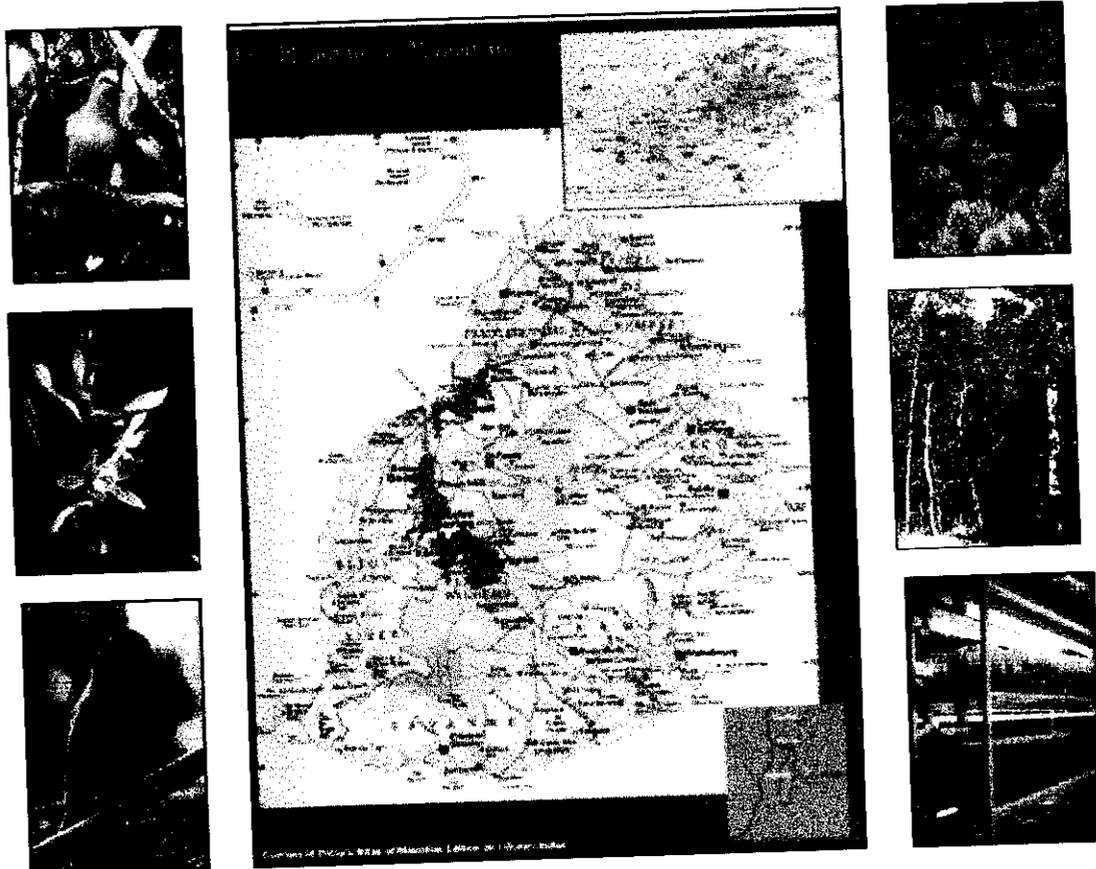


# Republic of Mauritius - First National Report to the Convention on Biological Diversity



**National Parks and Conservation Service,  
Ministry of Agriculture, FT and Natural Resources  
in collaboration with UNEP & GEF.**

*November 2000*

## CONTENTS

	Page
Preface	
Abbreviations	
1 Executive Summary .....	6
2 Introduction .....	8
3 Principal Measures in the Conservation and Sustainable use of Biodiversity in Mauritius .....	10
3.1 National Conservation and Environment Policy Framework .....	10
3.2 International Conventions and Agreements .....	11
3.2.1 Collaboration with International Agricultural Research Organisations .....	12
3.2.2 Bilateral relations and Regional Cooperation .....	12
3.3 National Legislations pertaining to Biodiversity Conservation .....	13
3.4 Status and Trends of Biodiversity .....	13
3.4.1 Forestry and Flora .....	13
3.4.1.1 Medicinal Plants .....	15
3.4.1.2 Institutions dealing with Forestry and Flora .....	16
3.4.2 Fauna Diversity .....	16
3.4.2.1 The Offshore Islets .....	18
3.4.2.2 Institutions .....	19
3.4.3 Agricultural Biodiversity .....	19
3.4.3.1 Sugar cane .....	20
3.4.3.2 Maize .....	20
3.4.3.3 Other Crops .....	22
3.4.3.4 Wild Relatives of crops .....	22
3.4.3.5 Fruit species, root and tuber crops .....	23
3.4.3.6 Farm Animal genetic Resources .....	23
3.4.3.7 Micro-organisms .....	23
3.4.3.8 Institutions .....	23
3.4.4 Biotechnology .....	24
3.4.4.1 Tissue Culture .....	24
3.4.4.2 Diagnostics .....	25
3.4.4.3 Genome Mapping .....	25
3.4.4.4 Genetic Transformation .....	25
3.4.4.5 Environment .....	25
3.4.4.6 Human Health .....	25
3.4.4.7 Biosensors .....	26
3.4.5 Aquatic Biodiversity .....	26
3.4.5.1 Marine Living Resources .....	27
3.4.5.2 Non- living Marine Resources .....	27
3.4.5.3 Fresh water Aquatic Biodiversity .....	28
3.4.5.4 Assessment of fish stocks .....	29
3.4.5.5 Export Trade .....	29
3.4.5.6 Economic values of Marine aquatic biological resources .....	30
3.4.5.7 Wetlands .....	31
3.4.5.8 Institutions involved .....	31
3.4.6 Conservation in Rodrigues .....	32
4 Threats to Biodiversity and Management measures .....	34
5 National Biodiversity Strategy and Action Plan .....	35
5.1 National Consultative Process .....	35
5.2 NBSAP time frame and status .....	35
6 Partners involved in the implementation of conservation and sustainable use projects .....	35
6.1 National and International Institutions .....	35
6.2 Plant Conservation Projects .....	36
7 Ongoing & Planned activities for protection, conservation and sustainable use of biodiversity (including monitoring) .....	43
7.1 Forestry .....	43

7.2	Fauna and flora .....	43
7.2.1	Conservation of plant genetic resources .....	43
7.2.2	In situ- conservation .....	43
7.2.3	Ex situ propagation .....	44
7.2.4	Herbarium .....	44
7.2.5	Tissue culture .....	44
7.2.6	Botanical gardens .....	44
7.2.7	Establishment of a first wetland reserve and a migratory bird sanctuary .....	44
7.3	Agricultural Biodiversity .....	45
7.4	Biotechnology and biosafety .....	46
7.5	Coastal Resources, Marine and Aquatic Biodiversity .....	46
7.5.1	Marine Parks .....	47
7.5.2	Fishing Reserves .....	47
7.5.3	Management of Marine Resources .....	47
7.5.4	Aquaculture .....	48
8	Gaps / Issues and the priorities in the various sectors .....	48
9	Resources for Biodiversity Conservation .....	48
10	References .....	49
	Annex 1 .....	52

#### List of Tables

Table 1	Status of native flowering plants of Mauritius and Rodrigues .....	14
Table 2	Status of Sugar cane germplasm in the MSIRI collection .....	20
Table 3	Species of fruits and root crops in collection .....	23
Table 4	Indian & Chinese carps introduced for Aquaculture .....	28
Table 5	Export Trade of Fish .....	30
Table 6	Economic values of aquatic biological resources and biodiversity .....	30
Table 7	Estimated economic value of the different extractive uses of marine aquatic resources ..	30
Table 8	Estimated economic value of recreational activities .....	31
Table 9	Summary of Major activities relating to biodiversity conservation and restoration .....	41
Table 10	Summary of Gaps/ Issues and the priorities under the various thematic areas .....	52

#### List of FIGURES

Figure 1	Relief and Settlement of Mauritius .....	9
Figure 2	Monkey ( <i>Macaca fascicularis</i> ) in the wild .....	14
Figure 3	Planted and Native Forests .....	15
Figure 4	Dodo ( <i>Raphus cucullatus</i> ) .....	16
Figure 5	Mauritian Kestrel, Echo Parakeet & Pink Pigeon saved bred from extinction.....	17
Figure 6	Keel Scaled Boa .....	18
Figure 7	Last Remnant of a Hurricane palm on Round Island .....	19
Figure 8	Land Use map for Mauritius .....	21
Figure 9	<i>Coffea macrocarpa</i> , a wild relative of coffee .....	22
Figure 10	Genetic transformation of sugar cane .....	26
Figure 11	Some of the marine species constituting the marine biodiversity .....	27
Figure 12	Coral ecosystem within the Blue Bay Marine Park .....	47

## PREFACE

This First National Report (FNR) has been prepared by the National Parks and Conservation Service of the Ministry of Agriculture, Food Technology and Natural Resources of the Government of Mauritius in fulfillment to the obligations contained in Decision II/7 of the second meeting of the Conference of the Parties to the Convention on Biological Diversity regarding the implementation of Article 6 of the Convention. The FNR is part of the country planning process pertaining to the Biological Diversity of Mauritius.

In compiling this report, the suggested guidelines for national reporting on the implementation of Article 6 (Decision II/17) have been followed. A few deviations from the guidelines have been made to reflect the specificity of the Republic of Mauritius.

In the information gathering process on the status, trends and ongoing progress for the protection of the biodiversity in the Republic of Mauritius, the documents consulted have been listed in the 'Reference' section'. In addition several unpublished papers and reports from the various sectors dealing with the conservation of biodiversity have also been consulted. Discussions were held with colleagues and scientists directly involved in the implementation of projects related to the conservation and sustainable use of the terrestrial and aquatic natural resources. The collections of the Mauritius Herbarium at the Mauritius Sugar Industry Research Institute and the Natural History Museum of the Mauritius Institute were also consulted.

The Ministry of Agriculture, Food Technology and Natural Resources expresses its heartfelt thanks to all scientists, the Planning Team on National Biodiversity Strategy and Action Plan, UNEP & GEF and other persons who have in one way or the other contributed towards the preparation of this First National Report.

National Parks and Conservation Service  
Ministry of Agriculture, Food Technology & Natural Resources

## LIST OF ABBREVIATIONS

A.R.E.U.:	Agricultural Research Extension Unit
A.V.R.D.C.:	Asian Vegetable Research & Development Centre
B.E.I.:	Biodiversity and Environment Institute.
C.I.A.T.:	International Centre for Tropical Agriculture
C.I.M.M.Y.T.:	International Maize and Wheat Improvement Centre
C.I.P.:	International Potato Centre
C.I.R.A.D.:	Centre International de Recherche Appliqué au Développement
C.I.T.E.S.:	Convention on International Trade in Endangered Species of Wild Fauna and Flora
C.M.A.:	Conservation Management Area
C.S.C.:	Commonwealth Science Council
C.W.A.:	Central Water Authority
CBD:	Convention on Biological Diversity
D.A.R.E.:	Directorate of Agricultural Research and Extension
D.W.S.T.:	Durrell Wildlife Conservation Trust
E.U.:	European Union
F.A.O.:	Food and Agricultural Organization
F.A.R.C.:	Food and Agricultural Research Council
G.E.F.:	Global Environment Facility
I.C.B.P.:	International Council for Bird Preservation
I.C.R.I.S.A.T.:	International Crops Research Institute for Semi-Arid Tropics
I.I.T.A.:	International Institute for Tropical Agriculture
I.O.C.:	Indian Ocean Commission
I.P.G.R.I.:	International Plant Genetic Resources Institute
I.U.C.N.:	The World Conservation Union
M.A.C.O.S.S.:	Mauritius Council of Social Services
M.C.A.:	Mauritius Chamber of Agriculture
M.o.A.:	Ministry of Agriculture, Food Technology and Natural Resources
M.R.C.:	Mauritius Research Council
M.S.I.R.I.:	Mauritius Sugar Industry Research Institute
M.W.F.:	Mauritian Wildlife Foundation
N.P.C.S.:	National Parks and Conservation Service
O.A.U.:	Organization of African Unity
O.D.A.:	Overseas Development Administration
O.R.S.T.O.M.:	Institut Français de Recherche Scientifique pour le développement en Coopération
S.A.D.C.:	Southern African Development Community
S.P.A.C.E.:	Society for the Protection and Conservation of the Environment
S.P.G.R.C.:	SADC Plant Genetic Resource Centre
U.N.D.P.:	United Nation Development program
UoM:	University of Mauritius
W.B.:	World Bank
W.W.F.:	World Wide Fund for Nature

## 1.0 EXECUTIVE SUMMARY

The Republic of Mauritius, a small island developing state, with a total land area of 2040 Km<sup>2</sup>, a population density of 579 persons/ Km<sup>2</sup> (among the most dense in the world) and an Economic Exclusive Zone (EEZ) 1000 times bigger than its land mass present special challenges for the conservation of biodiversity.

Over the last three decades, the Mauritian economy has been cited as a “success story”. With annual growth rates of over 5 % and a per capita income of US\$ 3,900 in 1999, Mauritius has graduated to the group of upper middle-income countries. It topped the list of African countries in competitiveness in the African Competitiveness Report of 1998 and it was ranked 29th in the World Competitiveness Report of 1999. The country was ranked 59<sup>th</sup> on the Human Development Index Basis with life expectancy at birth of 71.4 years, adult literacy of 83 % and real per capita income of US\$ 9,310 (PPP).

Mauritius has also achieved a fair degree of diversification in its economic activities. Agriculture, manufacturing and tourism have emerged as the three main pillars of the economy. The fourth pillar of the economy, the quaternary services sector, which represents 12 % of total output, is being expanded in view of making Mauritius a regional financial hub.

The climatic, geological and topographical regimes have resulted in the evolution of diverse biota with a high degree of endemism, further promoted by the island's age and isolation. Small island developing states are unfortunately often characterised by extensive habitat degradation and high rates of species extinction. It is estimated that in Mauritius only about 1.6 % of the land remain under native vegetation. Although conservation activities began some 25 years ago, with the implementation of programmes for the reproduction of threatened bird and plant species as well as habitat restoration, tremendous amount of works concerning in- situ and ex- situ conservations are being and still remain to be carried out to restore, conserve and manage the native flora and fauna of the country.

About 700 species of indigenous flowering plants occur in Mauritius out of which about 300 are endemic. A high proportion of the endemics (about 40%) are threatened or endangered by either alien invasive plants which overwhelm them in their natural habitat or by exotics animals which prevent their regeneration. The World Conservation Union (IUCN) rates Mauritius as the third country in the world after Hawaii and Canary islands to have the most threatened plant species (IUCN/WWF, 1984).

Of the 44 known species of endemic land vertebrates (mammals, birds and reptiles) which occurred on Mauritius and adjacent islands, 21 are extinct and among which are the famous Dodo (*Raphus cuculatus*) a fat flightless waddling bird, the giant black flightless parrot, and the giant Mauritian tortoise. Many of those that still exist are critically endangered. The south west area of the island is rated in terms of priorities for conservation action, by the International Council for Bird Conservation (ICBP) as first among the 75 forests of major importance for threatened birds in the African region. It is indeed the home of all the remaining threatened birds of Mauritius.

Crops and animals domesticated elsewhere were all introduced in the country during early settlements. However most of the crops grown and animals reared have formed the basis of agriculture for a long time. It is therefore these old varieties, landraces and local animal breeds, which constitute the agricultural biodiversity in Mauritius. Only a few wild relatives of economically important crops are found in the wild. Seeds collected during a collecting mission in 1985 are stored and managed by the PGR Unit of the MoA. There are 220 accessions in the collection. Concerning farm animal genetic resources that were introduced in Mauritius, the ‘local’ breeds found in Mauritius are considered as the genetic group that has originated from within animal breeds introduced in the country. However there has been indiscriminate crossing with exotic breeds and the present status of the local breeds has not been assessed.

Sugarcane (main crop), vegetables and tropical fruits are produced for local needs, whereas the majority of live animals, meat, meat products, processed food as well as dairy products are imported. The main staple foods include rice and wheat of which all is imported. Maize mainly for animal feed and the poultry industry is also imported. Mauritius depends largely on imported commodities from South Africa, Australia, Asia, the United States and Europe.

Sugar cane covers about 88% of the cultivated land, 7.5% is under vegetables, fruits and flowers, 3.6% under tea and 0.6% under tobacco. Interline cultivation is practiced in sugar cane field with bean, potato, tomato and maize. However, the share of agricultural sector's contribution to Gross Domestic Product

(GDP) has declined from 23 % in 1970 to 8 % in 1998 with sugar cane, tea, tobacco contributing some 66%, food crops and others 20%, livestock and poultry 10%.

During the last decade, Mauritius has been involved in new biotechnologies and today various institutions devoted to agricultural research as well as human and animal health are presently involved in biotechnology. Most of the researches in biotechnology have been predominantly in the agricultural sector and so far include projects in plant tissue culture, diagnostics for plant, animal and human, plant genetic transformation and molecular mapping.

With the growing economy and increasing pressures on the limited natural resources, biodiversity remains one of the highest priorities for Mauritius. It is evident that threats to biodiversity have to be addressed on a wider scale than is currently the case and through an integrated approach.

In recognition of its unique biodiversity and the challenges that faces it, Mauritius was the first country in the world to ratify the Convention on Biological Diversity (CBD) with the Ministry of Environment as its focal point. The Government of Mauritius is in the process of preparing its national biodiversity strategy and action plan under the project, not just to meet the obligations under the Convention but to be a blue print produced for biodiversity management for the coming decade in the Republic of Mauritius. This project is being funded by UNEP/ GEF and implemented by the National Parks and Conservation Service (National Executing Agency) of the Ministry of Agriculture, Food Technology & Natural Resources in collaboration with all the partners and stakeholders. This activity will complement the sectoral priority actions already identified and partly implemented in the first National Environmental Action Programme (NEAP 1, 1990) and also in the National Environmental Strategies for the Republic of Mauritius for the next decade (NES, 1999) which has already received the approval of the National Environment Commission and the Cabinet of Ministers early this year for implementation.

Mauritius is also a party to a number of International Conventions related to biodiversity and these include the International Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), United Nations Framework Convention on Climate Change and the World Heritage Convention amongst others.

A legal framework exists for the protection of key habitats, nature reserves and restoration of some of its unique ecosystems. Significant efforts have been made in halting terrestrial habitat destruction, through effective policies, legislations, public education, new investments and active collaboration with NGOs, bilateral and multilateral agencies. Following the recommendations of the NEAP 1, the Government of Mauritius has established with the assistance of international funding agencies the Black River Gorges National Park, prepared management plans for the offshore islets, reviewed the Wildlife Act, created the NPCCS, reviewed the Fisheries and Marine Resources Act and proclaimed two Marine parks amongst others. Many activities and researches in the field of biodiversity have also been undertaken in collaboration with various public and private organisations, University of Mauritius, Non Governmental Organisations and international agencies.

The marine ecosystem is quite vulnerable to any activity taking place. The threats to biological diversity due to both marine and landbased activities are addressed. Some monitoring programme are in place and additional ones are proposed. An attempt to compile a comprehensive list of aquatic species of the different taxonomic groups has been made. 1,656 species belonging to 290 families have been repertoried.

An outline of the on-going activities related to plant genetic resources and conservation projects in general are given.

An attempt has been made to give an estimate of the magnitude and distribution of the economic benefits associated with the biological resources of Mauritius and the economic costs associated with the management of biodiversity.

## 2.0 Introduction

The Republic of Mauritius is located at latitude 20° South and longitude 58° East, some 800 km from the south-east of Madagascar in the Indian Ocean. It has no continental shelf proper, the water reaching a depth of 3000 metres within few kilometres of its coastline. The geology of the island is of volcanic origin and encircled by fringing coral reefs enclosing lagoons of various widths.

It consists of a main island, Mauritius and a group of small islands scattered in the Mascarenes namely, Rodrigues, the Cardagos Caragos (St Brandon), Agalega, Tromelin and the Chagos Archipelago (Diego Garcia). Mauritius had its independence on the 12<sup>th</sup> March of 1968 and became a Republic on 12<sup>th</sup> March 1992. It has a total area is 2,040 km<sup>2</sup> and a total population of 1.13 million (Figure. 1). The main islands are Mauritius and Rodrigues, which account for almost 96 % of the land area. In 1999, the population density of Mauritius was 579 people per km<sup>2</sup>, one of the highest in the world for an agriculture-based country. Over 50% of that area, equivalent to nearly 90 percent of arable land, is under sugar cane cultivation. In 1978, Mauritius, a signatory member to the Third Convention on the Law of the Sea, proclaimed its 200 nautical miles Exclusive Economic Zone extending over an area of 1.9 million km<sup>2</sup>. Being a small island state with its own characteristics for instance, large population size, limited land mass, limited natural resource endowments and a high ratio of coastline to land area, Mauritius is very much different from the other African countries.

Before its discovery by the Portuguese in 1507, the Island of Mauritius was not inhabited by man or predatory animals except two small birds of prey, an owl and the kestrel. The Dutch were to visit the island after the Portuguese and Van Warwick's report (1601) on the resources of the island stated: "the island is uninhabited and very mountainous. The soil is extremely rocky but fertile as can be judged from the large number of trees which are so close to each other that one can hardly walk in the forest. The trees are mostly black ebony. There is also a large number of palms, the palms and the palmists are edible". This report resulted in the exploitation of the island's resources by the Dutch East India Company. They cleared the forests to exploit the ebony and palm in the lowland regions and the plains. The clearing process was later accelerated markedly during the French and the British administrations to make room primarily for agriculture and also infrastructure like roads and settlements. The cleared forest areas have been planted with sugar cane, tea and eucalyptus and pine. In the early 1970's, half of the endemic *Sideroxylon* scrub in Plaine Champagne was cleared for forestry plantation. This has resulted in a drastic decline in the population of endemic birds like Echo parakeets (*Psittacula echo*), Mauritius fody (*Foudia rubra*) and olive white eye (*Zosterops chloronothos*), which were using the scrub as foraging ground.

This island which used to support a very rich biogenetic diversity of wildlife is now sadly famous as the home of the extinct flightless Dodo (*Raphus cucullatus*), the very symbol of extinction. It is also quoted as the third country in the world to have the most threatened plant species.

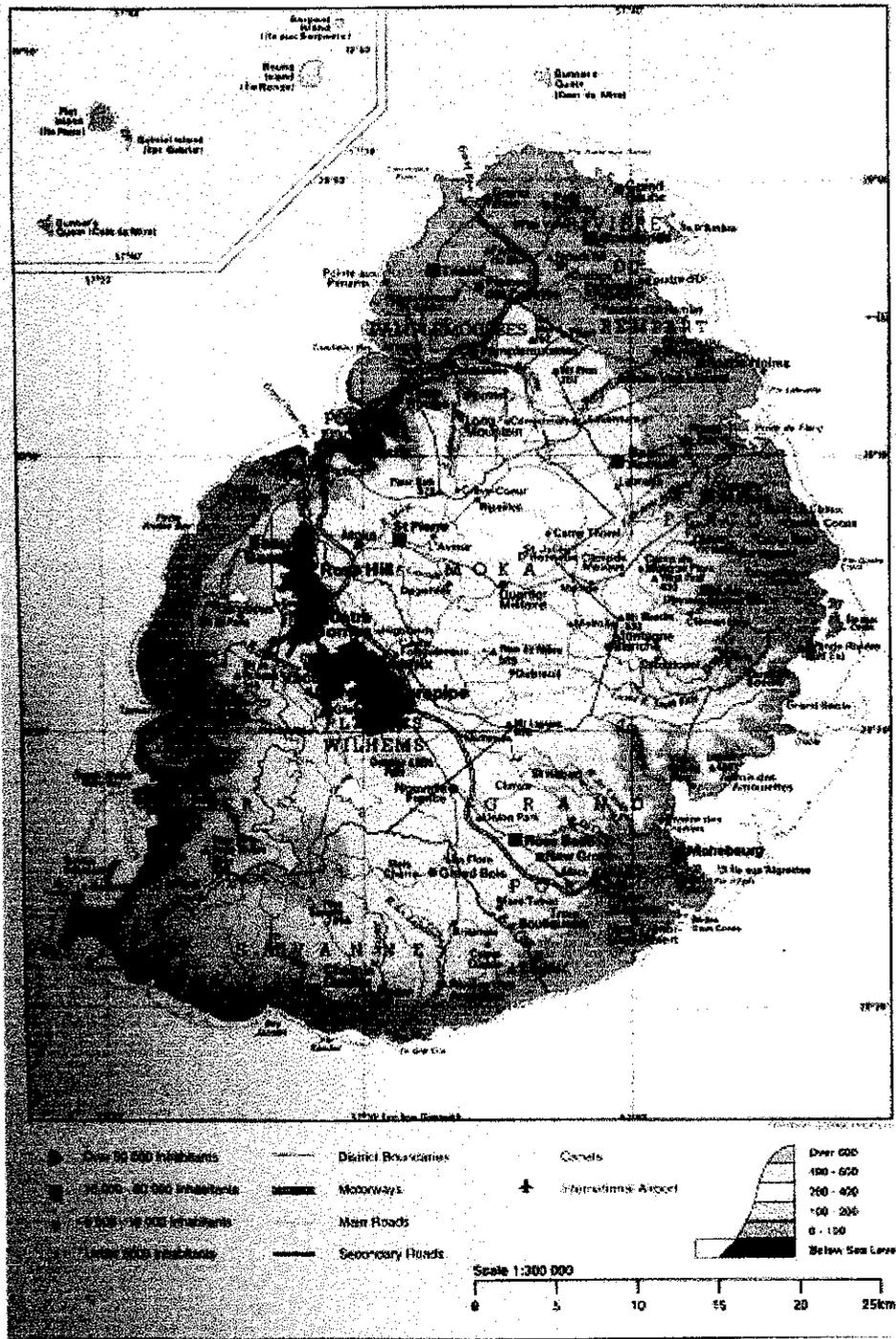
Nowadays, the indigeneous forests are mainly restricted to the south west escarpment which is the most inaccessible or least economically exploitable part of the island. These indigeneous forest remnants which represent about 2% of the pristine native vegetation are under heavy pressure of the proliferous, introduced exotics like privet (*Ligustrum robustum* var. *walkerii*), the vigorous scrambling bramble (*Rubus alceifolius*) and the Chinese guava (*Psidium cattleianum*) introduced by the French. The south west area of the island is rated in terms of priorities for conservation action, by the International Council for Bird Conservation (ICBP) as first among the 75 forests of major importance for threatened birds in the African region. It is indeed the home of all the remaining threatened birds of Mauritius.

In recognition of its unique biodiversity and the challenges that faces it, Mauritius was the first country in the world to sign the Convention on Biological Diversity. Until receipt of funding from UNEP/ GEF to assist in the preparation of the National Biodiversity Strategy and Action Plan (NBSAP) in 1997, there were limited staffs within the National Parks & Conservation Service, the National Executing Agency, and budget dedicated to CBD. However, conservation and sustainable use of biodiversity over the last three decades and also in future would be considered as one of the priorities for Mauritius. These are demonstrated by the achievements in that sector and the commitments of the Government to proceed with conservation and sustainable use of biodiversity.

Two National Consultants were recruited in 1998 to collate all the data and information on terrestrial and aquatic biodiversity resulting in the preparation of a draft interim First National Report (FNR). In July 2000, a National consultant was recruited for a period of one year to prepare the NBSAP and also to finalise the first national report. He is being assisted by seven sectoral Consultants recruited on a shorter

term basis. As the NBSAP process is still at a preliminary stage of consultation and in view of the obligation to submit this first national report to the Secretariat of the Conference of Parties by the end of the year, this report will be brief and succinct.

Figure 1: Relief and settlement of Mauritius



### **3. Principal Measures to Conserve and Sustainably use of Biodiversity in Mauritius**

#### **3.1 National Conservation and Environment Policy Framework**

The Government of Mauritius, aware of the rich biogenetic diversity (both terrestrial and marine) of the natural resources, initiated actions as far back in the early 70's when Sir Peter Scott who visited the island at the invitation of the Government of Mauritius in 1973 wrote a report entitled " Conservation in Mauritius" which was to become the forerunner to the work of the IUCN's " Conservation in Mauritius - 1974" by John Proctor and Rod Salm. They took cognizance of the approved forest policy, the laws pertaining to the environment that existed, the work carried out to protect the environment, both terrestrial and marine, and the various constraint that existed.

As there was rapid deterioration in the state of the fauna and flora of the Mascarene Islands and in the wake of the Laws of the Sea Treaty, in the 70's, interest in the Indian Ocean and its natural resources grew and culminated in the cooperation among the Indian Ocean and eastern African Countries to initiate several important conservation programmes and committees.

In 1985, Government of Mauritius published a White Paper for a "National Conservation Strategy" (NCS), in which the major objectives for the conservation of its natural resources were based on the same objectives as the World Conservation Strategy, namely,

- (i) to maintain essential ecological processes and life support system (for example soil regeneration and protection, the recycling of nutrients, and the cleansing of waters) on which human survival depend;
- (ii) to preserve genetic diversity (especially where is a broad genetic path for scientific work) ;
- (iii) to ensure the sustainable utilisation of species and ecosystems, for example, fish and other wildlife, forests and grazing lands.

Some of the priorities to attain the above- mentioned aims and objectives were as follows:-

- (a) Avoid extinction of endangered and threatened species of flora and fauna by providing sound planning, allocation and management of land and water uses supported by an on-site preservation in protected areas and an off-site protection such as zoo's and botanical gardens
- (b) preserve as wide a genetic diversity as possible of many varieties of the same plants and animals
- (c) preserve as many habitats as possible
- (d) maintain existing nature reserves and to find new ones
- (e) co-operate with international bodies in the furtherance of biosphere reserves
- (f) expand large conservation management areas to other key biodiversity hot spots areas.
- (g) encourage the protection of wetlands and river reserves.

In the wake of the rapid economic growth experienced in the country and the growing concerns about the degradation of the environment in 1988, Government organised a Technical Seminar on the Environment with the assistance of the World Bank to discuss key environmental issues facing the country. The outcome was a comprehensive first Environmental Investment Programme (EIP 1) to address key issues in the first National Environmental Action Plan (NEAP 1). The EIP 1 comprised of 32 projects with various components including institutional strengthening, land management, tourism, industry, solid waste, agriculture, marine and terrestrial conservation & management. The latter also contained a number of biodiversity projects funded by various international agencies including the World Bank and Overseas Development Agency (UK) among which was the setting the country's first National Park to conserve endangered endemic species of flora and fauna and the proclamation of two Marine Parks.

In 1991, Government published a White Paper for the National Environment Policy that gave a commitment to attaining sustainable development which would safeguard welfare and also pursue conservation, ecosystem preservation and environmental quality goals by focussing on monitoring, managing and enhancing the natural system. Government shall also conserve and enhance the quality of the natural heritage of the State of Mauritius including wildlife, biotic diversity and sanctuaries for specific habitats such as mountains, forests, lakes and rivers amongst others.

The policy was reviewed in *Vision 2020* ("The National Long Term Perspective Study" carried out in the 1997 by the then Ministry of Economic Development & Regional Cooperation) which seeks into the development prospects of the country in year 2020. It formulated the challenge for the next 25 years towards establishing a Resource Management Approach that requires the management of the entire ecosystem and to evolve to Environmental Management. This would be based on the modelling of interactions between the economy and the environment as part of an holistic approach.

In order to reiterate its commitment to sustainable development, protection and management of the environment and natural resources, in 1999, the Government of Mauritius through the Ministry of Environment prepared a National Environmental Strategies for the next decade comprising of a second 10 year National Environment Action Plan (NEAP II) and its supportive Second Environmental Investment Programme (EIP II) based on the outputs and lessons learnt from the NEAP I and the EIP 1. In recognition of the crucial role that broad-based consultations and consensus-building must play in the formulation of the National Environment Strategy, the Ministry of Environment established several working groups that assisted with the formulation and refinement of the strategies identified for various priority sectors of which Terrestrial Biodiversity & Conservation and Integrated coastal zone management were included. The reports (NEAP II, EIP II and Review of Legal & Institutional Frameworks for Environmental Management in Mauritius) under National Environmental Strategies for the next decade have already received the approval of the National Environment Commission and the Cabinet of Ministers early this year to start its implementation. Financial assistances are being sought.

The goal of the National Environmental Strategy can be summarised as follows:

*To follow the principles of sustainable development by providing environmental services, encouraging responsible environmental practices and enforcing appropriate environmental standards in order to safeguard the health and welfare, conserve the heritage, and enhanced the quality of life of all the people of Mauritius.*

This will require actions in the various sectoral areas including promoting international efforts to protect the global environment, promoting individual responsibilities, implementing a resource management approach and conserving the heritage amongst others by

- ◆ restoration of areas of original ecology;
- ◆ protection of the built heritage;
- ◆ restoration of marine and terrestrial biological resources and rendering their exploitation sustainable and economically rational.

For the forestry sector, the approved National Forest Policy is outdated and does not specifically address the issue of CBD. It came into force in the early sixties. Since then, a lot of new issues has emerged and need to be re-assessed. The Forestry Service of the MoA is working on a new forest policy in a holistic approach to the management of the forest resources that will spell out the national objectives for the short and long term.

### **3.2 International Conventions and Agreements**

Mauritius was the first country to sign and ratify the Convention on Biological Diversity in 1992. The Ministry of Environment has been designated as the focal Point for this convention and the National Parks & Conservation Service of the Ministry of Agriculture, Food Technology and Natural Resources as National Executing Agency for the preparation of the National Biodiversity Strategy and Action Plan and the First National Report.

The Government of Mauritius is also signatory to a number of International Conventions relating to Article 1 of the CBD, and these include

1. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
2. The African Convention for the Protection of Nature and Natural Resources
3. The Convention of International Whaling Commission
4. The RAMSAR Convention on Wetlands
5. The World Heritage Convention.

6. UN Convention pertaining to the exploitation of fish stock.
7. UN Convention on the Law of the sea ( UNCLOS).
8. UN Convention on the prevention of marine pollution (MARPOL).

The Government of Mauritius is also envisaging to sign the International Biosafety Protocol as called for under Article 19 of CBD which has been opened for signature since 5<sup>th</sup> June 2000 and has initiated action to ratify the African Eurasian Waterbird Agreement.

The Government is also member / Party /Signatory to the following:-

1. FAO and Commission on Plant Genetic Resources
2. The Inter-African Phytosanitary Council of the Scientific and Technical Commission of the OAU
3. Member of the Committee for Agricultural Collaboration of the Mascarene islands
4. IUCN Agreement of the World Conservation Union

Government also has strong ties with a host of international organisations like the:-

1. Durrell Wildlife Conservation Trust (UK)
2. World Centre for Bird of Prey, Peregrine Fund (USA)
3. World Wide Fund for Nature (WWF)
4. Royal Botanic Gardens, Kew (UK)
5. Royal Botanic Gardens, Edinburgh (UK)
6. Flora and Fauna International
7. World Conservation Union (IUCN)
8. International Council for Bird Preservation (ICBP)

### 3.2.1 Collaboration with International Agricultural Research Centers

Improved genetic material from International Agricultural Research Centers have been introduced in Mauritius and they are:-

Maize germplasm from	CIMMYT
Bean from	CIAT
Cowpea from	IITA
Ground nuts and pigeon pea from	ICRISAT
Potato from	CIP
Vegetables from	AVRDC
Germplasm exchange	CIRAD

### 3.2.2 Bilateral relations and Regional Cooperation

Mauritius has established many bilateral relations in the field of plant genetic resources. A few of these are :

1. Indo-Mauritian Commission covering exchange of sugarcane germplasm between Mauritius and Coimbatore (India)
2. Relations exist between the CIRAD (La Réunion, France) and the AVRDC
3. Bilateral relations exist between Mauritius and China in the field of Medicinal plants
4. Indian Ocean Commission and a number of Projects relating to biodiversity and environment are on-going :
  - Inventory and study of Medicinal and Aromatic Plants of the States of the Indian Ocean.
  - "Programme Regional Environment " which contains some actions for the conservation of the endangered species.
5. SADC Plant Resources Genetic Council .

Some of the projects that are being undertaken the SADC include:

- The SADC Forestry Sector Programmes which aims at strengthening and improving the forestry sector by way of training programs and the setting up of a SADC Tree seed centre Network.

- SADC Wildlife Sector and its Wildlife Protocol (Mauritius recently ratified the SADC wildlife protocol).

### ***Fisheries agreement and collaboration***

Mauritius has so far signed fishing agreements with the European Union (EU) and the Republic of Seychelles. The protocol to agreement with EU provides for fishing possibilities to 42 ocean going purse-seiners, 25 Gross Registered Tonnage /month on an annual average for vessels fishing by line and 40 surface longliners. The fishing agreement between Mauritius and Seychelles allows up to five Mauritian purse seiners and one longliner to be licensed to fish in the waters of Seychelles.

Mauritius is also a member of the Western Indian Ocean Tuna Organisation (WIOTO) with its seat in Seychelles. Mauritius is a signatory to the Indian Ocean Marine Affairs Cooperation (IOMAC), based in Colombo, Sri Lanka. For the conservation and exploitation of marine resources at the Chagos Archipelago, Mauritius and the United Kingdom have set up the British Mauritian Fisheries Commission.

### **3.3 National Legislation pertaining to biodiversity conservation**

There are several pieces of the National Legislations that provide for the conservation and sustainable use of biodiversity. Some of the most important ones are:

- The Fisheries and Marine Resources Act 1998*
- National Coast Guard Act, 1988
- Pas Geometriques Act, 1895
- Removal of Sand Act, 1975
- Environment Protection Act (EPA), 1991 and its subsequent amendments
- Wildlife and National Parks Act 1993, the National Parks and Reserve Regulations of 1996, and the Wildlife Regulations of 1998
- Forests and Reserve Acts 1983

A draft bill governing biosafety is presently under preparation.

The MoA is also presently working on appropriate amendments to the Forest & Reserves Act (1983) and the Wildlife & National Parks Act (1993) to eliminate overlap of responsibilities and to provide for more severe penalties against contravenants. The possibility of consolidating the control of deforestation on privately owned forests which at present does not fall within the ambit of existing legislations is also being considered. The EPA 91 is also in the process of being completely reviewed by the Ministry of Environment.

These legislations and a series of secondary legislations are being enforced by numerous institutions concerned with the conservation, protection, management and sustainable use of biodiversity resources.

### **3.4 Status and trends of Biodiversity**

#### **3.4.1 Forestry and Flora**

Out of a total land area of 185,000 ha, 45 % is devoted to agriculture, 31 % natural green areas (including forests) and the remaining 24 % is either built upon or unusable. The extent of native forest area remaining in Mauritius is estimated to amount to about 2 % of the original native vegetation. The native biodiversity is now confined mostly to the south western region of the island, a few other remote areas on mountain ridges and on offshore islets.

Over the years there has also been various deliberate or inadvertent introduction of exotic plant and animal species in Mauritius. Some of these plants and animals have turned out to be so invasive that they threaten the very existence and survival of the native forests. As there were no native ground-dwelling mammals in Mauritius, the introduced mammals have had a particularly devastating effect on the ecosystems. Monkeys (*Macaca fascicularis*), rats (*Rattus rattus* and *Rattus norvegicus*), pigs (*Sus scrofa*), and deer (*Cervus timorensis*) are directly detrimental to the native vegetation, and are either indirectly or, together with the lesser Indian mongoose (*Herpestes auropunctatus*) and feral cat (*Felis catus*), directly detrimental to the native fauna. The Figure 2 below illustrates a deer and a monkey in the wild.

As the native species are notorious for their slow growth, plantation of exotics was resorted to. By then, a lot of fast growing exotic species had been introduced and are growing well. These exotics have changed the physiognomy of the Mauritian landscape for ever. About ten major tree species have been raised as plantations of economic importance. *Pinus elliottii* and *P. taeda*, (65 %), *Cryptominia japonica* (13 %), *Araucaria sp.*, *Juniperus bermudiana* are the main softwood, whilst *Eucalyptus tereticornis* (16 %) & *E. robusta*, *Tabebuia palida*, are the main hardwood species.



Figure 2: Monkey (*Macaca fascicularis*) in the wild

The native forest areas still harbour a great diversity of important indigeneous forest trees which the early colonisers had been harvesting. The black ebony (*Diospyros tesselaria*), Makaks (*Mimusops spp.*), Bois d'Olive (*Cassine orientalis*), Bois fer (*Stadmania oppositifolia*), and many others were highly prized for their valuable timber. With the decline in native forest area, the population level of these species has become too low to allow any sustainable utilisation.

However, the remaining areas of native vegetation still hold a great diversity of plant species and are of great conservation value. About 700 species of indigenous plants occur in Mauritius out of which about 300 are endemic (naturally found only in Mauritius). To these should be added about 150 or more that are shared with the other islands of the Mascarenes, Reunion and Rodrigues (Strahm, 1994). Mauritius has 8 endemic genera and six endemic flowering plant genera in Rodrigues. A high proportion of the endemics (about 40%) are threatened or endangered by either introduction of exotic plants which overwhelm them in their natural habitat or are damaged by exotic animals preventing their regeneration. The World Conservation Union (IUCN) rates Mauritius as the third country in the world after Hawaii and Canary islands to have the most threatened plant species (IUCN/WWF, 1984). The status of plants of Mauritius and Rodrigues is given in the table 1 below.

Table 1 : Status of native flowering plants of Mauritius and Rodrigues

	Endemic		Non-endemic		Total	
	M	R	M	R	M	R
Extinct	12	8	1	-	13	8
Extinct/Endangered	6	3	-	-	6	3
Endangered	78	21	12	7	90	28
Vulnerable	42	7	16	5	58	12
Rare	52	10	10	2	62	12
Indeterminate	4	-	6	-	10	-
Insufficiently known		-	1	2	1	2
Status unassigned	18	-	36	17	54	17
Not threatened	31	3	54	17	85	20
Threatened (Total)	194	9	45	14	239	63
<b>Grand Total</b>	<b>234</b>	<b>52</b>	<b>136</b>	<b>0</b>	<b>79</b>	<b>10</b>

M = Mauritius

R = Rodrigues

(Source: Report on Conservation in Mauritius and Rodrigues with particular reference to information system and native flora. Michael Lear, Nov. 1989).

# IUCN classifies all these plants as being endangered.

It is estimated that the total natural green & forest areas of Mauritius is 57, 059 ha. 21, 867 ha are state forest land comprising the Black River Gorges National Park (6574 ha), nature reserves (799 ha), plantations (12, 609 ha) and the unplanted, protective or to be planted areas (1885 ha).

Privately owned forest lands consist of some 34,540 ha and comprise mountain reserves (3,800 ha) and river reserves (2740 ha). Forest lands including scrub and grazing lands have been estimated at around 28, 000 ha.

The "Pas géométrique" constitute 2,110 ha of which 652 ha is managed by the Forestry Service and this includes plantations ( mostly *Casuarina equisetifolia*); lands leased for grazing and tree planting as well as unplanted, protective or to be planted lands.

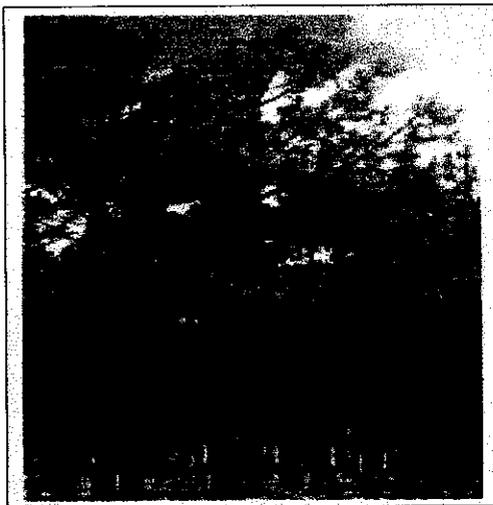
Whilst the state owned native forests benefit from legal protection, the private owned ones are very vulnerable and are being converted to other land uses. This trend which will continue for quite some time needs to be controlled.

Due to the unavailability of land for creation of forest plantations, there is limited timber production. About 30% of the demand of utility timber is met from local sources thus making Mauritius a net importer of timber.

Although limited in size, the native forests are strategically located in the uplands area of Mauritius and by virtue of their location, along with the planted forests (Figure 3) play a vital role in soil and water conservation. This protective function is of great relevance and significance to the National Economy as most of the sugar cane plantation are located at mid or low elevations. Moreover the forests of Mauritius provide direct and indirect employment to about 5000 people in the various forestry sub-sectors and contribute around 1% to the GDP.

Figure 3: A: Planted Forests

B: Native forest



#### 3.4.1.1 Medicinal Plants

Medicinal plants are collected from the forests by the local inhabitants. There are traditionally a few families who for generations are earning their living from sale of medicinal plants in Mauritius. An *ex-situ* collection of the more commonly used native medicinal plants has been established in the Sir Seewoosagur Ramgoolam Botanical Garden at Pamplémousses by a Chinese mission team. A small collection has been established at the Long Mountain Hospital but these include mostly exotics.

### 3.4.1.2. Institutions dealing with Forestry and Flora

The main institution dealing with the Forestry and conservation of flora outside the Black River Georges National Park in Mauritius is the Forestry Service of the MoA. The National Parks and Conservation Service with the collaboration of Mauritian Wildlife Foundation and a few other NGOs is responsible for flora inside the National Park and on the northern offshore islets (refer to section 3.4.2.2 for institutional detail).

The Forestry Service is responsible for an area of 16,000 ha. of state forests - out of which there are 3,000 ha of native forests that still contain areas of rich plant biodiversity. Some of the inaccessible areas also harbour a few species that are on the brink of extinction. To give more impetus to issues pertaining to native plant biodiversity, the Forestry Service has created the following Units/ Centre:

1. Biodiversity Unit
2. Greenhouse Unit
3. Tree Seed Centre

The total personnel of the units are composed of 1 Technical Officer, 5 Foresters, 2 Forest Guards, and 25 labourers.

### 3.4.2 Fauna diversity

Of the 44 known species of endemic land vertebrates (mammals, birds and reptiles) which occurred on Mauritius and adjacent islands, 21 are extinct among which are the famous Dodo (*Raphus cucullatus*) a fat flightless waddling bird (figure 4), the giant black possibly flightless parrot, 4 species of giant tortoise (2 each from Mauritius and Rodrigues), and probably many more of which no records exist. Many of those that still exist are critically endangered.



Figure 4: Dodo (*Raphus cucullatus*)

#### ***Mammals***

The only endemic mammals that have ever existed on Mauritius are the fruit bats. Of the three species (*Pteropus niger*, *P subniger* and *P rodricensis*) known to have occurred on Mauritius, only one is left, the Mauritian fruit bat (*Pteropus niger*). This species is still locally common, having major populations in the Black River Gorges, Combo and Bel Ombre within the National Park. *P rodricensis* now only occurs in Rodrigues. A program of captive breeding has been going for the past fifteen years to help save this species.

#### ***Birds***

Eleven species of land birds have so far escaped extinction in Mauritius. There are nine endemic bird species, seven of which are classified as threatened, and two native bird species. As a result of extensive conservation works that have been carried out both in captivity and management in the wild, three of the nine endemic bird species have been saved from extinction. These are:

- (a) the Mauritius Kestrel (*Falco punctatus*) was once the rarest bird, with a population of only 4 birds in 1974, as a result of pesticide abuse, especially DDT, an organochloride used for the control of mosquito, the vector of malaria, and habitat degradation. The kestrel population is now estimated to be 800 birds.

(b) the Echo Parakeet (*Psittacula eques echo*) is the last surviving parrot in the Mascarenes. It was considered the rarest parrot in the world, with only about 12 individuals in 1987. The population declined through nest predation and habitat loss. The current population is now about 120 birds. Besides captive breeding and release of captive bred or reared birds several management techniques like supplementary feeding, provision and monitoring of nest boxes, double clutching, control of animal pests etc have been applied concurrently in the wild to achieve these results.

(c) the number of Pink Pigeon (*Columba mayeri*) is now fluctuating around 400 birds from a population of some 25 birds in the 1970s. There are now four mainland wild populations, all in the Black River Gorges National Park and a fifth population on Ile aux Aigrettes.



Figure 5: a: Mauritius Kestrel

b: Echo Parakeet

c: Pink Pigeon

Of the remaining eight species, only the Mauritius Grey white eye (*Zosterops borbonicus*) is common. Mascarene cave swiftlet (*Collocalia francica*) and the Mascarene Swallow (*Phedina borbonica*) are fairly common while all the others namely Mauritius Cuckoo shrike (*Coracina typica*), Mauritius Black Bulbul (*Hypsipetes olivaceus*), Mauritius olive white eye (*Zosterops chloronothos*), Mauritius Fody (*Foudia rubra*), and Mauritius Paradise Flycatcher (*Terpsiphone bourbonensis*) are threatened. The Mauritius Fody and Mauritius Olive white eye are the two most threatened. In Rodrigues, the warbler (*Acrocephalus rodericana*) and the Fody (*Foudia flavicans*) are both seriously threatened and the latter was subject to a captive breeding program at the Durrell Wildlife Conservation Trust Zoo.

The northern offshore islets of Mauritius in particular Round Island, and Serpent island are important breeding grounds for many sea bird colonies which include Herald or Round Island Petrel (*Pterodroma arminjoniana*), Wedgetailed shearwater (*Puffinus pacificus*). Red tailed tropic bird (*Phaeton rubricauda*), white tailed tropic bird (*Phaeton lepturus*) and White or fairy Tern (*Sterna dougalsi*) breed on Cocos and Sables isles of Rodrigues.

Common introduced birds include the Indian mynah (*Acridotheres tristis*) and the red-whiskered bulbul (*Pycnonothus jocosus*), both of which are known to rob nests of native birds and disperse seeds of invasive plants. Mynahs and Indian ring-necked parakeets (*Psittacula krameri*) compete with the endemic echo parakeets for nest sites.

### Reptiles

The greatest concentration of native reptiles species occur on Round Island. It is inhabited by eight species which are all endemic to the Mascarene and four species now occur only on Round Island. These are the Durrell's night gecko (*Nactus serpensinsula durrelli*), Gunthers gecko (*Phelsuma guentheri*), Ornata Gecko (*Phelsuma Ornata*), Telfair skink (*Leiopisma telfairii*), Bojer's skink (*Gongylomorphus bojerii*), Bouton's skink (*Cryptoblepharus boutonii*), Round Island burrowing Boa (*Bolyeria multocarinata* - probably extinct last seen in 1975), and Round Island Keel scaled boa (*Casarea dussumeieri*).

In addition to these, there are many other species that exist on the mainland or other islets. The Macchabe forest skink (*Gongylomorphus bojeri fontenayi*), a sub species of the Bojer's skink was first described from a specimen collected from the Macchabe forest only in 1973. A new species of Night gecko (*Nactus coindemirensis*) was only discovered from Gunner's coin in 1982. An agama lizard (*Agama calotes*), house gecko (*Hemidactylus frenatus*, *Hemiphyllodactylus typus* and *Gehyra mutilata*), *Trionyx steindaeheri* in some rivers, *Chameleo pardalis* and two non-venomous snakes (*Typhlops caraei* and *Lycodon aulicus*) are all introduced species that are abundant and well-established.

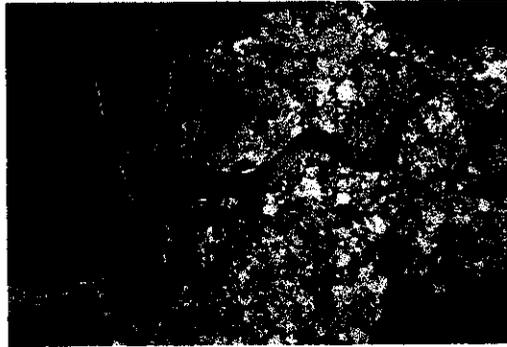


Figure 6: Keel Scaled Boa (endemic to Round Island only)

### ***Invertebrates***

The invertebrate fauna has only been scantily studied and is therefore not well known. 130 land snails are native to Mauritius of which 30 % have become extinct and another 30% are severely endangered due to habitat destruction and introduction from USA in 1961 of the carnivorous snails (*Euglandina rosea*) that have decimated the native snail fauna. The giant African land snail, *Achatina* spp are now abundant and are very damaging to young plants.

Among the butterflies, 37 species have been recorded from Mauritius of which 10 are either extinct or endangered.

#### **3.4.2.1 Offshore Islets**

Mauritius is surrounded by some 46 islets ranging from 1.4 ha to 253 ha. Bell *et al.* (1994) classified these islets under the following sections namely:

- (a) Strict nature reserves (with high endemism): Serpent island (31.66 ha), Round Island (151 ha), Ile aux sables ( 84.42 ha) and Vacoas island (1.4 ha).
- (b) Open nature reserves (With Conservation potential and Control tourism) : Ile aux cocos (14.6 ha), Flat Island (253 ha), Gabriel island (42 ha), Crab island (44.5 ha), Gunner's Coin.( 65 ha), Ile aux Aigrettes ( 24.69 ha), Ile aux Fouquets (0.2 ha), Ile aux Marianne (2 ha) , Ile de la Passe and Ile aux D'ambre.
- (c) Under the group Tourist and recreational: Gombrani, Bernache, Mangenie, Cerf and Benitiers islands, and
- (d) The remaining islands are those which should remain as passive reserves so that their values are maintained.

Round Island is one of the most thoroughly studied islets in Mauritius. It supports the last remnant of a palm savannah (figure 7), once characteristic of the northern and western plains of Mauritius. The island was infested by goats and rabbits that were introduced in the last century but is now pest free. Many ecological expeditions are being undertaken by the technical staff of NPCS and MWF as well as international botanists and zoologists to carry out monitoring and restoration activities on this island. Round Island is also internationally renowned for its unique reptilian fauna ( refer to section 3.4.2.1) and is also the breeding place for sea birds like Herald petrel (*Pterodroma arminjoniana*), red tailed and white tailed tropic birds (*Phaethon rubricauda* and *P. lepturus*), and wedge- tailed shearwater ( *Puffinus pacificus* ) .



Figure 7: A Last remnant of a hurricane palm on Round Island

Ile aux Aigrettes is another island Nature Reserve where much progress has been made following recent conservation activities. This islet which has been leased to MWF for conservation contains a relict of the coastal forest which has now almost completely disappeared from Mauritius. The islet is a small, low island of raised coralline limestone. Unlike Round Island, Ile aux Aigrettes is an easily accessible islet only 900 m off the south east coast of Mauritius in the Mahebourg bay. The flora of the island has been decimated largely due to the collection of firewood and the invasion by exotic species.

The Serpent Island is a key seabird island and provides the main breeding area for several species frequenting Mauritian waters. The island is also a very important habitat for two lizard species (*Scelotes bojeri* subsp. and *Nactus serpensinsula*). An undescibe tarantula spider also occurs on the island.

#### 3.4.2.2 Institutions responsible for flora and fauna in the National Park and Offshore Islets

The National Parks and Conservation Service was officially established on 9 May 1994 under Section 8 of Wildlife and National Park Act 1993. It is headed by a Director who is responsible to monitor all issues related to the conservation of terrestrial flora and fauna in Mauritius and also advises the Minister of Agriculture in this field. The Director is assisted by two Research and Development officers and six Technical officers to carry out conservation activities in Mauritius. Presently, the NPCS has an equipped native plant propagation centre, a captive breeding centre, 3 field research stations with facilities for field work, a shade house, information centres at Petrin and Black River, a fernery, a green house under construction. Though established in 1994, all the staff except the Director are on secondment in the NPCS.

There are also other organisations/ NGOs that are actively involved in conservation works and few of them are:

- (a) The Mauritian Wildlife Foundation (MWF) is a non-governmental organisation, created in 1984 by Mr G. Durrell following his interest to undertake conservation and restoration works on the endangered animals of Mauritius and Round island. It has a technical staff of about 40 members which also includes many volunteers and researchers. MWF is committed to conservation activities and has contributed greatly in helping biodiversity preservation.
- (b) Gold Award Holders Association (GAHA) of the National Youth Award is involved in restoration work and conservation of biodiversity on Iles de la Passe and Marianne. It has also carried some sensitisation programmes on biodiversity for secondary school students.
- (c) Friends of the Environment and The Wildlife Club of Mauritius are among the other NGO's involved in conservation activities in Mauritius.

#### 3.4.3. Agricultural Biodiversity

Up to the 1970's, the Republic of Mauritius was predominantly agricultural economic system, based on sugar cane production. Although later on in the 1980's, industrialization and diversification were growing in importance, sugar cane remains the most important agricultural export followed by flowers and

vegetables. Sugar cane covers about 88% of the cultivated land, 7.5% is under vegetables, fruits and flowers, 3.6% under tea and 0.6% under tobacco (figure 8). Through the implementation of the agricultural diversification policy, interline cultivation is practiced in sugar cane with bean, potato, tomato and maize. It is noteworthy that the share of agricultural sector's contribution to GDP has declined from 23 % in 1970 to 8 % in 1998 with sugar cane, tea, tobacco contributing 66%, food crops and others 20%, livestock and poultry 10%.

Crops and animals domesticated elsewhere were all introduced in the country during the first settlements. However most of the crops grown and animals reared have formed the basis of agriculture for a long time. It is therefore these old varieties and landraces and local animal breeds, which constitute the agricultural biodiversity in Mauritius. Only a few wild relatives of economically important crops are found in the wild.

### 3.4.3.1 Sugar cane

The previously cultivated *Saccharum* species, *S. officinarum*, *S. sinense*, *S. barberi*, and the wild *Saccharum* species *S. spontaneum*, *S. robustum* as well as the associated genera, *Erianthus*, *Miscanthus*, *Narenga*, *Sclerostachya* constitute the basic genetic resources of sugar cane.

The history of the introduction of sugar cane in Mauritius dates back to the Dutch era (1635-1710). It was during the British rule that many varieties were introduced and later there were more systematic introductions by the Chamber of Agriculture (Ramdoyal, Domaingue, 1995). The varietal situation witnessed a major change towards the turn of the century with the discovery of the sexual fertility of sugar cane and the advent of interspecific hybridization. When the Agricultural Department was established in 1913, variety introduction was further promoted from a range of countries. The Sugar Research Station established in 1930 continued the introduction of commercial hybrids and wild species and breeding activities. With the creation of the Mauritius Sugar Industry Research Institute (MSIRI) in 1953, breeding work was intensified and a dynamic varietal exchange policy was maintained. Today the MSIRI holds the collection of a number of clones, which have either directly or indirectly contributed to produce varieties, which are one of the major factors in increasing productivity of sugar cane lands. Details of this collection are shown in Table 2. It should be noted that these clones are conserved exclusively by vegetative means.

Table 2: Status of sugar cane germplasm in the MSIRI collection

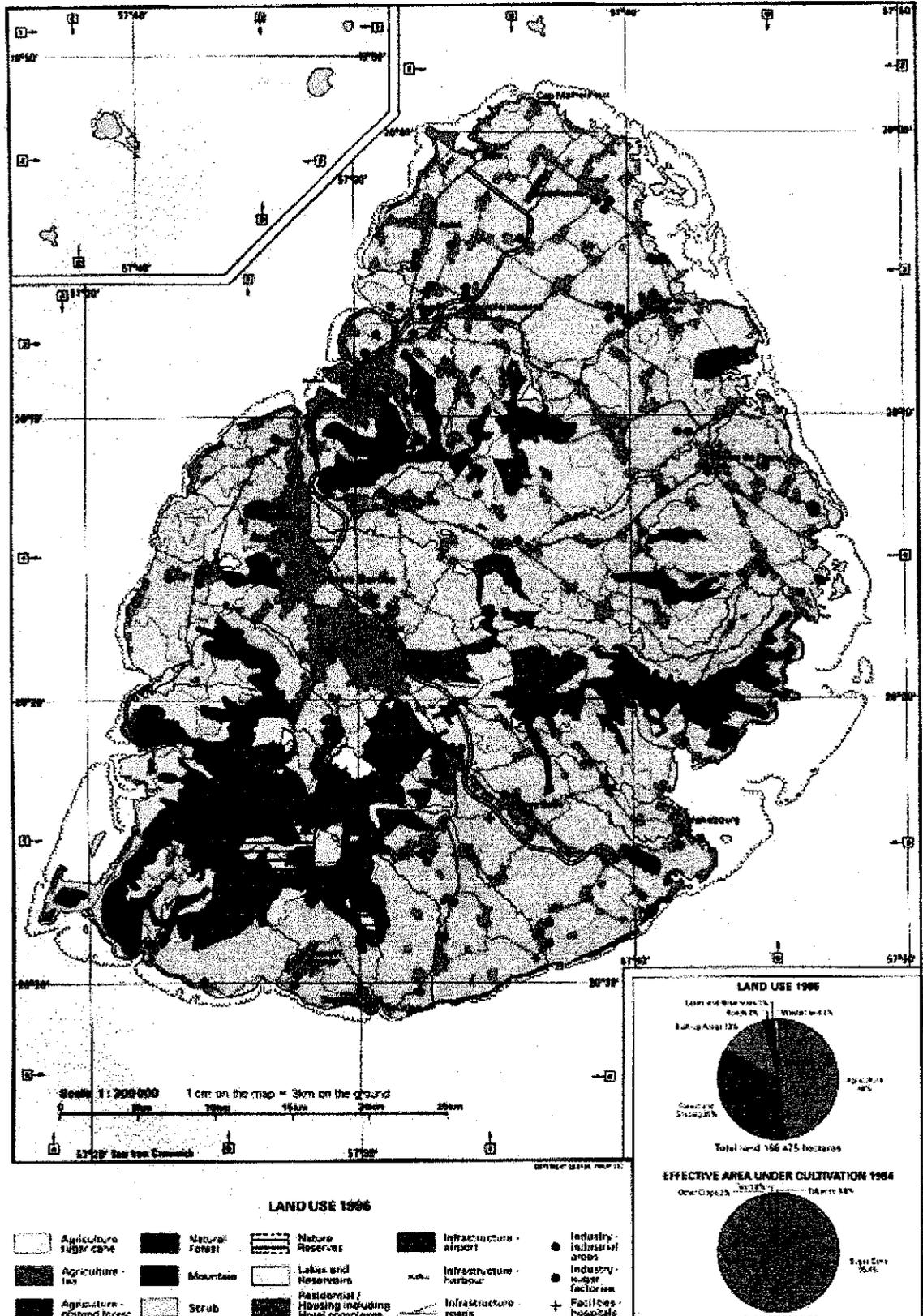
Germplasm group	Number of accessions
<i>Saccharum</i> spp and allied genera	193
F1 Hybrids	151
BC1 Hybrids	178
BC2 Hybrids	48
Commercial type Hybrids	
Foreign	621
Mauritian	769
<b>TOTAL</b>	<b>1962</b>

Source: Ramdoyal K, MSIRI

### 3.4.3.2 Maize

Maize (*Zea mays*) was an economically important crop at the beginning of the French colonization in the 18<sup>th</sup> century. There were also periodic introductions from several sources namely America, Europe and even Africa. Introductions were restricted when quarantine laws were enacted in 1940. It was then that farmers started selecting on the basis of their own taste and requirements. Thus while they were saving seeds from one generation to the next, farmers created a number of ecotypes suited to their production systems. The preference for these eco-types was more accentuated in Rodrigues as farmers continued to cultivate them even after the introduction of hybrids. It is these ecotypes that now constitute the available diversity in maize germplasm in Mauritius and Rodrigues. Forty-one accessions of ecotypes are held in the collection at the MSIRI.

Figure 8: Land use Map for Mauritius



### 3.4.3.3. Other crops

Since all food crops were introduced in Mauritius, only a few old varieties and landraces of a few crops constitute the diversity. Seeds collected during a collecting mission in a collaborative work between the MoA and IPGRI in 1985 are stored and managed by the PGR Unit of the MoA. There are 220 accessions in the collection. The crops collected are of the following genera: *Amaranthus*, *Allium*, *Brassica*, *Lycopersicum*, *Phaseolus*, and *Solanum* spp.

Two landraces of bean (*Phaseolus vulgaris*) still persist in Rodrigues. These are the 'local red' and the 'navy bean'. They are still cultivated in Rodrigues and are thus conserved on-farm by farmers who save seeds from one season to the next. At present there are no seeds of these landraces in the PGR Unit of the MoA. In Mauritius, there is an old variety known as 'long Tom', which is widely grown. Seeds are produced by the MoA and farmers produce their own seeds as well. There is another old cultivar of cowpea (*Vigna unguiculata* var. ) and the 'long yard bean' (*Phaseolus* spp var *sesquipedalis*).

The only local variety of onion (*Allium* spp.) is the 'local red', which is characterized by a very strong pungent smell and good keeping quality. However it is very low yielding.

Other old varieties of crops include: tomato (*Lycopersicum esculentum* spp.) var "quatre carres" groundnut (*Arachis hypogen* spp.) var "cabri", garlic (*Allium sativum* spp.) var "local", cucumber (*Cucumis sativa* spp.) var "local white" and pumpkin (*Cucurbita sativa* spp.) var "local". Farmers themselves conserve these old varieties. The PGR Unit of the MoA also conserves small samples of these varieties. Seeds are currently being produced by the MoA for farmers as well.

### 3.4.3.4. Wild relatives of crops

There are several wild relatives of important crops growing in Mauritius. These include:

Tomato	<i>Lycopersicon esculentum</i> var <i>tallerelli</i>
Pigeon Pea	<i>Cajanus cajan</i>
Potato	<i>Solanum commersoni</i>
Eggplant	<i>Solanum torvum</i> (white flowers) <i>Solanum indicum</i> (violet flowers).

An interesting species, *Vigna glabreus*, is believed to be unique in its kind. It was found in the Pamplémousses Garden and seeds are stored in the *Vigna* collection at Gembloux, Université Agricole, Belgium. This wild species is extensively used in the breeding of bean.

Wild relatives of coffee can also be found in the wild. There are three species, two of them endemic in Mauritius. These are: *Coffea macrocarpa*, *C. myrtifolia* and *C. mauritiana*.

Figure 9: *Coffea macrocarpa*, a wild relative of coffee, endemic to Mauritius.



Some of these wild relatives of crops have been used in breeding .

#### 3.4.3.5 Fruit species, root and tuber crops

Domestication changes seem to have been greater in crops grown for their seeds, the cereals and pulses, than in roots and vegetables such as potatoes, yams and cassava, and have been least in fruits, particularly in tropical fruits (Holden, Peacock, Williams, 1993). Therefore it is imperative that the local fruit varieties and root and tuber crops that are still in collections and cultivated, should be conserved. Table 3. shows the species in collections and their status.

Table 3: Species of fruits and root crops in collection (Source: Dr. Rojoo, Ministry of Agriculture & Natural Resources, April 1998)

SECTOR	COMMODITY	No of ACCESSIONS
Fruits	Banana	33
	Coconut	3
	Pineapple	5
	Guava	9
	Mango	62
Root Crops	Cassava	15
	Sweet potato	21
Fodder		16

#### 3.4.3.6. Farm animal genetic resources

All farm animal genetic resources were introduced in Mauritius during the colonizing periods. The 'local' breeds found in Mauritius are considered as genetic groups originating within animal breeds introduced in the country a long time back. However there has been indiscriminate crossing with exotic breeds and within the breed. The status of these local breeds has not been assessed. The following breeds exist in Mauritius:

Cattle:	Creole breed ( <i>Bos taurus</i> and <i>Bos indicus</i> )
Goat:	Local breed ( <i>Capra hircus</i> )
Sheep:	Local breed ( <i>Ovis aries</i> )
Deer:	Rusa Deer ( <i>Cervus timorensis</i> - the estimated number of head is 70,000)
Poultry:	<i>Gallus domesticus</i>
Pigs:	
Rabbits:	<i>Oryctolagus cuniculus</i>

#### 3.4.3.7 Microorganisms

Very limited works have been undertaken in this sector. The University of Mauritius has effected some studies on the micro fungi in the native forest and has censused about 300 species of which many have been recorded for the first time in Mauritius (pers. comm. Dullymamode).

#### 3.4.3.8 Institutions

Some of the institutions that are actively involved at the national level are:

- (a) PGR Unit of the MoA (*Ex situ* conservation of food crop, fruit, root and tuber genetic resources);
- (b) Mauritius Sugar Industry Research Institute (Conservation and utilization of sugar cane, maize and potato);
- (c) University of Mauritius (Training in biodiversity for students studying Agriculture at degree level. Two modules are offered by the faculty, namely: biodiversity and genetic resources management, plant diversity and genetic resources management. There is also a crop museum which is maintained at the University farm);
- (d) Agricultural Services including the Veterinary Service, Animal Production Division of the MoA;
- (e) Agricultural Research and Extension Unit;
- (f) Mauritius Chamber of Agriculture;
- (g) Farmers Service Center, and

(h) Food and Agricultural Research Council.

#### 3.4.4 Biotechnology

As mentioned earlier, Mauritius is an agricultural-based country with sugarcane as its main crop. Apart from sugarcane, vegetables and tropical fruits are produced for local needs, whereas the majority of live animals, meat, meat products, processed food as well as dairy products are imported. The main staple food include rice and wheat of which all is imported. Maize mainly for animal feed and the poultry industry is also imported. Mauritius depends largely on imported commodities from South Africa, Australia, Asia, the United States and Europe.

Biotechnology has many traditional applications in agriculture and has been applied in the processing of dairy products such as yogurt, brewing and in the transformation of sugarcane by-products such as molasses for the production of alcohol and animal feed. In the last decade, Mauritius has been involved in new biotechnologies and today various institutions devoted to agricultural research as well as human and animal health and the University have a Research and Development (R&D) programme in biotechnology. The following institutions are presently involved in biotechnology:

1. Agricultural Services, MoA
2. Food and Agricultural Research Council (FARC)
3. Agricultural Research and Extension Unit (AREU)
4. SSR Centre for Medical Studies and Research
5. University of Mauritius
6. Mauritius Sugar Industry Research Institute (MSIRI)
7. Private firms.

Most of the research and development in biotechnology have been predominantly in the agricultural sector and so far include projects in plant tissue culture, diagnostics for plant, animal and human genetic transformation and molecular mapping. However, these are all ongoing activities.

##### 3.4.4.1. Tissue culture

Plant tissue culture is of particular interest in Mauritius because it requires low biotechnological techniques. Presently six plant tissue culture laboratories are operational in the island and these are

1. the Food and Agricultural Research Council (FARC) laboratory;
2. the Agricultural Services Laboratory at Barkly;
3. Biofactory of the Biotechnology Department of the Mauritius Sugar Industry Research Institute (MSIRI);
4. one laboratory at the Faculty of Agriculture, University of Mauritius for teaching and research purposes, and
5. two private laboratories (Micro Lab Ltd and Bellissima Ltd).

Some of the laboratories carry out multiplication of imported starter cultures using commercial protocols while others are involved in all steps required for propagating tissue cultured plants, i.e., indexing of mother plants for diseases, culture of explants, micropropagation, hardening and commercialisation of products. Propagating plants include ornamentals (orchids, anthurium, carnation, syngonium, caladium, gerbera, chrysanthemum, begonia, roses), fruits (banana, pineapple, strawberry), vegetable crop (asparagus, potato, ginger) and sugarcane varieties.

The different laboratories have an *in vitro* annual production capacity of some 1 250 000 plantlets, but this production figure has not yet been attained due to several constraints. In 1997, only about 600 000 plantlets of the various crops were produced. The tissue culture plantlets are commercialised locally.

*In vitro* culture is also being used to eliminate diseases from sugarcane cultivars infected with pathogens of viral and bacterial origin. Successful elimination of the newly recorded sugarcane yellow leaf virus - associated with sugarcane yellow leaf syndrome- using tissue culture techniques provides new avenues to free our local sugarcane varieties from this pathogen. Tissue culture is also being investigated for short and long-term preservation of potato and sugarcane germplasm, while cryopreservation techniques are being developed.

#### **3.4.4.2 Diagnostics**

For the diagnosis of plant, animal and human diseases, molecular techniques based on serological tests using monoclonal and recombinant antibodies and nucleic acid sequence-based techniques are being applied. These new techniques provide a higher sensitivity, specificity and accuracy and thus enhance diagnosis of diseases. Several techniques including polymerase chain reaction (PCR) and many of its derivatives, reverse transcriptase - polymerase chain reaction (RT-PCR), random amplified polymorphic DNA (RAPD), restriction fragment length polymorphism (RFLP) and amplified fragment length polymorphism (AFLP) are already being applied for the detection of sugarcane and potato diseases, while monoclonal antibodies are in use in several laboratories for human, animal and plant diagnostics. These techniques are also proving to be useful for the study of genetic variability amongst strains of pathogens present in Mauritius. In the veterinary sector, a small volume of vaccines against Newcastle disease and Fowl pox are produced using imported seed vaccines.

#### **3.4.4.3. Genome mapping**

Molecular techniques are being applied to plant breeding as an aid to conventional methods. Since 1994, research in molecular mapping and genetic transformation has been initiated to improve the sugarcane crop. In 1993 a collaborative study between the MSIRI and the Centre de Coopération Internationale en Recherche Agronomique pour le développement (CIRAD) in Montpellier, France, looked at the genetic diversity amongst commercial sugarcane varieties as well as noble canes (*Saccharum officinarum*) and wild species using the RFLP technique. Present research is aiming to develop a molecular map for a commercial sugarcane cultivar using AFLP and microsatellite markers. The aim is also to identify molecular markers for resistance to yellow spot and leaf scald diseases, sucrose content and other agronomic traits. For example, if a piece of DNA is linked to a disease trait, the marker could be used for screening valuable clones early in a breeding and selection programme. Genetic fingerprinting of sugarcane varieties using microsatellite markers provides new means for identification of cultivars and this would allow better choice of parents in the breeding programme where genotypically diverse clones could be selected. Collaborative links of the MSIRI to various foreign institutions as a member of the International Consortium for Sugarcane Biotechnology (ICSB), has led the Mauritian sugar industry to benefit from the results of several biotechnology projects being undertaken in well known research centres abroad.

#### **3.4.4.4 Genetic transformation**

Research in the field of genetic transformation has also been initiated in Mauritius. In May 1999, the MSIRI produced its first transgenic sugarcane plants (figure 10). Scientists at the MSIRI introduced the bar gene that confers resistance to the herbicide Basta® into embryogenic callus of two commercial sugar cane varieties using the biolistic gun. The transgenic plants are being multiplied in vitro for further testing. Field-testing will only be carried out after appropriate legislation governing biosafety is enacted in the country. Genetic transformation for resistance of sugar cane varieties to other herbicides is also being investigated.

#### **3.4.4.5 Environment**

Use of biotechnology for the treatment of wastewater and production of proteolytic enzymes from pineapple wastes are being investigated at the University of Mauritius.

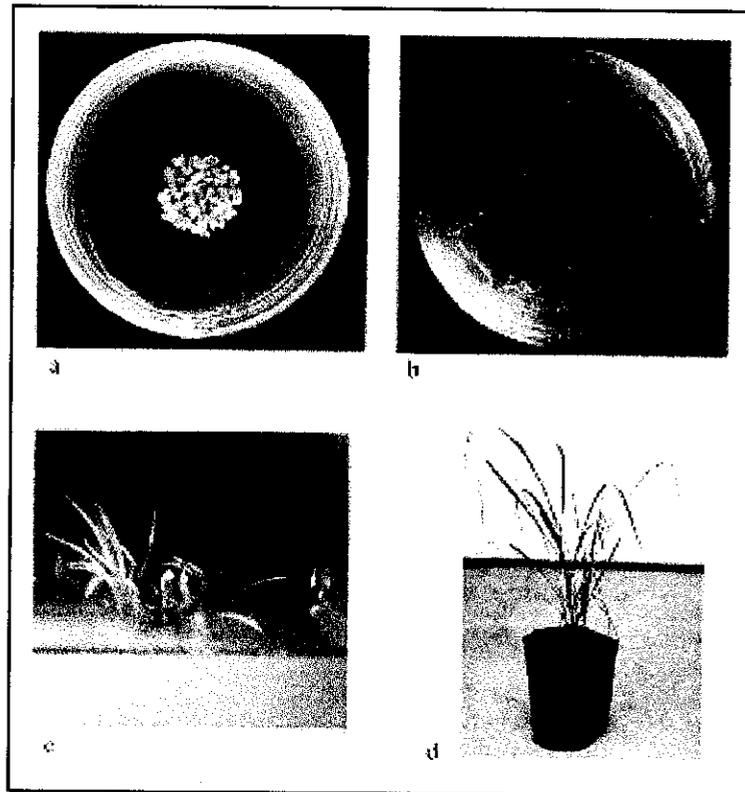
#### **3.4.4.6 Human health**

On the human health aspect, the Sir Seewoosagur Research centre for Medical Studies and Research, using molecular tools is trying to identify candidate genes predisposed to type 2 diabetics in the Mauritius population. At the University of Mauritius, research projects are treating aspects such as the production of secondary metabolites in vitro from medicinal plants.

#### 3.4.4.7 Biosensors

Biosensor techniques for rapid in situ testing of fruit maturation are being developed at the University of Mauritius.

Figure 10 : Genetic Transformation of Sugar Cane (a) Callus prior to bombardment (b) resistant callus regenerating (c) regenerated plantlets in vitro (d) plantlets transferred in the glasshouse. (Extract from MSIRI Annual Report 1996).



#### 3.4.5 Aquatic Biodiversity

The coastline of Mauritius is 177 km long and is almost surrounded by a fringing coral reef enclosing a lagoon area totalling 243 km<sup>2</sup>. The reef complex of Rodrigues almost surrounds the island except where there are passes and has an area of 200 km<sup>2</sup>. The coral reef of St Brandon covers an area of 190 km<sup>2</sup>, while that of Agalega is 100 km<sup>2</sup>. The Exclusive Economic Zone for the Republic of Mauritius extends over an area of 1.9 million km<sup>2</sup>.

The aquatic biodiversity of Mauritius comprise mainly marine biodiversity and to a lesser extent freshwater biodiversity.

The marine aquatic species have been surveyed and the number of families repertoried is 290 with some 1656 species (Figure 11).

Whales are usually encountered in Mauritius waters in early winter when they migrate from the Antarctica to the warm tropical water for calving. They are also encountered on the return journey with the calves to the cold feeding waters of the south pole. The Dolphins are encountered more frequently than whales. However, the breeding and nursery grounds of the dolphins have not been located yet. The marine turtles on the other hand use Cargados Carajos, Agalega, Rodrigues and Tromelin shores for breeding. The fish and shell fish occupy different niches in the water column. Most of coral diversity is confined up to the fifty metres isobath.

Figure 11: some of the marine species constituting the marine biodiversity



From the list of marine species so far identified only around fifty species are of economic importance. These include fish, molluscs, lobsters and shrimps. Marine turtles are considered to be endangered species and the turtle fishery has been banned (prohibited by law under section 6(2) of the Fisheries Act 1980). Corals and shells are protected by law and their removal is not permitted. Seagrass and seaweed beds serve as nursery grounds. Some sea weeds are used as bait in basket trap fishery. The public has been sensitised to the importance of mangroves and is urged to protect and propagate same.

#### **3.4.5.1. Marine Living Resources**

Fisheries resources exploited by Mauritius are found in the lagoon and off-lagoon areas of Mauritius, Rodrigues, Agalega, the banks along the Mauritius-Seychelles ridge, stretching from St Brandon to Saya de Malha and around the Chagos Archipelago and the oceanic fisheries. The total area of the fishery grounds amount some 52,000 km<sup>2</sup>. The total fish production in fresh weight equivalent has experienced a decrease from 19,000 ton in 1991 to 12,500 in 1996.

Aquaculture for raising fish and other marine organisms in coastal waters of Mauritius has quite a long history. Culture of fish, crabs and oysters are effected in coastal ponds enclosed by stone walls locally called "barachois". Fingerlings are collected from the open sea and are released in the "barachois" for growing after which they are harvested.

The catch from the artisanal fishery is marketed as fresh fish while the catch from the banks fishery is sold as frozen fish. Tuna (*Thunnus spp.*) caught by the purse seiners are canned at the tuna cannery and nearly 90% of the canned products are exported. Fish obtained from the sport fishery is also marketed locally. The fish caught by amateur fishermen is meant for home consumption. The artisanal fishery of Agalega is exploited at a subsistence level. A subsistence level fishery is prevalent in Rodrigues. However, part of the octopus catches are either dried or frozen for sale on the Mauritian market. Part of the high valued fishes from Rodrigues are also frozen and sent for sale into Mauritius.

#### **3.4.5.2. Non-living Marine Resources**

##### ***Coral Sand***

Sand is produced by degradation of coral reefs through hydrodynamic and natural processes and also from the disintegration of shells and coralline algae. It is estimated that regeneration of the sand deposits is part of a 4000 year cycle, making it a virtually non-renewable resource. Sand has been quarried from land based sources, namely inland deposits and dunes at several locations on the coast of Mauritius. Most of the inland deposits have been over-exploited without due consideration to the role they play on the stabilisation of the coastline and beaches. The lagoon is presently the main source for sand mining. In 1995, twenty-five cooperative societies were involved in sand extraction from the lagoon and the amount of sand removed was estimated at 800,000 tonnes compared to 300,000 tonnes in 1990 and 76,000 tonnes in 1987. The Government has already taken a policy decision to ban coral sand extraction as from the end of year 2001.

### **Common Salt**

Common salt is another non-living marine resource which has been exploited since 1598. Common salt is produced by the process of solar evaporation of sea water in salt pans.

There are five salines which are all located on the west coast of Mauritius which is the driest region and where the rate of evaporation is highest. An average of 6,000 tonnes of crude salt is produced annually. There is a salt refinery for the purification of the crude salt. The annual production of refined salt is around 3,000 tonnes. All the salt is used for local consumption.

Apart from the extractive uses of the oceans, the sea also provides for different other uses namely recreation and transportation routes for ships. Port activities are concentrated at Port Louis harbour in Mauritius and Port Mathurin in Rodrigues.

### **Recreation**

Going for a picnic on the beach and having a swim in the lagoon is one of the favourite leisure for most Mauritian. As hotel development has taken a large share of the shoreline, and a sizable area has been used for private dwellings local people concentrates on the few public beaches.

Apart from local people, the sea is also being exploited by tourists for recreational purposes. The economic importance of tourism has substantially increased during the past two decades. The number of international visitors has increased significantly from 180,000 in 1980, 375,000 in 1993 to nearly 560,000 in 1998. Expanded tourism has led to the rapid construction of new hotels and other facilities along the shore-line. Tourism in Mauritius is mainly a sea-oriented activity. The tourist industry has been one of the most dynamic sectors of the Mauritian economy; its contribution to GDP was 3.8 % in 1995 and this figure is expected to increase to 5.2 % in 2000. The tourism sector is the second largest gross foreign currency earner after the EPZ sector. Gross tourism receipts have grown from Rs 7.5 billion in 1995 to Rs 13.7 billion in 1999, and it is expected to reach Rs 15 billion in 2000.

#### **3.4.5.3. Freshwater Aquatic biodiversity**

Research in freshwater aquaculture started in the fifties with the introduction of four species of tilapia. A landmark was created in the field of aquaculture development in the seventies in Mauritius. In 1971-72, three exotic species of oysters were introduced for farming viz; the Japanese oyster (*Crassostrea gigas*), the American oyster (*Crassostrea virginica*) and the European oyster (*Ostrea edulis*). In 1972 the giant fresh-water prawn (*Macrobrachium rosenbergii*) was introduced and a hatchery was set up for the production of juveniles. In 1975 and 1976 six species of Indian and Chinese major carps (table 4) were introduced from India for fish culture.

**Table 4: Indian & Chinese carps introduced for Aquaculture**

SN	Common Name	Scientific Name
1	Rohu	<i>Labeo rohita</i>
2	Catla	<i>Catla catla</i>
3	Mrigal	<i>Cirrhinus mrigala</i>
4	Grass carp	<i>Ctenopharyngodon idella</i>
5	Silver carp	<i>Hypophthalmichthys molitrix</i>
6	Common carp	<i>Cyprinus carpio</i>

The carps were successfully induced bred in captivity by hormone injection. Experiments on polyculture of camaron and carps gave interesting results. However, due to the low acceptance of carps by consumers, their culture was discontinued. The giant fresh water prawn is commercially farmed in earthen fresh water ponds. The ponds are located on twelve sugar estate farms spread over the country. The annual production figure is in the range of 50-60 tonnes. It is unlikely that camaron production would increase as it is being hampered by increase in production costs.

In 1990, a triple cross hybrid of three species of tilapia (*Oreochromis niloticus*, *O. mosambicus* and *O. aureus*), the red tilapia locally named "berri rouge" was introduced for culture purposes. Red tilapia is commercially farmed in fresh water ponds. The annual production is around 55 tonnes. Though there is a potential for increase in production, the market demand for same is fairly low. Ponds for freshwater aquaculture cover an area of 110,565 m<sup>2</sup>.

With regard to native shrimps and prawn in the freshwater ecosystems, little information is known and practically, no study has been undertaken.

#### 3.4.5.4. Assessment of fish stocks

**Artisanal fishery:** The Maximum Sustainable Yield (MSY) for the artisanal fishery has been estimated at 1700 t and the annual catch for 1997 was 1246 t. The species are mainly demersal and territorial and do not migrate outside the territorial water and are therefore not harvested by other nations. The size of the fish has decreased over the years due to various factors and the total catch is decreasing with increase in effort. No quota system exists for this fishery but a few management measures are in place namely:

1. There is a close season of five months each year wherein fishing with Large Nets and Gill Nets is prohibited. This coincides with the summer months during which reef fishes spawn and nurture their fries and fingerlings;
2. The number of nets in the fishery is limited and licensed;
3. The length of each net is limited and its mesh size regulated;
4. The minimum size at capture for most of the common food fishes is regulated. It is set at a size just beyond first maturity so as to enable the species to spawn at least once;
5. A minimum size for harvest of oysters is set and crustaceans in the berried state are prohibited for capture.

Efforts are being made to restock the lagoon. Experiments on marine fish breeding are being undertaken. In 1989, "Gueule pavée" (*Rhabdosargus sarba*) caught in "barachois" were induced to spawn in captivity by hormone injection and some 5,000 juveniles were produced and released in "barachois". From 1992 to 1996, 65,286 fingerlings were produced and released. Fingerlings of Cordonnier (*Siganus sutor*) are also being produced and released while experiments are being conducted on the mud crab (*Scylla serrata*) seed production.

**Banks fishery:** The fish stock consists mainly of *Lethrinus* species. The MSY for the species is estimated at 5,100 T and the annual catch for 1997 is 5,478 T (including catch from Chagos). The species are demersal and do not migrate outside the territorial water and are caught by local vessels only. Statistics collected over the years indicate that the size of the fish has decreased. Management measures put in place to prevent over-fishing are:

1. Limited entry to the fisheries; only eleven vessels are licensed to operate;
2. A quota system has been established with a total allowable catch set at 4,288 t/annum for 1997.

**Tuna fishery :** Tuna is a migratory fish and the main species caught in the EEZ of Mauritius are skip jack and yellow fin. Purse seiners and long-liners are used to catch these species. At present studies are being carried out to estimate the size of the stock. The annual catch for 1997 was 4,435 t caught by one Mauritian purse seiner. As the local capacity to fish for tuna is limited, Mauritius has licensed foreign vessels to fish in the EEZ. A fishing agreement with the EU makes provision for 42 EU vessels to fish in our waters. Presently there are about 80 long line fishing vessels, mainly from Taiwan, fishing in Mauritian waters against payment of a licence fee. The present catching capacity for tuna is well below the sustainable catch levels.

#### 3.4.5.5 Export Trade

Mauritius exports a small quantity of chilled fish comprising the following species caught mainly in the off-lagoon fishery:

1. Vieille rouge (*Epinephelus fasciatus*)
2. Croissant queue blanche (*Variola albimarginata*)
3. Vieille laboue (*Epinephelus morrhua*)

4. *Epinephelus hexagonatus*
5. Vieille ananas (*Cephalopholis somnerati*)
6. Mama rouge (*Cephalopholis aurantia*)

The bulk of the export is however canned tuna and pet food produced mainly from *Thunnus albacares* and *Katsuwonus pelamis*. It should be noted that nearly 80% of the raw materials for the production of canned tuna is imported. Table 5 shows the quantity of chilled fish and canned tuna exported in tonnes as well as the value in million mauritian rupees (mRs).

**Table 5 – Fish Export Trade**

Year	Chilled Fish (t)	Canned tuna (t)	Pet Food (t)	Value (mRs)
1992	33.3	7,304	-	312.1
1993	30.0	4,344	1,061	405.0
1994	35.9	8,186	2,093	543.0
1995	30.0	10,513	2,850	658.0
1996	46.0	16,553	2,387	780.0
1997	32.1	13,827	2,615	

#### 3.4.5.6. Economic Values of marine aquatic biological resources

The Table 6 gives an indication of the various uses of the aquatic biological resources. Table 7 provides an indication of the economic values for the different extractive uses and recreational activities in this sector.

**Table 6– Economic Values of Aquatic Biological Resources and Biological Diversity**

	Direct-use Values		Indirect-use Values	Option Values	Existence Values
	Extractive	Non-extractive			
Rivers	Amateur fishing Production of electricity	Education Recreational	Drainage of water during rainfall		Ethical
Reservoirs	Drinking water Irrigation Amateur fishing	Education			Ethical
Sea	Amateur fishing Commercial fishing Subsistence fishing Sports fishing Salt production Sand mining	Scientific research Transport Recreation	Tourist sector	Polymetallic nodules & petrol	Ethical

Table 7: The estimated economic values of the different extractive uses of the aquatic resources at current prices

Sectors	Annual Prodn (t)	Price / t Rs	Value Rs
Artisanal ) Amateur ) Fishery Barachois)	3,470	100,000	347,000,000
Sports Fishery	650	80,000	52,000,000
Fresh Water Fishery: Fish	60	80,000	4,800,000
Prawn	40	200,000	8,000,000
Banks Fishery: Frozen	4,500	60,000	270,000,000

Salted	100	120,000	12,000,000
Tuna Fishery : Purse seiners	400	30,000	12,000,000
Longliners	2,193	70,000	153,510,000
Aquarium Fishery	3,500 units	Rs 20/ units	70,000
Salt Production	3,000	20,000	60,000,000
Sand mining	800,000	200	160,000,000
TOTAL			1,079,380,000

Watersport activities like water skiing, snorkelling, swimming, pedalos, surfing and para-sailing, sea-cruises and picnics on the surrounding islets generate considerable revenue. The revenues generated from scuba diving and underwater sea walk have been estimated for 1999. The Big Game Sports Fishery is an up market tourist product which also yields high revenue. Table 8 presents the estimated economic value from the three activities, which are tourism oriented.

**Table 8: Estimated Economic Value of Recreational Activities**

Activities	Units	Price/Unit (Rs)	Value (Rs)
Scuba diving	100,000	700	70,000,000
Underwater sea walk	20,000	700	14,000,000
Big game fishing	5,760	6,500	37,440,000
Total			121,440,000

#### 3.4.5.7 Wetlands

The existence and functions of wetlands in the northern, north western and western part of Mauritius have till recently been overlooked. Much of the wetlands at Grand Baie, Pereybère, Tombeau Bay and Flic en Flac have been reclaimed for hotel and housing development. Backfilling of wetlands has already done harm in certain places and is now considered as a priority problem which needs to be tackled as stated in the National Environmental Strategy.

However, the wetland at Rivulet Terre Rouge estuary has been proclaimed as Reserve for migratory bird under the Wildlife and National Parks Act 1993.

The Albion Fisheries Research Centre has prepared recently thematic maps of the coastal area around Mauritius and Rodrigues. These maps depict the different coastal habitat up to the reef and are meant for a temporal monitoring in the change in the coastline & its habitats.

#### 3.4.5.8 Institutions involved

The following institutions are involved with the conservation and sustainable use of aquatic resources:

1. Albion Fisheries Research Centre, Ministry of Fisheries;
2. Protection Service, Ministry of Fisheries;
3. Department of Environment, Ministry of Environment ;
4. Faculty of Science, University of Mauritius;
5. Ministry of Tourism;
6. Mauritius Marine Authority;
7. Meteorological Services;
8. Ministry of Agriculture Food Technology & Natural Resources;
9. Police (National Coast Guard);
10. Central Water Authority;
11. Water Resources Unit, Ministry of Public Utilities;

## 12. Outer Islands Development Corporation

Out of these institutions, the Ministry of Fisheries (comprising of two divisions) is most actively engaged with the conservation and sustainable use of aquatic resources and is the responsible enforcement agency under the Environment Protection Act, 1991, for waters in the Mauritian zone.

The Albion Fisheries Research Centre (AFRC) is the technical arm of the Ministry of Fisheries & Marine Resources. It has a staff of about 70 out of which 28 are Master degree holders in Fisheries and related sciences, 23 are bachelor degree holders and 3 are diploma holders. The activities of Albion Fisheries Research Centre are performed by four technical divisions, namely:

- I. Aquaculture;
- II. Marine Parks and Reserves Service;
- III. Marine Science; and
- IV. Marine Resources

The Protection Service of the Ministry of Fisheries and Marine Resources is responsible for the enforcement of the Fisheries Act and regulations and has a staff of about 200 ranging from Fisheries Assistants to the Chief Fisheries Protection Officer.

### 3.4.6 Conservation in Rodrigues

Rodrigues (109 Km<sup>2</sup>) is situated some 570 Km to the east of Mauritius. The island's flora was once very rich but with the arrival of man, the island's native vegetation was very rapidly decimated through cleaning and burning, leaving a barren landscape. Rodrigues has 36-38 species which are endemic. While the Mauritian flora is quite rich in diversity, the same cannot be said for Rodrigues. Rodrigues possesses one of the most devastated flora of the world. Nowadays the native vegetation can only be seen on mountain tops such as Grande Montagne, Mont Cimeti re, Cascade Mourouk, Mont Malartic, in steep valleys and cliff faces.

The few remaining areas are badly degraded with invasion by exotic plants. Without a conservation management program these areas will soon lose all indigeneous plants. Grande Montagne, Anse Quito and two islets to the west of the island, Ile aux Sables and Ile aux Cocos were declared Nature Reserves. Significant works have been undertaken by the Forestry Service and MWF in the restoration of Grande Montagne and Anse Quito where about 80,000 native and endemic plants have been planted, some of which are critically endangered.

Scientific accounts of the state of the flora of Rodrigues have been made principally by Wiehe (1949) and Cadet (1975), among others. More recently Strahm (1989) gave a comprehensive account of the state of the flora in the Red Data Book for Rodrigues.

Rodrigues has a forest cover of 4, 000 ha. The following figure gives an indication of new forests established from 1984 to 1997 (Meunier, 1998 - private comm.).

Yr	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Ha	51	67	119	106	89	209	78	48	87	31	24	67	42	40

The 4,000 ha under forestry in Rodrigues is contributing in preventing soil erosion, creating windbreaks, providing wood for timber and at the same time improving the island's visual physical surrounding. However, much of this forestry constitutes water-greedy trees which may be partially held responsible for the lack of available water in Rodrigues. Also many of the species such as *Acacia* and *Albizia* species are highly invasive and threaten the small pockets of native biodiversity that remain in Rodrigues.

Initially the native plants of Rodrigues were threatened both by the indiscriminate collection of firewood by the inhabitants and by the invasion of alien plants and animals. According to a census carried out in 1983 by the Central Statistics Office, 10 out of 13 Rodriguan households use wood as their source of energy for cooking purpose. With a human population of 35, 000 the pressure on the forested areas was high. However with the advent of cooking gas, electricity and petrol, and with much heightened awareness, 98% of the population nowadays do not use fire wood, thus pressure on the forested areas has reduced considerably.

Another threat that still exists is the collection of plants for handicrafts and medicinal use. MWF in association with community groups has recently received a UNDP/ GEF small grant to counter this threat with a participatory programme of sustainable use of native useful plants.

Introduced plants and animals constitute a serious threat to the native vegetation. In Rodrigues cattle, goat, sheep are left to roam freely in nature. Their browsing effects are detrimental to the regeneration of native plants and together with the introduced mynah birds they help in the spread of the exotic invasive plants. Fortunately, deer, monkeys and the Red whiskered bulbul, which are common pests in Mauritius are absent from Rodrigues. It is of great conservation importance that these animals are not introduced to Rodrigues. However, the Mauritian day gecko (*Phelsuma cepedianana*) has recently been sighted in Rodrigues (Meunier, 1998).

Among the exotic plants, the worst invasive are "piquant loulou" (*Acacia nilotica*), Jamrosa (*Syzygium jamrosa*), Bois d'Oiseaux (*Litsea glutinosa*), aloes (*Furcraea foetida*), Vieille fille (*Lantana camara*), acacia (*Leucaena leucocephala*) and Ravenala (*Ravenala madagascariensis*). Besides these plants, there are a number of other plants which potentially threaten native vegetation. Mention may be made of poivre marron (*Schinus terebinthifolius*), "Roussaillier" (*Eugenia uniflora*) and chinese guava (*Psidium cattleianum*).

There has also been reports that a species of toad has recently been introduced to Rodrigues. Sightings have been reported in the Mourouk area. This may affect the population of the endemic snail if left unchecked.

In Rodrigues, it was only recently that two areas of high botanic interest were made Nature Reserves. These are Grande Montagne and Anse Quitar. Much of Grande Montagne (about 26 ha) has been fenced under European Development Fund Projects. This means that grazing animals, especially goats are excluded from the area and that firewood collection has stopped. Further 1508 ha of new sylvo-pastoral areas have been established. Alongside, the Cattlewalk Regulation will be re-introduced soon. Furthermore, 81 watchmen, 16 forest guards and three foresters are now responsible for inter-alia the enforcement of legislations with regard to animal grazing on all state lands in Rodrigues.

The 4 Nature Reserves of Rodrigues are, however, under the menace of exotic plants. Extensive management of the Reserves are currently being carried out and many exotics are being manually weeded out. These are Anse Quitar and Grande Montagne and to a lesser extent on Cocos Islets and Sables Islets.

Over and above these areas, in 1996, a request was made to the Nature Reserve Board towards the setting up of Cascade St. Louis, Mourouk and Cascade Pigeon as Nature Reserves. Cascade Mourouk is another important area for nature conservation on mainland Rodrigues as it contains the last remaining individuals of *Gouania leguati* and 2 individuals of *Hibiscus liliiflorus*. In addition, Cascade Mourouk has populations of small endemic vertebrates, the Rodrigues Fruit Bat (*Pteropus rodricensis*), Warbler (*Acrocephalus rodericana*) and Fody (*Foudia flavicans*).

Besides the above, there are also two islets namely, Ile aux Sables and Ile aux Cocos as Nature reserve in Rodrigues. They are important breeding sites for many sea birds. These islands do not harbour any threatened plant species, except for a strand of *Sesuvium ayresii*. In November 1995, the Wildlife Management International Ltd., NPCS and MWF carried out a comprehensive campaign to eradicate mice from Cocos and Sables Islands. Some house sparrows were also removed. The presence of any surviving rodents on the two islands has been continuously monitored every 4 months and so far no sign of rodents has been found.

The diversity of native plants species on Cocos Islet is high compared to the other islets. However the greater diversity comes from the introduced species. There is at least 18 species of native plants on Cocos Islets and 34 introduced exotic species of which 10 are potentially invasive. It holds among others a major population of Bois Mapou (*Pisonia grandis*). Introduced species comprise Acacia (*Leucaena leucocephala*), Herbe sergent (*Achyranthes aspera*) and Chardon (*Argemone mexicana*).

The diversity of fauna on Cocos Islet is very limited. Three bird species, Brown Noddy (*Anous stolidus*), Lesser Noddy (*A. tenuirostris*) and Sooty tern (*Sterna fuscata*) predominantly use Cocos Islet as a breeding site. The *Gygis alba* nest mainly on Sables Islet. The native morning gecko (*Lepidodactylus lugubris*) is found in the thicket of *Pisonia grandis* on Cocos Islet. An endemic coleoptera (*Cratopus inormatus*) has recently been sighted on Cocos Islet.

The most promising conservation effort to save the threatened plants of Rodrigues is the propagation of the endangered plants in nurseries. Many of the native plants are down to their last individuals. There are three species which are currently known from a single individual in the wild. These are the "Café marron" (*Ramosmania heterophylla*), Bois pipe (*Dombeya rodriguesiana*) and *Gouania leguatii*. There are also a number of other plants whose populations have been reduced to less than 10 individuals. These species are being given priority for conservation. *Ex-situ* conservation remains the only hope to save these plants from becoming extinct. It is worth pointing that *Ramosmania* has been successfully cultivated in the MWF nursery where 2 clones currently exist and of a list of 34 endemic plants, MWF has now propagated 34.

The café marron case illustrates one of the last minute efforts at saving a species close to extinction. Only one tree of this plant survives in the wild. Cuttings were taken and flown to the Royal Botanic Gardens at Kew for propagation. This has been successful and several plants have now been raised. Actions have been initiated for repatriation of 7 out of 21 plants from the Royal Botanic Gardens, Kew. Similarly propagation of the *Dombeya rodriguesiana* and *Gouania leguatii* has been carried out and plants are held in nurseries and botanic gardens. Cuttings from other rare plants of Rodrigues have also been taken. In November 1997, a new genotype of *Hibiscus liliiflorus* was found at Tigome, Graviers and seeds will be collected in the next fruiting season and they will be raised in the nursery of the Forestry division as part of the species recovery programme.

There remains the problem of reintroduction in the wild. Reserve plots need to be created where plants can be planted back and be given all due protection. However, as a start, threatened plants can be planted out in Botanic Gardens where land tenure is secure. In Rodrigues, the first botanic garden will be created at Mourouk. This will become a major asset for conservation in Rodrigues. The proposed Botanic Garden if integrated into a Nature Reserve complex covering some 60 ha would overcome all the limitations of and further complement the existing reserves.

Also the Forestry Services, with the technical assistance of the MWF under the WB/GEF Biodiversity Restoration Project, has upgraded the Solitude Forest Nursery which is now equipped with all necessary equipments and consumables. The following works are being successfully undertaken:

- (i) the propagation of native and endemics plants from eight species (that now exist in the Rodrigues genebank).
- (ii) the development of a detailed plant record system
- (iii) the development of an annual cropping cycle for the nursery in association with seed collection, planting time and the existing nursery; and
- (iv) the setting up of a field gene bank.

With respect to the fauna, a recent survey by the Mauritian Wildlife Foundation has shown that the populations of the two remaining endemic birds are, fortunately, expanding. The Brush Warbler (*Acrocephalus rodericana*) is still restricted to some locations while the Fody (*Foudia flavicans*) is present across the North East, South East and the Centre of the island. This expansion could be the result of the reforestation programme.

The status of Rodrigues bats (*Pteropus rodricensis*) on has much improved owing to the protection and reforestation of critical bats habitat. The number is now estimated at around 2000 individuals.

#### **4 Threats to Biodiversity and Management Measures**

The most common threats to biodiversity are: natural disaster such as cyclones, extensive drought and flood, anthropogenic pressures on the limited natural resources due to expanding economy and growth in population pressures, pollution from various sources, industrial effluent discharges, coral sand mining in the lagoon, filling of marshy areas and wetlands, expanding coastal developments, siltation of lagoon, encroachment on forest lands and natural green areas, clearance of mangrove, alien (exotics) species, over-exploitation of resources and climate change.

Various management measures as set out under the several pieces of legislation are in place for development control, management and protection of biodiversity. However, some of the most critical issues in that sector are inadequate enforcement, overlapping and unclear responsibilities, shortage of staffs, equipment and trainings, outdated policies, need to update legislations amongst others.

## **5. National Biodiversity Strategy and Action Plan (NBSAP)**

### **5.1 Consultative Process**

The Mauritian NBSAP is being prepared using a multi-disciplinary, integrated and participatory approach, involving relevant government institutions, public, private organisations including NGO's and local communities. A multidisciplinary and multisectoral task force comprising of 20 representatives of Government Ministries, relevant scientific organisations, private sector, NGOs amongst others has been formed to oversee the activities and the implementation of the project. A Planning Team, chaired by the Director of the National Parks and Conservation Service of the MoA comprising of 12 members has been constituted to oversee the preparation of the NBSAP. The Technical support of UNEP is also being tapped.

### **5.2 NBSAP Time Frame and status**

The implementation of the project referenced GF/1200-96-58 commenced on the mid July 2000 with the recruitment of a National Consultant and Seven sub- Consultants (on a shorter term basis), is funded by the UNEP/GEF to the tune of 235, 000 US \$ and is scheduled to be completed by July 2001.

A first national workshop was held on the 25 & 26 September 2000 with the objective to update the available data & information, identification and prioritisation gaps/ issues in the various sectors. Three Ministers attended the opening session and in their speeches they affirmed that the Government of Mauritius is deeply committed to the protection and the preservation of the environment in Mauritius, Rodrigues and the Outer Islands with the objective to ensure sustainable development for improved quality of life. They admitted that effective environmental legislation is lacking, fiscal and economic measures have not been developed and kept in pace with the responsabilisation of the main stakeholder, that is the public. They stressed that the government has already taken the pledge to take bold measures to protect the environment and the urgent needs to implement the "polluter pays principle". They also observed that inadequate institutional capacity, unclear designation of responsibilities, lack of data and monitoring, inadequate knowledge and lack of incentives are the cumulative causes hampering the efforts to meet the goals set and which need to be addressed urgently.

Seven thematic areas were constituted in order to meet thoroughly the Mauritian specificities especially with regard to the important economic sectors related to and dealing with biodiversity. These are :

1. Socio Economic Factors Affecting and Benefiting Biodiversity;
2. Forest Biodiversity;
3. Terrestrial Biodiversity;
4. Agricultural Biodiversity;
5. Biotechnology and Biosafety;
6. Coastal Resources, Marine and Aquatic Biodiversity, and
7. Sustainable Eco-tourism Development in Mauritius.

Some 80 participants attended the two days workshop. Further consultations are being undertaken with all stakeholders in an attempt to further prioritise the issues and discuss possible strategy options for intervention under the various thematic areas. The strategy options would be discussed in thematic workshops that shall be organised during November and December 2000. In view of its specificities, a separate consultative process would be undertaken for Rodrigues.

This Mauritian NBSAP is scheduled to be finalised by mid July 2001.

## **6. Partners involved in the implementation of conservation and sustainable use of biodiversity projects.**

### **6.1 National and International Institutions**

There are at present various organisations from the public, parastatal, private, NGO's involved with conservation and sustainable use of biodiversity resources. However most, work independently from each other, and very often with an apparent competition which reduces the effectiveness of collaboration. There

is a need to have greater co-ordination for the execution of a national programme for biodiversity conservation which would ensure sharing of responsibilities among the various institutions involved. Furthermore, in order to ensure that Mauritius keeps up in the forefront of biodiversity conservation, a strong linkages with expert institutions from overseas has been maintained.

It is noteworthy that the Government of Mauritius, MWF, Royal Botanic Gardens (kew), Fauna & Flora International and DWCT signed a Memorandum of Agreement to achieve conservation objectives in an atmosphere of cordial international cooperation in Mauritius on 27<sup>th</sup> January 2000. Some of institutions that are directly and indirectly involved with the conservation and sustainable use of biodiversity are:

1. Ministry of Agriculture & Natural Resources and its various departments } Main Ministries
2. Ministry of Fisheries (Albion Fisheries Research Centre) }
3. Ministry of Environment
4. Mauritius Sugar Industry Research Institute
5. Agricultural Research Extension Unit
6. University of Mauritius
7. Ministry of Public Utilities
8. Ministry of Tourism
9. Meteorological Services
10. Mauritius Ports Authority
11. NGO's such as Mauritian Wildlife Foundation, Wildlife Club of Mauritius, Friends of Environment and others
12. Police Department
13. Outer Islands Development Corporation .

## 6.2 Plant Conservation Projects

The importance of Mauritius as a centre of plant diversity is highly recognised. In that respect, funds have been received from various international organisations to implement plant conservation projects. A summary of these projects is outlined below.

### (a) Restoration of highly degraded and threatened native forests in Mauritius

This project is being funded by UNDP/GEF to the tune of 200, 000 \$US. It started in June 1996 and is being implemented by the Mauritian Wildlife Foundation under the supervision of the NPCCS.

The objective of this project is to come up with a method to halt the degradation of the native forests caused by exotic weeds and animals and to restore to the extent possible the original structure and functions of the forest ecosystems. A 6 ha study plot has been fenced off in December 1996 and an inventory of the biodiversity of the area has been carried out by consultants recruited under this project.

A workshop was organised by the NPCCS in 1997 on the "Restoration of highly degraded and threatened native forests in Mauritius". This workshop was organised with the aim of convening a group of pest control experts and restoration ecologists together in order to come up with recommendations for the control of alien invasive plants and restoration of the degraded forest habitat. The proceedings of the workshop have been published into a book (Mungroo, Mauremootoo & Bachraz, 1997).

This project has been completed and the NPCCS & MWF are working on a project proposal to create a series of large CMAs that would exclude most alien species for submission to the GEF for funding. The University of Mauritius is also involved in training and capacity building of the locals on aspects of biodiversity. Biodiversity was incorporated in the BSc Biology degree stream.

### (b) Diversity & Conservation of wild population of Mascarene *Coffea* species

Some plants have more obvious economic importance than others owing to them being close relatives of major crops.

In Mauritius, the only truly indigenous genus which is a wild relative of an economic crop is *Coffea*. Out of the three species of native *Coffea* growing in the native forest of the island, two of them namely *Coffea macrocarpa* and *C. myrtifolia* are endemic to Mauritius and La Réunion. These species are known to be

naturally caffeine-free and could thus be of great importance in developing low caffeine cultivars (Dulloo & Owadally). Wild coffee species might provide new genes for improving this globally important crop.

The main aim of the project was to develop a sound conservation strategy based on an assessment of variability present in wild *Coffea* taxa at the genetic and taxonomic level.

This project which was funded by IPGRI to the tune of 65,000 US\$ is completed.

**(c) Mauritius Rare Fern Project.**

This project is being funded by the UK government under the "Darwin Initiative for the Survival of Species" scheme. The project consisted of developing horticultural facilities for propagating rare ferns in Mauritius, to train Mauritian nationals in fern propagation techniques and to reintroduce rare species of ferns back to suitable managed habitat.

The construction of a fern propagation centre in Curepipe started in August 1996 and was completed by June 97. Two officers of NPCS have benefitted from a training course in fern propagation at Royal Botanic Garden (Edinburgh). Some 90 species of ferns are being propagated from spores, bulbils and cuttings.

Under the Darwin Initiative project, a Darwin grant of £ 50,000 for the period 1999-2002 to set up "An Information System for Biodiversity and Conservation Management in Mauritius" has been awarded to the Statistical Services Centre of University of Reading. The objectives of the project are:

- To design and develop a computerised information system to serve as a tool for conservation management, research and education in Mauritius;
- To strengthen the capacity of local institutions in the management and use of conservation information.

**(d) Indian Ocean Commission Project (PRE/COI).**

This project falls under the "Programme Régionale Environment" whose objective is to have an integrated coastal zone management + restoration of natural vegetation and removal of exotic species. It is a regional project and is of 5 year duration starting from 1995.

Under this project the "Morne sèche" Conservation Management Areas (CMA) has been established. The Indian Ocean Commission is also funding the compilation of the remaining fascicules of the "Flore des Mascareignes".

**(e) Indian Ocean Commission Project (Inventory and Study of the Medicinal and Aromatic Plants of the States of the Indian Ocean)**

Mauritius and Rodrigues have got a history and a long standing tradition in the utilisation of Medicinal and aromatic plants. The inventory of all these plants have been carried out by the Faculty of Science, University of Mauritius and this project formed part of the Regional IOC Project funded by the European Union under the aegis of the Indian Ocean Commission to the tune of 250,000 Ecus.

A computerized database comprising of the following information on these plants now exists at the University and are:-

1. Ethnobotanical data, phytochemical screening data, botanical information on the various plants used, bibliographical data and also physico-chemical data on the essential oils etc..
2. For Mauritius, over 600 plants have been identified and these data have been published in the form of books (Gurib-Fakim *et al*, 1994-1997).
3. Other aspects of these plants are also being studied e.g. their anti-fungal, anti-bacterial, insecticidal, anti-cancer effects are also being studied. The full potential of these plants have not yet been realised and this should be possible once a full market study has been carried out. It must be pointed out however that the essential oil of Ylang ylang (*Cananga odorata*) is already being produced on commercial scale locally.

**(f) Southern African Development Community (SADC) Forestry Sector.**

Mauritius joined the SADC in 1995 and two projects have recently been approved within the SADC portfolio. These are :

1. SADC Project AAA 5.9 whose main objectives aim at strengthening and improving the forestry colleges in the SADC region. The sum of US \$ 45, 000 has already been budgeted for training of Forest Officers on Forestry by the University of Mauritius , leading to a certificate in Forestry.
2. SADC Tree Seed Centre Network had approved the setting up of a Tree Seed Centre in Mauritius and funds to the tune of 2 million Rupees was earmarked. Memorandum of Understanding between the Government of Mauritius and the Government of Canada was signed on 8 May 1998. The project has already been completed and the Tree Seed Centre is Operational.

The main aim of this project is towards the production of good quality seeds for re-afforestation programs. Good quality seeds from ornamentals, exotics and native plants are also be collected, processed and stored. These will then be used for restocking of nature reserves, native forests and also re-afforestation.

**(g) Management of the Offshore islets**

As far as management of the offshore islets is concerned, conservation and restoration works are well underway on Round Island and Isle aux Aigrettes. However, it is felt that a coherent long-term plan for the remaining islets be drawn up, which will cater for the different demands in a coordinated way.

*Round Island*

Many ecological expeditions have been undertaken on Round Island since the 1970s. In most of these expeditions, a complete survey of the flora and fauna have been made. The MWF is also in the process of implementing a restoration programme to render this island as much as possible to its original state. The grant agreement to the tune of 750,000 \$ was signed in August 2000.

In a management plan prepared by NPCS in collaboration with MWF, the need to effect regular visits to work towards the control/ eradication of exotics was recommended. In addition to the above, the plan also recommends among other suggestions that a hardwood forest be created on the island by introducing hardwood species known to have existed there and that a thorough search for burrowing boa be made. Hundreds of seedlings and thousand of seeds are planted during each expedition. Four scientific and management expeditions are carried out each year with a team of 8 workers, 4 each from the NPCS and the MWF. The management plan for the restoration of Round Island dates back to 1989 and at present a new one is under preparation by the MWF in collaboration with the NPCS and other international organisation.

It must be pointed out that all the progress in the conservation and understanding of Round Island's biota is a direct result of the close cooperation between national (the MWF in particular) and international organizations (Durrell Wildlife Conservation Trust, Royal Botanical Gardens kew and British Museum of Natural History) with the Mauritian Government.

*Ile aux Aigrettes*

Ile aux Aigrettes possesses a unique flora representing the last remnant of a coastal forest that once surrounded much of Mauritius. The plant community consists of many endemic plants which are endangered. Ile aux Aigrettes is a refuge for many of the rare plants of the lowland coastal forest of Mauritius such as Bois de boeuf (*Gastonia mauritiana*), Bois D'Ebene (*Diospyros egrettarum*), Bois de Fer ( *Sideroxylon boutonianum*), Vacoas ( *Pandanus vandermeerschii*), and Bois de Chandelle (*Dracaena concinna*) . The island harbours over 40 species of native plants, many of which are rare on the mainland.. 18 plant species are classified as endangered or very rare and have a limited distribution. The native orchid, *Oeniella aphrodite* which was only known from this island has recently been sighted on the mainland ( although it is also native to Rodrigues) . Regionally and internationally, this island has a very high conservation importance.

The fauna of the island is not very rich. There is only one endemic gecko (*Phelsum ornata*) which is quite common. There is no monkey or deer on this island. Rats which used to be a major concern as they ate the fruits of many native plants, preyed on the eggs and young of the native endemic reptiles and birds, have been eradicated. The house shrew (*Suncus murinus*) and wolf snake (*Lycodon aulicus*), however, are still present on the island.

Since 1986, the island has been leased to the MWF, and with the assistance of the WWF, an island rehabilitation program is under way. The objective of the program has been to eliminate the introduced plants, to eradicate the rats and to start a replantation program of native plants. With the help of the New Zealand Wild life Service, a rat eradication program was carried out. In addition, a comprehensive restoration program for plantation of native plants has already started under UNDP/GEF and the project is scheduled to be completed in March 2001. Large areas have been cleared of alien vegetation and planted with natives grown in a nursery for lowland species constructed on the island. It has now been possible to release on the islet the Mauritius Kestrel (*Falco punctatus*) and Pink Pigeon (*Columba mayeri*).

An ecotourism program has also been initiated to finance the restoration work on the island and a visitor's centre has been opened.

#### *Gunner's Quoin and Gabriel Islands.*

In September 1995, a comprehensive campaign funded by the ODA was carried out to eradicate brown rats (*Rattus norvegicus*) from Gunner's Quoin and black rats (*Rattus rattus*) from Gabriel Island. Although black-collared hares (*Lepus nigricollis*) were not originally targeted, these were also hit during the poisoning exercise.

Much change has been observed on Gunner's Quoin since the removal of rats. A night gecko (*Nactus coindemirensis*) are often noted and endemic plants have started regenerating.

The presence of any surviving rodent on the two islands has been continuously monitored every four months and so far no sign of rat has been found.

#### *Flat Island*

Flat Island is the largest offshore islet (253 ha) in Mauritius and it offers a high potential for nature conservation and tourism. The island is mostly flat, low lying comprising of a thin coralline soil overlying basalt. The vegetation is highly modified but still contains a number of indigenous species and it also harbours 2 native reptiles Bojer's and Bouton's skinks (*Scelotes bojeri* and *Cryptoblepharus boutonii*). The NPCS is presently carrying a restoration programme on the island through plantations of thousands of native plants. Works are also being undertaken to re-establish some bird and reptile species.

#### **(h) Biodiversity in Small Island States (Rodrigues)**

The Commonwealth Science Council has initiated a programme to promote the sustainable use of biodiversity by assisting SIDS to identify, monitor and empower the island communities to sustainably manage their biological resources. A pilot project funded by the CSC to the tune of £ 19,000 has been carried out by the MRC/MWF/UoM. Rodrigues has been chosen for this pilot study as it has a severely degraded ecosystem but is recognised as an internationally important site for biodiversity conservation. Rodrigues has also a large population and there is significant utilisation of the island's biological resources by the local community.

For the purpose of this project, three endemic plant species of importance to the people have been identified and are: *Carissa xylopicron* (Medicinal plant); *Latania vershafeltii* and *Pandanus heterocarpus* (for handicraft industry).

The first phase of this project which comprises of testing of the methodology designed by CSC in order to establish a generic and robust model for a wider application over a period of six months is completed. The final report highlights the current status and threats to these key biological resources utilised by the local community of Rodrigues and makes recommendations for future action.

The MWF in collaboration with Rodriguan Community Groups has started in November 2000, the project "Development of propagation techniques and community- lead sustainable management systems for useful Rodriguan endemic plants". The project is being funded under the UNDP- GEF - SPD to the tune of \$ 50,000 for the two years. The project will focus on 3 target endemic species (Vacoas (*Pandanus heterocarpus*), Vetiver (*Vetiveria arguta*), and Latanier jaune (*Latania vershaffeltii*)).

Measurable objectives of the project are:

- To develop propagation and husbandry techniques for a wide range of useful or potentially useful endemic plant species;
- To raise awareness about biodiversity and sustainable harvesting of 3 target handicraft species within the artisan community - providing a model for future similar awareness raising;
- To develop community - lead sustainable management systems for these 3 target handicraft species - providing a model for future community- lead sustainable management systems;
- To build capacity in the artisan community to propagate and husband plants for use - providing a model for future participatory training in biodiversity horticulture.

**(i) Management of the Natural and Agricultural resources of Rodrigues.**

The topography of the Rodrigues island is such that it is very prone to erosion. This problem is compounded by the fact that it lies in the cyclonic belt and the population relies heavily on subsistence farming. Over grazing by the cattle herd is also a big problem in Rodrigues.

In order to improve the economic situation of the island, within an ecologically fragile milieu as well as enhance and optimise agricultural production on the island, the European Development Fund is currently funding a project to the tune of 1, 960, 000 Ecus under the 7th EDF Convention.

The project will provide training, assist in the management of the forestry and agriculture sectors, protection of the lagoon ecosystems as well as other nature reserves of the island.

**(j) Black River Gorges National Park**

The development of the Black River Gorges area as a National Park was proposed by Sir Peter Scott (1973) and Proctor and Salm (1974) as one of the conservation measures to preserve our genetic resources. Though the Government took several immediate remedial actions listed in the Procter report to come to the rescue of the various endangered species of animals and plants in the Black River Gorges area, it was never declared a National Park. This project resurfaced in 1988, under the first Environment Investment Program (EIP 1) projects funded by the World Bank.

The proclamation of the Black River Gorges National Park by the President took place on June 1994 under the provisions of Section 11 of the Wildlife and National Parks Act 1993. The boundaries of the park enclose an area of 6574 ha. A visitor centre, an information centre, three field research stations have been completed and the Gerald Durrell Endemic Wildlife Sanctuary (ex- Captive Breeding Centre) has been expanded and improved.

The main aims of the Park are:-

1. conservation of the natural resources of the park with special regard to the highly endangered native plants and animals;
2. restoration of the park's natural communities which have been disrupted by past exploitation and present competition with introduced plants and animals;
3. recognition and protection of the park's scenic beauty for the benefit of the local people and tourists and;
4. promotion of environmental education.

To achieve the above aims, the park has been zoned in order to be put to different use. There are some areas of special importance for rare birds and endemic plant communities. Other areas are particularly fragile and require protection. Some areas are very degraded and are beyond redemption from the conservation point of view and yet are of outstanding scenic beauty. Three zone types have thus been identified:

1. Reserved zone
2. Nature zone and
3. Recreation zone

The park is therefore an area where the long term cultural needs of the nation are not sacrificed for short term economic gain. A Management Plan for the park has been finalised and published.

**(k) A vegetation survey of Mauritius to identify priority rain forest areas for conservation management .**

A survey carried out by Page & D'Argent (1998) shows that less than 2% of this total area of Mauritius supports grade 1 or 2 native forests. The survey indicates that out of the 266 km<sup>2</sup> (26,000 ha) available for supporting native vegetation in the south west, only 145 km<sup>2</sup> (14,500 ha) remains today. Of this area, only 9 km<sup>2</sup> (900 ha) has been found to support grade 1 rainforest communities and 12 km<sup>2</sup> (1200 ha) found to support grade 2 rainforest communities. The remaining vegetation is degraded with exotic species.

The northern and eastern range forest support very little rainforest today, and only 3,5 km<sup>2</sup> (350 ha) supports grade 1 rainforest and 4,7 km<sup>2</sup> (470 ha) supporting grade 2 rainforest.

The conservation management is intended to focus on those areas supporting grade 1 and 2 native vegetation. 43 areas of rainforest vegetation have been listed as priority areas for conservation management. 20 areas of lowland native vegetation have been identified as requiring urgent conservation management and additional vegetation surveys.

A summary and status of the projects/ activities are listed in the table 9 below.

**Table 9:** Summary/ status of major activities relating to Biodiversity conservation and restoration.

Projects	Duration	Funding Agencies	Executing Agencies	Budget	Status
1. Kestrel Recovery	since 1973	Fund / DWCTI/ GoM/ Peregrin	MWF/NPCS	Rs 150, 000 / annually	Ongoing
2. Pink pigeon Recovery	Since 1985	DWCT/ Deutschebank	MWF/ NPCS	Rs 2.2 million/ Yr	Ongoing
3. Echo Parakeet Project	Since 1994	DWCT/UNDP /GoM and other trusts/ charities	MWF/NPCS	Rs. 3 million/ annually	Ongoing
4. Black River Nat. Park	Created 1994	WB / GoM	NPCS	\$ 2,910,000	Ongoing
5. Restauration of Native Forests in the upland	3 yrs (96-1999)	UNDP/GEF	MWF/NPCS/Uo	\$ 200,000	Completed
6. Biodiversity Restauration in outer Islets (Iles aux Aigrettes, Round Island & Rodrigues)	5 yrs (1996-2001)	WB/GEF/ Govt	MWF/NPCS	\$ 1,200,000	Nearing completion
7. Management of Offshore Islets		ODA	NPCS/MWF	\$160, 000	completed
8. Vegetation Survey of rainforest for conservation Priorities	1.5 Yr	NC/IUCN	MWF	\$ 70, 000	completed
9. Management of the tropical lowland forests (Morne Seche)		EU (IOC/PRE) /GoM	NPCS	\$ 60,000	ongoing
10. Flore des Mascareignes		EU (IOC/PRE)	MSIRI	165, 000 Ecu	Nearing completion
11. Mondrain Nature Reserve			MWF/Royal Soc.		Ongoing
12. Management of nature Reserve		GoM	Forestry Dept.	Recurrent	ongoing

13. Env't Education (Rodrigues)	1998-	Philadelphia Zoo	MWF	\$ 20, 000 annually	ongoing
14. Inventory & Study of medicinal & Aromatic Plants of the States of the Indian Ocean		EU (IOC)	UoM/MoA	250, 000 Ecus	Completed
15. Diversity & Conservation of wild population of Mascarene Coffea species		IPGRI	MWF	\$ 65, 000	completed
16. Ecological restoration of Ile d'Ambre and Ilot Bernache	18 months	UNDP/GEF	B.E.I	\$ 50, 000	stopped
17. Mauritius Rare Fern Darwin Initiative project		UK Govt.	NPCS	\$ 34,000	completed
18. Strengthening & Improvement of forestry colleges in the SADC region		SADC	Forestry Service	(MRU Rs350,000)	ongoing
20. SADC Tree Seed Centre Network.		SADC/ Canada	Forestry Sector	(Mru Rs) 2M	ongoing
21. Identification & Monitoring of the sustainable use of bio- diversity in SIDS (Rodrigues)		CSC (UK)	MRC/ MWF	£ 19, 000	completed
22. National Biodiversity Strategy & Action Plan		UNDP/GEF	NPCS	\$ 235, 440	ongoing
23. Rivulet Terre Rouge Estuary bird Sanctuary		GoM	NPCS	10m (Mru Rs)	ongoing
24. Preparation of National Biosafety framework in Mauritius		UNEP/GEF	MSIRI		Completed
25. Forest restoration in Rodrigues	1996	World Bank /GEF/UK charitable Trusts	MWF/ Forestry	\$ 25,000 annually	Ongoing
26. Ecosystem restoration on Round Island	2000-2004	World Bank/GEF	MWF/ NPCS	\$ 750,000 for 3 years	Ongoing
27. Community capacity building for sustainable use of Rodriguan useful endemic plants	2000-2003	UNEP-GEF/SGP	MWF/ Rodriguan Community Groups	\$ 50,000 for 2 years	Ongoing
28. Restoration of Ile aux Aigrettes	1985-	WWF, World Bank- GEF, Ecotourism revenue, sponsorship by Business community	MWF	\$ 80,000 annually	Ongoing
29. Recovery of Endangered Passerines	1999-2003	Ruth Smart Foundation (UK Trust)	MWF	\$ 76,000 over 4 years	Ongoing
30. Development of Information management systems for conservation	2000-2002	Darwin Initiative (UK Government)	MWF/ NPCS/ UoM	£ 50,000 for 3 years	Ongoing

## **7. Ongoing and Planned Activities for protection, conservation and sustainable use of biodiversity ( including monitoring )**

### **7.1 Forestry**

The Forestry Service is the custodian of 12,000ha. of forest plantations and 3010ha. of native forests. The main activities of the Service is geared towards the creation of new forest plantations (nursery operations and planting out), the maintenance of young plantations and other silvicultural operations e.g. pruning and thinning to improve the quantity of the final crop. Most of the native vegetation under the control of the Forestry Service are degraded with the exception of a few regions with rich plant biodiversity e.g. Cabinet, Mt. Canon, Pouce, Anse Jonchée. At present the activities towards conservation of plant biodiversity carried out by both NPCS and the Forestry Service consist of the following:

- Exploration in the very remote areas, of endemic vegetation (L'Etard, Corps de Garde, Pouce etc.)
- Propagation of critically endangered species with less than five known individuals in the wild.
- In-situ conservation works in areas with relatively rich biodiversity e.g. Mont Vert, Anse Jonchée, Cabinet.
- In-situ conservation in the small Nature Reserves with endemic species e.g. Perrier.
- In-situ conservation on the threatened biodiversity on Le Morne Brabant.
- Setting up of an arboretum and medicinal plant garden.
- Creation of a Nature Walk to promote conservation & education on Mont Vert.
- Creation of a date-base on native biodiversity.
- A mobile-unit to impart conservation education to schools and colleges.
- Raising of seedlings of native plants with ornamental value for sale or for free distribution to socio-cultural organisations and owners of mountain and river reserves.

It is estimated that Rs200m is spent annually by the country as a whole on the conservation of biodiversity in addition to external funding. The Forestry Service itself has a recurrent budget of about Rs150 m.

### **7.2. Fauna & Flora**

#### **7.2.1 Conservation of plant genetic resources.**

In this field the NPCS is running a native plant propagation project with the technical expertise of the Royal Botanical garden of Edinburgh and Kew, Scotland. A national plant committee has been set up by the Government to draw up a list of threatened plants and to document & monitor their status in Mauritius. It also makes recommendations about specific action plans to save those which are most endangered. Recently this committee reviewed a list of endangered plants according to new IUCN criteria.

#### **7.2.2 In situ conservation.**

Presently 9 managed vegetation plots also known as Conservation Management Areas (CMA's) have been set up by the NPCS in different areas of native forests representing major endemic plant communities in the national park. The plots vary from 0.4 to 20 ha in size. The invasive exotics have been manually removed and the areas have been fenced to keep out animals like hare, deer and wild pigs. Maintenance weeding is being carried out regularly every 3 months to remove any seedlings arising from the seed bank in the soil. Managed areas of forest improve in health and produce abundant flowers and fruits. In the absence of exotic species, regeneration of native plants has increased tremendously. These plots are favoured by native birds including echo parakeets (Jones and Duffy, 1993) and pink pigeons which often nest in them (Jones et al 1992). The density of birds and lizards in these plots is higher than in the surrounding unweeded areas of forest (Vaughan and Wiehe 1937).

A nature garden and a boardwalk adjacent to Le Petrin Information Centre have also been established mainly for educational purposes.

### **7.2.3 Ex situ propagation.**

The NPCS has a well developed ex situ plant conservation programme. Some 205 species of endemic plants of which 120 species are flowering plants and 85 are species of ferns are being propagated from spores, seeds and cuttings in the plant propagation facility found in Curepipe. In 1999, the total number of native plant produced was 5000, out of which some 2000 were reintroduced in the wild and offshore islands. Some 500 were sold and 500 distributed freely.

A plant recording system has been developed using a computer programme for the careful monitoring of plants in the wild and nursery. The construction of a fern propagating centre partly funded by the UK Government under the Darwin initiative for the survival of species scheme has been completed. The objective is to propagate rare ferns in Mauritius and to reintroduce them in their suitable managed habitat.

The establishment of an arboretum at Robinson Curepipe by the NPCS offers another approach to do ex-situ work. It is an ex-situ living collection and occupies an area of 4 ha planted with different native plants.

### **7.2.4 Herbarium**

A herbarium is housed at the MSIRI and comprises some 25,000 sheets mounted specimens. It also houses a unique assemblage of publication, manuscripts, original sketches, paintings relating to the original flora and maps. The collection includes plant materials collected from the three Mascarene islands and from islets including Agalega, St Brandon, and the Chagos Archipelago. The flora of the Mascarene is nearing completion with the financial assistance from European Union funding and will be an important tool for the identification of local plant species.

### **7.2.5 Tissue culture**

NPCS in collaboration with the tissue culture laboratory of the Agricultural Services at Barkly is working on the micro propagation of rare and endangered orchids. A training programme on this issue was organised for all those involved in this work. A South African expert gave the training on orchid propagation.

### **7.2.6 Botanical gardens**

Five botanical gardens exist in Mauritius and among them are the Sir Seewoosagur Ramgoolam Botanical gardens at Pamplémousses and Curepipe. The Sir Seewoosagur Ramgoolam Botanical gardens at Pamplémousses has an area of about 60 acres with some 500 plant species. It harbours a collection of native plants which are known to naturalists throughout the world, thus making it among the most visited tourist sites in the Indian Ocean. A medicinal plant garden has also been established there and the NPCS has also provided some 600 native plants for the establishment of a native garden.

### **7.2.7 Establishment of a first wetland Reserve and a migratory bird sanctuary for Mauritius**

The Rivulet Terre Rouge Estuary Bird sanctuary (RTREBS) has been declared as a Nature Reserve on the 27 August 1999 by the Government of Mauritius. This area which is located on the outskirts of Port Louis harbour, in Roche Bois, occupies an area of 26 ha mostly of mud flats and muddy sand. Around 1000-1200 birds visit RTREBS each year representing 11 regular species and 4-5 vagrant species (Bird count 1997, NPCS unpublished). The Rivulet Terre Rouge meets the sea at fish landing station and the estuary formed is abundant in marine organisms like crustaceans, and forms a refuge and an important ground for migratory birds. The objective of the project is to preserve the estuary as a wetland habitat for migratory birds, preserve its biodiversity components especially the marine life and promote ecotourism and develop the area for bird watching, recreation and education. There is a strong involvement of NGO's e.g. Mouvement pour le Progrès de Roche Bois and the RTREBS steering Technical committee headed by Mr Alain Huron, a naturalist.

### 7.3 Agricultural Biodiversity

One of the main objectives of researchers and producers has been to increase yields of agricultural produce per unit area. Recently there has been growing interest in improving quality of agricultural products especially as regards products for the export market. In the animal sector as well, several attempts have been made at farmers level to increase productivity. The first step has been to introduce high yielding varieties (HYV) and new breeds. This is now an on-going process where food crops are concerned. A total number of 222 varieties of 24 different crops have been introduced by the Crop Research Department of the Agricultural Research and Extension Unit in 1998. As farmers are encouraged to grow these varieties, they will resort less and less to local varieties. Such practice narrows the genetic diversity within the species and bring it to a narrow genetic base, which in the long run is highly detrimental to food security. Therefore the tendency now is towards HYV, which can lead to eventual genetic erosion. One striking example is the case of the local variety of onion, the 'local red'. Most of planters now are growing HYV's, which are bringing good revenues.

Work in the sector of farm animal biodiversity will only start now with a project to characterize the local breeds of farm animals starting with the 'Creole' breed of cattle in Mauritius. This project is a regional one involving the SADC region. The main objective of this project is to conserve and manage farm animal genetic resources in Mauritius, formulating legislation governing conservation and sustainable use of farm animals genetic resources. A workshop has already been organized involving the UoM, MOA, Veterinary services, Chamber of Agriculture, farmers and extension workers. A field survey to be carried out in the country is now at the planning stage.

The trend towards legislation in this sector is becoming a major issue. Negotiations are underway concerning UPOV and TRIPS Agreements.

Other activities in this sector:

1. Monitoring of viability of accessions in the Genebank. Regular germination tests for seeds in storage are done to assess viability. This is followed by multiplication, regeneration and characterization of accessions.
2. Establishment of field genebanks for fruit species and tuber crops.
3. Maintenance and management of sugar cane accessions in the field.
4. Evaluation of accessions
5. Utilisation of germplasm in sugar cane breeding programme
6. Release of new varieties of sugar cane
7. Evaluation of palm species
8. Training of students studying agriculture at degree level
9. Member of the SADC Plant Genetic Resources Centre. This is a regional genebank for all the SADC countries. Mauritius joined this organization in 1996. Each country is responsible for its own plant genetic resources activities and an annual planning meeting is held in Lusaka, Zambia to review the work in the sector and to discuss related issues.
10. Participation in the SADC project for the management of farm animal genetic resources in the SADC region.

The Crop Research Department of the Agricultural Research and Extension Unit (AREU) has been carrying research in the following:-

1. Introduction and evaluation of new and improved crop varieties (vegetables, fruits and ornamentals),
2. Mushrooms production,
3. Development of new varieties (conventional and mutation breeding in tobacco, onion, ornamentals and fruits),
4. Hydroponics and protected cultivation,
5. Pest and disease control (including weed control),
6. Development of Integrated Pest Management,
7. Post harvest technology,
8. Optimising the use of natural resources (e.g. soil and water management)
9. Improvement in the use of agricultural wastes, such as poultry litter in crop production, and
10. Use of biofertilisers in Agriculture.

So far work has focussed on 35 Projects and 83 trials have been carried out during 1996 (Anon, 1996).

#### **7.4 Biotechnology**

The development of biotechnology is still in its embryogenic phase in the various institutions, but our knowledge and technical capacities are rapidly increasing. There is a government will to promote biotechnology through different sectors and to provide funds and infrastructures for such development. Works under the various subsectors, that is, tissue culture, quality assurance, crop breeding and so on.

So far, most of the development in biotechnology is confined to agriculture, but in the coming years, other sectors such as human and animal health, aquaculture, marine biology, pharmaceuticals, forestry and environment will start benefiting from this new technology.

The application of biotechnology to crop breeding will be emphasized. Apart from sugarcane, where genome mapping, marker-assisted selection and genetic transformation are being developed, it is expected that in the next 5 - 10 years biotechnology be integrated into the classical plant breeding programme to enhance the production of new cultivars. The introduction of other traits, for disease resistance, drought resistance, nitrogen fixing genes and production of products such as bioplastics in sugarcane, using the genetic modification techniques are being contemplated. These techniques will also be transferred to other crops such as potato for the production of pest and virus resistant clones.

The financing of research and applications in biotechnology in Mauritius is financed mostly by government funds. Sugarcane biotechnology is mainly financed by a cess on sugar produced. International funding by the European Union (EU) has partly contributed to the setting up of the FARC tissue culture laboratory. Inadequate funding is a major constraint towards the progress of many of the existing laboratories. In 1997 the overall funds allocated to biotechnology in the country was estimated to be less than MUR 12 million. Special funding for biotechnology can also be obtained from the National Agricultural Biotechnology Advisory Committee (NABAC) and a budget of MUR 40 million has been allocated for the period 1998-2003.

#### **7.5 Coastal Resources, Marine and Aquatic Biodiversity**

The following activities are being undertaken for this sector:

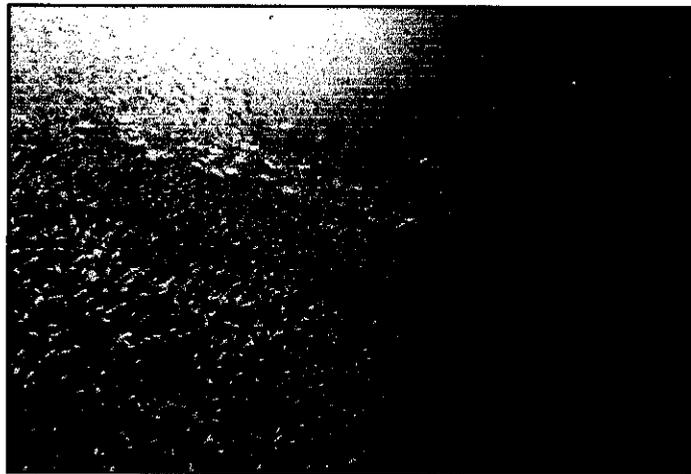
- Marine Pollution Monitoring;
- Marine Ecosystem Monitoring;
- Physical Oceanography;
- Ecotoxicology;
- Sand Resources Monitoring;
- Monitoring of Marine Parks;
- Monitoring of Marine Reserves;
- Setting up of marine parks infrastructures;
- Scientific investigations;
- Publications;
- Management;
- Extension and public relations;
- Management and monitoring of Fishing Reserves;
- Survey of Islets around Mauritius;
- Gear development & bathymetric surveys;
- Training of fishermen;
- Fish inspection service;
- Coastal Fisheries;
- Offshore demersal fisheries;
- Monitoring of fishing vessels;
- Stock assessment (lagoon);
- Tuna Fisheries;
- Seed production;
- Pond management & marine aquaculture extension;
- Berri-rouge culture & development;
- Freshwater aquaculture & extension.

Monitoring of the coral ecosystem at 8 selected sites around Mauritius (namely; Albion, Pionte aux Sables, Trou aux Biches, Anse la Raie, Trou d'Eau Douce, Bambous Virieux, Bel Ombre and Ile aux Benitiers) has been carried out since the early nineties and is still ongoing. Observations on coral spawning, growth and recruitment of coral larvae are being carried every year between October and December. Identification of coral reef fishes to constitute a database is in progress. The first phase of the Mangrove propagation programme which started in 1995 is still ongoing around the coastal region of Mauritius. Coral bleaching was observed in 1998, and a study was initiated. The percentage of corals totally bleached was relatively low. Recent observation show that the bleached coral colonies have recovered.

In order to detect any variation over time and space in the seawater quality, monitoring of the physico-chemical parameters are being carried out at least 11 selected sites (namely; Albion, Pionte aux Sables, Trou aux Biches, Anse la Raie, Trou d'Eau Douce, Bambous Virieux, Bel Ombre and Ile aux Benitiers, Balaclava, Tombeau Bay/Terre Rouge Bird Sanctuary, Port Louis Harbour, Albion/Belle Eau estuary at the fore reef, back reef, shore reef, and sea-grass stations) on a quarterly basis.

### 7.5.1 Marine Parks

In October 1997 the Blue-Bay (353 ha) and Balaclava (485) Marine Parks were proclaimed. A long-term monitoring programme at these two parks has been established and monitoring works are being carried out regularly at the different permanent stations, so as to tracks any significant change over time. Data on coral, benthos and fish population are collected, compiled and analyzed. Physical, chemical and bacteriological properties of water are also monitored. Coral bleaching in 1998 was observed and studied in the lagoonal patch reefs, back reefs and fore reefs at Blue-Bay and Balaclava Marine Parks respectively (Figure 12).



(Figure 12: Coral ecosystem within the Blue Bay Marine Park)

### 7.5.2 Fishing Reserves

Six Fishing Reserves namely Port Louis Fishing Reserve, Grand Port Fishing Reserve, Black River Fishing Reserve, Poudre d'Or Fishing Reserve, Poste La Fayette Fishing Reserve and Trou d'eau Douce Fishing Reserve have been proclaimed as MPAs under the Fisheries and Marine Resources Act 1998.

The main objective of the Fishing Reserves is to protect and conserve its habitats, which are ideal nursery ground for juvenile fish.

### 7.5.3 Management of Marine resources

The Government policy is to phase out sand mining from our lagoon before the end of 2001. Since 1996 Management measures are taken to discourage large nets and gill nets fishing and a buy-back policy has been put in place. Cast nets fishing has been banned early this year. Fish Aggregating Devices (FADs) have been placed outside the lagoon for fishermen to move from the heavily over exploited lagoon. A quota system has been established for the bank fishery since 1994 for the management of its fishery.

#### **7.5.4 Aquaculture**

Research is being undertaken for the development of aquaculture. Seed production of the sea bream, *Rhabdosargus sarba* (gueule pavée) and the marine shrimp *Penaeus monodon* for propagation did not attain expected levels mainly due to lack of spawners from the wild. In the case of the fresh water Cray fish (*Cherax quadricarinatus*) both seed production and grow-out culture trials at La Ferme Experimental Station gave encouraging results. Demands for berri rouge fingerlings for culture in fresh and seawaters were successfully met.

### **8. Gaps/Issues and the priorities in the various sectors**

The gaps/ issues and opportunities that exists under the various sectors are summarised in the table 10 (in the Annex 1) that were identified and discussed as part of a First National Workshop held in September 2000. Some of the most common issues under the various thematic areas are:

- Capacity building
- Need for equipments and facilities
- Lack of data
- Inadequate enforcement and legislations
- Outdated policy measures
- Unclear responsibilities (often duplication and overlapping)
- Set in place and implement economic instrument
- Need for aggressive public awareness and sensitisation campaigns.

### **9. Resources for Biodiversity Conservation and Sustainable Use**

While the National Biodiversity Strategy and Action Plan will not be completed for a further 9 months, it is important that the funding sources be identified. Though there exist various possible funding options, external funding will remain indispensable.

## 10. References.

1. Anon (1990). Staff appraisal Report. Mauritius Environmental Monitoring and development project. World Bank Report No. 8996-MAS.
2. Anon (1992). The Global Biodiversity: Status of the Earth's Living Resources. World Conservation Monitoring Centre. Chapman & Hall, London, U.K.
3. Anon (1992-94). National Development Plan 1992-1994. Vol 1. Programme & Policies. Ministry of Economic Planning & Development, Port Louis, Mauritius.
4. Anon (1995). Mauritius Biodiversity Restoration Project. Report No. 14527 - MAS. WB/ GEF Project Document.
5. Anon (1996). The Annual Report of the Food & Agriculture Research Council.
6. Anon (1996) Marine Resources and the Environment, Albion Fisheries Research Centre 14p.
7. Anon (1997) Development of Marine Resources, Albion Fisheries Research Centre, 45p.
8. Anon (1998). Water Quality in Selected Wetlands. Ministry of Local Government and Environment.
9. Atchia M. (Dr.), 1990 – Sea Fishes of Mauritius and the South-west Indian Ocean. United Nations Environment Programme, Nairobi, Kenya, 188p.
10. Baissac de J. SWIOP Document IOSO April 1990 Checklist of the Marine Fishes of Mauritius, 42p.
11. Baker, J. G. (1877). Flora of Mauritius and the Seychelles. A description of the flowering plants and ferns of those islands. London: Reeve. pp 1-557.
12. Bell, B. D.; Dulloo, M. E., Bell, M. (1994). Mauritius offshore island survey report and management plan, prepared for the Gov. of Mauritius on behalf of the Jersey Wildlife Preservation Trust.
13. Bosser, J.; Cadet, TH., Guého, J.; Julien, H. R.; Marais, W. (Eds.) (1976 - on-going). Flore des Mascareignes: La Réunion, Maurice, Rodrigues. Mauritius Sugar Industry Research Institute, l'Office de la Recherche Scientifique et Technique and the Royal Botanic Gardens, Kew, Port Louis, Mauritius.
14. Capital Budget 1997-1998, Ministry of Finance
15. Carrying Capacity Study of the Republic of Mauritius and Rodrigues, Ministry of Tourism. KPMG, 44p.
16. Cornic A. (1987) Poissons de l'Ile Maurice Edition de l'Océan Indien, Ile Maurice, 335p.
17. Dulloo, E.; Naseeven, R.; Rojoa, H. (1995) Ed. Country Report on Plant Genetic Resources - Mauritius. International Conference and Programme for Plant Genetic Resources.
18. Dulloo, E.; Dulymamode, R. Ed. (1995). Plant Genetic Resources in Mauritius towards a National Strategy. Proceedings of a National Workshop on Plant Genetic Resources in Mauritius, University of Mauritius, 21-22 October 1993. Published by the National Parks and Conservation Services, Ministry of Agriculture & Natural Resources, Réduit, Mauritius.
19. Flore des Mascareignes (May 1984), MSIRI, 191-201p.
20. Goorah D. and Naidoo D., 1987 - Aquaculture Development and Prospects in Mauritius, Ministry of Agriculture, Fisheries & N.R., 6p.
21. Gueho, J. (1989). La Vegetation de l'Ile Maurice. Editions de l'Océan Indien.

22. Gurib-Fakim, A.; Guého, J.; Sewraj, M. D., Dulloo, E. (1994). *Plantes Médicinales de L'Ile Rodrigues*. Editions de l'Océan Indien, Rose Hill, Mauritius.
23. Gurib-Fakim, A.; Guého, J.; Bissoondoyal, M. D. (1995-1997). *Plantes Médicinales de Maurice*. Editions de l'Océan Indien, Rose Hill, Mauritius. Tomes 1, 2, 3.
24. *Mauritius Economic Review 1992-1995, (1996)*, Ministry of Economic Planning & Development, 258p.
25. Merton, D.V.; Atkinson, A. E.; Strahm, W.; Jones, C.; Empson, R. A.; Mungroo, Y.; Dulloo, E.; Lewis, R. (1989). *A management plan for the restoration of Round Island, Mauritius*. Jersey Wildlife Preservation Trust and Ministry of Agriculture, Fisheries and Natural Resources. Mauritius.
26. Meunier, H. (1998). *Forest Ranger*. Ministry of Agriculture & Natural Resources, Solitude, Rodrigues. Personal Comm.
27. Ministry of Economic Development and Regional Cooperation (1997). *Vision 2020. The National Long Term Perspective Study*. Volume 1 & 2. ISBN 99903-907-5-4.
28. Mungroo Y. Mauremootoo J. R. and Batchraz V. (1997). *Proceedings of the Workshop on restoration of highly degraded and threatened Native forests in Mauritius*.
29. Motwani M.P. (1971) – *Techno-economic Survey of Mauritius*. Vol. III – Fisheries, 75p.
30. *National Environmental Strategies for the Republic of Mauritius (1999)*. Ministry of Environment, Government of Mauritius.
31. *National Development Plan 1992-1994, Programmes and Policies (1993)*, Ministry of Economic Planning & Development, 226p.
32. Page, W.; d'Argent, G. (1998). *A Vegetation Survey of Mauritius (Indian Ocean) to Identify Priority Rainforest Areas for Conservation Management*. Mauritius Wildlife Foundation. Unpublished results. Strahm, W. (1989). *Plant Red Data Book for Rodrigues*. WWF/IUCN, Koeltz Scientific Books, West Germany.
33. Parameswaran S., Jehangeer M.I. and J.D. Ardill (1977) – *Introduction of Indian and Chinese Carps and Preliminary Observations on Polyculture in Mauritius*. *Rev. Agric. Sucr. Ile Maurice*, 56, 124-140p.
34. Parameswaran S. & Goorah D. (1981). *Occurrence of the striped murrel, *Channa striatus* (BLOCH), 1793 in Mauritius*. *Revue Agricole et Sucr.Ère de l'Ile Maurice*, 60, 117-124p.
35. Proag V. (1995), *The Geology and Water Resources of Mauritius*, Mahatma Gandhi Institute, 939p.
36. *Recurrent Budget 1997-1998*, Ministry of Finance.
37. Smith J.L.B. (1965) – *The Sea Fishes of Southern Africa* Central News Agency Ltd, South Africa, 1–580p.
38. Strahm, W. (1994). *The Conservation and restoration of the flora of Mauritius and Rodrigues*. PhD. thesis, University of Reading, UK. Allen G.R. (Dr.) and Steene R., 1994 - *Indo-Pacific Coral Reef Field Guide*. Tropical Reef Research Singapore, 378p.
39. *State of the Environment in Mauritius (1991)*, Ministry of Environment and Quality of Life, 403p.
40. *Survey Report on the Outer Lagoon Fisheries Development Project in Mauritius Island, 1994*, OFCF, 93p.
41. *The Fisheries and Marine Sectors of Mauritius – An Overview (1995)*, Ministry of Fisheries and Marine Resources, 47p.

42. Veron J.E.N. (1986) Corals of Australia and the Indo-Pacific. Angus and Robertson Publishers, United Kingdom, 644p.
43. Whales and Dolphins of Mauritius, May 1991 – An Identification Guide. A Publication of the Mauritius Marine Conservation Society and the Mauritius Wildlife Appeal Fund.

**Table 10: Summary of Gaps/ Issues and the priorities under the various thematic areas**

Thematic area	Gaps/ Issues	Priorities
<b>Socio-Economic factors affecting &amp; benefiting Biodiversity</b>	Population growth: <ul style="list-style-type: none"> <li>➤ Lack of measures to reduce pressure on natural resources</li> <li>➤ No study/ empirical data to assess impact of population growth on biodiversity</li> </ul>	Need for a study to assess impact of population growth and economic development on biodiversity
	Change in Land Use Pattern: <ul style="list-style-type: none"> <li>➤ Need for the implementation of the National Physical Development Plan (prepared in 1994)</li> <li>➤ Absence of legislative framework (the Town and Country Planning Act dates as far as 1954)</li> <li>➤ Lack of proper enforcement of guidelines</li> </ul>	Implementation of the National Physical Development Plan. Enactment of appropriate legislation. To reinforce strict enforcement of guidelines
	Agricultural Sector: Use of Agro-chemicals. <ul style="list-style-type: none"> <li>➤ Weakness in legislation and enforcement</li> <li>➤ Lack of public awareness about the direct and indirect effects of excessive use of agro-chemicals</li> <li>➤ Lack of database on the levels and impacts of agro-chemical</li> <li>➤ Unclear institutional responsibilities, and</li> <li>➤ Need for capacity building</li> </ul>	Monitoring and Enforcement Need for a more aggressive public awareness campaign Establishment of a database related to the use of Agro-chemical
	Industrial sector: <ul style="list-style-type: none"> <li>➤ Need for international expertise to validate the effluent standards (those already prepared)</li> <li>➤ Lack of appropriate technology</li> <li>➤ Absence of economic instruments and the need to implement the Polluter Pays Principle</li> </ul>	Capacity Building Setting of appropriate standards Establishment of a Cleaner Production Centre under the ETP 2 Immediate implementation of the Polluter Pays Principle

<b>Forest Biodiversity</b>	Absence of Policies (which specifically address the issue of biodiversity)	Urgent need to review the current policy which were enunciated in the early sixties in the light of emerging issues: <ul style="list-style-type: none"> <li>➤ Eco-tourism</li> <li>➤ Conservation and sustainable use of exotic &amp; native plant species</li> <li>➤ Access to resources and benefit sharing</li> <li>➤ Agro forestry</li> <li>➤ Medicinal plants</li> <li>➤ Conservation of water</li> <li>➤ Soil erosion and flood control</li> <li>➤ Recreational facilities</li> </ul>
	Inadequate Legislation	There is an urgent need to amend & consolidate existing legislation to address: <ul style="list-style-type: none"> <li>➤ Loss of biodiversity on privately owned forests</li> <li>➤ Empowerment of NGO's for the management of areas with biodiversity</li> <li>➤ Incentives to the private sector to conserve biodiversity</li> </ul>
	Institutional Capacity: Acute shortage of staff at the level of NPCS and Forestry Service	Urgent need to increase the number at the scientific, technical and field levels
	Research & Propagation Infrastructure: At present, there is lack or under utilisation of existing infrastructure for propagation of critically endangered spp. ( e.g. tissue culture )	There is a need for mass production of native plants of economic importance (ornamental & medicinal, hard woods) Seed processing and storage facilities must be created Need for research on Genetic improvement of native biodiversity of economic importance
<b>Terrestrial Biodiversity</b>	Resources Inventory: <ul style="list-style-type: none"> <li>➤ Lack of inventory on Biological Resources</li> <li>➤ Absence of proper database for storing &amp; disseminating information on activities related to CBD</li> </ul>	Need to undertake inventory Put in place information system
	Inadequate Institutional capacity at the National Parks and Conservation Service	Urgent need of institutional strengthening in terms of human resources, logistic facilities and expertise
	Inadequate collaboration among various biodiversity related institutions & unclear designation of responsibilities	Need to streamline role of different institutions to optimise resources and avoid duplication and develop inter- institutional Coordination
	Training Islets Management	Herpetology and Plant Taxonomy as priority training area <ul style="list-style-type: none"> <li>➤ Eradication of plant exotics over the long term with the possibility of translocating animals on some of the rat free islands.</li> <li>➤ Setting up of permanent research station on the islands.</li> </ul>

	New Areas of study	<ul style="list-style-type: none"> <li>➤ Caves : to implement the Middleton Report (1995) on caves with biodiversity interest in Mauritius and Rodrigues;</li> <li>➤ Wetlands: To carry out a survey of all wetlands and assess all those with biodiversity of interest;</li> <li>➤ Passerines: The endemic passerines are all classified as endangered. Need to be fully studied as a priority and urgently brought into captivity for breeding and release programme.</li> <li>➤ Establishment of a national genebank incorporating native species of actual or potential economic importance.</li> </ul>
	Legal Frameworks	<ul style="list-style-type: none"> <li>➤ Review the legal frameworks (with regard to numerous loopholes);</li> <li>➤ Need for a Rescue Centre for animals seized during illegal trade ( legal provision already made in the legislation)</li> </ul>
	Conservation Management Areas	<ul style="list-style-type: none"> <li>➤ CMA's should be applied on a larger area/ scale in addition to smaller ones;</li> <li>➤ Build predator proof fences in CMAs and wildlife corridors</li> <li>➤ Long term Management of the CMA's;</li> <li>➤ Conduction of surveys to collect baseline data for evaluation of progress at a later stage.</li> </ul>
	Pest Control	A National Pest Control Strategy/ Alien invasive species programme for both animals and plant pests should be worked out. Need to control pet trade ( both import and export)
	Private sector Forest Land (Lack of Incentives)	Owners should be encouraged (provided with incentives) to maintain biodiversity within their properties.
	Public Education and Awareness	Urgent needs to undertake sensitisation campaign. Primary schools, Secondary institutions, young and old associations should be the focus area where education on biodiversity could be dispensed on the preservation of biodiversity component.
	Poor Coordination among the various institutions	Revival or setting of a National Committee on Plant and Animal Genetic Resources
<b>Agricultural Biodiversity</b>	Inadequate Institutional and Human capacities (wild relatives of crops not properly conserved, any conservation of animal genetic resources, lack of equipment for management of genetic resources)	There is an urgent need to carry out an assessment of the existing Institutional and human capacities in the various institutions concerned to take stock of the facilities required and their training needs (Documentation Centre to be included).
	Lack of comprehensive data on all GR	<ul style="list-style-type: none"> <li>➤ Institutions concerned to carry out an inventory and collect relevant data on all resources available;</li> <li>➤ Development of an effective information system for the dissemination of information at the national level.</li> </ul>
	Low representation of the diversity in the local sugar cane collection, limited evaluation works & conservation of wild relatives of crops)	To undertake Conservation and utilisation of GR programme. More resources should be allocated to strengthen conservation and utilisation of GR.
	Need for a National Genebank	Establishment of a National Genebank

<b>Biotechnology and biosafety (on going programme)</b>	Cell and Tissue culture	<ul style="list-style-type: none"> <li>➤ Making use of existing facilities in various institutions to their full capacity;</li> <li>➤ Increase or initiate propagation of plantlets of banana, ginger, strawberry and anthurium;</li> <li>➤ Propagation &amp; preservation of endangered species;</li> <li>➤ Propagation of medicinal Plants and secondary metabolites.</li> </ul>
Molecular Diagnostics	<ul style="list-style-type: none"> <li>➤ Upgrading of existing laboratories to enable molecular diagnostic of plant, animal and human diseases;</li> <li>➤ Procurement of new equipment;</li> <li>➤ Training of personnel in molecular diagnostics.</li> </ul>	
Improvement of Varieties	<ul style="list-style-type: none"> <li>➤ Application of marker assisted selection in breeding programmes of sugar cane and other crops such as anthurium;</li> <li>➤ Making use of molecular markers for variety fingerprinting and identification (sugar cane, banana, anthurium and endangered species)</li> </ul>	
Genetic Transformation	<ul style="list-style-type: none"> <li>➤ Genetic transformation of sugar cane for disease resistance;</li> <li>➤ Genetic transformation of potato and tomato for resistance to insect pests and viruses.</li> </ul>	
Vaccines production	Production of recombinant vaccines for bovine and poultry industries.	
Detection of genetically modified organisms in food products	<ul style="list-style-type: none"> <li>➤ Setting up of a laboratory for the detection of GMOs in food products;</li> <li>➤ Training of personnel in the detection of GMOs in food products.</li> </ul>	
Legislation	Enactment of legislation governing the development and introduction of GMOs in Mauritius	
Capacity Building	<p>There is a need for capacity building in the following fields:</p> <ul style="list-style-type: none"> <li>➤ Biotechnology</li> <li>➤ Biosafety legal framework</li> <li>➤ Risk assessment and risk management of GMOs</li> <li>➤ Public awareness in biotechnology, GMOs and biosafety.</li> </ul>	

<b>Coastal Resource, Marine and Aquatic Biodiversity</b>		
<p>Marine pollution: Seepage (freshwater &amp; Sewage), chemical pollution, Agricultural run off.</p>	<p>Over exploitation of lagoon by different users (local, fishermen and tourists)</p> <p>Physical alteration:</p> <ul style="list-style-type: none"> <li>➤ Careless anchoring, harmful fishing method, improper planning of hotel development in the coastal region, and alteration of the coastline.</li> <li>➤ Siltation (Land based)</li> <li>➤ Removal of sand, deforestation, undersea walk and dredging activities</li> </ul> <p>Alien species from ballast water</p> <p>Global Climate Change:</p> <ul style="list-style-type: none"> <li>➤ Coral Bleaching</li> <li>➤ Sea Level Rise</li> </ul> <p><b>Other Gaps:</b></p> <ul style="list-style-type: none"> <li>➤ Biological data w.r.t. freshwater resources including wetlands incomplete</li> <li>➤ Responsibilities lying with different organisations should be integrated</li> <li>➤ unclear designation of responsibilities</li> <li>➤ Inadequate enforcement of existing legislations</li> <li>➤ Inadequate public awareness and education to various target groups (including decision makers)</li> </ul>	<ul style="list-style-type: none"> <li>➤ Enforcement of proper standard.</li> <li>➤ Capacity building with the help of consultant/ expertise.</li> <li>➤ Need for adequate requirement to enforce EIA license as per the EPA Act.</li> <li>➤ Wetlands to be identified and declared as Marine Protected Areas.</li> <li>➤ Implement Polluters Pay Principle.</li> <li>➤ Carry out monitoring.</li> <li>➤ Continue zoning of lagoon (already under way)</li> <li>➤ Encourage off lagoon fishing (make use of Fish Aggregating Devices)</li> <li>➤ Dive sites to be declared as MPA's</li> <li>➤ Need of a policy for watersport &amp; speed boats in MPAs</li> <li>➤ Installation of permanent mooring buoys.</li> <li>➤ Public awareness campaign</li> <li>➤ Adequate enforcement of EIA licence</li> <li>➤ Buy back policy to discourage net fishing</li> <li>➤ Imposing strict regulations regarding activities undertaken</li> <li>➤ Enforcement of existing legislation</li> <li>➤ Need to investigate on the extent of the problem and actions required</li> <li>➤ Continue with monitoring programme</li> <li>➤ Creation of new setbacks for future development on coastline</li> <li>➤ Need to initiate comprehensive monitoring programme for wetlands</li> <li>➤ An ICZM Unit has been created in the Ministry of Environment. Need to be fully operationalised</li> <li>➤ Need to streamline role of different institutions to optimise resources and avoid duplication</li> <li>➤ Review and consolidation of existing legislations and Strict enforcement</li> <li>➤ More aggressive public awareness and education campaigns to be effected.</li> </ul>

Sustainable Eco-tourism Development in Mauritius		
Inadequate appreciation of native biodiversity by the tourism operators	Urgent Need for Capacity Building	
Some of the land planning guidelines too stringent on the coastal areas ( to the detriment of biodiversity)	Review the land planning guidelines for the coastal areas and need for a proper development control mechanism	
Shell and corals extraction	A possibility of banning collection & importation	
Coral Sand mining	Decision to ban sand extraction by the end of year 2001 to be executed	
Pleasure craft Operations	Urgent need for appropriate legislation	
<p>Other gaps and issues:</p> <ul style="list-style-type: none"> <li>➤ Pollution, Littering and dumping of non-biodegradable waste in the lagoon</li> <li>➤ Inland Conservation Areas</li> <li>➤ Stray animals (dogs, cats, rats etc. ) and crows</li> <li>➤ Code of practice &amp; Ethics for Eco-tourism</li> <li>➤ Inter Ministerial Coordination is inadequate (mis-match of priorities)</li> <li>➤ Global Warming/Climate change</li> <li>➤ Beach Management in-existent</li> <li>➤ Creation of Marine Parks and artificial reefs</li> <li>➤ Planning at Local Authorities level</li> <li>➤ Undersea walk: motorisation is a possible threat</li> </ul>	<ul style="list-style-type: none"> <li>➤ Enforcement of existing legislation and intensive Public Awareness programme</li> <li>➤ Enhance the tourism value of the resources/ areas</li> <li>➤ Need for immediate action to be taken to control stray animal</li> <li>➤ Training in Eco-tourism development</li> <li>➤ Proper coordination and board of investment</li> <li>➤ Determination of impact on tourism activities (water sports, sun - bathing etc)</li> <li>➤ Creation of a Beach Development Authority</li> <li>➤ Legal framework and proper management</li> <li>➤ Need a sound tourism development agenda</li> <li>➤ Definition of undersea trail</li> </ul>	