

these institutes has been directed towards research and educational purposes (Mahdi, 1994).

2.10.2. Biodiversity of microbes and food biotechnology

Dirar (1997) noted that Sudan has over 80 indigenous fermented foods and beverages that are distinctly different from each other. This indicates an extensive variety and biodiversity in the microflora of the country.

For example, "kisra", which is the staple food of the majority of Sudanese people, was studied by many workers (Mohamed *et al.*, 1991; Hamad *et al.*, 1992; El Khalifa and El Tinay, 1993, Hamad *et al.*, 1997, Farahat, 1998). In spontaneous sorghum fermentation, Mohamed (1991) isolated seven species of bacteria, two species of yeast and four species of moulds.

2.10.3. Biodiversity of industrial microbes and biotechnology applications in Sudan

Hamad (1986) isolated 29 different yeast species from samples taken from 9 locations in the Sudan. Some species were represented by up to 7 different strains (Baerwald & Hamad, 1984).

Some yeast strains were described as thermoat 50°C and osmotolerant in 60% sugar. Others have the ability to metabolize complex carbohydrates such as starch and inulin and to produce or alcohol. One of these yeast was tested for the production of single cell protein (SCP) and ethanol from molasses.

2.10.4. Biodiversity and biotechnology applications in livestock

a. Artificial insemination

The use of artificial insemination biotechnology for the development of livestock breeds in Sudan had been adopted since 1977 when the first center was established to disseminate this technology. A few state centers are currently providing such a service (e.g. Gezira, Darfur). This technology is mainly used for the development of cattle livestock only, as it has not yet been successfully applied in camels (Musa *et al.*, 1988).

b. Vaccination

To produce the rinderpest vaccine, scientists at the ARRC had already exploited a low-level biotechnology for the development of vaccine production and vaccination of animals in Sudan.

2.10.5. Biodiversity and biotechnology application in human health

Several studies had already used advance level of biotechnology including DNA techniques and the use of monoclonal antibodies (MCAB) for the diagnosis of diseases like leishmaniasis, bilharzia, malaria, onchocerciasis, mycetoma, and cancer.

a. Human genome project

Sudan has recently joined this international scientific activity that essentially aims to establish a complete database for the human genome. Sudan is represented by a research group at the Institute of Endemic Diseases (U of K).

2.10.6. Biosafety

Genetically modified organisms are developed to solve problems of food and energy supply, control of diseases, treatment of wastes and removal of environmental hazards. However, these GMOs can themselves be a source of hazards. Some scientists argue that it is difficult to predict the behavior of all GMOs when released into the environment. Proper biosafety measures must be developed for the assessment and the control of these potential hazards.

2.10.7. Biopiracy

Microbes of interesting properties are being continuously transferred from the Sudan to developed countries for research purposes. These microbes are kept in culture collections in these countries. No agreements are made which give the Sudan rights in sharing the benefits that may arise from the utilization of the genetic material of these microbes. This situation must change. The Sudan needs help to formulate regulations and agreements in this respect.

2.10.8. Biosafety and risk assessment

Special consideration should be given to the issue of biosafety. The introduction of GMOs must be controlled by a specialized and well authorized body. The establishment of a national center for biotechnology is inevitable, to shoulder such a responsibility. Regulations of dealing with biotech products must be revised and evaluated according to international standards. An international collaboration may be of great significance for the evaluation of biosafety measures with reference to biotechnology applications particularly when dealing with hazardous biological products and GMOs. The appropriate measurements are not yet introduced and Sudan needs help in assessment of such risks.

PART II

THREATS, OPPORTUNITIES AND CONSTRAINTS

3. MAJOR THREATS TO BIODIVERSITY IN SUDAN

Factors threatening the genetic diversity, species and ecosystems in Sudan are many. They include natural factors and man-made ones. Some of these can be summarized in the following:

3.1 Environmental Changes

Among these changes are the drought spells and fluctuations in the rains, floods and temperature. Such changes could result in genetic erosion due to failure in crops and loss of varieties. A good example of such situation is the loss of varieties and complete failure of crops like pearl millet in the western Sudan. Changes affect medicinal plants, livestock, Rangeland, Forestry, Wildlife and coastal and marine ecosystems.

3.2 Land Use Planning

These include construction and building of roads, factories, canals, dams and new residential areas. Such expansions, in many cases, take place in different regions that used to be cultivated by traditional farmers on a small scale in a system known as "*Bilda*". Such system of agriculture is characterized by using highly diversified local varieties of crops. Building new dams, as it is projected in the Northern region (Hamadab dam) and in the central states (heightening of Roseries dam), will affect the cropping systems and types of crops and varieties grown in these areas. In some situations these development construction disturb wildlife, and birds, rabbits and in many cases lead to deforestation and cutting or scarce important trees indiscriminately.

3.3 Socio-Economical Factors

Such factors have their impacts on the types of crops grown by farmers. The land tenure system and land fragmentation have forced farmers in the Northern states to shift to high yielding varieties or to crops with low input cost and high revenues. A good example of such situation is the 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 due to security or economic factors, and therefore the abandoning of farming and shifting to other jobs, has its negative impacts on the agrobiodiversity. So too is the negative impact of increase in human and animal population. This associated with economic pressures leads to deforestation, overgrazing, poaching and overfishing, land degradation and ultimately poverty.

3.4 Modern Agriculture

Modern agriculture is characterized by the use of improved cultivars in a mono-cropping system of agriculture. This is taking place in the Sudan at present, where many improved high yielding varieties and livestock breeds are introduced. This occurs at the expense of indigenous landraces, old cultivars or breeds.

Expansion in the rainfed agriculture and irrigated schemes in central and western Sudan has been accompanied by changes in the vegetation

complexes in rangeland and forests areas and by shifting from the small-scale traditional agriculture to large-scale modern agriculture.

3.5. Overgrazing

Some regions are occupied by a large number of livestock beyond the optimal carrying capacity. This reflects on:

Considerable reduction in the proportion of livestock feed that comes from shrubs and trees. Most affected tree species are such as *Acacia senegal*, *Acacia seyal*, *Balanites aegyptiaca*, *Maerua crassifolia* "Serehe", *Cadaba glandulosa* (Kurmut) and *Grewia tenax* "Goddaim" as these are difficult to regenerate.

Deterioration in rangeland productivity has led to intrusion and grazing into the Red Sea coastal mangrove and halophyte areas.

Livestock have been competing with wildlife in grazing and habitat areas.

3.6. Biotic Factors

Pests and diseases can attack both plants and animals species resulting in negative impacts on the genetic variability within the species. They exert selection pressure on such crops leading to the extinction of those susceptible strains and breeds. Quarantine measures are ineffective and inadequate in restricting the introduction of new pests and diseases. Therefore, the biodiversity in agricultural crops is very much threatened by these factors under such a situation.

3.7. Fire

Seasonal bush and grassland fires are usually started for purposes such as preparing the land for cultivation, honey collection and for discouraging livestock herding nearby crop fields. Fire in most cases spread unintentionally over large areas. This has drastic effects on high temperature intolerant herbs and woody species. It also affects and destroys large quantities of seeds. Fire contributes to killing many wildlife species or destroy their habitats e.g. snakes and small mammals. Large animals flee their habitats to remote areas and might be subjected to death hazard.

3.8. Inadequate Institutional Capacities

Many institutions, sectors and departments have limited resources and funds to survey study, inventory and protect the biodiversity resources. This is evident in many biodiversity relevant sectors such as range, wildlife, fisheries and marine departments. These institutions are inadequately equipped to monitor and protect the resources. This also contributes to lack of information on the status and trends of biodiversity in the country. Furthermore, taxonomists in both plants and animals are lacking.

3.9. War and Civil Strife:

Many of the biodiversity rich areas in the country are incidentally in the war zone. A lot of diversity losses in plants and animals are caused directly by war or indirectly by destruction of habitats. Heavy military machinery has remarkable physical effects on vegetation cover. Important trees are removed indiscriminately to pave the road for military and other purposes. Animals either get killed or flee the area some times across the border to neighboring countries. The war that is waging in the southern part of the country is best example of such situation.

3.10. Farmers' Practices

Farmers used to select the outstanding strains of crops within their fields for the future cultivation. They tend to do so based on their knowledge of their environments and crops. Such selection practice results in the dominance of some genotypes at the expense of others. After the drought spells, farmers of pearl millet in western Sudan tended to select early maturing varieties rather than medium and late maturing varieties, providing a good example of the effect of such practice on the diversity of crops.

3.11. Legislation

Most governmental sectors having to do with biodiversity have inadequate or no legislation altogether especially in natural resources management. This can be seen in:

- Illicit felling and over-cutting of tree species.
- Unauthorized introduction of plant specimens (seeds, seedlings,...etc).
- Over-hunting and poaching of wildlife and over-fishing.
- Continuous expansion of agricultural land at the expense of rangeland areas.
- Export or smuggling of genetic material.
- No clear penalties on oil spills that destroy marine life in the Sudanese Red Sea.

3.12. Economic Distortions and Failures

Key contributors to environmental degradation are market, policy, institutional and implementation failures. In most cases in Sudan at least one or combinations of these failures are encountered.

4. OPPORTUNITIES AND CONSTRAINTS

4.1. Raising awareness of communities at all levels

There is a crucial need to raise awareness on biodiversity and its importance among various communities and stakeholders e.g. decision makers, communities, at village levels, institutions, universities, schools, farmers, pastoralists, foresters... etc.

Help is apt to be needed from the international community at large including NGOs to address all these sectors of the society. Through appropriate methods and approaches.

4.2. Exploration, collection, preservation and documentation of fauna and flora of the Sudan

Though some information is available on the flora and fauna of the Sudan, yet there is a need for more information on various aspects e.g. authentication, taxonomy, ecology including gene-ecology, utilization, indigenous knowledge and potential.

This could be realized by joint explorations by local and foreign experts. Participation from NGOs, universities and organizations at national and international levels is expected for the mutual benefit of all.

Such efforts are expected to result in herbaria at national and state level arboreta and natural museums to enrich the knowledge about these resources.

4.3. Conservation of representative areas of ecosystems

As several ecosystems are threatened by various factors including urbanization, agricultural expansion, deforestation, over-grazing etc, it is necessary to reserve certain areas for conservation of biodiversity. For this purpose the following areas are suggested: -

- A. Part of Wadi-Hawar as nature reserve;
- B. The relics of "Bowl Forests" such as Azaza, Leboni in Equatoria states;
- C. Part or several parts of the wetlands in the "Sudd" Region;
- D. Part of natural bamboo forests in Southern Kordofan, Blue Nile, Southern Darfur, Upper Nile, Equatoria and Bahr El Gazal states;
- E. Parts of hill vegetation in several parts of the country; and
- F. Parts of the watershed areas in Equatoria, Bahr El Gazal and Upper Nile.

4.4. Limiting cultivation of annual crops in marginal fragile ecosystems and their gradual replacement by suitable animal-raising activities

Extensive areas in the dry lands of the Sudan are devastated by the practice of annual crop cultivation in these fragile environments where the rainfall varies spatially and temporally and fluctuates quantitatively a great deal. In these areas "Mahl years" (dry years) are fairly common as in Northern Kordofan and Darfur. Cultivation of annual crops could not be prohibited by punitive or administrative measures, yet, it is feasible to replace this practice,

gradually by a pasture-based economy for animal raising. Models for application could be worked out.

4.5. Ex-situ Conservation

Germplasm of important species can be conserved in gene banks at Agricultural Research Corporation (ARC) both at Wad Madani and Soba the H.Q. of Forestry Research where initial facilities are available to build upon. Botanic gardens, arboreta and herbaria could be started at Soba and Wad Madani.

Also state herbaria, arboreta and botanic gardens are suggested to be established at El Fashir, Nyala, El Obeid, Singa, El Damazin, Kassala, Port Sudan, Juba, Wau and Malakal.

4.6. Re-organization of Coordination Mechanisms

Devastation of natural resources and conflicts often arise because of lack of coordination between the various units dealing with natural resources particularly with regard to its allocation and usage.

Coordination among various units is necessary for a successful conservation strategy. This coordination should be at all levels from the central authority down to the village level through appropriate means where all parties concerned are represented and where appropriate measures for conservation and sustainable development are not ignored. This is a central axis of this strategy and help from all sources including the international community, NGOs, on bilateral, multilateral and other basis will be necessary.

4.7. Legislation Particularly on Land Tenure

Land tenure is an important issue in the strategy for biodiversity together with the empowering laws for the various units concerned with biodiversity.

All lands in the Sudan belong to the Government unless registered with the registrar of lands under a title. Yet traditional laws and customs are upheld and applied in many parts of the country. Changes that transcend the written laws have occurred in the native administration systems because of various factors including the start of breakdown of "dars" in many parts of the country, urbanization, migration and other factors.

The whole of land tenure and land allocation issues need to be reviewed and developed to meet the national and international aspirations, to lessen local conflicts and to promote conservation of biodiversity. Other legal aspects need to be taken care of.

4.8. Economic Factors

Even though Sudan is going through a process of liberalizing the economy a step which might possibly enhance biodiversity conservation, it will not work properly unless efficient financial incentives and mechanisms are considered.

PART III

NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN

5. THE NATIONAL STRATEGY

The NBSAP project's steering committee formulated a task force of seven national experts to develop the BSAP for the country. The BSAP first draft document was prepared between November and end of December 1999. It was first reviewed by IUCN Eastern Africa Regional Office (EARO). As part of stakeholders involvement and building consensus the BSAP draft was distributed to ministries, institutes, agencies and departments of relevance for comments (listed below). To widen the circle of participation five regional-based workshops were held in different parts of the country. The BSAP was also presented in the project's final national workshop held from 17th to 18th April 2000. It was then subjected to more discussion and written comments were also received from expert individuals. The participants agreed to adopt the BSAP provided that useful comments that have emerged during the review and discussion of the BSAP draft are incorporated and it is amended.

5.1 Vision

The vision of National Biodiversity Strategy is:

“Conservation of diversity, and related indigenous knowledge for sustainable national development of Sudan”.

1. Guiding Principles

The following are guiding principles that were followed in developing the NBSAP:

- Protection of the natural environment and its constituent biological, ethnic and cultural diversity, the development and good use thereof is an authentic aspect of fulfilling man's role as vicegerent on earth. Conversely, the destruction of environment is a mischievous sort of corruption. Thus, furnishing a healthy social environment, its improvement and development is an essential demand in responding to the principle of sustaining the dignity of mankind;
- Every Sudanese citizen has a constitutional right to a healthy environment that secures health, abundance and prosperity;
- Stakeholders at the local, state and national level should have an equitable share of benefits accruing from biological and other dimensions of diversity;
- The formulation of a national biodiversity strategy and an attendant implementation action plan require the voluntary and democratic participation of the society at large; and
- Some aspects of the natural environment and its constituent biological, ethnic and cultural diversity recognize no political or geographical boundaries within or between countries which necessitate subregional, regional and international cooperation for the protection of the environment and its development in the context of international conventions and agreements.

5.2. Overall objective

To conserve and enhance biological diversity for the prosperity and development of the Sudan.

5.3. Specific objectives

The specific objectives are:

a. Conservation of biodiversity (CBD articles 12 and 17)

This is to ensure conservation of the biological heritage for present and future generations through:

- i. Strengthening research and monitoring and assessment activities: by improving inventories, database and documentation. This includes indigenous knowledge of the flora, fauna and microorganisms. Collaborative efforts from home and abroad will be necessary for the benefits of all concerned;
- ii. In-situ conservation (CBD article 8): Conservation of representative samples of ecosystems including terrestrial, marine and fresh water ecosystems through nature reserves, national parks, on-farm conservation, forest reserves and restorative procedures; and
- iii. Ex-situ conservation (CBD article 9):
- iv. Establishment of arboreta, botanic gardens, herbaria and zoological gardens at national and state levels; and
- v. Establishment of gene banks for the important species.

b. Promotion of sustainable use of biodiversity products (CBD article 10) this is to be through:

- i. Reducing, halting and ultimately reversing the over-exploitation of biological resources through appropriate land use, especially the horizontal expansion in crops on marginal lands of fragile ecosystems, overgrazing and deforestation, and by promoting efficient farming techniques and multiple use of the resources to realize their inherent potential;
- ii. Creating alternative products and sources of alternative income; and Controlling the formal introduction of germplasm especially noxious species in forests and food crops and in livestock.

c. Promoting awareness on biodiversity conservation (CBD article 13)

- i. This can be achieved through:
 - Informing the public and decision-makers by providing adequate information through the media, improved extension service and networks;
- ii. Assigning real economic and other values to biodiversity products, so as to formulate sound policies for stakeholders through incentives in conservation activities. Initiatives from NGOs (national and foreign) and the private sector should be encouraged. This

includes promotion of environment friendly activities like ecotourism, wildlife ranching and upfront preventive activities like environmental impact assessment.

d. Creating an enabling environment for biodiversity conservation by:

- i. Promoting political goodwill for the cause of biodiversity and availing incentives to stakeholders;
- ii. Strengthening the institutional technical capacity by improving the technical infrastructure and strengthening the manpower base through training to carry out the tasks;
- iii. Enacting a comprehensive and effective biodiversity conservation policy and practice that addresses, among other things, issues such as land allocation, land tenure and possible conflicts;
- iv. Adopting economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biodiversity (CBD article 11); and
- v. Undertaking and considering financial resources and financial mechanisms as stated in articles 20 and 21 of the CBD.

e. Complying with and benefiting from regional and international agreements and mechanisms (CBD article 22 and COP decisions)

Through signature and/or ratification, Sudan is a party to a number of arrangements and mechanisms, legally binding and non-legally binding, which contain substantive elements, addressing different biodiversity and environmental aspects. Sudan should honor its commitments and benefit, to the maximum from ratified arrangements. The Sudan participated in and is party to the following agreements:

A. Global

- i. Convention on Wetlands of International Importance, especially as Waterfowl Habitats (Ramsar);
- ii. Convention for the Protection of the World Cultural and Natural Heritage;
- iii. United Nations Framework Convention on Climate Change (UNFCCC);
- iv. Convention on Biological Diversity (CBD);
- v. United Nations Convention to Combat Desertification (UNCCD);
- vi. Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); and
- vii. General Agreements on Tariffs and Trade (GATT) / World Trade Organization (WTO).

B. Regional

- viii. League of Arab States (LAS) and its organizations e.g.:
 - Arab Organization for Agricultural Development (AOAD);
 - Arab League Educational, Cultural and Scientific Organization (ALESCO); and
 - Arab Center for the Studies of Arid Zones and Drylands (ACSAD).
- xi. Organization of African Unity (OAU).
- x. Lome IV Convention
- xi. The Common Market for Eastern and Southern Africa (COMESA)
- xii. Inter-governmental Authority on Development (IGAD)

C. Treaty-based organizations

- xiii. Center for International Forestry Research (CIFOR)
- xiv. Consultative Group for International Agricultural Research (CGIAR)
- xv. International Monetary Fund (IMF)
- xvi. Regional Development Banks
 - African Development Bank (AfDB)
 - Arab Bank for Economic Development in Africa (BADEA)
- xvii. Islamic Development Bank (IDB)
- xviii. Food and Agricultural Organization of the United Nations (FAO)
- xix. United Nations Educational, Scientific and Cultural Organization (UNESCO)
- xx. World Bank (WB)
- xxi. World Trade Organization (WTO)
- xxii. International Fund for Agricultural Development (IFAD)

D. Non-legally binding arrangements

D.1. Organizations and fora

- i. International Center for Research in Agroforestry (ICRAF)
- ii. Intergovernmental Panel on Climate Change (IPCC)
- iii. International Union for Conservation of Nature (IUCN)
- iv. International Union of Forestry Research Organizations (IUFRO)
- v. International Plant Genetic Resources Institute (IPGRI)
- vi. International Center of Genetic Engineering and Biotechnology (ICGEB)

D.2. Initiatives, processes and other political commitments

- vii. United Nations Programs (created by the General Assembly of UN)
 - United Nations Development Program (UNDP)
 - United Nations Environment Program (UNEP)
 - United Nations Conference on Trade and Development (UNCTAD)
 - World Food Program (WFP)
 - FAO Regional Commissions (including Near East and Africa Forestry Commissions)
- viii. Agenda 21, Chapter 11 (UNCED)
- ix. Non-legally Binding Authoritative Statement of Forest Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All types of Forest (Forest Principles-UNCED)
- x. Commission on Sustainable Development (CSD)
 - Intergovernmental Panel on Forests (IPF)
 - Intergovernmental Forum on Forests (IFF)
 - Criteria and Indicators for Sustainable Forest Management
 - Dry Zone Africa Initiative
 - Near East Initiative
- xi. Global Environment Facility (GEF)

E. Legislative aspects

(CBD article 14, 15, 16 and 17)

- i. Promote appropriate institutional, legislative, technical or other arrangements to ensure that the environmental consequences of sectoral programs and activities that have or are likely to have impacts on biological diversity are taken into account, mitigated or reduced;
- ii. Promote appropriate conditions and measures for legal access to genetic resources and techniques deemed important for agriculture, forestry, animal husbandry and safety;
- iii. Emphasize biosafety and social considerations in the development and application of biotechnology; and
- iv. Build capacity and promote legal capabilities to safeguard the national interests and rights of the Sudan and Sudanese people over their intellectual property rights pertaining to biodiversity resources, indigenous knowledge and national heritage.

6. ACTIONS

Below are suggested general and specific actions that need to be taken:

6.1 General

- Goals are to promote institutional, legislative, technical or other arrangements to ensure that the environmental consequences of sectoral programs and activities that have or are likely to have impacts on biological diversity are taken into account, neutralized or reduced;
- Promote appropriate conditions and measures for legal access to genetic resources, indigenous knowledge and techniques deemed important for agriculture, forestry, animal husbandry and safety;
- Emphasize biosafety and social considerations development and application of biotechnology;
- To develop the CNS 1992-2002 into a new CNS 2002 – 2012 and to develop a national action plan. A land use plan is a priority within the action plan;
- The legislation in relation to establishment of the 26 states should be revised to cater for neglected ecological concerns e.g. dividing the states of Kordofan and Darfur into northern and southern states and causes further stress on their deteriorated resources;
- Revisions of laws dividing power and revenues in relation to natural resources between the central government and state government to come up with the best situation that emphasize conservation and sustainable use;
- Existing institutional set up related to biodiversity conservation should be subjected to critical evaluation and restructuring should dictate lines of coordination and integration;
- Capacity building is needed in the areas of genetic resources protection and biosafety. Necessary legislation should be established;
- To evaluate and suggest improvement measures of land use tenure legislation and practices to include regulations that requires sustainable use; and
- Facilitate popular participation in biodiversity conservation programs capacity building programs for NGOs and CBOs should be developed.
- Consolidation of the role of the HCENR as the national focal point and coordination body in relation to biodiversity and other environmental issues.

6.2. Specific

Strategies and actions should be directed to alleviate poverty. A participatory approach to development should be adopted. Awareness raising is needed and decision-makers should be won to the cause of environmental conservation. There are many actions that are in common between the different biodiversity components and need to be taken. The actions to be taken are summarized in the following:

6.2.1 In-situ conservation

The following in-situ conservation measures need to be considered:

- Systematic surveying and inventorying of plant and animal genetic resources;
- In-situ conservation of wild relatives of field and horticultural crops, endemic and indigenous herbaceous and woody species. Species and areas need to be determined, e.g. pearl millet in the west, okra in the center, watermelon in the north and medicinal in their locations;
- On-farm conservation of farmers' varieties: improvement of cultural practices for better yields by traditional varieties, e.g. sorghum, in Nuba Mountains, southern Blue Nile, southern Sudan and River Atbara; watermelon in western Sudan, date palm in northern Sudan and Darfur;
- Restoration of traditional varieties in war or disaster-affected areas, e.g. sorghum for the south and Nuba Mountains;
- Mitigation measures to reduce the negative impacts of natural and man-made factors upon in-situ conserved crops, e.g. floods, drought, riverbank erosion and fires; and
- Developing monitoring and early warning system for loss of genetic resources.

6.2.2. Ex-situ conservation

The following ex-situ actions should be taken:

- Priorities should be set for collecting plant and animal 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;
- These genetic resources need to be collected through a national campaign that involves governmental and non-governmental institutions. Research centers, universities, agricultural departments, farmers, national societies, women,...etc. could participate;
- For such task of short- and long-term ex-situ conservation there is a need to strengthen the present PGR Unit at ARC to accommodate new collections that include natural vegetation species. New establishment for animal embryo and tissue culture is to conserve plant, domestic animals and wildlife genetic resources;
- Establishment of in-vitro conservation facility and field gene banks for the conservation of vegetatively propagated crops;

- Current field genebanks of fruit trees need to be maintained;
- Regeneration program is to be executed for the current collections in the PGR Unit/ARC;
- Establishment of program of surveys and research to generate and collect information-related to biotechnology
- Establishment of gene banks to preserve microbial cultures of importance
- Promotion of the effective use of plant tissue culture methods for conservation and propagation of endangered species.
- Proposal of projects that essentially aim to provide base data of microflora collections in Sudan.
- Retrieval of Sudanese germplasm conserved abroad;
- Creation of capable full-time collection team;

6.2.3. Utilization

Conservation and utilization are inextricably linked, because utilization provides the principal utilization purpose for conservation. Utilization of genetic resources involves the following:-

- Multiplication and characterization of collected materials in the regions where they are collected;
- Evaluation of local germplasm for the desirable characters;
- Participation between genebank, breeder and farmers in the utilization of the local germplasm or breed;
- Use of molecular evaluation techniques to develop core collections, and to avoid duplications;
- Purification of local diversified germplasm to produce varieties for commercial use;
- Production of multi-line varieties;
- Promotion of under-utilized, local varieties;
- Promotion of seed production systems both at local and national levels.

6.2.4. Documentation

- Many plant and animal breeders are deterred from using collections because of a lack of information and documentation. Documentation should include the following activities:
- Documenting while collecting or characterizing;
- Documenting of plant and animal genetic resources using a computerized system;
- Documentation of indigenous knowledge, practices and technologies;
- Establishment of information network between plant and animal genetic resources units and users in research centers and universities; and
- Publication of germplasm or breed catalogues.

6.2.5. Training, education and Extension

- 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;
- Training staff of research centers, universities and agricultural departments to participate in the collection operations;
- Development of syllabi on plant and animal genetic resources in the curricula of universities and colleges;
- Training in the areas of taxonomy (both plant and animal);
- Strengthening extension and extension facilities to develop a feedback mechanism to help researchers to scientifically approach field problems; and
- Inclusion of biodiversity issues in the curricula of schools.

6.2.6. Institutional arrangements

- Establishment of centrally coordinated program for plant genetic resources under the umbrella of the ARC for the conservation of local germplasm of current and potential agricultural crops;
- PGR Unit/ARC is to be expanded into a national plant genetic resources center (in Khartoum or Wad Madani) where the base collection of crop germplasm in Sudan is maintained;
- The objectives of the national center include planning for collection, evaluating and use of the crop genetic resources as a coordinating body with the regional units. It will be responsible for the distribution of germplasm as regulated by legislation;
- The base collection is to be deposited in the national center while the active collections are to be held by the regional units;
- Some central facilities are to be attached to the national center for the conservation and evaluation of the collected germplasm. Examples of these are molecular biology laboratory and in-vitro conservation facility;
- Five regional plant genetic resources units are to be established in the north, west, south, east and center where active collections of the materials collected from those regions are maintained;
- Objectives of establishing regional units include collecting inside the regions, and evaluation of such materials collected in these regions;
- Consolidation of relationship and cooperation with relevant regional and international organizations; and
- Strengthening institutional capacities by determining the proper affiliations. For example, RPA should be affiliated to other natural resources administrations. The WCGA affiliations should be revised and its linkages with natural resources agencies strengthened. The relationship between the WCGA and WRC are to be formalized.

6.2.7. Legislative arrangements

- Development of national legislation to regulate access to biological resources including both crop and animal genetic resources;
- Development of national legislation to protect local communities, farmers and pastoralist rights to biological resources and their indigenous knowledge, practices and technologies;
- National legislation to safeguard and protect breeders rights;
- Development of national legislation to regulate the movement of germplasm and breeds to and out of the country;
- The rangeland legislation should be passed to address land use in rangelands, integration of animal production and crop production, establishment of range reserves. (unfenced through people participation), and develop land tenure system that recognizes rangeland use as a major land use type;
- Maritime, marine and coastal legislation need to be enforced;
- Enforcement of laws that regulate introduction of exotic biological specimens (Pathogenic);
- Endorsement and implementation of Biosafety and risk assessment laws,
- Endorsement and implementation of laws that protect patents of intellectual property rights;
- Endorsement and implementation of laws that prohibit Bio-piracy; and
- Adoption of plans to promote understanding of bioethics with emphasis on manipulation of human genome and gene transfer.

Table 4 links threats to biodiversity, opportunities and actions.

Table (4): Summary of threat, opportunities and proposed actions.

Threats	Opportunities	Actions
<ul style="list-style-type: none"> ▪ Environmental changes ▪ War and civil strife ▪ Biotic factors ▪ Fire 	<ul style="list-style-type: none"> -Exploration, collection, preservation and documentation of flora and fauna -Ex-situ conservation -Conservation of representative areas of ecosystems 	<ul style="list-style-type: none"> -In-situ conservation -Ex-situ conservation (establish genebanks, botanic gardens, arboreta... etc) -Documentation (information system, database, internet... etc) -Training, education and extension
<ul style="list-style-type: none"> ▪ Improper land use planning ▪ Modern agriculture ▪ Inadequate or lack of legislation 	<ul style="list-style-type: none"> -legislation, particularly on land tenure -limiting cultivation of annual crops in marginal fragile ecosystem and gradual replacement by suitable land use system 	<ul style="list-style-type: none"> -Develop national legislative arrangements that consider land allocation issues -Raise awareness of communities at all levels including decision makers -Empower laws for the various units concerned with biodiversity
<ul style="list-style-type: none"> ▪ Socio-economical factors ▪ Economic distortions and failures 	<ul style="list-style-type: none"> -Efficient financial incentives and mechanisms -minimize market, policy, institutional and implementation failures 	<ul style="list-style-type: none"> -Adopt economically and socially sound measures that act as incentives for the conservation of biodiversity components
<ul style="list-style-type: none"> ▪ Inadequate institutional capacities 	<ul style="list-style-type: none"> -Re-organization of coordination mechanisms -adequately provide institutions with skilled personnel and equipment 	<ul style="list-style-type: none"> -Strengthen institutional capacities by determining the proper affiliations -Consolidation of relationship and cooperation with relevant regional and international organizations -improve technical skills by training and education in areas of biodiversity and provide necessary equipment

7. IMPLEMENTATION MODALITIES

7.1. How the NBSAP should be put into effect and used

The Sudan NBSAP shall be a useful guide to the implementation of the CBD. Accordingly, the NBSAP should be:

1. Presented by the Ministry of Environment and Tourism (MEAT) to the Council of Ministers for Government approval. It should further be passed by Parliament and endorsed by the President of the Republic. This is to secure government ownership and commitment to its implementation. The approved NBSAP shall be publicized widely to secure stakeholder and public ownership and understanding. The latter could involve making it user-friendly through preparation of abridged versions for different stakeholders;
2. Used as a planning tool by the National Council for Planning and other levels of government planning to integrate biodiversity in the over-all national development and sectoral planning respectively;
3. Used by the MFNE as reference in budgeting and allocation of government resources;
4. Used as a useful tool for fundraising and co-ordination of donor support to biodiversity conservation and implementation of CBD, UNFCCC, UNCCD, CITES, Ramsar, Forest Principles and other related conventions, including facilitating synergy among the conventions. It is suggested that an environment/biodiversity donor liaison committee be formed immediately to harmonize funding strategy for implementation of the NBSAP and biodiversity related activities;
5. Used as a guiding tool for the HCENR as a Government agency responsible for the CBD. The NBSAP will greatly assist to oversee the implementation of Sudan's obligation to the CBD. In line ministries, the desk officers responsible for the related conventions will find this NBSAP a useful tool for coordinating implementation of CBD and the conventions they are responsible for;
6. Used as a guiding tool for assisting states to integrate biodiversity in their states development planning, policies and laws;
7. Used as a source of information for the National Information data bank(s), research institutions and sectoral agencies (e.g. Agriculture, Forestry, RPA, Livestock, Fisheries, Wildlife... etc.). It will also point out information gaps and research priorities that sectoral agencies should work on;
8. Used as a guide to the development agencies/partners that would identify programs for support to biodiversity conservation and sustainable development; and
9. Used as a guide to Government of the Republic of the Sudan in implementing regional and international conventions and agreements as well as the Horn of Africa and other regional frameworks.

7.2. Implementation of the NBSAP

7.2.1. Endorsement and approval

The draft NBSAP will be subjected to formal endorsement by a forum of key stakeholders. The Council of Ministers, Parliament and the president will then table it for approval. The key institutional stakeholders from whom endorsement will be sought will include:

- Government ministries particularly MAF, Animal Resources, Irrigation, MEAT, Interior, External Relations, National Finance & Economy, Culture and Information, Industry & Investment and Justice;
- Research institutions namely ARC, ARRC, NCR and universities;
- Training institutions including universities and training institutions affiliated to line ministries;
- Donor and development assistance partners such as UNDP, FAO, UNESCO, EC and member countries; and
- Relevant NGOs such as SOS Sahel (Sudan) and SECS.

7.2.2. The Launch of the NBSAP

The NBSAP will be launched on March 14th 2001, as part of commemorating the Sudan National Environment Day March 14th is the day that the Sudan National Environmental legislation was assented

7.2.3. Implementation

The NBSAP will be implemented through 12 projects (table 8) taking into consideration the specific objectives, and suggested actions in preceding chapter. The project approach is preferable in Sudan because:

- It is the appropriate mechanism for implementing activities that need multisectoral approach such as those suggested in NBSAP;
- The project lead agency will be in a better position to co-ordinate the resources requirements and delivery of outputs;
- Limited capacity that is also scattered in different sectoral institutions with limited experience in multisectoral planning and co-ordination; and
- Mobilization of fund will be much easier and facilitate its allocation to most pressing and priority areas.

7.2.4. Institutional arrangements

The HCENR is envisaged to be the federal agency responsible for coordinating management and conservation of biodiversity in the Sudan. Its organizational setup, hierarchy and mission need to be revised to reflect this and other roles. As such the HCENR is the lead agency for coordinating implementation of the NBSAP and especially the proposed projects. It is also to be the lead agency in implementing the following specific projects:

- Organizational setup for conservation of biodiversity in Sudan;
- Capacity building in systematic;

- Capacity building for biodiversity information management and monitoring;
- Any other projects that need capacity or multi-sectoral co-ordination if cannot be adequately implemented by the relevant sectors.
- The HCENR will establish a biodiversity coordinating unit that will be responsible for;
- Providing secretariat support for the national environment committee on biodiversity issues;
- Implementing all biodiversity projects under HCENR;
- Coordinating the overall implementation of the NBSAP; and
- Providing technical support to the government in the general implementation of the CBD and preparations for CBD events such as Conference Of the Parties (COP) and Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), Africa and other regional biodiversity fora.

7.2.5. Implementation schedule

The NBSAP will be implemented over an initial period of six years, (Table 5). equivalent to two three-Year Programs in conformity with the planning cycle adopted in CNS as follows:

Table 5: Implementation Schedule of NSAP

Activity	Lead agency	YR. 1	YR. 2	YR. 3	YR. 4	YR. 5	YR. 6
Endorsement and Government approval	MEAT	-					
Establish Biodiversity Coordinating Unit	HCENR	-					
Launching	MEAT	-					
Fund raising for project development	MFNE		-	-	-	-	-
Projects approval and resources allocation for implementation	HCENR MFNE		-	-	-	-	-
Project implementation	*		-	-	-	-	-
NBSAP implementation Review	HCENR				-		
National Biodiversity report	HCENR						

* Various line ministries.

7.3. Prioritization of NBSAP Activities

Following approval and launching of NBSAP by early 2001, the proposed projects will be implemented in the order they appear in table (2) over a period of six years, 2001-2007.

7.4. Monitoring, Evaluation and Reporting

The implementation of NBSAP will require monitoring and evaluation of the progress as well as the assessment of biodiversity status and trends to follow up on the impact of the implementation. HCENR is the overall responsible for monitoring of biodiversity and NBSAP implementation. Through a participatory process, the council will identify areas for monitoring and develop a comprehensive monitoring programme. Among other areas the programme will include:

- Monitoring implementation of the NBSAP;
- Monitoring the state of biodiversity; and
- Monitoring reporting on biodiversity.

The council will also guide and build capacity of all participating institutions for their contribution in implementing the monitoring programme (Table 6).

Table 6: Key steps for developing a monitoring program.

Output 1: needs and capacity for monitoring assessed	
Action	Activities
Identify biodiversity issues (in addition to those mentioned above) for monitoring and respective responsible institutions.	Identify biodiversity Areas/themes/sectors/ecosystems/species/states etc. for biodiversity monitoring Identify focal co-ordinators for co-ordinators in different themes etc. Assess and build capacity
Output 2: Implementation of the NBSAP monitored	
Develop indicators for monitoring Institutional/management changes for biodiversity management and conservation	Develop indicators on monitoring: Planning, reforms and budget availability for incorporating NBSAP principles, goal and objectives Institutional arrangements and capacity enhancement to accommodate NBSAP implementation needs
Output 3: Biodiversity status and trend monitored	
Develop list of reporting requirements, types of reports, deadlines, types of audience e.g. biannual national biodiversity status report, report to COP, annual report to parliament, half-yearly sectoral reports etc.	Develop appropriate technologies for data processing and reports production as per reporting needs Prepare reports including mechanism for approving reports. Publish and distribute reports as per identified requirements

7.5. Financing the Implementation of NBSAP

Implementation of the proposed projects under NBSAP will be financed through public, donor and private sector resources. Public sector sources will include:

- allocation and reallocation of existing government funds;
- improved and new methods of public revenue regeneration and allocation;
- cost-saving through more efficient budgeting and use of funds.

Private sector financing and cost-sharing will be encouraged through the dismantling of existing barriers to investment in biodiversity and the setting in place of positive incentives such as:

- establishment and improvement of biodiversity prices and markets;
- appropriate property rights;
- increased devolution of responsibilities and opportunities for biodiversity management and utilization for profit and for non-profit purposes, through private, joint and collaborative management arrangements;
- use of appropriate fiscal instruments (such as differential taxes) and financial inducements (such as credit, funds and trusts).

Donor and international funding sources will include:

- Conventional grants, loans and development assistance;
- Innovative donor funding arrangements such as debt-for-nature swaps, trusts and compacts;
- Innovative international financial flows such as offsets, transferable development rights, biodiversity sales.