legal and institutional instruments for conservation and sustainable use of PGRFA.
6. Training and capacity building should be undertaken in several areas of relevance to conservation and sustainable use of PGRFA including plant identification, population biology, ethno-botany, use of geographical information systems (GIS), and molecular tools.
7. Up-grading the status of the PGR Unit of the ARC (PGR Unit/ARC) into a national centre responsible for conserving and enhancing the sustainable use of plant genetic resources for food and agriculture, under the following mandate and objectives:
 - a. The overall mandate and general objective of the centre is to conserve the plant agrobiodiversity in Sudan against deterioration and loss, and to enhance its sustainable use in scientific research, genetic improvement, training and germplasm restoration into the original farming systems.
 - b. In-country regional plant genetic resources units are to be established in the north, west, east and south where active collections of the materials collected from those regions are to be maintained.
 - c. The base collection of PGRFA is to be deposited in the national center while the active collections are to be held by in-country regional units under the centre.
 - d. Objectives of establishing regional units include collecting inside the regions, and evaluation of such materials collected from within these regions;
 - e. Some central facilities are to be attached to the national center for the conservation and evaluation of the collected germplasm. Examples of these are a molecular biology laboratory and *in-vitro* conservation facility.
8. Collecting and conserving samples of PGRFA from Darfur region.
9. Collecting and conserving samples of PGRFA from some pockets in central and eastern Sudan.
10. Collecting and conserving samples of range and pasture plant genetic resources.

11. Collecting and conserving samples of date palm genetic resources.
12. Collecting and conserving samples of wild relatives of crops.
13. Measures to be taken for safe duplication of germplasm materials inside and / or outside the country.
14. Development of core collections from big collections under conservation in the PGR Unit / ARC such as those of sorghum and pearl millet.
15. Establishment of participatory activities between gene bank, breeders and farmers for promoting the use of the local germplasm including farmers' varieties.
16. Priorities should be set for collecting plant genetic resources throughout the country to rescue material that may soon disappear in the field or be subjected to catastrophes such as war, epidemics or drought.
17. Establishment of *in-vitro* conservation facility and field gene banks for the conservation of vegetative propagated crops such banana, date palm, and garlic.
18. Promotion of the effective use of the *in-vitro* culture methods for conservation and propagation of endangered species.
19. Taking necessary measures to ensure proper management of current field gene banks of fruit plants that are under the management of the PGR Unit / ARC or others.
20. Regeneration programme is to be executed for the current collections in the PGR Unit / ARC.
21. Repatriation of Sudanese PGRFA conserved abroad; especially from the international agricultural research centers of the Consultative Group on International Agricultural Research (CGIAR). Cs
22. Systematic surveying and inventorying of plant genetic resources under *in-situ* or *ex-situ* conditions.
23. Include, as appropriate, among the purposes and priorities of protected areas, the conservation of PGRFA, in particular appropriate forage species, CWR and species gathered for food or feed in the wild, including in their biodiversity hotspots and genetic reserves.
24. Enhancing on-farm conservation of farmers' varieties through improvement of cultural practices for better yields by traditional varieties.
25. Restoration of traditional varieties in war or disaster-affected areas as in Darfur, South Kordofan and Blue Nile states.

Agencies responsible for implementation are Ministry of Agriculture, Agricultural Research Corporation (Plant Genetic Resources Unit), Ministry of Justice, Ministry of Environment and Ministry of Human Resources Development.

Target 16: *By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.*

Target 18: *By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.*

Component Target: Issuance and implementation of a national legislation on plant genetic resources with establishment of necessary institutional set-ups for regulating the access to plant agro-biodiversity and related indigenous traditional knowledge on the basis of fair and equitable benefit sharing, and the full consideration of farmers' and local community rights in consistence with the international instruments of relevance such as the CBD and the ITPGRFA, by 2015 at latest.

Actions proposed:

1. Enactment of necessary national legislations for conservation and sustainable use of biodiversity taking into consideration the matters related to access and benefit sharing as well as protection of the local communities, farmers and pastoralists rights to biological resources and their indigenous knowledge, practices and technologies; including issuance of a national legislation on PGR
2. Establishment of institutional bodies for regulating the access to plant agro-biodiversity and relating indigenous traditional knowledge on the basis of fair and equitable benefit sharing with necessary consideration to farmers' and local community rights in consistence with the international instruments of relevance such as the CBD and the ITPGRFA
3. Development of a national legislation for protection of plant varieties and breeders rights with necessary harmonization with the national and international instruments on the PGR.

Implementing agencies: include Ministry of Justice, Ministry of Agriculture and the National Parliament.

Aichi Target 19: *By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.*

Component Target: Improvement of the knowledge and science base on the genetic diversity of plant genetic resources for food and agriculture, and information sharing mechanisms in order to enhance their use, by 2020.

Actions proposed:

1. Conducting genetic diversity studies on conserved germplasm.
2. Expanding characterization, evaluation and further development of specific subsets of collections to facilitate use through:
 - a. Morphological and molecular characterization of collected genetic resources using standardized descriptor lists.
 - b. Evaluation of PGRFA for tolerance against stresses such as climate change induced stresses and pests and diseases.

- c. Initiating pre-breeding activities using the local genetic resources of cultivated plants.
 - d. Splitting of local diversified PGRFA to produce pure lines for further evaluation and/or commercial use;
3. Promotion of under-utilized and neglected crops and varieties;
 4. Promotion of seed production systems both at local and national levels including farmers and local communities' initiatives and mechanisms.
 5. Making available to the concerned bodies and communities the necessary characterization and evaluation information to assist in identifying useful accessions for restoring crop systems, respecting access and benefit-sharing agreements.
 6. Strengthening the present PGR documentation systems adopted by the PGR Unit / ARC to cover different aspects of PGR information and to use it as a nucleus for a national PGR information system.
 7. Documentation of indigenous knowledge, practices and technologies that are associated with the PGRFA.
 8. Establishment of national PGR information system for documenting and sharing the information on the PGRFA.
 9. Developing a monitoring and early warning system on the PGRFA using the national PGR information sharing mechanisms.
 10. Publication of germplasm catalogues.
 11. Recruitment and training of staff for the national plant genetic resources center and the regional units. Training includes training at the postgraduate level for researchers, and long and short training courses for researchers and technicians in a number of technical, managerial and policy areas.
 12. Capacity building in the area of plant taxonomy.
 13. Strengthening extension and extension facilities to develop a feedback mechanism.

Agencies responsible for implementation are Agricultural Research Corporation, PGR Unit ARC, Ministry of Agriculture and Ministry of Human Resources Development.

Aichi Target 20:

By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Component Target: Mobilization of necessary financial resources for effectively implementing the actions related to conservation and sustainable use of plant agrobiodiversity.

Action proposed:

Establishment, by 2015 at latest, of a national funding strategy for agro-biodiversity to which different sources of funding can contribute, including a major contribution from the

government. Prospects of funding from different other donors have to be tapped through possible national, regional and international Organizations including the private sector. Agencies responsible for implementation are Ministry of Environment, Ministry of Agriculture and Ministry of Finance.

6.2. Forest biodiversity Action Plan

Aichi Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Component Target: Development of public awareness/education, required for the conservation and sustainable use of forest biodiversity

Actions proposed:

Enhance awareness among the local communities, farmers, nomads and other stakeholders on the role of the forests in environmental protection and forestry biodiversity conservation and sustainable use through:

1. Translation of policies and legislation into simpler forms and involve stakeholders in policy reforms.
2. Undertake awareness campaigns and disseminate forest biodiversity awareness materials such as posters, leaflets, fact sheets and videos.
3. Promote and integrate forest biodiversity issues into educational institutions
4. Extend formal and sustainable agricultural extension programs in forests protection and biodiversity conservation, particularly, in the rain-fed sector and the climate change hotspots.
5. Implement a specialized training program on CHM

Implementing agencies: the National Forestry Corporation, Ministry of Environment and Ministry of Agriculture and Forestry, Range and Pasture General Directorate, Ministry of Finance Non-Governmental Organizations (NGOs), Private sector, Higher Council for the Environment, Ministry of Culture and Information, Ministry of Education, Ministries of, Oil, Minerals, Water Resources, PGR Unit ARC, Ministry of industry and all relevant bodies Authority

Aichi Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Component Target: Sustainable and efficient use of the forestry resources for purposes of social and economic development, taking into account the preservation of biodiversity

Actions proposed:

1. Train relevant civil servants and stakeholders in transforming biodiversity components into items of monetary value.
2. Encourage universities to incorporate biodiversity economic accounting in their curricula.
3. Enhancing the contribution of the forests to the national economy, considering the preservation of the biodiversity.

4. Taking forestry resources as means for rural development and strategy for poverty alleviation.

Aichi Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.

Component Target: Promote and enhance those measures, grants and activities that reduce the loss and degradation of forest ecosystems and habitats.

Actions proposed

1. Distribution of free or subsidized seedlings to encourage rural communities to establish community forests.
2. Provide incentives and benefits to communities involved in sustainable management of forest resources.
3. Provide subsidies and encourage the development of alternative energy sources to firewood/charcoal such as solar, gas, hydro- and electricity.

Implementing agencies: Implementing Organizations: the National Forestry Corporation, Ministry of Environment and Ministry of Agriculture and Forestry, Range and Pasture General Directorate (RPGD), Ministry of Finance, NGO, Private sector and Relevant Bodies.

Aichi Target 4: By 2020, at the latest, governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Component Target: Strengthening implementation of policies, laws and administrative measures aiming at improving natural resource rehabilitation, forest biodiversity conservation and management.

Actions proposed

1. Involvement of local communities in forest management, protection and utilization.
2. Stop illegal activities in forests which influence their degrading through law enforcement.
3. Integration of forest biodiversity conservation agenda into the Forests National Corporation (FNC) development plans.
4. Development and operate land use plans and laws governing land tenure and land use.
5. Development and strengthening implementation of a policy, and regulations and legislations for the sustainable forest management, conservation and uses.
6. Integrating biodiversity issues into the 25 year national strategy (2002-2026) within the remaining period of this strategy.
7. Adjustment of professional and technical programs of education in forestry to serve the objectives of policies and strategies at the local, national and regional levels

8. Improve institutional collaboration in the management of forest biodiversity.

Implementing agencies: National Forestry Corporation, Ministry of Environment, Ministry of Agriculture and Forestry, RPGD, Ministry of Finance, NGOs, Private sector and Relevant Bodies.

Aichi Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Component Target: Minimize the loss and degradation of forest ecosystems and habitats as a result of utilization of the forests

Actions proposed

1. Apply crop rotation/sequence in traditional rain-fed cultivation on both clay and sand soils

Implementing agencies: National Forestry Corporation, Ministry of Environment, Ministry of Agriculture and Forestry, RPGD, Ministry of Finance and National Economy, NGOs, Private sector and Relevant Bodies.

Aichi Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Component Target: Encourage and promote activities and utilization methods that sustain and protect biodiversity

Actions proposed

1. Rehabilitation and establishment of forest plantations in degraded traditional rain-fed areas
2. *In-situ*, on-farm and *ex-situ* conservation and management of reserved forests in representative ecosystems

Implementing agencies: National Forestry Corporation, Ministry of Environment, Ministry of Agriculture and Forestry, RPGD, Ministry of Finance and National Economy, NGOs, Private sector and Relevant Bodies.

Aichi Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Component Target: Regulation and control the introduction of invasive alien species and spread of harmful alien species.

Actions proposed

1. Demonstration trials for new alien introduced forest species, to ensure that the species is suitable and to avoid undesirable effects

National Forestry Corporation, Ministry of Environment, Ministry of Finance and National Economy, NGOs, Private sector and Relevant Bodies.

Aichi Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Component Target: Development of reforestation and efficient use program of the forest resources, taking into account the preservation of threatened indigenous species.

Actions proposed:

1. By 2020, 10% of proposed reserved forests registered as reserved forests and established by reforestation and mainly stocked by indigenous species such as *Acacia senegal*, *Acacia nilotica* and *Khaya senegalensis*.
2. Establish protected area(s) (*in-situ*) in representative ecosystems for the conservation of forest biodiversity.
3. *Ex-situ* conservation measure taken as an "insurance policy" against extinction of forest genetic resources.

Implementing agencies: the National Forestry Corporation, Ministry of Environment Ministry of Finance and National Economy, NGOs, Private Sector and Relevant Bodies.

Aichi Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Component Target: To conserve, develop and manage the area under forests to enhance environmental protection, minimize soil degradation and preserving biological diversity.

Actions proposed:

1. Adoption of climate-smart farming systems such as agroforestry and agro-silvo pastoral systems that lead to natural regeneration of native species and rehabilitation of degraded and deforested areas, especially, in vulnerable areas as in traditional dry-land farming.
2. Save wood by the dissemination of alternative sources of energy and energy saving techniques.
3. Development of a programme for combating desertification and addressing the issues of climate change.
4. Creation of shelter belts as a measure of boosting agricultural yield and protection purposes such as sand dune fixation.
5. Rehabilitation and restoration of the natural forests for biodiversity conservation.

Implementing agencies: National Forestry Corporation, Ministry of Environment Ministry of Finance and National Economy NGOs, Private sector and Relevant Bodies

Aichi Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Component Target: Promote and encourage community participation in forest management and enhance reforestation activities at local community level.

Actions proposed:

1. Document indigenous knowledge and practices relevant to the conservation and sustainable use of forest biodiversity
2. Enhance legal access to forest genetic resources and the associated traditional knowledge
3. Support and promote the utilization of traditional practices and indigenous knowledge that are beneficial to the sustainable management and exploitation of forest biodiversity.
4. Promote collaboration between relevant government institutions and local communities in the use and adoption of these practices.
5. Enforcement of existing land legislation and customary rights concerning land ownership and management of forest resources.

Implementing agencies: National Forestry Corporation, Ministry of Environment Ministry of Finance and National Economy, NGOs, Private sector and Relevant Bodies

Aichi Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Component Target: To facilitate research on biodiversity and agro-forestry techniques development as conservation and an efficient land use practice.

Actions proposed:

1. Research on forest genetic resources assessments and development of resources conservation plans.
2. Capacity building for conservation and sustainable use of forest genetic resources.
3. Research on the use of tissue culture for forest genetic resources conservation.
4. Research on the problems of shifting cultivation to develop agroforestry systems in the climate change sensitive areas.
5. Evaluate the role of protected forests in protection of biodiversity

Implementing agencies: National Forestry Corporation, Ministry of Environment, Ministry of Finance NGOs, Private sector and Relevant Bodies

Aichi Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by parties.

Component Target: Promote and encourage community participation in forest management and enhance reforestation activities at local community level.

Actions proposed:

1. Encourage the private sector to invest in forest plantations including opportunities for commercial forest production.

2. Strengthen partnership among government organizations, non-governmental organizations (NGOs) and the private sector for establishment of financial mechanism for the conservation of forest biodiversity.

Implementing agencies: the National Forestry Corporation, Ministry of Environment Ministry of Finance and National Economy, NGOs, Private sector and Relevant Bodies.

6. 3. Rangeland and livestock biodiversity Action Plan

Aichi Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Component Target: By 2020, at the latest, people are aware of the values of range and livestock biodiversity and the steps they can take to conserve and use it sustainably

Actions proposed

1. Awareness of range and livestock biodiversity created among all stakeholders through: Education curricula modified to include range and livestock biodiversity issues such as benefits accruing from promotion and threats from erosion of biodiversity and Meetings of stakeholders to increase awareness.
2. Implement a specialized training program on CHM

Implementing agencies: Ministry of Livestock Fisheries and Rangelands, Ministry of Agriculture, Ministry of Environment, Higher for Environment and Natural Resources, Genetic Resources Unit, the Ministry of Culture and Information, Ministry of Education, Ministries of Petroleum, minerals, water resources, industry and all Relevant Bodies, Private sector

Aichi Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes are being incorporated into national accounting, as appropriate and reporting systems.

Component Target: By 2020, at the latest, relevant civil servants and other stakeholders trained in transforming biodiversity components into items of monetary value.

Actions proposed:

1. Organization of training activities for specific target stakeholders including Range and Pasture General Directorate (RPGD), Ministry of Finance and National Economy, Central Bank of Sudan, Ministry of Livestock, Fisheries and Range Lands, Ministry of Agriculture and Forestry
2. Encourage universities to incorporate biodiversity economic accounting in their curricula.

Determine the real monetary value of rangelands, which is now neglected, for use to convince policy makers of the contribution of rangelands and their biodiversity to the economy and poverty reduction.

Implementing agencies::Ministry of Livestock Fisheries and Rangelands, Ministry of Finance and National Economy, local communities, NGOs, and Private sector

***Aichi Target 3:** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.*

Component Target: By 2020, at the latest, incentives, including subsidies, harmful to livestock and rangeland biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of livestock and rangeland biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

Actions proposed:

1. New water sources should be distributed in a way that reduces overgrazing.
2. Encourage pastoralists and farmers to collect and broadcast seeds of endangered range species.
3. Provide incentives and benefits to communities involved in sustainable management of community range.
4. Encourage establishment of small scale individual range properties through assigning title to land.

Implementing agencies:: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance and National Economy, local communities NGOs, Private sector and Relevant Bodies

***Aichi Target 4:** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.*

Component Target: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural range resources well within safe ecological limits.

1. Actions proposed:

2. Develop a vision for sustainable use of range resources and enact laws governing land tenure and land use.
3. Develop a policy framework, a strategy and legislations for the sustainable management of rangelands for conservation and proper use of biodiversity.
4. Put into action national goals and policy priorities for the management of range resources.
5. Integrate biodiversity issues into the 25 year national strategy (2002-2026).
6. Involve all stakeholders in management, protection and utilization of range resources.
7. Revise professional and technical programs of education in range management to serve the objectives of policies and strategies at the local, national and regional levels

8. Improve institutional collaboration in the management of range biodiversity.

Implementing agencies:: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance and National Economy, local communities NGOs, Private sector and Relevant Bodies

Aichi Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Component Target: By 2020, the rate of loss of all natural habitats, including range, is at least brought down by 25% and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Actions proposed:

1. rehabilitate rainy grazing season areas
2. Develop and agree-on plan for introduction and propagation of range plant species for specific areas.
3. Develop a plan for introduction of farm animal species for specific purposes and for specific areas.

Implementing agencies:: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance, local communities NGOs, Private sector and Relevant Bodies

Aichi Target 7: by 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Component Target: By 2020 areas under 25% of rangeland areas are managed sustainably, ensuring conservation of biodiversity

Actions proposed

1. Strengthen RPGD through staff recruitment and training and logistical and financial support.
2. Create community awareness.
3. Enact legislations that facilitate protection of the rangelands.

Implementing agencies:: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance, local communities NGOs, Private sector and Relevant Bodies

Aichi Target 12: by 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Component Target: By 2020 the extinction of known threatened range plant species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

1. Actions proposed:

2. Identified endangered indigenous range species especially those most preferred.
3. Propagate, collect and broadcast seeds of endangered indigenous range plant species, on the range and in certain sanctuaries to restore endangered species.

4. Communities trained and involved in these efforts.

Implementing agencies: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance, local communities NGOs, Private sector and Relevant Bodies

Aichi Target 13: by 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Component Target: By 2020, the genetic diversity of natural and cultivated forage plants and farmed and domesticated animals and of wild relatives is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Actions proposed:

1. Ensure appropriate methodology, equipment, trained personnel plus criteria and indicators to assess mix up of gene pools of indigenous farm animals with exotic are in place.
2. Establish areas where pure local farm animal species are kept remote from mixing.
3. Develop selective breeding programmes and establish special farms to improve Kenana and Butana breeds of cattle.

Implementing agencies: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance, local communities NGOs, Private sector and Relevant Bodies

Aichi Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Component Target: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Actions proposed:

Rehabilitation of degraded rangelands through:

1. Reseeding with palatable species.
2. Adoption of good range management practices.
3. Balance extracting units with available resources.

Implementing agencies: Ministry of Livestock Fisheries and Rangelands, Ministry of Finance, local communities NGOs, Private sector and Relevant Bodies

Aichi Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and

reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Component Target: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of range and farm animal biodiversity, and their customary use of them as biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels

Actions proposed:

1. Document indigenous knowledge and practices relevant to the conservation and sustainable use of range and domestic animal resources.
2. Engage some modern practices with indigenous ones.
3. Encourage coordination between various stakeholders in order to sieve and implement indigenous practices.
4. Assign land title for sustainable management and production from rangelands

Implementing agencies: Ministry of Livestock, Fisheries and Rangelands, Ministry of Finance and National Economy, Local communities, NGOs, private sector and relevant agencies.

Aichi Target 19: by 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Implementing agencies: Ministry of Livestock, Fisheries and Rangelands, Ministry of Finance and National Economy, Higher Council for Environment and Natural Resources, Local Communities , NGOs, private sector, and relevant agencies.

Component Target: By 2020, knowledge, the science base and technologies relating to range and farm animal biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Actions proposed:

1. Develop a better understanding of the scientific basis of desirable characters of range plants and livestock. Specific characters to investigate in plants are tolerance to fire, grazing pressure, water stress and nutritional qualities.
2. In farm animals emphasis should go to tolerance to disease, high productivity, and tolerance to harsh environments.
3. Capacity building to enable personnel address above issues.
4. Conduct animal census to allow a better understanding of the resource capability and the needs of extracting units.
5. Utilize genetic markers to evaluate good characters in plants and animals.

Aichi Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource

Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Component Target: By 2020, at the latest, the mobilization of financial resources for effectively implementing the NBSAP, including for range and farm animal biodiversity, from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties

Actions proposed:

1. Assessment of financial resources needed to implement the biodiversity action plan for range and livestock.
2. Mobilize funds from government, international donors, NGOs and other stakeholders.

Implementing agencies: Ministry of Livestock, Fisheries and Rangelands, Ministry of Finance, Higher Council for Environment and Natural Resources Local Communities NGOs, Private sector and Relevant Bodies

6. 4. Wildlife, marine and in-land waters ecosystems

Aichi Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Component Target: By 2020, at the latest, people are aware of the values of biodiversity of Wildlife, marine and in-land waters ecosystems and the steps they can take to conserve and use it sustainably.

Actions proposed:

1. Organize workshops and meetings with identified stakeholders to raise awareness about the importance of conservation of biodiversity
2. Design and implement awareness programs on the importance of conservation of the wildlife, marine and in-land ecosystems
3. conduct awareness programs for the local communities for sustainable use of natural resources
4. Resolve through educational programs the misconceived conflict between conservation of biodiversity through establishment of wildlife reserves/protected areas and the welfare of the local communities
5. Seek the help of NGOs in spreading awareness among local communities about the long-term value of establishment of new protected areas
6. Increase awareness of ecosystems and economic values of protected areas within the local communities.
7. Implement a specialized training program on CHM

Implementing agencies: Ministry of Culture and Information, Ministry of Environment, Ministry of Education, HCENR, and NGOs.

***Aichi Target 2:** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.*

Component Target: By 2020, at the latest, sustainable use and conservation of terrestrial and aquatic wildlife have been integrated into national and local development and poverty reduction strategies and planning processes

Actions proposed:

1. Incorporate economic valuation of conservation of wildlife, marine and inland water ecosystems into educational programmes
2. National plans for poverty reduction should take into account sustainable use of resources.
3. Train civil servants in transforming biodiversity components into items of monetary value. The training must cover the following stakeholders:
4. Encourage universities to incorporate biodiversity economic accounting in their curricula.

Implementing agencies: Ministry of Higher Education and Scientific Research, Ministry of Finance and National Economy, Ministry of Environment, and Ministry of Agriculture and Forestry.

***Aichi Target 3:** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the convention and other relevant international obligations, taking into account national socio-economic conditions.*

Component Target: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the convention and other relevant international obligations, and are integrated into the national development plans

Action proposed:

Encourage the federal as well as the states authorities to reduce/remove incentives/subsidies or impose penalties for activities that are harmful to terrestrial and marine wildlife biodiversity

Implementing agencies: include Ministry of Finance and National Economy, Ministry of Environment, Ministry of Petroleum and companies, HCENR, Wildlife Conservation General Administration (WCGA).

***Aichi Target 4:**By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.*

Component Target: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption of marine and inland water resources

Actions proposed:

1. Enhance the role of the community in enforcing environmental laws.
2. Encourage the private sector to invest in ecotourism.
3. Promote more contribution of protected areas to local and national economies.
4. Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.
5. Environmental and social impact assessment studies for new development projects should assure the value of conserving biodiversity.
6. Revise the government existing five year strategy (2012 – 2016), in order to incorporate the mentioned target.
7. Encourage business men and women and other stakeholders to comply with the mentioned target as well.

Implementing agencies: include Ministry of Justice, WCGA, HCENR and Wildlife Research Centre (WRC).

Aichi Target 5: *By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.*

Component Target: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and degradation and fragmentation of wildlife habitat is significantly reduced.

Actions proposed:

1. Resettlement of war and civil strife displaced communities should be undertaken in consultation with appropriate environmental authorities to avoid marginal and fragile land and areas allocated as protected wildlife and game reserves
2. Conservation of areas that constitute a unique habitat for endangered wildlife species.

Implementing agencies: include Ministry of Environment, Ministry of Justice, WCGA and Ministry of Agriculture.

Aichi Target 6: *By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.*

Component Target: By 2020 all fish and invertebrate stocks and aquatic plants in Sudan are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable

ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Actions proposed:

1. Establish regulations that encourage sustainable fishing, avoid over-fishing to reach a point where fishing has no adverse effects on the ecosystem and poses no threats on endangered species.
2. Introduce ecosystem-based fisheries management to the protected marine parks.
3. Strengthen the capacity of the coastal communities to use ecosystem based management for utilization of their resources.
4. Help the local communities and stakeholders to define standards for environmental quality.
5. Design and implement an effective ecological monitoring system.
6. Develop both social and economic monitoring systems to the nature and distribution of benefits tied to marine resources and protected areas.

Implementing agencies: Ministry of Agriculture, Ministry of Environment and HECNR.

Aichi Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Component Target: By 2020, pollution to marine and fresh water systems has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Actions proposed:

1. Reduce/remove incentives/subsidies or impose penalties for activities that pollute the natural habitats of terrestrial, inland water and marine flora and fauna
2. Enhance the role of the community in enforcing environmental laws
3. Reduce to environmentally acceptable levels the adverse impacts of tradition as well as organized gold mining on wildlife and inland waters and marine habitats
4. Enforce laws for the conservation of biodiversity of the coastal communities around oil-exporting facilities

Implementing agencies: Ministry of Agriculture, Ministry of Environment, Ministry of Justice, Ministry of Petroleum, HECNR, and NGOs.

Aichi Target 9:

By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Component Target: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment especially in inland water systems.

Actions proposed:

1. Enforce strict control on the introduction of alien species specially to the wildlife and marine ecosystems
2. Eradicate invasive alien species that are already been found having adverse effects on biodiversity of wildlife, marine, coastal and inland water ecosystems

Implementing agencies: include Ministry of Finance and national Economy, Ministry of Agriculture, Ministry of Interior, Customs and Security Authorities, HECNR, WCGA.

Aichi Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Component Target: By 2015, the multiple anthropogenic pressures on coral reefs in Sudan, and other vulnerable ecosystems impacted by climate change are minimized, so as to maintain their integrity and functioning.

Actions proposed:

1. Provide institutional, legal and technical capacity for coastal communities to adopt an environment base management system.
2. Enforce environmental laws for the safe management of the coastal ecosystem.
3. Regulate tourism in the coastal ecosystem to ensure sustainable utilization of the resources.

Implementing agencies: include Ministry of Justice, Ministry of Agriculture, HECNR Ministry of Tourism and WCGA,

Aichi Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Component Target: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services in Sudan, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Actions proposed:

1. Establish new protected areas, game reserves and sanctuaries to represent all ecological zones and states and adopting international categories of protected areas with special attention to inclusion of the semi-desert, Inland fresh water (khors and wadis), Coastal and marine (salt marshes and mangroves).
2. Establish protected areas for the following species and habitats:
 - a) Habitats of Nubian Ibex and Klipspringer.
 - b) One of the non-Nilotic lakes such as Kundi and Abayd.

- c) In low rain fall zone in Khor Yabous up to the border with South Sudan, South of Talodi (South Kordofan), Upper Jebel Marra, Garsila (Darfur) and Shu'ab Rumi,,
 - d) One in the north and one in the south of the Red Sea coast.
 - e) Southern part of Lake Nubia,
 - f) Sudanese stretch of Wadi Alalagi.
3. Improve management effectiveness by implementing the existing management plans and formulate management plans for areas without.
 4. Facilitate more stakeholders' involvement in establishment of protected areas.

Implementing agencies: include HECNR and WCGA,

Aichi Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Component Target: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Actions proposed:

1. Enforce specific conservation measures for endangered fish and mammals outside the protected areas.
2. Continue monitoring coral reef habitats to include fish, corals, mangroves, seaweeds, turtles and birds.
3. Identify if any of the marine inland and wildlife species are threatened and conduct habitat restoration
4. Establish wild animal genetic resources unit and gene bank within the Wildlife Research Centre for the conservation of local genetic resources of wild animals.
5. Conduct programme for the protection of threatened species.
6. Mainstream of migratory soaring bird species into existing and future conservation projects.
7. Mainstream wildlife conservation in other sectors and land use plans.
8. Reintroduction of extinct species.
9. Establish more sanctuaries for sociable lapwing plover and other endangered species.
10. Establish a zoo park and aquarium.
11. Strengthen the institutional technical capacity.
12. Conduct training programs on community-based management for coastal and protected areas communities.
13. Alleviate conflicts between wildlife conservation and human activities.

Implementing agencies: include WRC, HECNR, WCGA, Ministry of Environment and Ministry of Education,

Aichi Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and

safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Component Target: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Actions proposed:

1. Encourage measures for the sustainable utilization of natural resources that provide potential food, fodder and medicinal value of aquatic plants.
2. Encourage active participation of the local communities and authorities in formulating policies and management of the protected areas.

Implementing agencies: include HECNR, Ministry of Finance and National Economy, Ministry of Livestock, Range and Fisheries and Ministry of Agriculture.

***Aichi Target 19:**By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.*

Component Target: By 2020, knowledge, the science base and technologies relating to biodiversity of terrestrial and aquatic wildlife, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Actions proposed:

1. Update information on the status of wildlife biodiversity after the cessation of South Sudan.
2. Conduct exploration and research on non-Nilotic inland water ecosystems.
3. Conduct a national census on the status of natural resources.
4. Conduct research on the aquatic biota of the Nile Basin in a subsystem perspective.
5. Conduct surveys on the biodiversity of the habitats representing the low rainfall wooded grassland ecosystems.
6. Conduct research on the status of endangered endemic wildlife species.
7. Provide institutional, legal and technical capacity for coastal communities to adopt an environment base management system.
8. Enhance the role of research in wildlife policies and management.
9. Developing, apply and transfer appropriate technologies for maintenance and conservation of protected areas.
10. Conduct research on: Protected area valuation assessment, Climate change resilience and adaptation assessment, protected area integration and mainstreaming assessment.
11. Design and implement programs for capacity building in the planning, establishment, management and financial sustainability of protected areas and national and regional systems of protected areas.
12. Study, document and assess all terrestrial wildlife, marine and inland biota and conduct a gap assessment study for newly designated protected areas.

Implementing agencies: include WRC, HECNR, WCGA, Ministry of Environment and relevant departments in Universities.

Aichi Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Component Target: By 2020, at the latest, the mobilization of financial resources for effectively implementing the NBSAP from all sources, including national development and economic plans as well as international donors. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Action proposed:

1. NGOs should help the local communities in availing national and international funding for conservation projects.

Implementing agencies: include NGOs, HECNR, Ministry of Environment, Ministry of Finance and National Economy and WCGA.

6. 5. Biotechnology and biosafety

Aichi target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Component Target: Enhancement of awareness programs among various sectors of the community about the beneficial role of modern biotechnology in improvement of the livelihood of people and sustainable agricultural development.

Actions proposed:

1. Launching of awareness campaigns to enlighten the public about importance of biotechnology and biosafety.
2. Production and dissemination of awareness and educational materials on the concepts of modern biotechnology and biosafety and their importance in biodiversity and sustainable development of the agricultural sector.
3. Integration of biosafety principles into education programs.

Implementing agencies:, National Research Center, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education.

Aichi target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Component Target: Integration of modern biotechnology values in agricultural and socio-economic development strategies and plans.

Actions proposed:

1. Development of a national action plan and relevant programmes for the utilization of modern biotechnology for the acceleration of the development of the agricultural sector and the national economy at large with sustainable utilization of biodiversity.
2. Building the capacity of the national agricultural research systems (NARS) to develop biotechnological products.
3. Integration of biotechnology and biosafety into national development plans.

Implementing agencies:, National Research Center, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education and National Council for Strategic Planning

Aichi target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Component Target: By 2020 necessary steps are taken by federal and state governments, the private sector and other stakeholders to utilize biotechnology in sustainable production with maximum biosafety precaution and measures.

Actions proposed:

1. Establishment of incentive programmes for expansion in commercialization of new genetically modified crops of high economic value and low negative impact on the environment.
2. Development of biotechnological products to enhance agricultural productivity and competitiveness and to manage genetic resources on a sustainable basis

Implementing agencies:, National Research Center, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education and National Council for Strategic Planning

Aichi target 13: by 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Component Target: Modern biotechnology methods and techniques are adequately used to maintain genetic diversity and minimize genetic erosion of cultivated plants and farmed and domesticated animals.

Actions proposed:

1. Approval, adoption and execution of programs for utilization of modern biotechnology (e.g. tissue culture and other techniques) in conservation and multiplication of threatened and endangered species and conservation of genetic diversity.
2. Establishment of Centers of Excellence in biotechnology.

Implementing agencies:, National Research Center, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education.

***Aichi target 16:** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.*

Component Target: Approval and implementation of national legislations paving the way for modern biotechnology and biosafety measures to contribute to access to genetic diversity and equitable sharing of its benefits.

Actions proposed:

1. Empowerment of the national biosafety authority to exercise its full supervision and control over transfer, handling and use of GMOs in order to ensure the protection of the different components of indigenous biodiversity against any hazards that might be brought about by any un-authorized introduction into environment or use of GMOs or by any non-strict implementation of risk assessment or risk management measures.
2. Capacity building for effective participation of the national biosafety authority in biosafety clearing house of the Cartagena Protocol.
3. Set up biosafety monitoring system.
4. Establishment of effective mechanism for exchange of biosafety information and data management nationally and internationally.
5. Strengthen capacity for enforcing biosafety legislations.

Implementing agencies:: National Research Center, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education.

***Aichi target 19:**By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.*

Component Target: To maximize utilization of modern biotechnology and genetically modified crops for socio-economic development with the necessary biosafety measures in place.

Actions proposed:

1. Initiation of a national programme to upgrade technical capacity to carry out transgenic research and development and to implement biosafety regulatory systems.
2. Promotion of research and development in soil biotechnology.
3. Establishment of biosafety information system on gene flow parameter data, effect of GMOs on non-target organisms, allergenicity and toxicology of GMO products.
4. Establishment of Centers of Excellence in biotechnology.

Implementing agencies:: National Research institutions, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education.

***Aichi Target 20:** By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be*

subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Component Target:

Development of funding strategy and mechanism for biotechnology and biosafety targeting international, regional and local sources.

Action proposed:

1. Establishment of funding strategy, mechanism and programmes to finance biotechnology and biosafety. Potential funding bodies include the Sudanese government, international donors and the private sector.

Implementing agencies:: National Research institutions, Ministry of Finance, Ministry of Science and Technology Ministry of Culture and Information, Ministry of Education.

6. 6. Invasive Alien Species Action Plan

Aichi Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Component 1: Develop a nation-wide invasive species management plan by 2020.

Actions proposed:

1. Produce an inventory of invasive species and evaluate their economic, social and environmental impacts.
2. Develop invasive species management plans that emphasize prevention of introductions, control and eradication of invasive species.
3. Develop effective systems and tools for monitoring and evaluation of invasive species.

Implementing agencies: include Higher Council for Environment and Natural Resources (HCENR) and Ministry of Agriculture and Irrigation.

Component 2: Develop mechanisms to prevent the introduction and establishment of new invasive species by 2015.

Actions proposed:

1. Strengthen quarantine measures and border control to ensure that intentional introductions are subject to appropriate authorization.
2. Develop risk assessment and management programmes and guidelines for newly introduced species.
3. Develop and implement effective response procedures for the prevention of new potential invasive species.

Implementing agencies: include Plant Protection Directorate (PPD), Sudanese Standards and Metrology Organization (SSMO) and Ministry of Interior.

Component 3: Develop cost effective invasive species management programmes by 2016.

Actions proposed:

1. Identify invasive species problems and recommend management actions
2. Develop appropriate methods to monitor, prevent and stop spread of invasive species.

Implementing agencies: include Agricultural Research Corporation (ARC), Forests National Corporation (FNC), Ministry of Livestock, Fisheries and Rangelands.

Component 4: Promote awareness of the threat to biological diversity and related ecosystem goods and services posed by invasive species by 2016.

Actions proposed:

1. Develop and implement a public awareness program about the invasive species and their impacts on biodiversity and livelihood of the local communities.
2. Develop database of invasive species, identification guides and make the information accessible to the stakeholders.
3. Encourage media organizations and extension workers to participate in dissemination of information about the impact of invasive species.
4. Support education institutions to incorporate issues of invasive species, identification, prevention, eradication and management into their curricula.
5. Encourage and support the involvement of all stakeholders in alien invasive species management programs.

Implementing agencies: include HCENR, FNC, ARC, Technology Transfer and Extension Administration in Ministry of Agriculture and universities.

Component Target 5: Enhance and facilitate coordinated research and monitoring of invasive alien species.

Actions proposed:

- i. Assess the movement of invasive species and develop maps of distribution of the most important invasive species.
- ii. Formulate and implement result oriented research on characterization of invasive species; vulnerability of ecosystems, social and economic impact; prevention, control, eradication and management methods.
- iii. Promote research on the use of traditional knowledge in the development and implementation of measures to manage invasive species.
- iv. Harmonize state and sectoral rules and regulations relevant to invasive species and formulate policy and legislation for the control of introductions, movement and management of alien invasive species.
- v. Strengthen an existing institution to coordinate research, management and eradication of alien invasive species.

Implementing agencies: include Ministry of Agriculture and Irrigation, ARC, FNC, HCENR, universities, Ministry of Justice, Ministry of Higher Education and Scientific Research and Ministry of Science and Communications.

6.7 Climate Change Impacts Action Plan

Aichi target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Component Target: Enhancement of awareness programs about the impact of climate change on biodiversity in Sudan.

Actions proposed:

1. Develop awareness raising and communication material on impact of climate change on biodiversity.
2. Launch awareness building campaigns and information dissemination about biodiversity conservation under stress of climate change.
3. Integrate the concept of climate change and its impact on biodiversity into educational materials and education programs.

Implementing agencies: include line ministries, ARC, FNC, HCENR, universities, Ministry of Higher Education and Scientific Research and Ministry of Science and Communications.

***Aichi Target 15:** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.*

Component Target: Maximize resilience of ecosystem which has high biodiversity and greatest capacity to buffer climate change impacts.

Action proposed:

1. Develop climate change adaptation policies and programmes in sectors that affect biodiversity conservation, including agriculture, forestry, and rangelands.

Implementing agencies: include line ministries, , universities, Scientific Research and Ministry of Science and Communications.

***Aichi target 19:** By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.*

Component Target: By 2020, knowledge, the science base and technologies relating to impacts of climate change on biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Actions proposed:

- i. Undertake a detailed vulnerability assessment of impact of climate change on biodiversity in Sudan.
- ii. Develop, apply and transfer appropriate technologies that minimize impacts of climate change on biodiversity loss.

Implementing agencies: include line ministries, universities, Scientific Research and Ministry of Science and Communications.

Aichi Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Component Target: Development of funding strategy and mechanism for assessment and adaptations to climate change impact on biodiversity.

Action proposed:

Establishment of funding strategy, mechanism and programs to finance climate change assessments and implementation of adaptation projects to buffer climate change impacts on biodiversity.

Implementing agencies: include line ministries, NGOs and Private Sector

Part III Implementation and Financing

Chapter 7

7. Enabling environment for implementation of NBSAP

Sudan has political commitment to mainstream biodiversity components and ecosystem as high development priorities. There are many opportunities for mainstreaming and endorsement such as the National Constitution polices strategies, and legislations. In the Proposed National Constitution, government should consider efforts to address biodiversity components and ecosystem as an integrated element of sustainable development policies (macroeconomic, agricultural policy and climate change). Management and conservation of biodiversity components and ecosystem frameworks have been integrated into sustainable development planning.

7.1 Biodiversity related polices, strategies and Plans and legislations

- ❖ The Agricultural Revival Program (ARP) provides a strategic framework for the prioritization and planning of investments that will drive Sudan’s agricultural growth and development. ARP is a central pillar of economic policy in the Quarter Centennial Strategy (2007-2032). The ARP is a 10-year road map for agricultural and rural development that identifies priority areas for investment and estimates the financing needs to be provided by government and its development partners. The Second Five Year Plan of the ARP (2015 -2019) has a comprehensive and consistent set of policies and strategies, which reflect the importance of the sector in the nation’s development aspirations. Its features comprise: control degradation of resources, conserve genetic resources, enhance livelihoods of low income groups, alleviate poverty at household and community levels and increase their resilience under an environment of climate change. However the institutional capacity to implement these is generally limited.
- ❖ Forest Policy (2006) supports biodiversity conservation and sustainable use (Ministry of Agriculture and Irrigation, 2012).The policy provides clear guidelines for rehabilitation. This made local communities becoming more aware of the importance of the resources. Converting policy into action always faces limitations at the local implementation level due to a lack of experience.
- ❖ A recent wildlife policy was formulated under “Enhancing capacity building in wildlife conservation and sustainable protected area management for the Near East countries project, sponsored by FAO” to encourage the establishment of new protected areas. Two protected areas were suggested one in the White Nile State and the other in Kassala State.
- ❖ A number of pastoral strategic action plans were formulated for Semi Desert and Low Rainfall Savannah in Sudan 2014- 2024” in 2013 under a project funded by the ITPGRFA, with the objective of building the resilience of pastoral communities to climate change in two ecosystems of Sudan. Development of recent Agriculture Sector Investment Plan (2012). One of its main strategic objectives is the development and protection of natural resources sector to ensure its replenishment and sustainability.

7.2 Good governance

- ❖ Reform of policies and legislations that affecting the biodiversity components development is highly recommended to ensure equal opportunities for accessing and sharing the benefits to achieve conservation and sustainable use of the natural resources.
- ❖ The NBSAP is implementing comprehensive and integrated policies that are focused on sustainable use and conservation which is an indication of good governance.
- ❖ There is a need of appropriate biodiversity integrated policies and legislative frameworks that provide effective institutional support and strong coordination to avoid conflicting and overlapping mandates. Efficient decentralization system that could result in useful communication and coordination between local levels (states) and national is needed.
- ❖ Sudan has links with a number of international and regional frameworks that are related to biodiversity including conventions, organizations and networks.
- ❖ Clarification of land tenure and resource rights to strengthening policy and legislation towards natural resources management and land use system.
- ❖ Strengthening local level unions and community-based organizations (CBOs) to ensure that leaders are democratically elected in order to give grassroots, particularly the poor, more political power and a voice in formulating policies and decision making process.
- ❖ Creation of local community organizations which should be motivated and committed to interventions and efforts for sustainable resources management and development as well as for mobilizing local communities to participate.
- ❖ Efforts should focus on institutions reorganization, and establishment of new ones to provide an efficient framework for planning, implementation and monitoring of sustainable natural resources management actions. It should aim also at promoting the roles of these institutions in increasing awareness and technology transfer. Efforts should be made to strengthen State institutions, national NGOs, CBOs and other community organizations dealing with impacts of climate change, natural resources protection and utilization. These efforts should be extended to ensure coordination and complimentary activities in all actions pertinent to the management and development of these resources as well as increasing the resilience of communities.
- ❖ Biodiversity and ecosystem conservation can only be sustained when public awareness is raised and policy makers have access to reliable information upon which sound policies and decisions are made.
- ❖ Actions to conserve genetic resources should be planned and implemented at a scale determined by ecological and social criteria. Information and knowledge systems can be developed through establish user friendly information and knowledge systems such as databases on resources development to enhance accessibility to end-users.
- ❖ Foster the development of human, institutional and technical capacity building in the area of management and sustainable use.
- ❖ Knowledge sharing between government, donors and other actors when allocating fund for existing initiatives.

- ❖ The key opportunities are enhancing strategic investments and partnerships. Cooperation between different parts of the community is essential to increase effective engagement in biodiversity components conservation. More private expenditure on biodiversity conservation and partnerships between sectors are necessary for successful outcomes.
- ❖ The government, through its own resources and in collaboration with donor communities and organizations, should provide capital and infrastructure, introduce appropriate technology and enhance national staff abilities to formulate, implement and monitor relevant actions to mitigate climate change impacts and increase local communities' resilience.
- ❖ Government institutions, NGOs, CBOs and native administration should play a leading role in communicating information, sharing knowledge, lessons learned and experiences on dealing with impacts of climate change and environmental deterioration. They can mobilize community for joint actions and active participation in efforts to address the consequences of climate change.
- ❖ Integrating Indigenous Knowledge, and experience in dealing with biodiversity and ecosystem can provide valuable knowledge which can be useful in designing and implementing conservation actions.
- ❖ Research and Technology gap; Multidisciplinary research and technology transfer are required.
- ❖ Utilization of funding: Sufficient financial resources allocated directly related to management of biodiversity component ecosystems. Advantaged prioritization and allocation of biodiversity component ecosystems .Availability and allocation criteria of financial resources
- ❖ The Roles of Partners: The government, through its own resources and in collaboration with donor communities and organizations, should provide capital and infrastructure; Partnerships will also have to be strengthening between the public financial sector and the private sector, thereby improving awareness.

7.3 Synergies with conventions, treaties and programs

Synergies can provide tangible benefits for biodiversity and it's cost effective. They could also allow avoiding the risk of solution of one problem impacting on another since you ensure solutions take into consideration the ecosystem as a whole. NBSAP could have synergies with a number of conventions such as: UNCCD, UNFCCC, ITPGRA, and Ramsar convention.

These conventions are basically linked and operating in the same ecosystems and addressing interdependent objectives which include: Enhance implementation through participatory planning, knowledge management and capacity building through communications, educations and public awareness, all conventions relay on science-based research and communications with policy makers and traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity.

All conventions could be linked to NBSAP Aichi target 20 as there are different of potential sources of finance, therefore, finance mechanisms could be introduced for

financing biodiversity conservations and sustainable use, these include public finance (annual budget), climate funding including (NAPA integration, REDD and REDD+), environmental fiscal reforms such as park entrance fees, hunting fees, park fees, removal of harmful subsidies , biodiversity offset (mining offset and compensation), private sector involvement, Access and Benefit sharing (ABS), regional and international funding institution.

7.3.1. CBD/ UNCCD/UNFCCC

They are addressing sustainable land management including food security, climate change adaptation and land degradation. There is a linkage between NBSAP (2011-2020) and the UNCCD SAP, both addresses rehabilitation of degraded ecosystems. The CBD/ UNCCD/ and UNFCCC address vulnerability of ecosystems to climate change NBSAP.

The projects from UNFCCC in Sudan include:

7.3.2. CBD/ ITPGRA/ Nagoya protocol

All call for access and benefit sharing, maintenance of genetic diversity of crops and farm animals. These coincide with NBSAP Strategic Goal D: enhance the benefits to all from biodiversity and ecosystem services.

The strategic objective of ITPGRA is the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the CBD and Nagoya Protocol, for sustainable agriculture and food security.

ABS is regarded as suitable framework that provides the country with good basis for developing and implementing related policies and plans for safeguarding the genetic resources and enhancing their sustainable utilization for the benefit of the people and providing access on the basis of fair and equitable benefit. ABS could generate different benefits which could be invested in conservation of biodiversity.

7.3.3. CBD/ Ramsar:

There are some projects and activities related to coastal and marine biodiversity and wetlands funded through the regional organizations such as Regional Organization for Environment Protection of Red Sea and Gulf of Aden (PERSGA).

Chapter 8

8. Implementation Mechanisms and Financing Aspects

The implementation of the NBSAP is a national state responsibility through the different Organizations and institutions at national and sub-national levels. Both government and society have to be aware of their responsibilities towards this NBSAP and act effectively to implement it.

8.1. National capacity assessment for successful implementation of the NBSAP

8.1.1. Strengths and gaps in national capacity for biodiversity management

8.1.1.1. Strengths

- Involvement of many national experts from the different sectors in the development the biodiversity enabling activities and preparing the national biodiversity targets and fifth report will assist in the process of monitoring and evaluation of biodiversity components in the Sudan.
- Availability of experts and specialists in different biodiversity components.
- There are efforts on biodiversity informal educations and learning which include;
 - Documentations (Herbaria): Currently there are only four herbaria in the Sudan namely:
 1. Herbarium of the Range and Pasture General directorate of MoLFR in Khartoum ;
 2. University of Khartoum Herbarium located at the Botany Department, Faculty of Science;
 3. Forest Research Centre Herbarium at Soba; and
 4. Herbarium of the Medicinal and Aromatic Plants Research Institute, Khartoum.
 - Botanical Gardens in Khartoum Exhibitions: events per year include: Horticultural Exhibitions, Biannual Flowers Fairs.
 - FNC Exhibition.
 - Accessibility of Zoos and Protected Areas.
- Specialized Universities (Marine Ecosystem University, Forestry, Rangelands Agriculture, Veterinary, etc...)
- Marine ecosystem education (Tourism, study tours (Universities).
- Endangered species recovery and conservation programmes including:
 - rangeland: Ex- situ conservation which has been practiced for endangered valuable range plants species to restock disappeared species to their natural habitat through reseedling native species and natural successions.
 - FNC: in situ, on-farm and ex situ conservation (forestry reserves & afforestation)
 - Wildlife: protected areas, game reserves and sanctuaries
- Possibility of implementing REDD+ in community-managed forests and rangelands

- Community based management of forest biodiversity.
- Establishment of the Sudan Clearing-House Mechanism (CHM) of the convention on biological diversity.

8.1.1. 2.Gaps

- Lack of awareness on economic value of biodiversity
- Communities and land users have no willingness to pay for conservations & and sustainable use by users
- Inappropriate information system for sharing the information on the PGRFA
- Lack of policies and framework on access to genetic resources and benefit sharing
- Inadequate institutional capacities to address integrated biodiversity managements
- Inadequate government funding for the biodiversity sector.
- Inadequate networking among biodiversity professionals and scientist
- Lack of baseline information on endangered species
- Limited capacities and lack of qualified technical staff in certain fields such as environmental economics, plant taxonomy, lack research capacity to develop appropriate technologies and provide reliable information and technology for sustainable range resources management
- lack of clear policy regulating access and conservation of natural rangelands,
- Lack of clear & officially recognized tenure coupled with doctrinaire structured and formalized land laws and land ordinances which hinder sustainable management
- Inadequate funds and technology for sustainable management of protected areas, rangelands and forests

Table 8.1 Capacity needs for successful implementation of the NBSAP

Needs	Responsible institution	Time Frame				
		1	2	3	4	5
Incorporate biodiversity Syllabus in academic curricula at schools and universities	Mo C I, MEAT, MoE			×	×	
Train communities and those engaged in seed production, on matters related to conservation and utilization of the biodiversity values and techniques of pure seed collection from wild stand	MoAI, MEAT, HECNR, WCS,PAS, SSFS, ENRRI,FNC, RPGD, Universities	×	×	×	×	×
Train coastal communities, pastoralists farmers and others on ecosystems sustainable use and ecosystem based management	WCGA, MEAT ,Relevant Universities	×	×	×	×	×
Train government staff in related institutions on matters related to conservation and monitoring.	HECNR, FNC, RPGD Universities, MoAI, Mo C I, MEAT,M of education					
Awareness raising workshops, advocacy and dialogue for policy makers, local leaders and other stakeholders on biodiversity economic values.	Mo C I, MEAT, Ministry of Education, NGOs,	×	×	×	×	
Encourage media organizations and extension workers to participate in dissemination of information about the impact of invasive species	ARRC	×	×			
Revise professional and technical programs of education range management to serve the objectives of policies and strategies at the local, national and regional levels	RPGD and Universities	×	×			
Establish land users platforms at state and federal levels.	HECNR, MoJ, WCGA, MoAI, Mo C I					
Conducting of genetic diversity studies and researches on :						
- Resource inventories to assess ecosystem status for biodiversity components, Document indigenous knowledge and practices relevant to the conservation and sustainable use of range and animal resources	RPGD, MoAI, HECNR. WCGA, Mo C I		×	×		
-Mapping of vulnerable biodiversity components	RPGD, MoAI, HECNR. WCGA		×	×		
-Research on the role of indigenous knowledge in supporting the livelihood of local communities	RPGD, MoAI, HECNR. WCGA ,M oCI			×		
- Develop selective breeding programs and establish special farms to improve Kenana and Butana breeds of cattle	ARRC			×		
-Climate change resilience and adaptation assessment	HECNR, FNC, RPGD Universities, MoAI .			×	×	
-Systematic surveying and inventorying of plant genetic resources under in-situ or ex-situ conditions	MoLFR, HECNR, FNC, RPGD	×	×	×		
-Conduct and strengthening research on the problems of shifting cultivation and	ARC			×		

traditional farming systems						
Policies, strategies and plan						
Develop risk assessment and management programs and guidelines for newly introduced Species.	MoAI, MoCI, MoEFPD, MoFNE, MoHRDL, MoJ, MoLFR, MoSC, HCENR, HCSP		×			
Measures for the sustainable utilization of natural resources that provide potential food, fodder and medicinal value of aquatic plants	MoAI, MoCI, MoEFPD, MoFNE, MoHRDL, MoJ, MoLFR, MoSC, HCSP			×		
Guidance and regulatory mechanisms on g fair and equitable sharing of benefits arising from using genetic resources	ARC, ARRC, HCENR and relevant institution			×		
formulation of law on access to genetic resources and benefit sharing	M of Justice, RPGD, MoAI, HECNR. WCGA, FNC, MoAI, RPGD, MoAI, HECNR			×		
Development of a policy framework ,a strategy for the sustainable management for conservation and proper use of biodiversity	MoAI, MoCI, MoEFPD, MoFNE, MoHRDL, MoJ, MoLFR, MoSC, HCENR, HCSP, M of Justice	×				
-Development of legislations for the sustainable management for conservation and proper use of biodiversity, taking into consideration the matters related to access and benefit sharing as well as protection of the local communities, farmers and pastoralist rights to biological resources and their indigenous knowledge, practices and technologies	RPGD, HECNR, FNC, Universities, MoAI,		×	×	×	
-Enact laws governing land tenure and land use	M of Justice, RPGD, MoAI, HECNR. WCGA, FNC, MoAI, RPGD, MoAI, HECNR.					
Develop and endorse a plan for introduction of farm animal breeds for specific purposes and areas	HCSP RPGD, MoAI, HECNR.			×	×	
Develop and endorse a plan for the federal as well as the states' authorities to reduce/remove incentives/subsidies or impose penalties for activities that are harmful to terrestrial and marine wildlife biodiversity	MoAI, MoCI, MoEFPD, MoFNE, MoHRDL, MoJ, MoLFR, MoSC		×	×		
Environment impact assessment studies for new development projects	HCENR			×	×	
Integration of biotechnology and biosafety into national development plans	CBGE, ARC, ARRC			×	×	

Technology Needs Assessment

Table 8.2 Existing technologies

Actions to be taken	Agency
1. Remote sensing unit	FNC
2. wild animal genetic resources unit and gene bank	Wildlife Research Center
3. Gene Bank	ARC,ARRC
4. Laboratories ,Vaccines and medicines	MoLFR, Universities CVRL
5. Soil analysis Laboratories ,	MoAI , Universities
6. Feed analysis Laboratories	MoLFR, Universities, CVRL
7. Laboratories ,Vaccines and medicines	MoLFR, Wildlife department
8. PGR Unit / ARC	MoAI

Table 8.3 Technology needs for biodiversity management

Technology needs	Actions to be taken	Implementing Agency
1. Monitoring and evaluation system of biodiversity components.	establishment of standardized full M&E systems and make them part of the work performance	All government institutions
2. Protection of rangelands from seasonal wildfire	Remote sensing unit	RPGD
3. Conservation of local genetic resources of wild animals	Establishment of wild animal genetic resources unit and gene bank	Wildlife Research Center
4. Conservation of forest biodiversity	Establishment of Gene Bank	FNC Research Centre
5. Conservation of local genetic resources of domestic animals	Establishment of wild animal genetic resources unit and gene bank	ARRC
6. Prevention and control of diseases.	Laboratories ,Vaccines and medicines	ARRC
7. Conservation of plant genetic resources for food and agriculture	Provision of Conservation and use facilities	
8. Empowerment of the national biosafety authority to exercise supervision and control over transfer, handling and use of Genetically Modified Organism and to ensure safety of human and animal health and adequate level of protection of the environment	Establishment of Centers of Excellence in biotechnology	HECNR,M of Justice, HCENR, MoAI
Conservation and evaluation of the collected germplasm and in particular conservation of vegetative propagated crops develop feedback mechanism	molecular biology laboratory and in-vitro conservation facility	ARC, MoAI, MoEFPD
	Extension facilities for all biodiversity sectors	MoAI ,MoCI, MoEFPD, MoFNE, MoHRDL, MoJ, MoLFR, MoSC
Documentation and mapping of range plants by region zones	Updating of existing herbarium and establishment of regional range plant herbaria	NCR PAS, RPGD, Farmers and Pastoralists unions and Associations
GMO testing technologies and strengthening of the Laboratories mapping of threatened fauna and flora	Establishment of Gene Bank, development and use of technologies for controlling invasive and alien species	

8.3. Strategy for monitoring and evaluation of NBSAP implementation

As a part of the future implementing phase of the NBSAP strategy, a set of National Biodiversity Indicators upon which the implementation of the strategy and the progress towards the achievement of the target can be evaluated, have to be established and set time frame for the achievement of the national goals and targets. Such indicators should provide an efficient monitoring system. Accordingly, an initial set of national indicators for the NBS are established and may improve over time. The proposed indicators emerged from a preliminary analysis of the national strategic goals and targets, based on the global targets set out at COP10. The indicators will be used for reporting on progress towards the NBSAP targets. At the same time the indicators will assist to determine and monitor national policies on biodiversity and ecosystems.

The matrix presented in table (8.4) below will serve as a guide to assess progress towards 2020 targets and to effectively communicate trends in biodiversity that are related to the three objectives of the CBD. It reflected selected priority actions, performance indicator (s), means of verification and the implementing institution(s).

Table 8.4 Matrix of Targets, priority actions, performance indicators, Means of Verification and implementation

Selected priority actions	Performance Indicator(s)	Means of Verification	Implementing Institutions
Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably			
Establish awareness campaigns for the stakeholders and produce awareness materials on the values of biodiversity and its importance for food security and sustainable development.	Coverage_of_awareness activities /Trends in stakeholders involvement with biodiversity Trends in public awareness in value of biodiversity.	Progress, scientific and office reports and Surveys, CHM	line ministries, HCENR
Launch of awareness campaigns to enlighten the public about importance of biotechnology and bio-safety.	Coverage of awareness activities. % of people aware of importance of biotechnology and bio-safety.	Reports, surveys ,CHM	Ministry of Agriculture and Irrigation, ARC, National Council of Biosafety, HCENR.
Integrate bio-safety principles, range and livestock , forests , wildlife biodiversity issues into education programs	Trends in incorporation bio-safety and biodiversity issues in educational programs	Curricula	M of Educ. line ministries. ARC, National Council of Biosafety, HCENR.
Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.			
Integrate the issues related to biodiversity conservation and sustainable use into the 25 year national strategy (2002-2026) within the remaining period of this strategy.	Trends in incorporation of biodiversity conservation and sustainable use into national plans	5 years plans	Ministries inline, Finance, planning, Animal resources, National council of strategic planning, M of Environ.. and HCENR.
Develop and adopt of a national policy and strategic action plan for the conservation and sustainable use of agro-biodiversity as part of the national policies and strategies for economic and social development.	Existence of national policy and strategic action plan for the conservation and sustainable use of agro-biodiversity.	CHM, Reports , policies and plans	Ministry of Agriculture and Irrigation, ARC, National council of strategic planning

Train civil servants on transforming biodiversity components into items of monetary value.	Trend in training of civil servants on transforming biodiversity components into items of monetary value.	Reports	Ministry of Finance , Central Bank of Sudan, M of Environment, Ministry of Agriculture and Irrigation, universities
Encourage universities to incorporate biodiversity economic accounting in their curricula.	Trends in incorporating biodiversity economic accounting. In university curricular	Curricula	Universities
Aichi Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.			
Encourage the federal as well as the states authorities to reduce/remove incentives/subsidies or impose penalties for activities that are harmful to terrestrial and marine wildlife ,forest resource, and community range biodiversity.	Trends in reduction/ removal of incentives/subsidies or imposition of penalties that harmful to terrestrial and marine wildlife biodiversity	Reports	Ministry of Tourism and wildlife and other ministries in lines at all levels
Aichi Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.			
Develop and operate land use plans and laws governing land tenure and land use.	Existence of land use plans and laws	Laws, plans	Forest, Mini. Of Justice and other ministries
Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources	Trends in integrating principles of sustainable development in policies and programs	Polices, programs, reports	All relevant ministries /sectors
Aichi Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.			
Aichi Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.			

Establish regulations that encourage sustainable fishing, avoid over-fishing to reach a point where fishing has no adverse effects on the ecosystem and poses no threats on endangered species .	Trends in establishment of regulations that encourage sustainable fishing and avoid over-fishing	Regulations, reports, CHM	M of animal resources and fisheries , M of Justice
Introduce ecosystem-based fisheries management to the protected marine parks.	Existence of the system	Reports	M of animal resources and fisheries, wildlife authority,
Strengthen the capacity of the coastal communities to use ecosystem based management for utilization of their resources	Trends in strengthening the capacity of the coastal communities to use ecosystem based management	Reports	M of environment at state level, NGOs.
Develop both social and economic monitoring systems to the nature and distribution of benefit tied to marine resources of protected areas	Existence of monitoring system	Reports	wildlife authority, M of environment at state level
Aichi Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity			
Develop agricultural policy that is based on the sustainability of resources.	Existence of Policies adopted for sustainable management of resources.	Reports, CHM	Ministry of Agriculture and Irrigation, HCENR
Adopt of adequate policies to support diversified production systems, including the use of multi-line varieties as an option for improvement of agricultural production while maintaining diversity.	existence of Policies for supporting diversified production systems	Reports, CHM	Ministry of Agriculture and Irrigation, ARC
Identify of appropriate farmers' varieties/landraces for multiplication and/or for developing new breeding populations that incorporate specific traits into locally adapted materials.	Trends in identification of farmers' varieties/ landraces identified	Reports	Ministry of Agriculture and Irrigation, ARC
Conduct and strengthen research on the problems of shifting cultivation and traditional farming systems.	Trends in conducting and strengthening of researches.	Reports	ARC , Academia
Rehabilitation and establishment of forest plantations in degraded traditional rain-fed areas	Trends in rehabilitation of area under rain-fed rehabilitated. % of forest plantation in rainfed area	Reports	National of forests corporation
Aichi Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function			

and biodiversity.			
Reduce to environmentally acceptable levels the adverse impacts of tradition as well as organized gold mining on wildlife and inland waters and marine habitats	Trends in reduction of the adverse impacts of tradition as well as organized gold mining on wildlife and inland waters and marine habitats	Repots	Ministry of Agriculture and Irrigation, MEAT, HECNR, M of Justice, NGOs, M of Petroleum
Enforce laws for the conservation of biodiversity of the coastal communities around oil-exporting facilities	Trend in the enforcement of laws	Existing Laws, reports	M of environment at state level, HECNR, M of Justice, NGOs, M of Petroleum
Aichi Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.			
Strengthen and capacitate the quarantine services and formulate quarantine laws and other regulations to control import of alien species, pests and diseases	Existence of strengthened quarantine services Existence of quarantine laws and other regulations	Laws, regulations	Forests ,Customs, Ministry of Agriculture and Irrigation., wildlife,
Eradicate invasive alien species that are already been found adverse effects on biodiversity of wildlife, marine, coastal and inland water ecosystems	Trend in eradication of invasive alien species	Reports	All ministries inline
Aichi Target 10:By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning			
Enforce environmental laws and Regulate tourism in the coastal ecosystem to ensure sustainable utilization of the resources	Trend in sustainable utilization of marine and costal zone resources		Ministry of Justice, tourism, environment
Aichi Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.			
Establishment of new protected areas, game reserves and sanctuaries to represent all ecological zones and States and adopting international categories of protected areas and with special attention to inclusion of the	Trends in establishment of protected areas	Reports, CHM	Ministries of environment, tourism and wildlife, forests, HCENR

following ecosystems: The semi-desert , Inland fresh water (<i>khors</i> and <i>wadis</i>), Coastal and marine .			
Aichi Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained)			
Conduct program for the protection of threatened species	Trends in prevention of threatened species	Reports	All relevant ministries
Identify endangered indigenous range species especially those most preferred.	Existence of list of endangered indigenous range species	CHM	
Aichi Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity			
Develop and implement a national strategic action plan for the conservation of plant genetic resources for food and agriculture, domesticated animals and wild relatives. .	Existence of national strategic action plan for the conservation of genetic resources for food and agriculture in Sudan developed	CHM, Plans, Reports	Ministry of Agriculture and Irrigation, ARC
Enhance on-farm conservation of farmers' varieties through improvement of cultural practices for better yields by traditional varieties	Existence of improved cultural practices for better yields by traditional varieties. No. of farmers varieties conserved.	Reports	Ministry of Agriculture and Irrigation, ARC
Approval, adoption and execution of programs for utilization of modern biotechnology (e.g tissue culture and other techniques) in conservation and multiplication of threatened and endangered species and conservation of genetic diversity	Existence of a programs for utilization of modern biotechnology for conservation of genetic diversity	reports	Ministry of Agriculture and Irrigation, ARC
Aichi Target 15:By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.			
Adopt climate-smart farming systems such as agro forestry and agro-silvo pastoral systems that lead to natural regeneration of native species and rehabilitation of degraded and deforested areas ,especially, invulnerable areas(traditional dry land farming.	Trend in rehabilitation of degraded rangelands and forests	Scientific and progress reports	Ministry of Agriculture and Irrigation, ARC, forests, rangelands

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation			
Ratification of the Nagoya Protocol	Existence of national legislating and tools on ABS	CHM, Reports	HCENR
Enactment of necessary national legislations for conservation and sustainable use of biodiversity taking into consideration the matters related to access and benefit sharing as well as protection of the local communities, farmers and pastoralist rights to biological resources and their indigenous knowledge, practices and technologies; including issuance of a national legislation on PGR	Existence of national legislating on Access and Benefit Sharing (ABS) and indigenous knowledge	CHM, Legislations and reports	HCENR and ministries inline
Establish institutional bodies for regulating the access to plant agro-biodiversity and relating indigenous traditional knowledge on the basis of fair and equitable benefit sharing with necessary consideration to farmers' and local community rights in consistence with the international instruments of relevance such as the CBD and the ITPGRFA	Existence of national competent authorities	CHM, Information system	Ministries in lines
Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.			
Develop a national legislation for protection of plant varieties and breeders rights with necessary harmonization with the national and international instruments on the PGR.	Existence of national legislation on traditional knowledge	CHM	Ministries in lines
Documentation of indigenous knowledge, practices and technologies that are associated with the PGRFA and the conservation and sustainable use of forest and rangeland biodiversity	Existence of documentation on indigenous knowledge, practices and technologies produced	Reports, CHM	Ministry of Agriculture and Irrigation, ARC, forests
Enforce the existing land legislation and customary rights concerning land ownership and management of forest resources.	existence of enforced legislations	Legislations, CHM	Ministries in lines
Target 19: By 2020 Improvement of the knowledge and science base on the genetic diversity of plant genetic resources for food and			

agriculture and information sharing mechanisms in order to enhance their use.			
Conduct genetic diversity studies on conserved germ plasm	Trend in conduction of studies on conserved germplasm	scientific reports, CHM	Ministry of Agriculture and Irrigation, ARC
Strengthening the present PGR documentation systems adopted by the PGR Unit / ARC to cover different aspects of PGR information and to use it as a nucleus for a national PGR information system.	the presence of improved documentation system		Ministry of Agriculture and Irrigation, ARC
Establish of national PGR information system for documenting and sharing the information on the PGRFA.	Existence of PGR national information system	CHM, Statistics and information,	Ministry of Agriculture and Irrigation, ARC
Target 20 By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.			
Establishment of a national funding strategy for agro-biodiversity to which different sources of funding can contribute, including a major contribution from the government. Prospects of funding from different other donors have to be tapped through possible national, regional and international Organizations including the private sector.	Assessment of resources needs.. Existence of different effective and financial resources (Resource mobilization plan)	Resource mobilization document Fund raising plan, CHM	Ministries in lines

8.4. Awareness, Communication, and Outreach Strategy

In the context of strategy implementation, awareness, communication and outreach are ways to influence people's knowledge and attitudes and, hence, the actions that they take. For the actions of NBSAPs to be implemented, biodiversity will need to become an urgent priority nationally and locally. This will require a solid communication and public awareness strategy for the national NBSAP Table (8.5) illustrate awareness, communication, and outreach strategy. Set the integral role humans play in conserving biodiversity, an awareness and communications strategy can offer an influential means to help the strategy achieve its conservation goals. The following awareness, communication, and outreach strategy was developed with the aim of supporting the actions taken to address priority issues in the revised NBSAP. The strategy identifies target audiences, key messages, actors and appropriate communication tools and media.

Table 8.5 Awareness, Communication, and Outreach Strategy

Actions	Message to be communicated	Target groups	Communication tools	Actors
Organize Biodiversity awareness campaign , production and dissemination of awareness materials	importance of conserving biodiversity and ecosystems (benefits and services)	All	Brochures, posters, leaflets, fact sheets ,videos , media, CHM etc	HCENR, inline ministries, information.
Promotion of cooperation between different sectors especially private sectors and CBOs to establish strategy for conservation of biodiversity and ecosystems.	The importance of cooperation between different sectors in conservation of biodiversity and ecosystems.	Government Organizations, CBOs, private sector and Other conservation organizations.	Meetings with stakeholders	HCENR, inline ministries
Create awareness activities about the biodiversity and ecosystem services	the economic values of biodiversity and its importance for food security and sustainable agricultural development	Policy makers	CHM, Meetings, seminars, fact sheets.	HCENR, inline ministries
Awareness workshop about the important of protected areas	importance of protected areas	General public specially Local communities, schools located near protected areas	workshop	Wildlife administration, education, NGOs
Awareness campaign/workshop about the importance of coastal and marine biodiversity.	Importance of coastal and marine biodiversity for poverty eradication, sustainable development and other services.	Users , government Organizations	Posters, photos, leaflets, media	Ministries of Environment, livestock and fisheries, Tourism, university and specialized faculties, NGOs

Actions	Message to be communicated	Target groups	Communication tools	Actors
Organize plantation program in Degraded areas.	the role of the forests in environmental protection and forestry biodiversity conservation and sustainable use	Users and local communities, government Organizations.	Posters, photos, leaflets, media, CHM	FNC, NGOs
Identify new species introduced.	Risks related to introduction of alien and invasive species (its impacts on human, animal health, plants and wildlife).	ALL	Reports, studies., CHM ,	Relevant ministries and departments, research institutions.
Establishment of guidelines for management of invasive species	Management of alien and invasive species	ALL	CHM, Involve local people in eradicating or controlling the invasive species, guidelines manual	Professionals
Capacity building to incorporate biodiversity Ecosystem based adaptation plan	Biodiversity and climate change	Stakeholders	Meeting/ workshops, guidance documents	HCENR
Establishment of laws, awareness raising	Benefit sharing arising from utilization of genetic resources and associated traditional knowledge	All	CHM, Seminars, media, meetings.	Ministries of environment, justice, ARC, other line Organizations, NGOs.
Launch of awareness campaigns to enlighten the public about importance of biotechnology and bio-safety.	importance of biotechnology and bio-safety	Public, Gov. Organizations, CBOs	Workshops, meetings, media	Ministry of environment, National council of bio-safety, ARC

8.5. Finance Mobilization

Funding is a major challenge in this regard. While the national government role is major in providing necessary financial resources, all stakeholders have to be as creative and active as possible to obtain funding from different internal and external sources such as Global Environment facility (GEF), and donor organization, government of Sudan, State governments Localities and communities, private sector in coordination with Ministry of Finance and Economic Planning. A Resource mobilization strategy is developed for this purpose.

❖ Technical Committee

As a one of implementing tools it is proposed to formulate a technical committee composed of a group of experts in Biodiversity who work closely with HCENR to develop and update policies and review work plans and advice on biodiversity issues.

❖ The Higher Council for Environment and Natural Resources

- i. Responsible for ensuring that strategy and action plan is being implemented as planned.
- ii. Assists the Trust Fund in raising funds from internal and external sources.
- iii. Coordinates an annual meeting for the Strategy and Action Plan Coordination Committee.
- iv. Monitor progress towards achieving the national targets.

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Appendices

Appendix 1: Thematic implementation plan for plant agro biodiversity

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
Education, training and awareness	Establishing awareness campaigns and activities through organization of different fora targeting key target audiences (Target 1)	780000	2015-2020	MoAF, MoENRPD, HCENR, MoC, MoE, MoP, MoM, MoWRE, MoI, PGR/ARC.
	Production of awareness materials on the values of plant agro-biodiversity and its importance for food security and sustainable agricultural development (Target 1)	200000		
	Media training and awareness activities for putting messages about crop diversity in the public eye (Target 1).	100000	2015-2020	MoAF, MoENRPD,, ARC, MoL, DHR, MoC, MoE, HCENR
	Implement a specialized training program on CHM.	50000	2015	HCENR
	Train civil servants in transforming biodiversity components into items of monetary value (Target 2).	50000	2015-2020	MoAF, CBoS, MoAF, MENRPD, MoL
	Encourage universities to incorporate biodiversity economic accounting in their curricula (Target 2).	157000	2015-2020	University, MoHE
	Training and capacity building in several areas of relevance to conservation and sustainable use of PGRFA including plant identification, population biology, plant taxonomy ethno-botany, use of GIS and GPS, and molecular tools (Target 13).	440000	2015-2020	MoI, HRD, MoAF, ARC, NRC

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	Agricultural Extension in the rain fed agriculture	135000	2015-2020	EDMoA
	Recruitment and training of staff for the national plant genetic resources center and the regional units. Training includes training at the postgraduate level for researchers, and long and short training courses for researchers and technicians in a number of technical, managerial and policy areas (Target 13).	2000000	2015-2020	PGRC, HUR, MoL,
Legislation	Taking necessary legislative and administrative measures to implement the international instruments related conservation and sustainable use of plant agro-biodiversity such as the CBD and ITPGRFA to which Sudan is a party (Target 13)	350000	2015-2017	MoAF, ARC, MoJ, HCENR, MoENRPD, FPTUA, LC, Parliament, and all relevant stakeholders
	Taking necessary legislative and administrative measures to ensure that conservation of PGRFA is a national concern that has to be conducted by governmental institutions and under public domain (Target 13).			
	Issuance of a national legislation on PGR (Target 13).			
	Enactment of necessary national legislations for conservation and sustainable use of biodiversity taking into consideration the matters related to access and benefit sharing as well as protection of the local communities, farmers and pastoralist rights to biological resources and their indigenous knowledge, practices and technologies; including issuance of a			

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	national legislation on PGR (Targets 16 and 18)			
	Establishment of institutional bodies for regulating the access to plant agro-biodiversity and relating indigenous traditional knowledge on the basis of fair and equitable benefit sharing with necessary consideration to farmers' and local community rights in consistence with the international instruments of relevance such as the CBD and the ITPGRFA (<i>Target 16 and 18</i>)	250000	2015-2018	MoAF, ARC, LC, FPTUA, MOFE
	Development of a national legislation for protection of plant varieties and breeders rights with necessary harmonization with the national and international instruments on the PGR (<i>Target 16 and 18</i>).	150000		
Policy	Integrating the issues related to agro-biodiversity conservation and sustainable use into the 25 year national strategy (2002-2026) within the remaining period of this strategy (<i>Target 2</i>).	92000	2015-2020	NCSP, MoAF, ARC, MENRPD, HCENR
	Development and adoption of a national policy and strategic action plan for the conservation and sustainable use of agro-biodiversity as part of the national policies and strategies for economic and social development (<i>Target 2</i>).	50000	2015-2018	MoAF, ,ARC, , NCSP
	Development of agricultural policy that is based on the sustainability of resources (<i>Target 7</i>)	55000	2016-2018	MoAF, FPTUA, MENRPD, ARC, HCENR, MoAF and other relevant stakeholders
	Adoption of adequate policies to support diversified production systems, including	100000	2016-2020	MoAF, FPTUA, MENRPD, ARC, HCENR, MoAF

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	the use of multi-line varieties as an option for improvement of agricultural production while maintaining diversity (Target 7)			and other relevant stakeholders
	Application of crop rotation in traditional rain-fed cultivation on both clay and sand soils (Target 7).	350000	2015-2020	MoAF
	Extending formal and sustainable agricultural extension programs into the rain-fed sector (Target 7)	250000	2015-2020	MoAF, AED
	Development of one national program for biodiversity conservation and management, combating desertification and addressing the issues of climate change (Target 7).	222a000	2016-2020	MoAF, FPTUA, MENRPD, ARC, HCENR, MoAF, NDDCM, and other relevant stakeholders
	Development and implementation a national strategic action plan for the conservation of plant genetic resources for food and agriculture in Sudan (Target 13).	200000	2016-2020	MoAF, ARC, MoAF
	Establishment of a national funding strategy for agrobiodiversity to which different sources of funding can contribute, including a major contribution from the government. Prospects of funding from different other donors have to be tapped through possible national, regional and international agencies including the private sector (Target 20)	50000	2016-2020	MoAF, ARC,
Conservation	In-situ on farm conservation of plant genetic resources for food and agriculture in close collaboration with local farmers and communities (Target 7).	435000	2015-2020	MoAF, ARC
	Identification of appropriate farmers' varieties/landraces	195000	2015-2017	MoAF, ARC,

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	for multiplication and/or for developing new breeding populations that incorporate specific traits into locally adapted materials (Target 7).			FPTUA
	Conduct and strengthening research on the problems of shifting cultivation and traditional farming systems (Target 7).	95000	2015-2020	MoAF, ARC, universities
	Consider integrating the conservation and management of PGRFA, particularly CWR and wild food plants, in land-use plans in the biodiversity hotspots (Target 7).	50000	2015-2020	MoAF, ARC
	Establishment, strengthening and provision of necessary physical, human and financial capacities and building necessary legal and institutional instruments for conservation and sustainable use of PGRFA (Target 13).	400000	2015-2020	MoAF, ARC
	Up-grading the status of the PGR unit of ARC into a national centre responsible for conservation and sustainable use of plant genetic resources for food and agriculture, with following mandate and objectives (Target 13):	190000	2016-2018	MoAF, ARC
	Collecting and conserving samples of PGRFA from Darfur region.	250000	2016-2020	MoAF, ARC
	Collecting and conserving samples of PGRFA from some pockets in central and eastern Sudan (Target 13)	240000	2016-2017	MoAF, ARC
	Collecting and conserving samples of range and pasture plant genetic resources (Target 13).	125000	2016-2020	MoAF, ARC, MoARF, DRPL
	Collecting and conserving samples of date palm genetic resources (Target 13).	125000	2015-2017	MoAF, ARC
	Collecting and conserving samples of wild relatives of crops (Target 13).	140000	2016-2019	MoAF, ARC

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	Measures to be taken for safe duplication of germplasm materials inside and / or outside the country (Target 13).	150000	2015-2020	MoAF, ARC
	Restoration of germplasm of local farmers' varieties into the original farming systems in disasters and war affected areas, or where requested (Target 13).	100000	2016-2020	MoAF, ARC
	Priorities should be set for collecting plant genetic resources throughout the country to rescue material that may soon disappear in the field or be subjected to catastrophes such as war, epidemics or drought (Target 13)	150000	2015-202	MoAF, ARC
	Establishment of <i>in-vitro</i> conservation facility and field gene banks for the conservation of vegetatively propagated crops such banana, date palm, and garlic (Target 13).	300000	2016-2020	MoAF, ARC
	Promotion of the effective use of the <i>in-vitro</i> culture methods for conservation and propagation of endangered species (Target 13).	120000	2015-2020	MoAF, ARC
	Taking necessary measures to ensure proper management of current field gene banks of fruit plants that are under the management of the PGR Unit / ARC or others (Target 13).	200000	2015-2020	MoAF, ARC
	Regeneration program is to be executed for the current collections in the PGR Unit/ARC (Target 13).	250000	2015-2020	MoAF, ARC

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	Retrieval of Sudanese germplasm conserved abroad; especially from the CG IARCs (Target 13)	185000	2015-2020	MoAF, ARC, Customs , SSMO
	Systematic surveying and inventorying of plant genetic resources under <i>in-situ</i> or <i>ex-situ</i> conditions (Target 13).	2200000	2016-2019	MoAF, ARC
	Enhancing on-farm conservation of farmers' varieties through improvement of cultural practices for better yields by traditional varieties (Target 13).	145000	2015-2020	MoAF, ARC
	Developing a monitoring and early warning system on the PGRFA using the national PGR information sharing mechanisms (Target 19).	450000	2016-2019	MoAF, ARC
Sustainable use	Development of core collections from big collections under conservation in the PGR Unit / ARC such as those of sorghum and pearl millet (Target 13).	200000		Agricultural Research Corporation
	Establishment of participatory activities between gene bank, breeders and farmers for promoting the use of the local germplasm including farmers' varieties (Target 19).	22000	2015-2020	MoAF, ARC , NRC, Universities, Farmers
	Conducting genetic diversity studies on conserved germplasm (Target 19).	50000	2015-2020	Universities
	Expanding characterization, evaluation and further development of specific subsets of collections (Target 19):	150000	2015-2020	Ministry of Agriculture
	Restoration of traditional varieties in war or disaster-affected areas as in Darfur,	100000	2016-2018	ARC,MoAF

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	South Kordofan and Blue Nile states (Target 13).			
	Promotion of under-utilized and neglected crops and varieties (Target 19)	160000	2015-2020	MoAF, ARC, NRC, Universities, Information, farmers.
	Promotion of seed production systems both at local and national levels including farmers and local communities' initiatives and mechanisms (Target 19).	180000	2015-2020	MoAF, ARC, NRC, LC, Universities, Information, Media, farmers
	Making available to the concerned bodies and communities the necessary characterization and evaluation information to assist in identifying useful accessions for restoring crop systems, respecting access and benefit-sharing agreements (Target 19).	50000	2015-2020	ARC. MoAF
	Strengthening the present PGR documentation systems adopted by the PGR Unit / ARC to cover different aspects of PGR information and to use it as a nucleus for a national PGR information system (Target 19).	205000	2015-2019	MoAF, ARC, NRC, Universities, Information, Media, farmers
	Documentation of indigenous knowledge, practices and technologies that are associated with the PGRFA (Targets 18 and 19).	150000	2016-2018	MoAF, ARC, NRC, Universities, Information, Media, farmers
	Establishment of national PGR information system for documenting and sharing the information on the PGRFA (Target 19).	100000	20176-2017	MoAF, ARC, NRC, Universities, Information, Media, farmers
	Publication of germplasm catalogues (Target 19).	50000	2016-2017	MoAF, ARC, NRC, Universities, Information, Media, farmers

Theme	Action and Aichi Target	Cost US\$	Time frame	Implementing Agencies
	Strengthening extension and extension facilities to develop a feedback mechanism (Target 19).	60000	2015-2018	MoAF, ARC

Appendix 2: thematic implementation plan for forest biodiversity conservation action plan

Theme	Actions	Cost (US\$)	Time frame	Implementing Agencies
Education, Training and Awareness	Undertake awareness campaigns and disseminate forestry biodiversity awareness materials: posters, leaflets, fact sheets ,videos etc.(Target 1).	195000	2015-2020	MoAF, MoENRPD, NFC, HCENR, MoC, MoE, MoP, MoM, MoWRE, MoI, PGR/ARC...etc
	Implement a specialized training program on CHM	50000	2015	HCENR
	Promote and integrate forestry biodiversity issues into educational institutions (Target 1).	40000	2015-2020	MoAF, MoENRPD, NFC, HCENR, MoC, MoE, MoP, MoM, MoWRE, MoI, PGR/ARC...etc
	Sustainable agricultural extension programs in forests protection and biodiversity conservation, particularly, in the rain-fed sector (climate change hotspots) (Target 1).	50000	2015-2020	NFC Extension unit
	Extend formal and Adjustment of professional and technical programs of education in forestry to serve the objectives of policies and strategies at the local, national and regional levels (Target 4)	70000	2015-2020	NFC, Universities, CBO

Theme	Actions	Cost (US\$)	Time frame	Implementing Agencies
	Encourage universities to incorporate biodiversity economic accounting in their curricula (Target 2).	45000	2015-2020	Universities, Faculties of Forest and Economics, FNC,
	Train relevant civil servants and stakeholders in transforming biodiversity components into items of monetary value (Target2)	57000	2015-2020	FNC, PGR,ARC, Sudanese tree planting society, HRD
	Capacity building for conservation and sustainable use of forest genetic resources (Target 19).	50000	2015-2020	FNC, PGR,ARC, Sudanese tree planting society, HRD
legislations	To stop illegal activities in forests which influence their degrading through law enforcement(Target 4).	60000	2015-2020	MoJ, MoAF, NFC, FPTUA, MoFE, HCENR, Land use
	Development and operate land use plans and laws governing land tenure and land use (Target 4).	150000	2015-2020	MoJ, MoAF, NFC, FPTUA, MoFE, HCENR, Land use and relevant stakeholders
	Development and strengthening implementation of a policy, and regulations and legislations for the sustainable forest management, conservation and uses (Target 4).	150000	20175-2018	NFC, MoAF, NCSP, National Assembly
	Enforcement of existing land legislation and customary rights concerning land ownership and management of forest resources (Target 18)	50000	20175-2018	NFC, MoAF, MoJ
Policies	Enhancing the contribution of the forests to the national economy, considering the preservation of the biodiversity (Target 2).	50000	2015-2020	NFC, Private sector, MOFNE ,
	Taking forestry resources as a means for rural development and strategy for poverty alleviation (Target 2).	150000	2015-2020	MOFNE

Theme	Actions	Cost (US\$)	Time frame	Implementing Agencies
	Distribution of free or subsidized seedlings to encourage rural communities to establish community forests (Target 3).	200000	2015-2020	NEC, CBOs, NGOs,
	Provide incentives and benefits to communities involved in sustainable management of forest resources (Target 3).	250000	2015-2020	NFC, CBOs
	Provide subsidies and encourage the development of alternative energy sources to firewood/charcoal such as solar, gas, hydro- and electricity (Target 3).	150000	2015-2020	NFC, MoWRE, MoP, Energy research center
	Involvement of local communities in forest management, protection and utilization (Target 4)	125000	2015-2020	NFC, CBOs, LCs
	Integration of forest biodiversity conservation agenda into the FNC development plans(Target 4).	150000	2016-2020	NFC, NCSP
	Integrating biodiversity issues into the 25 year national strategy (2002-2026) within the remaining period of this strategy(target4).	200000	2016-2020	NFC, NCSP
	Promote collaboration between relevant government institutions and local communities in the use and adoption of these practices (Target 18).	150000	2015-2020	NFC, NCSP, LCs
	Encourage the private sector to invest in forest plantations including opportunities for commercial forest production (Target 20).	200000	2015-2020	NFC, Private sector
	Strengthen partnership among government organizations, NGOs and the private sector for establishment of financial mechanism for the conservation of forest biodiversity (Target 20).	200000	2015-2020	NFC, Private sector, NGOs

Theme	Actions	Cost (US\$)	Time frame	Implementing Agencies
	Translation of policies and legislation into simpler forms and involve stakeholders in policy reforms(Target 1).	250000	2015-2020	NFC, MoJ, relevant institutions
Conservation	Rehabilitation and establishment of forest plantations in degraded traditional rain-fed areas (Target 7)	350000	2015-2020	FNC, FRC/ARC, MoAF, CBOs
	in situ, on-farm and ex situ conservation and manage of reserved forests in representative ecosystems (Target 7)	450000	2015-2020	NFC, NTSC/ FRC/ARC, CBOs, remote sensing , land use
	10% of proposed reserved forest registered as reserved forests and established by reforestation and mainly stocked by indigenous species (Target 12)	250000	2016-2018	NFC, MoAF and relevant stakeholders
	Establish protected area(s) (in-situ) in representative ecosystems for the conservation of forest biodiversity (Target 12).	2000000	2016-2020	FNC , wild life Authority
	Ex-situ conservation as an "insurance policy" against extinction (Target 12).	350000	2015-2020	MoAF. NFC
	Adoption of climate-smart farming systems such as agro-forestry and agro-silvo pastoral systems that lead to natural regeneration of native species and rehabilitation of degraded and deforested areas ,especially, in vulnerable areas(traditional dry-land farming) (Target 15).	200000	2015-2020	MoAF. NFC
	Save wood by the dissemination of alternative sources of energy and energy saving techniques (Target 15).	450000	2015-2020	MoAF. NFC, Energy research center, MoWRE, private sector
	Creation of shelter belts as a measure of boosting agricultural yield and protection purposes such as sand dune fixation (Target 15).	350000	2015-2020	MoAF. NFC, Communal tree planting, Youth, students and woman Unions, NDDCM, private

Theme	Actions	Cost (US\$)	Time frame	Implementing Agencies
				sector
	Rehabilitation and restoration of the natural forests for biodiversity conservation (Target 15).	400000	2015-2020	MoAF, NFC
	Enhance access to forest genetic resources and the associated traditional knowledge (Target 18)	150000	2015-2020	MoAF, NFC and relevant stakeholders
	Research on forest genetic resources assessments and development of resources conservation plans (Target 19).	100000	2015-2020	MoAF, NFC , NCSP
	Research on the use of tissue culture for forest genetic resources conservation (Target 19)	100000	2015-2020	MoAF, NFC, FRC
	Evaluate the role of protected forests in protection of biodiversity (Target 19).	100000	2016-2017	MoAF, NFC HCENR
	Development of a program for combating desertification and addressing the issues of climate change (Target 15).	150000	2016-2018	MoAF, NFC
Sustainable use	Apply crop rotation/sequence in traditional rain-fed cultivation on both clay and sand soils (<i>Target 5</i>).	250000	2015-2020	MoAF, NFC
	Research on the problems of shifting cultivation to develop agro-forestry systems in the climate change sensitive areas (<i>Target 19</i>).	100000	2015-2020	ARC, FRC
	Support and promote the utilization of traditional practices and indigenous knowledge that are beneficial to the sustainable management and exploitation of forest biodiversity (<i>Target 18</i>).	100000	2015-2020	MoAF, NFC, MoC and information

Theme	Actions	Cost (US\$)	Time frame	Implementing Agencies
	Document indigenous knowledge and practices relevant to the conservation and sustainable use of forest biodiversity (<i>Target 18</i>)	200000	2016-2018	MoAF, NFC, , MoC and information

Appendix 3: Thematic implementation plan for conservation of the biodiversity of rangelands and livestock

Theme	Recommended Actions			Implementing Agencies
Awareness, Training and Education	Enhance awareness among policymakers, legislators, pastoral and farmer communities and other stakeholders regarding the importance of conserving and judiciary using rangelands and livestock for sustainable production and protection of the environment and biodiversity for future generations through organizing campaigns mass media, workshops, as well as meeting relevant policymakers.(Aichi target	365000	2015-2020	MoC, information, Media, Radio, TV, Newspapers, MoAF , MoM, MoP, MoE, MoWRE, , HCENR , Range and Pasture),NGOs
	Introduce range and livestock biodiversity issues in education curricula at all levels (Aichi target 1)	250000	2015-2020	MoE, MoAF, Range and pasture, HCENR, Universities , specialized colleges
	Train relevant civil servants and other stakeholders in transforming biodiversity components into items of monetary value.	447000	2015-2020	MFNE, CBS
	Implement a specialized training program on CHM	50000	2015	HCENR
	Encourage universities to incorporate biodiversity economic accounting in their curricula(Aichi target 2).	335000	2015-2020	Universities, HCE, MoE, Range and Pasture dept.
	Determine the real monetary value of rangelands (now neglected) for use to convince policymakers of the contribution of rangelands and their biodiversity to the economy and poverty reduction(Aichi Target 2)	320000	2016-2017	MoAF, Range and Pasture dep and relevant stakeholders
	Integrate biodiversity issues into the 25 year national strategy (2002-2026(Aichi Target 4)	500000	2016-2020	MARFRP; MoAF, NCP

Theme	Recommended Actions			Implementing Agencies
	Revise professional and technical programs of education in range management to serve the objectives of policies and strategies at the local, national and regional levels(Aichi Target 4)	200000	2016-2020	MARFRP;, MoE
	Conduct research for better understanding the scientific basis of ability of range plants to tolerance fire, grazing pressure, water stress and nutritional qualities (Aichi Target 19).	320000	2015-2020	ARC, Universities
	Conduct research for better understanding the scientific basis of desirable characters of farm animals with emphasis on tolerance to disease, high productivity, and tolerance to harsh environments (Aichi Target 19).	240000	2015-2020	ARC, Universities
Legislation	Enact laws governing land tenure and land use. (Aichi Target 4)	190000	2015-2020	MoJ, MoAF, National Legislative Assembly
	Development of legislations for the sustainable management of rangelands for conservation and proper use of biodiversity (Aichi Target 4)	580000	2015-2020	MoJ, MoAF, State Legislative Assemblies at state level, ARFRP, MoFE,land use
	Develop a vision for sustainable use of range resources and enact laws governing land tenure and land use (Aichi Target 4).	890000	2016-2017	M MoJ, MoAF, State Legislative Assemblies at state level ARFRP, HCENR, FPTUA, MoFE, land use
Policies	Provide incentives and benefits to communities involved in sustainable management of community range(Aichi Target 3	540000	2015-2020	MoAF, FPTUA , private sector, MFNE,
	Development of a policy framework ,a strategy for the sustainable management of rangelands for conservation and proper use of biodiversity	540000	2016-2018	MFNE, MARFRP, Legislative councils

Theme	Recommended Actions			Implementing Agencies
	(Aichi Target 4)			
Conservation	Distribute new water sources in a way that reduces overgrazing (Aichi target 3).	2250000	2015-2020	State Ministries of Agriculture, MoWRE
	Encourage pastoralists and farmers to collect and broadcast seeds of endangered range species. (Aichi Target 3).	540000	2015-2020	MoAF, ARC, MARFRP, Research center for animal resources
	Encourage establishment of small scale individual range properties through giving title to land.(Aichi Target 3).	345000	2015-2020	MARFRP
	Develop and endorse a plan for introduction and propagation of range plant species for specific areas (Aichi Target 5).	750000	2016-2017	MARFRP
	Identify endangered indigenous range species especially those most preferred Aichi Target 12).	100000	2015-2018	MARFRP
	Establish areas where pure local animal breeds/types are kept remote from mixing (Aichi Target 13)	830000	2015-2020	MARFRP
	Rehabilitation of degraded rangelands through reseeding with palatable plant species (Aichi Target 15)	500000	2015-2017	MARFRP
	Mobilize funds from government, international donors, NGOs and other stakeholders (Aichi Target 20).	50000	2015-2020	MARFRP
Sustainable Use	Document indigenous knowledge and practices relevant to the conservation and sustainable use of range and animal resources (Aichi Target 18). Engage some modern practices with indigenous ones	500000	2016-2017	MARFRP, FPUTA
	Conduct animal census to allow a better understanding of the resource capability and the extracting units (Aichi Target 19).	75000	2016-2017	MARFRP

Appendix 4: thematic implementation plan for conservation of the biodiversity of wildlife, marine and in-land waters ecosystems

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
Education Training and Awareness,	Organize workshops and meetings with identified stakeholders to raise awareness about the importance of conservation of biodiversity (Aichi Target 1)	410000	-2015 2010	MoE, MoC, MoI, MoTWL, NGOs, ,HECNR,CBOs
	Design and implement awareness programs on the importance of conservation of the wildlife and marine ecosystems (Aichi Target 1)	300000	-2015 2020	MoE, MoC, MoI, MoTWL, NGOs, ,HECNR
	conduct awareness programs for the local communities for sustainable use of natural resources(Aichi Target 1)	150000	-2015 2020	MoE, MoC, MoI, MoTWL, NGOs, ,HECNR
	Educational programs on the important of conservation of biodiversity through establishment of wildlife reserves/protected areas and the welfare of the local communities (Aichi Target 1)	200000	-2015 2020	MoE, , MoTWL, NGOs, HECNR
	spread awareness among local communities about the long-term value of establishment of new protected areas (Aichi Target 1)	440000	-2015 2020	MoE, , MoTWL, MoENRPD, NGOs, CBOs, HECNR
	Increase awareness of ecosystems and economic values of protected areas within the local community (Aichi Target 1)	300000	-2015 2020	MoE, , MoTWL, MoENRPD, NGOs, CBOs, HECNR
	Incorporate economic valuation of conservation of wildlife, marine and inland water ecosystems into educational programs(Aichi Target 2)	200000	-2016 2017	MoE, , MoTWL
	Train civil servants in transforming biodiversity components into items of monetary value. The training must cover the following stakeholders (Aichi Target 2)	170000	-2015 2020	MoFNE, CBS
	Implement a specialized training program on CHM	40000	2015	HCENR
	To encourage universities to incorporate biodiversity economic	300000	-2015	Universities, High education

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	accounting in their curricula (Aichi Target 2)		2020	
	Strengthen the capacity of the coastal communities to use ecosystem based management for utilization of their resources (Aichi Target 6)	400000	-2015 2020	MoTWL, MoE in Red Sea state, HRD
	Conduct training programs on community-based management for coastal and protected areas communities. (Aichi Target 12)			
	Design and implement programs for capacity building in the planning, establishment, management and financial sustainability of protected areas and national and regional systems of protected areas (Aichi Target 19)	500000	-2015 2020	MoJ, MoTWL
Legislation	Establish regulations that encourage sustainable fishing, avoid over-fishing to reach a point where fishing has no adverse effects on the ecosystem and poses no threats on endangered species (Aichi Target 6)	300000	-2016 2018	MoJ, MoTWL
	Enforce laws for the conservation of biodiversity of the coastal communities around oil-exporting facilities (Aichi Target 8)	200000	-2015 2018	MoJ, MoTW, MoP, MoE Red Sea atate
Policies	Integrate sustainable use of resources into national plan for poverty reduction (Aichi Target 2)	170000	-2015 2020	MoTWL, MoFNE
	Encourage the federal as well as the states authorities to reduce/remove incentives/subsidies or impose penalties for activities that are harmful to terrestrial and marine wildlife biodiversity (Aichi Target 3)	200000	-2016 2020	MoTWL, MoP and companies, MoI, MoM, and all relevant stakeholders
	Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources (Aichi Target 4)	250000	-2016 2020	MoTWL, HCENR, and all relevant stakeholders
	Promote more contribution of protected areas to local and national economies (Aichi Target 4)	200000	-2015 2020	MoFNE

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	Encourage the private sector to invest in ecotourism (Aichi Target 4)	250000	-2015 2020	MoTWL, HCENR
	Reduce/remove incentives/subsidies or impose penalties for activities that pollute the natural habitats of terrestrial, inland water and marine flora and fauna (Aichi Target 8)	200000	-2015 2020	MoTWL and relevant stakeholders
	Reduce to environmentally acceptable levels the adverse impacts of tradition as well as organized gold mining on wildlife and inland waters and marine habitats (Aichi Target 8)	250000	-2015 2020	MoTWL, MoM
	Regulate tourism in the coastal ecosystem to ensure sustainable utilization of the resources (Aichi Target 10)	350000	-2015 2020	MoTWL and relevant stakeholders
	Mainstreaming of migratory soaring bird species into existing and future conservation projects (Aichi Target 12)	200000	-2015 2020	MoTWL and relevant stakeholders,
	Mainstreaming wildlife conservation in other sectors and land use plans	200000	-2015 2020	MoTWL and all relevant sectors
	Encourage active participation of the local communities and authorities in formulating policies and management of the protected areas (Aichi Target 14)	200000	-2015 2020	MoTWL, CBOs, LC
	Enhance the role of research in wildlife policies and management (Aichi Target 19)	500000	-2015 2020	MoTWL, Wild life research center
Conservation	Environment impact assessment studies for new development projects should assure the value of conserving biodiversity (Aichi Target 4)	200000	-2015 2020	MoFEN, MoTWL, Wildlife Authority, HCENR, and relevant stakeholders
	Conservation of Areas that constitute a unique habitat for endangered wildlife species. (Aichi Target 5)	500000	2015- 2020	MoTWL Wildlife Authority
	Introduce ecosystem-based fisheries management to the protected marine parks (Aichi Target 6)	250000	2015- 2019	MoTWL Wildlife Authority, MoAF

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	Design and implement a effective ecological monitoring system	200000	2016-2017	MoTWL, MoA Wildlife Authority F
	Enforce strict control on the introduction of alien species specially to the wildlife and marine ecosystems (Aichi Target 9)	400000	2015-2020	MoTWL, MoAF, all other relevant ministries, Customs, SSMO, Security authorities, HECNR,
	Eradicate invasive alien species that are already been found adverse effects on biodiversity of wildlife, marine, coastal and inland water ecosystems (Aichi Target 9)	400000	2015-2020	MoTWL, MoAF, all other relevant ministries, Customs, SSMO, Security authorities, HECNR
	Establishment of new protected areas, game reserves and sanctuaries to represent all ecological zones and States and adopting international categories of protected areas and	300000	2015-202	MoTWL Wildlife Authority all other relevant
	Establishment of protected areas for the following species and habitats: a) Habitats of Nubian Ibex, Klipspringer b) One of the non-Nilotic lakes such as Kundi and Abayd. c) In low rain fall zone: Khor Yabous up to the border with Southern Sudan, South of Talodi (South Kordofan), Upper Jebel Marra, Garsila (Darfur), Shu'ab Rumi,, d) One in the north and one in the south of the Red Sea coast. e) Southern part of Lake Nubia, f) Sudanese stretch of Wadi Alalagi (Aichi Target 11)	300000	2015-202	MoTWL Wildlife Authority all other relevant
	Improve management effectiveness (Implement existing management plans and formulate management plans for areas without) (Aichi Target 11)	300000	2016-2018	MoTWL Wildlife Authority
	Reintroduction of extinct species	300000	2016-2018	MoTWL Wildlife Authority
	Establishment of a zoo park and aquarium(Aichi Target 12)	1500000	2016-2020	MoTWL Wildlife Authority and relevant stakeholders

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	Continue monitoring coral reef habitats to include fish, corals, mangroves, seaweeds, turtles and birds(Aichi Target 12)	50000	2015-2020	MoTWL Wildlife Authority
	Identify if any of the marine inland and wildlife species are threatened and conduct habitat restoration(Aichi Target 12)	300000	2016-2018	MoTWL, Wildlife Authority
	Establishment of wild animal genetic resources unit and gene bank within the Wildlife Research Center for the conservation of local genetic resources of wild animals. (Aichi Target 12)	1500000	2016-2020	MoTWL, Wildlife Authority WRC
	Update information on the status of wildlife biodiversity after the cessation of South Sudan (Aichi Target 19)	200000	2016-2018	MoTWL, Wildlife Authority WRC
	Conduct exploration and research on non-Nilotic inland water ecosystems (Aichi Target 19)	200000	2015-2016	Research centers and universities
	Conduct research on the aquatic biota of the Nile Basin in a subsystem perspective(Aichi Target 19)	200000	2015-2020	WRC, , Relevant departments in Universities , research centers
	Conduct surveys on the biodiversity of the habitats representing the low rainfall wooded grassland ecosystems(Aichi Target 19)	100000	2016-2020	WRC, Universities
	Conduct research on the status of endangered endemic wildlife species(Aichi Target 19)	150000	2015-2020	WRC, , Relevant departments in Universities , research centers
	Developing, apply and transfer appropriate technologies for maintenance and conservation of protected areas(Aichi Target 19)	200000	2015-2020	MoTWL, Wild life Authority
	availing national and international funding for conservation projects (Aichi Target 20)	120000	2015-2020	MoTWL, Wild life Authority,
Sustainable Use	Integrate the principles of sustainable development into country policies and	120000	2016-2020	MoTWL, Wild life Authority, HCENR,

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	programmes and reverse the loss of environmental resources (Aichi Target 4)			WRC
	Encourage measures for the sustainable utilization of natural resources that provide potential food, fodder and medicinal value of aquatic plants (Aichi Target 14)	80000	2015-2020	MoTWL, Wild life Authority, WRC, MoAF, Range land dept, ARC

Appendix 5: thematic implementation plan for biotechnology and biosafety aspects for biodiversity conservation

Theme	Recommended Actions	Cost US\$	Time frame	Implementing Agencies
Awareness, Training and Education	Launching of awareness campaigns to enlighten the public about importance of biotechnology and biosafety (Aichi Target 1).	150000	2015-2020	National Council for Biosafety, MoC, MoI, MEAT, MoE, NGOs, HECNR
	Production and dissemination of awareness and educational materials on the concepts of modern biotechnology and biosafety and their importance in biodiversity and sustainable development of the agricultural sector(Aichi Target 1).	100000	2015-2020	National Council for Biosafety, MoC, MoI, MEAT, MoE, NGOs, HECNR
	Integration of biosafety principles into education programs (Aichi Target 1).	100000	2016-2020	National Council for Biosafety, MoI, High education, universities ,HCENR
	Capacity building for effective participation of the national biosafety authority in biosafety clearing house of the Cartagena Protocol (Aichi Target 5).	100000	2015-2020	National Council for Biosafety, HCENR, HRD
	Initiation of a national program to upgrade technical capacity to carry out transgenic research and development and to implement biosafety regulatory systems (Aichi Target 6).	300000	2016-2020	National Council for Biosafety, HCENR, HRD, research centers

Theme	Recommended Actions	Cost US\$	Time frame	Implementing Agencies
Legislation	Strengthen capacity for enforcing biosafety legislations (Aichi Target 16).	250000	2015-2020	MO AF. HECNR, M o J
Policies	Development of a national action plan and relevant programs for the utilization of modern biotechnology for the acceleration of the development of the agricultural sector and the national economy at large with sustainable utilization of biodiversity (Aichi Target 2).	200000	2016-2020	MO AF , MoFNE , ,Biosafety council , NCSP
	Integration of biotechnology and biosafety into national development plans (Aichi Target 2).	200000	2016-2020	MO AF , MoFNE , ,Biosafety council , NCSP,ARC
	Establishment of Centers of Excellence in biotechnology (Aichi Target 13).	250000	2016-2020	Biosafety council ,MoAF , ,ARC
	Empowerment of the national biosafety authority to exercise supervision and control over transfer, handling and use of GMOs and to ensure safety of human and animal health and adequate level of protection of the environment	700000	2016-2019	Biosafety council, HRD
	Promotion of research and development in soil biotechnology (Aichi	200000	2015-2020	Biosafety council, research centers, universities

Theme	Recommended Actions	Cost US\$	Time frame	Implementing Agencies
	Target 19).			
	Establishment of Biosafety information system on gene flow parameter data, effect of GMOs on non-target organisms, allergenicity and toxicology of GM products (Aichi Target 19).	300000	2015-2016	Biosafety council
	Establishment of funding strategy, mechanisms and programs to finance biotechnology and biosafety. Potential funding bodies include the Sudanese government, international downers and the private sector(Aichi Target 20).	100000	2015-2016	Biosafety council
Conservation	Approval, adoption and execution of programs for utilization of modern biotechnology (e.g. tissue culture and other techniques) in conservation and multiplication of threatened and endangered species and conservation of genetic diversity (Aichi Target 13).	250000	2016-2018	Biosafety council, Research centers, tissue culture centers
Sustainable Use	Development of a national action plan and relevant programs for the utilization of modern biotechnology for the acceleration of the	250000	2016-2017	Biosafety council, MoAF, MoENE, NCSP

Theme	Recommended Actions	Cost US\$	Time frame	Implementing Agencies
	development of the agricultural sector and the national economy at large with sustainable utilization of biodiversity(Aichi Target 4).			

Appendix 6: thematic implementation plan for management of invasive alien species

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
Awareness, Training and Education	Develop and implement a public awareness program about the Invasive species and their impact on biodiversity and livelihood of the local communities (Aichi Target 9).	150000	2015-2020	MoE , MoCI, al relevant ministries, HECNR CBOs, NGOs,
	Encourage media organizations and extension workers to participate in dissemination of information about the impact of invasive species (Aichi Target 9).	100000		
	Support education institutions to incorporate issues of invasive species, identification, prevention, eradication and management into their curricula (Aichi Target 9).	250000	2015-2020	M of Culture, M of Information, MEAT, M of education, NGOs, SECS,HECNR
	Develop database of invasive species, identification guides and make the information accessible to the stakeholders (Aichi Target 9).	200000	2015-2020	All relevant institutions
	Qualify and train taxonomy specialists in plants, animals, forestry, wildlife, fishery, birds and insects. (Aichi Target 9)	150000	2015-2020	MoAF, MoAFPL and relevant institutions
Legislation	Harmonize state and sectoral rules and regulations relevant to invasive species and formulate policy and legislation for the control of introductions, movement and management of alien invasive species (Aichi Target 9).	150000	2015-2020	MoJ and all relevant ministries
	Enforcing the international regulation for maritime activities related to disposal of waste and ballast water. (Aichi Target 9)	100000	2015-2020	MoJ and all relevant ministries
	Penalties for illegal activities within the declared protected	150000	2015-2020	MoJ and all relevant ministries

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	areas, game reserves and sanctuaries should be strictly enforced. (Aichi Target 9)			
Policies	Strengthen quarantine measures and border control to ensure that intentional introductions are subject to appropriate authorization (Aichi Target 9)	250000	2015-2017	MoAF , Quarantine, customs
	Development of risk assessment and guidelines for recent introduced species	100000	2016-2017	MoAF, MoTWL, MoAFRP and all relevant ministries
	Develop and implement effective response procedures for the prevention of new potential invasive species (Aichi Target 9).	150000	2016-2018	MoAF, MoTWL, MoAFRP and all relevant ministries
Conservation	Identify invasive species problems and recommend management actions (Aichi Target 9).	200000	2015-2017	MoAF, MoTWL, MoAFRP, Customs, Quarantine , and all relevant ministries
	Develop appropriate methods to monitor, prevent and stop spread of invasive species (Aichi Target 9).	250000	2015-2017	MoAF, MoTWL, MoAFRP, Customs, Quarantine , and all relevant ministries
	Assess the movement of invasive species and develop maps of distribution of the most important invasive species (Aichi Target 9).	500000	2016-2017	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries
	Formulate and implement result oriented research on characterization of invasive species; vulnerability of ecosystems, social and economic impact; prevention, control, eradication and management methods (Aichi Target 9).	200000	2016-2017	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries
	Promote research on the use of traditional knowledge in the development and implementation of measures to manage invasive species	150000	2015-2020	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries

Theme	Recommended Actions	Costs US\$	Time frame	Implementing Agencies
	(Aichi Target 9).			
	Develop invasive species management plans that emphasize prevention of introductions, control and eradication of invasive species (Aichi Target 9).	500000	2016-2017	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries
	Develop effective systems and tools for monitoring and evaluation of invasive species (Aichi Target 9).	350000	2016-2018	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries
Sustainable Use	Strengthen an existing institution to coordinate research, management and eradication of alien invasive species (Aichi Target 9).	250000	2015-2017	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries.
	Produce an inventory of invasive species and evaluate their economic, social and environmental impacts (Aichi Target 9)	240000	2015-2018	MoAF, MoTWL, MoAFRP, Research centers , universities Customs, and all relevant ministries