

Biological Diversity and Genetic Resources

The Programme of the
Commonwealth Science Council

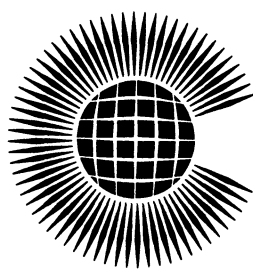


P. KAPOOR-VIJAY

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**The Programme of the
Commonwealth Science Council**

P KAPOOR-VIJAY



The Commonwealth Science Council

1992

*The Commonwealth Secretariat
Marlborough House, Pall Mall, London SW1Y 5HX*

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Marlborough House
Pall Mall
London SW1Y 5HX**

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ISBN 0 85092 388 3

**CSC (92) RNR-18
PD 293**

Typeset in Times New Roman 11.5/13.5 at The Commonwealth Secretariat

Contents

Foreword	v
Preface	vi
Acknowledgements	viii
Acronyms	ix

PART I

Summary	1
1. Introduction	
1.1 What is biological diversity?	3
1.2 How biological diversity contributes to sustainable development	3
1.3 International efforts to conserve biodiversity	7
1.4 A biodiversity convention	8
1.5 Commonwealth countries and biodiversity	8
2. Biological Diversity and Genetic Resources Programme	
2.1 Background	9
2.2 The BDGR project	11
2.3 Model for the BDGR project as it has been implemented	12
2.4 National co-ordinators	15
2.5 Regional co-ordinators	15
2.6 Development of the BDGR project	15
2.7 Key activities of the programme	19
3. Results of the BDGR project	32
4. Future directions	36
4.1 Identified constraints and challenges in the BDGR programme	37
4.2 Proposed actions for 1992–1995	38
4.3 Timeframe and estimated costs	39

PART II

	Summary	41
I	Guidelines for developing the Commonwealth Biodiversity and Genetic Resources project	43
II	Recommendations of key workshops held under the BDGR programme	47
III	List of national co-ordinators of the BDGR programme	107
IV	List of Publications	
	A. Documents prepared by CSC	112
	B. Suggested reading list	113
	Text of the Convention on Biological Diversity	116
	Glossary	142

TABLES AND FIGURES

Table 1	Research, science and educational role of institutions in different activities for the collection, evaluation, conservation and utilisation of Biological Diversity	18
Table 2	Multifarious interactions within the BDGR Programme...	20
Table 3	Workshops/Symposia	48–49
Figure 1	A range of views on conservation of biodiversity	4
Figure 2	Model for conservation of environment and development of biological resources	10
Figure 3	Evolution of the BDGR Programme over time	16
Figure 4	Results of the BDGR Project	34

Foreword

The Convention on Biological Diversity signed by many nations at Rio de Janeiro recently recognises the intrinsic value of biological diversity and its ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values, as well as its importance for evolution and for maintaining life-sustaining systems of the biosphere. The Commonwealth of 50 diverse sovereign states is not only rich in cultural diversity but also in genetic wealth. Many mega-diversity areas occur in the Commonwealth. It has therefore been an act of vision on the part of the Commonwealth Science Council to have initiated a Biodiversity and Genetic Resources (BDGR) Programme over six years ago.

This report is an eloquent testimony to the power of co-operative efforts. Much valuable work has been done at minimum cost. Valuable genes, species and ecosystems have been saved. The concept of ecological and economic key species has been promoted and operationalised. Human resource development and capacity building have received priority. The BDGR programme can now look forward to its next phase with added vigour and support, thanks to the universal interest in preserving biodiversity and utilising genetic resources for developing eco-friendly biotechnology products. We must maximise the benefits of our genetic endowments for improving the livelihood security of the economically underprivileged sections of our societies.

Indira Gandhi, quoting the **Atharva Veda**, in her address at Stockholm twenty years ago, pleaded:

*What of thee I dig out,
let that quickly grow over,
Let me not hurt thy vitals,
or thy heart*

Loss of biological diversity is like hitting the vitals, since without such diversity it will not be possible to achieve sustainable advances in biological productivity. This underlines the significance of the BDGR programme of the Commonwealth Science Council. I have every hope that this dynamic programme will play a significant role in the achievement of the scientific goals of the Biodiversity Convention, signed by over 150 nations at Rio de Janeiro.

M S Swaminathan

12 June 1992

Preface

Sustainable development is essential if the billions of people inhabiting the Earth are to enjoy their human rights which include economic and ecological security. The key to sustainable development lies in using Earth's biological resources prudently without losing any species inhabiting it.

Need for the conservation and use of biological diversity has in recent years been amply highlighted by a number of major reviews on the state of the Earth and of human needs. The *World Conservation Strategy* made an attempt to bring together the then divergent issues of environment and development and emphasised their inseparability. The report of the World Commission on Environment and Development, *Our Common Future*, put the need to rationalise the use of our biological resources on the agenda of governments throughout the world by placing the key issues in front of the public at large. Biennial *World Resources and Environmental Data* reports and the annual UNEP *State of the Environment* reports have provided authoritative overviews of the health of our planet. The successor and complement to the *World Conservation Strategy*, *Caring for the Earth: A Strategy for Sustainable Living*, has once again drawn our attention to the need to live within the carrying capacity of the Earth.

A series of discussions held under the *Keystone International Dialogue* on the conservation and utilisation of global plant genetic resources sought to bring together the significant constituencies in a structured, off-the-record process to develop consensus recommendations and strategies regarding the availability, use, exchange and protection of plant germplasm. The recognition that biological diversity is the building block for technology and our necessary defence against global climate change gave impetus to the need for further research in this area. *From Genes to Ecosystem: A Research Agenda for Biodiversity*, published by IUBS, SCOPE and UNESCO, gave the outlines of a research programme to answer some leading questions on biodiversity and its importance for the proper functioning of biological systems from populations to ecosystems. Most recently, the *Global Biodiversity Strategy* prepared by WRI, IUCN and UNEP gave guidelines for action to save, study and use Earth's biotic wealth sustainably and equitably.

Earth's plants, animals and micro-organisms interacting with one another and with the physical environment in ecosystems form the foundation of sustainable development. The continuing loss of biodiversity is a reflection on the imbalance of human needs and wants, and nature's capacity to meet the needs. The importance of developing scientific programmes on biological diversity was realised in 1984 by the Commonwealth Science Council as stated in the Kendrew Report, *Science for Technology for Development*.

A Biological Diversity and Genetic Resources (BDGR) Project was developed in 1986 by the Commonwealth Science Council to help member countries in the conservation and rational utilisation of biological diversity and genetic resources. This project has evolved over

time and has now come to be known as the Programme on Biological Diversity and Genetic Resources. The five components of the programme cover: survey and authentication; techniques and methods; key species; economic plants; and development of appropriate networks for co-ordination of activities on a pan-Commonwealth basis. It utilises the process of multifarious interactions among different participants responsible for conserving and using our genetic resources; it can be described as using a 'bottom-up' approach as it relies heavily on the involvement of people on the ground. The initial focus for the first five years of the programme was on under-exploited plants. This has been subsequently expanded to cover animals and micro-organisms. The key activities which have been instrumental in implementing the underlying process of the programme are holding of workshop and review meetings; preparation of country reports, training courses and technical documentation; and development of networks and project proposals. Since 1985, CSC has directly trained more than 1,100 professionals. In the BDGR programme, 28 member countries have identified national co-ordinators who are grouped under seven regional networks covering the Caribbean, West Africa, East Africa, Southern Africa, Asia and the Mediterranean, South-East Asia, and the Pacific.

This document is a consolidated account of the BDGR programme. It consists of two parts. Part I gives the programme details highlighting the underlying concepts, structure and processes. Part II contains background information that will help the reader in getting a better perspective of practical aspects of the programme; it includes the text of the Convention on Biological Diversity signed in Rio de Janeiro, Brazil, at the Earth Summit by all countries except the USA.

The achievements and success of this programme are attributed to experts, scientists and the local people; and to the governments and various organisations within and beyond the Commonwealth who provided their inputs directly and indirectly between 1985–1992 and continue to help in supporting it.

P Kapoor-Vijay

June 1992

Commonwealth Science Council

Acknowledgements

The author of this report would like to thank all the past and present CSC Members for their unflinching support in building the BDGR programme to its current state. She is also grateful to the numerous fellow scientists, including those working in the BDGR programme, for their valuable comments on the contents of this programme. The insights provided by them on their respective areas of specialisation have helped in shaping and structuring it. Their contributions are gratefully acknowledged. Several international, regional and national organisations, and aid agencies have provided financial assistance for holding workshops, conferences and training courses. Their assistance is much appreciated.

ACRONYMS

AIDAB	Australian International Development Assistance Bureau
BGCI	Botanic Gardens Conservation International
BGCS	Botanic Gardens Conservation Secretariat of IUCN
CIMAP	Central Institute for Medicinal and Aromatic Plants, Lucknow, India
CIP	International Potato Centre
CITES	Convention of International Trade in Endangered Species of Wild Flora and Fauna
CNPPA	Commission on National Parks and Protected Areas of IUCN
CPC	Centre for Plant Conservation
ECG	Ecosystems Conservation Group
FAO	Food and Agriculture Organisation of the United Nations
FRIM	Forest Research Institute Malaysia
GATT	General Agreement on Tariffs and Trade
GEF	Global Environment Facility
GEF/STAP	Global Environment Facility/Science and Technology Advisory Panel
GEMS	Global Environment Monitoring System of UNEP
IARC	International Agriculture Research Centre
IBPGR	International Board for Plant Genetic Resources
ICBP	International Council for Bird Preservation
ICDP	Integrated Conservation/Development Project
ICRO	International Cell Research Organisation
IDRC	International Development Research Centre, Canada
IPBC	International Panel on Biodiversity Conservation
IRRI	International Rice Research Institute
ISIS	International Species Inventory System
ITTA	International Tropical Timber Agreement
ITTO	International Tropical Timber Organisation
IUBS	International Union of Biological Sciences
IUCN	International Union for Conservation of Nature and Natural Resources, also known as World Conservation Union
JICA	Japanese International Co-operation Agency

BIOLOGICAL DIVERSITY AND GENETIC RESOURCES

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MARDI	Malaysian Agricultural Research and Development Institute
MCDP	Marine Conservation and Development Programme
NCL	National Chemical Laboratory, Pune, India
NGO	Non-governmental Organisation
PLANTI	Plant Quarantine Training Institute, Serdang, Malaysia
PORIM	Palm Oil Research Institute of Malaysia
PRCRC	Philippines Research Council for Root Crops
RRIM	Rubber Research Institute of Malaysia
SCOPE	Scientific Committee on Problems of the Environment
UN	United Nations
UNCED	United Nations Conference on Environment and Development, also known as the 'Earth Summit'
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UPLB	University of Philippines, Los Banos
WRI	World Resources Institute
WWF	World Wide Fund for Nature (previously World Wildlife Fund and still so in the USA)

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PART I



Summary

Part I gives a brief description of the importance of biological diversity and its contribution to sustainable development, and how timely launch of the Commonwealth Science Council's BDGR Programme in 1986 has addressed this issue. Chapter 1 describes the current scenario of the loss of biodiversity and the multitude of responses of different groups of people in developed and developing countries. International efforts to conserve biodiversity are described including those related to the convention on biodiversity recently signed by 170 governments at Rio de Janeiro in June 1992.

The genesis of the CSC's BDGR programme lies in the work done on an under-exploited plant, *Chenopodium*, and in the recommendations of the Kendrew Report. The project has two phases. Phase I consists of the study, use and conservation of under-exploited plants; Phase II comprises expansion of the programme to include both vertebrates and invertebrates, and micro-organisms. While the plan of work under Phase I has been well established, the activities to be undertaken during Phase II remain to be delineated at the operational level.

The structure, thematic programmes and components of the BDGR project are described in Chapter 2. At the operational level the BDGR programme has four processes, namely: (a) interactive dialogue; (b) adaptive transfer of technology; (c) negotiations; and (d) field work at national level. The role of national and regional co-ordinators is also given in this chapter. Development of the two phases of the programme derives strength from its interlinked thematic key components of biodiversity, genetic resources, and tropical forest ecology. Details of activities which have been instrumental in implementing the processes of the programme have been given. These comprise holding of workshops and training courses, preparation of technical documentation, country reports and project proposals, and development of networks.

Activities undertaken in the BDGR programme have resulted in indigenous capacity building. Details of this are in Chapter 3. A programme has been developed on sustainable tropical forestry for the Government of Guyana. Several international collaborations and co-operations have been initiated. Operational models developed within the programme have been used for the implementation of medicinal plants projects, and steps have been taken to establish appropriate computerised databases of relevance to the programme, e.g. the ILDIS database. Training manuals and guide books have been prepared in the area of conservation biology, ethnobotany and investigation of traditional herbal medicines.

Chapter 4 gives the future directions of the programme. These are in line with the UNCED convention, i.e. the conservation of biological resources to ensure sustainable development for the survival of the human race on this Earth. The essential change suggested in the future direction of the BDGR programme is to enlarge its scope and include micro-organisms and animals. Main recommendations for future programmes include: (i) compiling a *materia medica* of ethnobotanical knowledge by involving local people in the gathering of this information; (ii) development of *in situ* and *ex situ* protected areas, national parks, gene banks, botanical gardens and museums as repositories of rare, threatened or endangered germplasm; and (iii) development of the required technology and methods for using local biodiversity on a sustainable basis. Specific actions are proposed together with an indication of an appropriate time frame and estimated costs for undertaking such action.

CHAPTER 1

Introduction

1.1 What is Biological Diversity?

'Biological diversity' encompasses all species of plants, animals and micro-organisms and the ecosystems of which they are part. It is an umbrella term for the degree of nature's variety, including both the number and frequency of ecosystems, species or genes in a given assemblage. It is usually considered at three different levels, '**genetic diversity**', '**species diversity**' and '**ecological diversity**'. Genetic diversity is a concept of the variability within a species, as measured by the variation in genes (chemical units of hereditary information that can be passed from one generation to another) within a particular variety, subspecies or breed. Species diversity refers to the variety of living organisms on Earth and has been variously estimated to be between 5 and 30 million or more, though only about 1.4 million have actually been described. Ecological diversity relates to the variety of the habitats, biotic communities and ecological processes in the biosphere, as well as the tremendous diversity within ecosystems in terms of habitat differences and the variety of ecological processes.

Ecosystems cycle nutrients (from production to consumption to decomposition), water, oxygen and carbon dioxide (which affect the climate), and other chemicals such as sulphur, nitrogen and carbon. Their integrity is essential for maintaining the biological resources in forests, plains, mountains and wetlands which are the physical manifestation of the globe's biological diversity.

1.2 How Biological Diversity Contributes to Sustainable Development

The contribution of biological diversity to sustainable development was acknowledged in 1987 by the World Commission on Environment and Development (WCED): "Today, the conservation of wild living resources is on the agenda of governments, nearly 4% of the Earth's land area is managed explicitly to conserve species and ecosystems, and all but a small handful of countries have national parks. The challenge facing nations today is no longer deciding whether conservation is a good idea, but rather how it can be implemented in the national interest and within the means available to each country".

While biological resources are essential to human welfare, the biological diversity of the planet is under greater threat than ever before. It faces problems from the local level (poaching, encroachment of protected areas) and the global level (deforestation, global climate change). Despite the best efforts of biologists, ecologists, wildlife managers and park planners, biological diversity is now under siege throughout the world. More species than ever before are threatened with extinction, with hundreds – perhaps thousands – disappearing each year, many before they are even described. The genetic resources of the Earth's natural heritage are barely understood, let alone utilised, by the world, yet those resources are disappearing before their myriad life forms can even be named and counted. And the

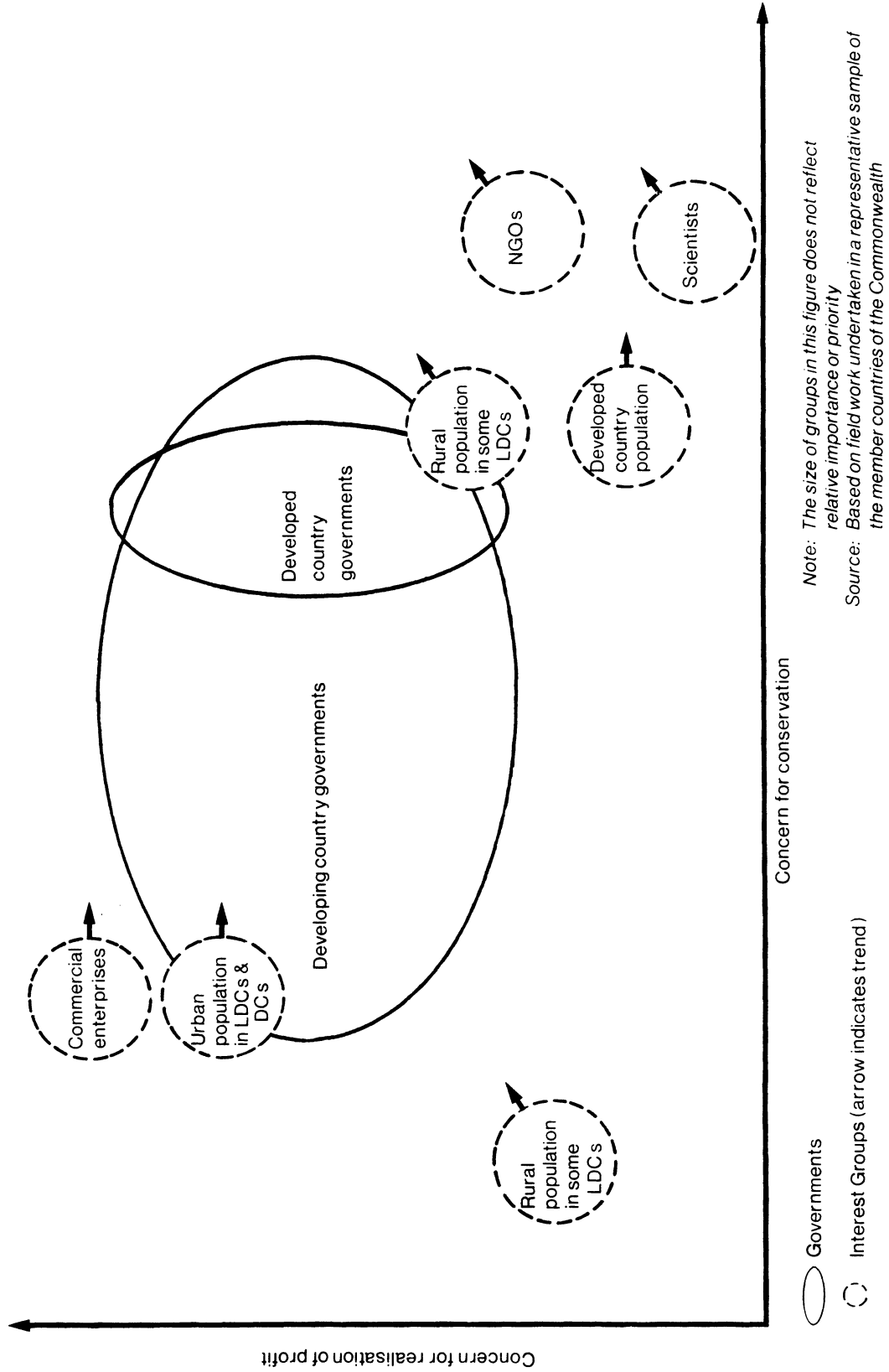


Figure 1.
A range of views on conservation of biodiversity

knowledge of the possible uses of plants and animals, which is held largely by indigenous peoples living in remote undeveloped areas, is being lost as forest habitats are destroyed relentlessly.

About a quarter of all drugs dispensed in the world, including anaesthetics, sedatives, stimulants, antitumour agents, analgesics, cardiotonics, antimalarial agents, aspirin and birth control pills, are derived from forest plants. Perhaps the best known example from Africa is Madagascar's rosy periwinkle, a small flowering plant that yields chemicals which have enhanced the chances of the successful treatment of childhood leukaemia from 1 in 5 to 4 in 5. Moreover, some of the most commonly prescribed and fundamental drugs used throughout the world are derived from less than 90 species of higher plants. Only 5,000 species have been thoroughly screened for their medicinal properties, and most of these grow in temperate climates, leaving the vast potential resources of the tropics unknown to the world.

The possible uses of genetic resources are not restricted to medicine. Plant and animal products have benefited agriculture, forestry, fisheries and industry. Advances in biotechnology, plant breeding and genetic engineering have enabled the genes of a wild species to confer new properties such as disease resistance or improved yield upon a domesticated species. But the source of wild varieties is being diminished. Diversity in genes, species and ecosystems provide the raw materials with which we can adapt to change; and the loss of each additional species reduces the option for nature and people to respond to changing conditions.

The distribution of centres of origin of species is unequal geographically due to historical factors, especially the continental drifts. Areas with richer diversity are essentially in tropics and subtropics and in the less advanced countries but are least understood due to lack of infrastructure; there is therefore need for international effort to harness biological resources for human welfare.

The World Conservation Union (IUCN)'s List of Endangered Species is growing quickly (compare the 1986 list with the 1988 list). IUCN's List of Threatened Protected Areas of the world is now twice as long as it was only four years ago (IUCN/CNPPA, 1988). A recent comprehensive review of the world's avifauna concluded that, of the globe's 9,000 bird species, over 1,000 (11%) were at some risk of extinction, up from just 290 bird species threatened in 1978. These increases are however partially due to more complete information becoming available in the past several years.

It should be noted that biological diversity constitutes an invaluable source for the discovery of natural resources. Its identification and authentication is crucial. The germplasm of this planet contains a repository of genes which can potentially be used to enhance the quality of natural products, many of which are uneconomical to synthesise. Also, a knowledge of naturally occurring diverse genetic systems will give us an insight into the mechanisms required for the synthesis and manipulation of desired genetic material which may well provide the cornerstone for solving complex environmental problems that face us today or may do so tomorrow.

Though we cannot determine whether the biological resources within one biogeographic region are potentially more valuable than those in another region, even if the number of species differs vastly between regions, equal weight would initially be given to all ecosystems, each with its own characteristic biological diversity and its own importance to the

people living in and around the ecosystem. Priorities are to be established on the basis of uniqueness, present and potential future value, and threat of extinction.

The conservation of biological wealth is not simply a traditional protection agenda, but a scientific, economic, social, political and development issue. New modes of financing, co-operation and the integration of conservation into the developmental process are required. It is not simply a problem of the tropical poor countries. While more than half of Earth's biological wealth lies in the tropics, and at least 40% of the total in the 20 countries containing significant amounts of the remaining tropical moist forests, **all** nations carry responsibilities to conserve the biodiversity within their own borders. Any scheme to establish priorities for the conservation needs of biological resources must recognise that, from a national perspective, the maintenance of local biological resources is essential to support sustainable development even if the nation's biological diversity is not particularly high from a global perspective.

In a desire to simplify the definition of biodiversity and in order to make it more acceptable to policy agencies, conservation advocates began to use biodiversity to mean simply the number of species and, occasionally, the diversity of ecosystems as well. This abbreviated definition has been used by the many national and international organisations charged with biodiversity conservation.

International and national development agencies cling to this over-simplified definition of biodiversity while the academic scientific community has been constantly refining and debating the meaning of biodiversity. Scientists have identified several critical deficiencies in the simple definition, including the lack of a spatial and temporal framework and the lack of any component of process. Feedback from the scientific community, which would allow conservation policy makers to incorporate new understanding of biodiversity, is absent.

Conservation of biological diversity and its sustainable utilisation evokes a multitude of responses depending on the perceptions of different groups of people. Figure 1 gives a comparative view of various such groups. Axis one gives the concern for conservation while axis two describes the concern for realisation of economic value. The diagram is based on subjective information collected as a result of field work undertaken in developing countries of the Commonwealth. Most of the sovereign governments are concerned about biodiversity loss for both reasons, to varying degrees: they recognise the intrinsic value of biodiversity, but are also concerned about the potential loss of commercial value from over-exploitation. As a generalisation, the developed countries are more concerned about the loss of commercial value though they want to show concerns for conservation and can afford to place greater emphasis on conservation for its own sake. It should be noted that the rural population of LDCs fall into two classes. In LDCs that are under extreme economic and political trauma the concern for conservation among the rural population is very low for they are fighting for survival, while in others where the basic needs of human existence are met the population is more concerned about maintaining their ecologically sound traditional life style. This dichotomy is also reflected in the concerns expressed by developing country governments in that the range of their views *vis-à-vis* conservation spans a much wider spectrum than that of developed countries.

Environmental pressures such as climatic change, acid rain, pollution and depletion of natural forests and wetlands that support biological diversity are causing great concern to all humans. The capacity of natural habitats to sustain their innumerable plants, animals and

micro-organisms is today being eroded. To stop this decline it is essential to have consensus on international priorities for maintaining the diversity of life forms and to provide a framework for detailed action plans at the national level. National level plans will, in turn, address priority needs for protection of critical ecosystems, related strengthening of institutional capabilities, and computerised information databases.

A fundamental issue which needs to be addressed by member countries is determining the optimal distribution of benefits from utilising biological resources. Most of today's benefits from harvesting the forests, grasslands and seas flow to the global community at large. Relatively few benefits are provided to the local people who bear the bulk of costs. For example, worldwide sales of the drug made out of the rosy periwinkle now total around US\$100 million a year, while indigenous populations of Madagascar lack money for conserving their unique flora and fauna. If biodiversity is to be conserved effectively, appropriate mechanisms will have to be developed with speed, to redress this imbalance.

The need for co-operation between the users and owners of biological resources can no longer be ignored. Concrete steps at the policy planning and operational level are needed to protect our biological resources, before irreversible damage has been done. Leading ecologists consider the loss of biological diversity as an even more urgent and immediate problem than the well known ecological disasters such as ozone depletion and the greenhouse effect, though it is less well appreciated by the world's leaders and organisations at present due to lack of information on the problem. The designers and implementers of any programme to conserve biological diversity and genetic resources also have to undertake the task of dissemination of knowledge and information on the critical issues contained in the loss of biodiversity which has begun to threaten human existence.

1.3 International Efforts to Conserve Biodiversity

The overall strategy of the United Nations system is based on concerted efforts to implement the principles propounded in the *World Conservation Strategy, Caring for the Earth: A Strategy for Sustainable Living*, the *World Charter for Nature*, the *Action Plan for Biosphere Reserves* and *From Genes to Ecosystem: A Research Agenda for Biodiversity*. These entail collaborative action between international organisations such as FAO, IBPGR, IUBS, IUCN, SCOPE, UNEP, UNESCO and WWF. The Commonwealth countries are also indirectly involved in this exercise but there is so far no effort within the Commonwealth as a whole to formally provide guidance on practical implementation of the strategies being formulated. To speed up much needed action for the conservation of the biological wealth of the member countries of the Commonwealth, there is an urgent need for Commonwealth Heads of Governments to issue a mandate for creating forthwith an implementing agency within the institutional mechanism of the Commonwealth Secretariat.

Various development agencies have tried to incorporate conservation of biological diversity into their programmes and it stands out among the four thematic concerns of the Global Environment Facility. The governments of many countries have also started declaring biodiversity conservation as one of their domestic and foreign policy objectives. All the countries except the USA have signed a global convention on biodiversity at the Earth Summit held in June 1992 at Rio.

A Global Biodiversity Strategy has been developed jointly by UNEP, IUCN and WRI, with inputs from several partner organisations including the Commonwealth Science Council (CSC). It recommends 85 actions. These actions do not yet have practical plans for implementation. Specific algorithms need to be formulated to do this. CSC's BDGR programme seeks to provide these. The Global Biodiversity Strategy has recognised the distinctive role of CSC in this regard.

1.4 A Biodiversity Convention

North-South differences have deadlocked the negotiations aiming to create binding global agreements for the conservation of biodiversity. A convention was drawn up, however questions remain over the rules governing access to genetic resources, availability of technology and appropriate financial mechanisms. It is also not clear as to how these will be affected by changes in intellectual property rights. Many countries of the South are demanding agreements and funding for the transfer of biotechnology, to compensate them for the stewardship and conservation of biodiversity. Governments of countries of the North, in contrast, oppose this, arguing that biotechnology has little role to play in the conservation of biodiversity. They place more emphasis on setting aside protected areas to ensure their continued supply of genetic resources. This form of *in situ* conservation (which could affect up to 10% of global land) would further threaten the livelihood of many farmers with small holdings. These farmers, who are in a position to implement their own *in situ* strategies for maintaining diversity on their farms, are being completely ignored by the North in the debate. The treaty on biodiversity has been signed by 170 governments with the exception of the USA at the Earth Summit. However, the details of appropriate financial and institutional mechanisms for implementing the agreement will take some time before being finalised. The text of the Convention on Biodiversity signed by Heads of Governments in Rio de Janeiro is given in Part II of this report.

1.5 Commonwealth Countries and Biodiversity

Commonwealth member countries are among the richest repositories of the biological diversity of the Earth, a substantial proportion of which in many of these countries is lying intact. It was, therefore, only natural that a pan-Commonwealth programme be launched to conserve this most valuable resource. Commonwealth concern over the maintenance of biodiversity and genetic resources and sustainable development was expressed in the 1989 Langkawi Declaration on Environment and further underlined by Heads of Commonwealth Governments in the Harare Communiqué of their summit meeting in 1991. The following chapters of this report describe the Commonwealth Science Council's BDGR programme in detail and seek to: (a) consolidate the work done to date under the aegis of this programme; and (b) indicate a direction for future action required to conserve what is perhaps our most valuable asset.

CHAPTER 2

Biological Diversity and Genetic Resources Programme

2.1 Background

The genesis of the Commonwealth Science Council's Biodiversity and Genetic Resources (BDGR) programme can be found in the project on under-exploited plant species 'the chenopods', part of the All India Co-ordinated Project on Under-exploited Plants of the Indian Council of Agricultural Research. These plants are of great importance because of their socio-economic and survival value to the fragile ecosystems of the Himalayas and the Andean mountains. The work on the *Chenopodium* species was carried out within the project on 'Population dynamics of wild and cultivated biotypes of *Chenopodium album*' undertaken at the Bio-science department of Himachal Pradesh University, Simla, India. Recognising the importance of the role these plants played in maintaining the environmental integrity, it was agreed that the project needed to be extended to include similar indigenous under-exploited plants.

A similar idea was mooted in the Kendrew report of 1984, *Science for Technology for Development*, which stated that biological diversity is crucial both for enhancing genetic resources and for the discovery of new resources. It said: "In agriculture, the productivity of major crops cannot be maintained, let alone expanded, without a constant infusion of fresh genetic variability." It further noted that "wild species offer considerable potential for entirely new foods.... In industry, plants are used across a wide spectrum, from the production of paper to thickening of dessert food, fire hoses, detergents, cosmetics, paints and varnishes, shoes, golf balls and drilling muds. The chemical industry in particular may, in the future, find phytochemicals more cost effective than petrochemicals. Scientists have only conducted a cursory screening of one plant species in ten, and an intensive screening of one in a hundred. Thus an analysis of all 250,000 plant species would reveal many new materials of benefit to mankind." The report went on to recommend: "*The Council should, therefore, urgently consider undertaking the study of biological diversity because of its pressing relevance to genetic resources for mankind.*" The report thus highlighted the need to develop a Commonwealth-wide programme on under-exploited species. The Government of New Zealand provided the catalytic support by outlining a project concept initially in 1984 for South Pacific countries for the "*study of the genetic diversity of perennial plants which are (i) poorly known, (ii) not studied by other organisations, and (iii) of potential value for the production of food, fibre, and pharmaceuticals, etc.*"

Subsequently in 1984 it was decided at the CSC's biennial meeting in Canada to take steps to launch a Biological Diversity and Genetic Resources project in the Commonwealth. A professional ecologist with practical experience of work in the conservation and use of under-exploited plant species was appointed in September 1985 to design and develop a pan-Commonwealth project in this area.

BIOLOGICAL DIVERSITY AND GENETIC RESOURCES

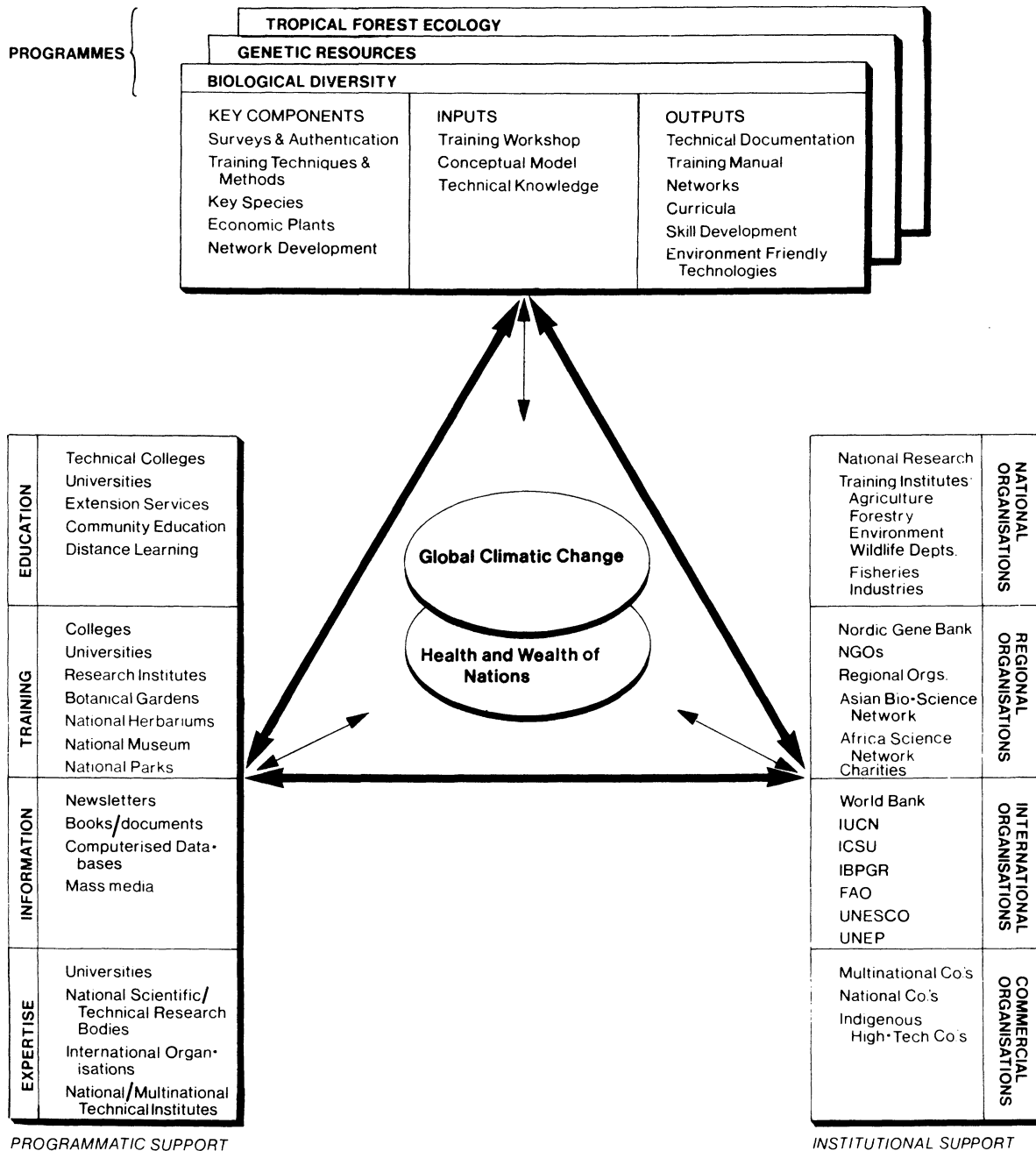


Figure 2.

Model for Conservation of Environment and Development of Biological Resources

2.2 The BDGR Project

The Commonwealth Science Council's BDGR project was designed in 1986 to help Commonwealth member countries in formulating and implementing national, regional and intra-regional strategies for conservation and rational utilisation of BDGR. This project has been accepted by the experts working in this area as providing a paradigm for better understanding of global changes occurring in the biosphere and their implication for food and livelihood security of indigenous people. It has five components: survey and authentication; techniques and methods; key species; economic plants; and development of appropriate networks for co-ordination of activities on a pan-Commonwealth basis. The programme utilises the process of multifarious interactions among different participants responsible for conserving and using our genetic resources described in detail in Section 2.3.

2.2.1 Aim of the project

Conservation of biological resources to ensure sustainable development for survival of mankind on this Earth.

2.2.2 Higher level objective

To initiate and develop national, regional and intra-regional strategies and practical action plans for the conservation and sustainable utilisation of biological diversity and genetic resources of under-exploited species.

2.2.3 Immediate objectives

- (a) Exploration and authentication of species having socio-economic value (through the survey and authentication component)
- (b) To initiate, develop and provide practical training to scientists and technicians at all levels for the study and sustainable use of biological diversity and genetic resources through inexpensive techniques and methods (through the techniques and methods component)
- (c) To identify key species of ecological and socio-economic importance. These may assume importance in the context of postulated changes in temperature, precipitation, carbon dioxide concentration, ultraviolet radiation and sea-level rise (through the key species component)
- (d) To promote and develop regional centres for the study of plants having industrial and medicinal value (through the economic plants component)
- (e) To provide information and give appropriate training to senior, middle and field level scientists and technicians (through training workshops)
- (f) Access by Commonwealth member countries to advances in molecular biology and genetic engineering (through the techniques and methods component)
- (g) To develop appropriate organisational structures and institutional mechanisms for storage, analysis and dissemination of information (through the network building component of the programme).

The programme's structural framework has been developed by taking into account:

- (a) Current status of species diversity in the plant kingdom and their extinction
- (b) Current status of techniques available for the study of biodiversity and genetic resources
- (c) Use and conservation of the diversity of plant species in member countries of the Commonwealth
- (d) Neglect of indigenous economic species due to preoccupation with a handful of food crops
- (e) Training needs for indigenous human resource development for facilitating rational utilisation and conservation of the local germplasm
- (f) Existing national conservation strategies.

2.3 Model for the BDGR Project as it has been Implemented

2.3.1 Structure

The project is based on the pillars of 'programmatic' and 'institutional' support which provide the foundation for the thematic programmes that evolved over time and were developed to meet the emerging priorities of the member states based on their scientific and technical needs. This is diagrammatically depicted in Figure 2. The model is interactive and its key components and processes take into account vital issues of importance, e.g. global climate change and the ability of nations to cope with it.

2.3.2 Thematic programmes

There are three thematic programmes with overlapping components within the project:

- (a) **Biodiversity** – The aim of this programme is to initiate and develop national, regional and intra-regional strategies and action plans for the conservation and rational utilisation of biodiversity
- (b) **Genetic Resources** – The aim of this programme is to assist member countries to assess and survey the indigenous genetic resources and to meet their needs for building human resource capability and capacity for the conservation and use of key plant genetic resources
- (c) **Tropical Forest Ecology** – The specific aim of this programme is to determine ways and means of reducing the undesirable consequences of forest exploitation and development through training and sound economic planning in terms of timber supplies, species diversity, watershed management, preservation of ethnocultural diversity, etc., through sound ecological principles.

2.3.3 Components

The thematic programmes have the following five key components:

- (a) Survey and authentication of species of socio-economic value
- (b) Training and development of techniques and methods
- (c) Identification of key species for conservation and development
- (d) Economic plants, especially medicinal plants, and industrial species which have potential in the pharmaceutical industry
- (e) Establishment of regional and national networks of scientists and technicians.

Necessary indigenous and external inputs have been provided into the programme through:

- (a) Training workshops
- (b) Refinement of the conceptual model
- (c) Designing of appropriate programmes at regional and national levels suitable to the prevailing ecological conditions.

A number of project proposals and action plans were prepared based on exhaustive guidelines prepared in 1986 at the time of refinement of the project design. The BDGR project is interchangeably also known as the Biodiversity and Genetic Resources Programme. Each country has its own priority within the BDGR programme.

The outputs derived from the processes of the BDGR programme comprise:

- (a) Preparation of technical documentation including training manuals
- (b) Establishment of appropriate networks
- (c) Development of curricula and courses
- (d) Institutional and individual capacity building
- (e) Determination of environment friendly approaches for economic development.

The two pillars of the model are 'Programmatic support' and 'Institutional support'.

Programmatic support

This support to the thematic programmes is given in the following four areas:

- (a) Education – involves technical colleges, universities, extension services, community education and distance learning
- (b) Training – involves training of senior, middle and field level scientists and technicians working at the colleges, universities, research institutes, botanical gardens, national herbarium, national museum and national parks
- (c) Information – involves communication through newsletters, publication of books, documents, reports, computerised databases and mass media

- (d) Expertise – required for undertaking work in the programmes, is taken from the local national universities, national scientific/technical research bodies, international research institutes and organisations, national and multinational technical institutes.

Institutional support

This is provided through the following four sources:

- (a) **National organisations** – These are the national research and training institutes of agriculture, forestry, environment, wildlife, fisheries and industry
- (b) **Regional organisations** – These are the regional networks and organisations, both governmental and non-governmental. Examples are: the Southern African regional gene bank, Nordic gene bank, the African science network and the Asian bioscience network
- (c) **International organisations** – These are organisations that are actively working for the conservation and sustainable development of genetic resources especially in the tropical ecosystems and regions rich with biodiversity, e.g. the United Nations Environment Programme, United Nations Educational, Scientific and Cultural Organisation, Food and Agriculture Organisation, International Board for Plant Genetic Resources, International Council of Scientific Unions, World Bank, International Union for the Conservation of Nature and Natural Resources
- (d) **Commercial organisations** – These comprise the multinational and national high-tech companies using biotechnology and needing genetic resources as a key raw material.

2.3.4 Processes

The following four processes are an integral part of the BDGR programme:

- (a) **Interactive dialogue** between various scientists, institutions, funding agencies and people providing grassroots support who are critical for implementing the programme
- (b) **Adaptive transfer of technology** so that the relevant scientific and technical know-how is adopted by indigenous national groups for further diffusion and use throughout member countries of the Commonwealth. This entailed setting up of national and regional networks
- (c) **Negotiations** with various agencies involved in funding specific activities of the programme
- (d) **Field work at national level** to obtain feedback from technicians and field level scientists for modifying the programme if necessary and for building an inventory of indigenous biological resources and scientific and technical skills.

To initiate the various processes of the project CSC prepared a background paper on Biological Diversity for Human Welfare. This paper provided the background for the CSC activities under this programme. The processes entailed in the overall programme were meant to be used appropriately by the national co-ordinators.

2.4 National Co-ordinators

The national co-ordinators were appointed by the CSC members and were identified to make the programme self sustaining. Their roles are as given below:

- (a) act as contact for the country's BDGR project for CSC
- (b) identify national teams of experts which would work in the project
- (c) set up a national committee of scientists and institutions for each project component which would assist in developing and implementing the national project on BDGR
- (d) meet members of national committee at regular intervals to review the progress of the project and identify priority areas for action
- (e) interact and establish collaboration with national organisations and donor agencies who would provide financial and technical assistance
- (f) interact with planners and policy makers to enable them to incorporate various components of the project into the national development plans
- (g) prepare national reports on the status of the project and send it to CSC's Project Officer and Regional Co-ordinator
- (h) hold national and regional workshops, seminars and training programmes on the project activities
- (i) nominate relevant individuals, scientists, etc., to attend international, regional and national conferences, workshops, etc., related to the BDGR project activities.

2.5 Regional Co-ordinators

The regional co-ordinators were identified during the Kew workshop in 1986 and were entrusted with the following responsibilities:

- (a) to keep active contact with national co-ordinators in the region regarding progress of work on the project
- (b) to hold agreed regional activities jointly with other regional bodies and organisations. These are approved and prioritised by the national co-ordinators
- (c) to assist and facilitate in establishing formal collaborations with international and regional agencies for providing financial and technical assistance.

2.6 Development of the BDGR Project

The studies carried out on the *Chenopodium* species between 1975-1985 sought to understand the complexity of: (1) species variability undertaken at intra- and inter-species level in diverse ecological conditions; (2) species distribution and abundance on a temporal and spatial scale; (3) species interactions at intra- and inter-species level; (4) ethnobotanical aspects; (5) processes of evolution affecting the species' domestication; and (6) floral biology and seed polymorphism.

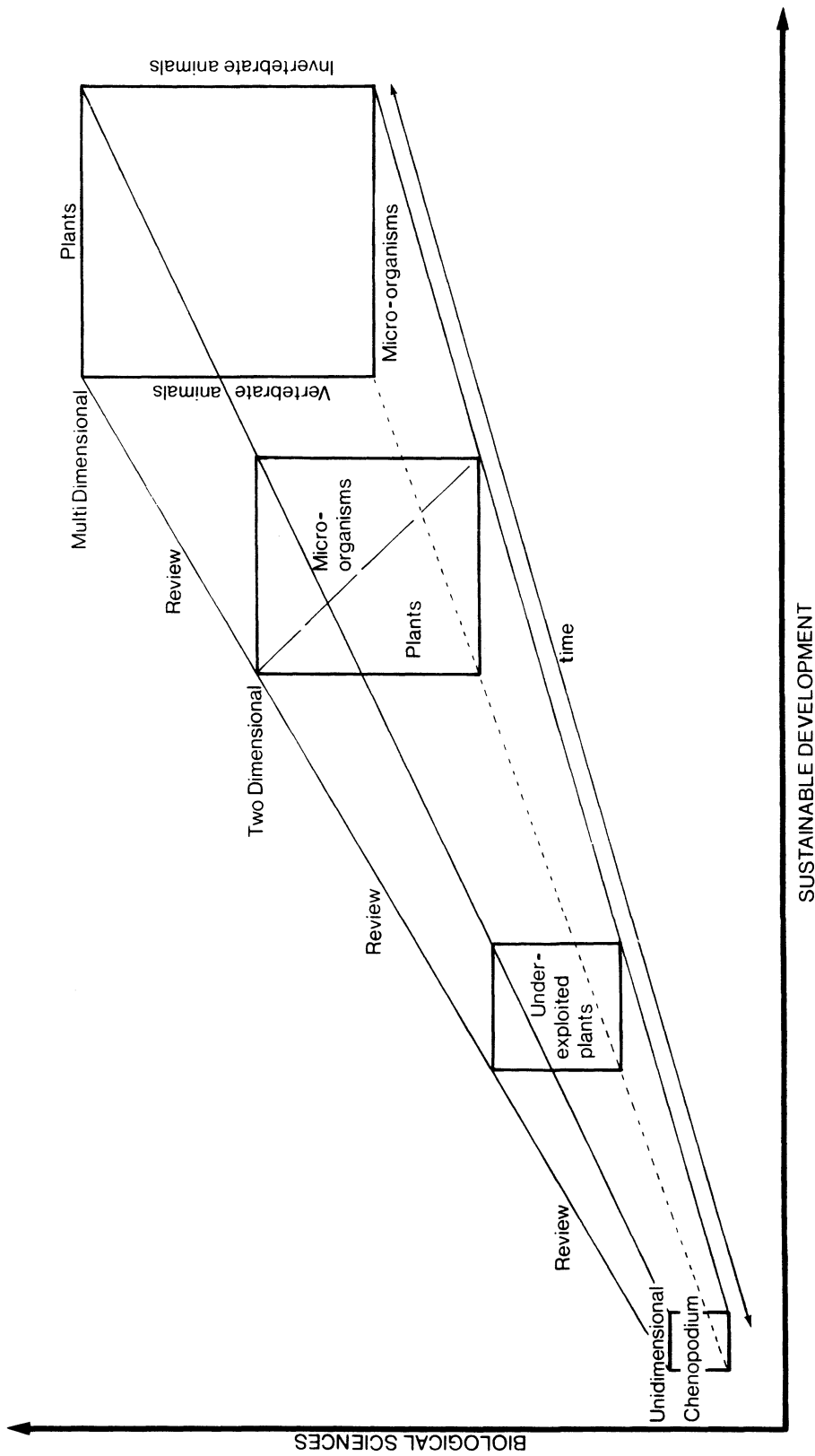


Figure 3.
Evolution of the BDGR Programme over time
 Contribution of Bio-resources to sustainable development

The timely launching of the BDGR project by the CSC in 1986 allowed the use of earlier experience gained through the research and field work done on the *Chenopodium* species (chenopods) and provided a sound scientific basis for developing the CSC project. The components and activities of the project were based on a background paper prepared in 1985 which identified: (i) germplasm collection and authentication; (ii) evaluation of plants for economic value; (iii) conservation of genetic material; and (iv) bio-engineering, as key activities that needed to be undertaken under this project (Table 1). In addition the paper suggested that appropriate institutions be developed at the national and regional levels to cater to the research, service and educational needs required by member countries when undertaking these activities. The role institutions (existing or new ones to be created to meet the needs) are expected to play in this process are shown in Table 1.

The development of the BDGR project from its original unidimensional beginning to its projected multi-dimensional structure is depicted in Figure 3. In this figure the vertical axis gives the degrees to which specialisations within the biological sciences are applied to the study and use of biodiversity while the horizontal axis indicates the degree of sustainable development. The diagram thus shows that as inputs from biological sciences increase into the system being used for understanding and using biodiversity the related development becomes more sustainable.

The evolution of the BDGR project over time is depicted in this diagram. In stage I the project had a very narrow focus on only one under-exploited plant (Chenopods) and the studies conducted on it were primarily concerned with ethnobotanical, population biology and agroecological aspects. In stage II work expanded and attention was given to all "under-exploited plants in the Commonwealth member countries". This widening of the scope was based on the scientific review given by Sir John Kendrew and his expert group in 1984. The fully fledged CSC programme on BDGR was subsequently launched in 1986 using the inputs provided by: (i) Project Concept as given by the Government of New Zealand; (ii) CSC's own research during 1985-86; and (iii) the recommendations of the International workshop on Biological Diversity and Genetic Resources held in Kew, Britain, in 1986. All these helped to identify the scientific disciplines which needed to be used in the project. These disciplines spanned all the key components of the BDGR programme. With the passage of time the BDGR project developed to its current state and the need was felt to expand it to include animals and micro-organisms. This led to stage III of the project which was ratified at a review meeting held in London in 1990 as the biological systems in the widest sense of the definition have a bearing on sustainable development. The various evolutionary stages of the BDGR programme were reviewed and approved by the members of the CSC in their biennial meetings held in 1986, 1988 and 1990. Future work on the BDGR programme will rely heavily on applying the appropriate scientific disciplines to the key components of the project.

As suggested in the Kendrew Report, the project was developed in two phases. In phase I, the objective of the CSC programme was to initiate activities on under-exploited plants, especially multi-purpose species, which are useful as food, fodder, fuel, timber, medicines, biochemicals, and for soil amelioration.

The focus was on (1) identification and evaluation, (2) development, (3) harnessing/exploitation, (4) improvement, manipulation, (5) conservation and maintenance, both *in situ* and *ex situ*.

ACTIVITIES	SCIENTIFIC TECHNIQUES	INSTITUTIONS		
		RESEARCH	SERVICE	EDUCATIONAL
I Germplasm collection & authentication	Curating	M	M	m
	Herbarium	m	M	M
	Museum	m	M	M
	Culture collection	M	m	M
	Computer-aided design*	M	m	m
Inventory banks of bio-resources*		m	M	m
	Advanced technology/laser technology*	M	M	m
II Evaluation for economic application	Autoecology	M	m	M
	'r' properties of growth	M	M	M
	'k' properties of growth agro-ecological	m	M	M
III Conservation of genetic material	Field	m	M	M
	Laboratory – seed banks <i>in vitro</i>	m	M	m
	national protected areas * gardens, zoos, safari parks	m	M	m
IV Bio-engineering	Macro	m	M	m
	Micro	M	M	m
	traditional farming resource system	m	M	m
	modern farming resource system	M	M	m
* involves international support	micropropagation	M	m	M
	meristem-cultivation	M	m	M
	gene fusion techniques/manipulation*	M	m	M
	cryopreservation*	M	M	m

Table 1.
Research, science and educational role of institutions in different activities for the collection, evaluation, conservation and utilisation of Biological Diversity

Preference was given to plants of the following groups: (1) legumes, (2) Palmae, (3) root crops, (4) grain crops, (5) tree species.

Specifically, the project sought to:

- (a) improve nutrition and health
- (b) ensure fuelwood supply
- (c) ensure preservation of knowledge and the use of plants in traditional food and health care
- (d) incorporate the findings of the project into agricultural diversification
- (e) ensure sustained utilisation of environmental resources on a renewable basis.

In phase II, a theoretical review was added to study the importance of biodiversity of invertebrates and micro-organisms as recommended by the Kendrew Report.

The interlinked key components of the thematic programmes of tropical forest ecology, genetic resources and biodiversity remained the same. The strength of the project continues to grow with the support of, and links with, the programmatic and institutional programmes. In phase III it is envisaged that the project will evolve further, and the work will expand to include plants of other taxonomic groups, animals, both vertebrates and invertebrates, and micro-organisms. Practical work remains to be done in phase II. This will involve multifarious interactive dialogue between various scientists, institutions, fund agencies and grassroots support people who would undertake actual implementation of the programme (see Table 2).

2.7 Key Activities of the Programme

The following key activities have been instrumental in implementing the processes of the programme:

- (a) Workshops
- (b) Preparation of country reports
- (c) Training courses and technical documentation
- (d) Development of network with appropriate nodal points
- (e) Project Proposals.

2.7.1 Workshops

To ensure proper involvement in the BDGR programme of appropriate scientists and technicians in member countries, 21 workshops, seminars and review symposiums and four courses were held during the period 1985-1992. A listing of these is given below.

Full recommendations of the key workshops are given in Part II of this report.

	Intergovernmental Agencies (1)	Individual Scientists (2)	Technicians (3)	Institutions (4)	Governments (5)
Intergovernmental Agencies (1)	PX	PX	X	PX	X
Individual Scientists (2)	PX	MX	MX	MX	X
Technicians (3)	X	X	MX	MX	X
Institutions (4)	PX	MX	X	X	MX
Governments (5)	PX	PX	X	MX	PX

MX Major Interaction
 PX Potential Future Interaction
 X Minor Interaction

Table 2.
Multifarious Interactions within the BDGR Programme

(a) Medicinal and Aromatic Plants of the West Indies, St Christopher & Nevis, West Indies, 1985

This workshop was held in St Christopher & Nevis, West Indies, to develop strategies and an action programme for utilisation of the natural diversity of plant species for human welfare, by harnessing plants of medicinal and economic value.

(b) International Workshop on Micropropagation and Meristem Culture, Kuala Lumpur, Malaysia, 1986

This workshop and symposium was organised to help promote capability in the currently available micropropagation and meristem culture techniques in the Asia-Pacific region. The workshop's objective was to evaluate the application of tissue culture techniques for scientific research and commercial purposes.

(c) International Workshop on Biological Diversity and Genetic Resources of Under-exploited Plants, London, Britain, 1986

The aim of the workshop was to discuss and develop action plans for survey, documentation, evaluation, cultivation, utilisation and conservation of biodiversity and genetic resources of under-exploited plants. A Commonwealth-wide project was finalised using selected species of importance which support national economies in the areas of agriculture, forestry and industry. Specific discussions for developing training programmes on conservation biology, herbarium techniques, ethnobotany and tissue culture were held. The workshop laid the foundation of the current BDGR programme of the CSC.

(d) Pharmacognostic Authentication and Standardisation of Crude Drugs, Colombo, Sri Lanka, 1986

The aim of the workshop was to agree guidelines for preparing technical manuals for: (1) pharmacognostic aspects; (2) botanical aspects; and (3) phytochemical aspects of drugs extracted from medicinal plants.

(e) International Workshop on Maintenance and Evaluation of Life Support Species, New Delhi, India, 1987

In this workshop guidelines and methodologies were developed for preparing inventories of life support species under different stress conditions. Recommendations for the evaluation of such species and their use in agriculture, forestry, fisheries, etc., were given.

(f) Regional Workshop on Conservation Biology in SADCC member countries, Lusaka, Zambia, 1987

The main aim of the workshop was to develop training programmes and training materials for conservation biology. At this workshop the framework of a general course in conservation biology was developed for use by senior scientists.

(g) International Workshop on Ethnobotany held in Christchurch, New Zealand, 1988

This workshop was organised to develop a training programme in Ethnobotany. Sixteen specific recommendations emerged from it. The need to regard the local

people as key experts for imparting knowledge on indigenous species in their region was highlighted. It was agreed that a process which respects the rights and the culture of these people was required to ensure that their knowledge is not lost. It was also determined that studies on traditional uses of plant species in the islands of the Pacific region should be undertaken.

(h) Regional Training Workshop on Conservation Biology for Humid Tropics, Peradeniya, Sri Lanka, 1988

This workshop was organised to develop a specific curriculum in conservation biology for humid tropics to supplement the earlier general course developed in the Zambia Workshop held in 1987.

(i) Regional Workshop on Tropical Forest Ecology and Management for Pacific Island Nations, Lae, Papua New Guinea, 1988

This workshop was jointly organised with UNESCO in Papua New Guinea to develop a Tropical Forest Action Plan for integrated research, education and training. It covered all the key aspects of tropical forest management in the Pacific Island region with emphasis on both traditional and commercial utilisation of forests in a sustainable manner.

(j) Training Workshop on Standardised Methodology and Guidelines on Pharmacognostic and Botanical aspects of Medicinal Plants for use as Drugs in Industry, Georgetown, Guyana, June 1988

This workshop was held in Georgetown, Guyana, to provide training in the pharmacognostic aspects of medicinal plants. It was a follow-up to the workshop held in Sri Lanka in 1987. Plants which are useful or have potential use in providing cures for (a) malaria, (b) hypertension and (c) diabetes were considered. A project was developed with a view to develop (1) ethnobotanical, (2) pharmacological and (3) phytochemical screening of indigenous plants having medicinal properties and used as such by traditional healers. These plants can be used in the pharmaceutical industry if a systematic approach is developed and applied for their identification and screening.

(k) Identification of Key Species for Conservation and Socio-economic Development, Port of Spain, Trinidad and Tobago, 1989

The above workshop was jointly organised with IUCN. It examined and developed guidelines and methodologies for: (1) systematic analysis of 'key' species which have a controlling influence on biotic communities, (2) identification and development of priority action on species which have life support value for rural people, and (3) developing co-ordinated research programmes on theoretical/predictive, experimental and socio-economic aspects of key species.

(l) Workshop on Standardisation Methodologies for Survey and Documentation of Locally used Plant Genetic Resources, Ibadan, Nigeria, 1989

The aim of this workshop was to identify training needs and to develop project proposals for the survey, documentation and evaluation of locally used plant genetic resources.

(m) Regional Training Workshop on Conservation Biology for SADCC member countries, Lusaka, Zambia, 1989

At this workshop the draft edition of the general training manual on conservation biology was reviewed. Guidelines and additional curricula for regional training courses for field extension workers were prepared.

(n) Tropical Forest Ecology and Management in Asia-Pacific, Lae, Papua New Guinea, 1989

The above training workshop, organised jointly with UNESCO, covered the fundamental issues for the implementation of sustainable management of tropical forests. These are: (a) the philosophy of sustainable management, (b) research requirements for developing Sustainable Yield Management Systems (SYMS), (c) planning and logging using SYMS, (d) preparation of forest inventories, and (e) contribution of appropriate forestry management to rural development.

(o) International Workshop on Ecological Foundation for Sustainable Agriculture: Biological Diversity of Invertebrates and Micro-organisms, London, Britain, 1990

This workshop was jointly organised with CABI, CASAFA, ICSU and TWAS. It reviewed the status of biodiversity among invertebrates and micro-organisms, and assessed how agricultural and other changes were affecting it at present and how they may affect it in future. It made recommendations about action that needs to be taken by scientists and governments to improve knowledge in this area and to determine future action.

(p) International Workshop on Biological Diversity: Conserving germplasm, Botanic Gardens, London, Britain, 1990

This workshop was organised jointly with the Botanic Gardens Conservation Secretariat of the IUCN. It reviewed the ways in which the world's botanic gardens can co-operate effectively in the assessment and conservation of germplasm (genetic resources) of wild plant species and crop relatives. The workshop addressed the specific role of botanic gardens in global germplasm conservation strategy with particular reference to those wild plant species that at present are not covered by the existing agricultural genetic resources networks.

(q) Workshop on Conservation through *in vitro* methods, Kuala Lumpur, Malaysia, 1990

This workshop was planned to formulate strategies for the conservation of biodiversity and plant genetic resources in the Asia-Pacific region through *in vitro* methods. It also sought to review and standardise protocols for genetic conservation through tissue culture techniques, molecular biology, germplasm exchange, and to develop course material for future training in this area.

(r) Workshop on the Biodiversity of Traditional and Under-utilised Plants, Malta, 1991

This workshop was held to select under-utilised crops that have promising economic, industrial, nutritional and environmental uses.

(s) International Conference on Bioresources Diversity, Ethnobiology Development and Sustainability, Hawkesbury, Australia, 1991

This conference examined traditional usage patterns of biological resources, sustainability of such uses and their development. It examined *inter alia* use of such resources in the aboriginal context. The topics covered were: bioresources diversity for good health, clothing, shelter, and technology available for sustainable use of these resources and ethnobotany.

(t) Workshop on Tropical Forest Ecology: Methods of Research in Social Sciences Research on Non-Timber Products in Asia, Bangkok, Thailand, May 1992

This workshop was held to initiate studies among researchers in Asia to undertake long-term social science and natural sciences research in tropical forest management and to develop a network of such scientists to work in a long-term research project. It was jointly developed with Harvard Institute of International Development and UNESCO. The workshop's follow-up will help other Commonwealth member countries including 'The Iwokrama Rain Forest Programme' of the Commonwealth and the Government of Guyana.

(u) Planning meeting of the CSC BDGR network, London, Britain, June 1992

The objective of this meeting was to prepare an agenda and give recommendations for the second International Workshop on the BDGR project to be held for expanding the scope of this project. It also helped in determining new initiatives, approaches, and action plans for the 1990s for studying the interactive relationship between climate change and biological diversity in the current socio-economic context of sustainable development.

2.7.2 Preparation of Country Reports

The National Co-ordinators were requested to prepare National Status reports based on guidelines (given in Part II) provided to them by the CSC. The country report encapsulates the work done in a country under the BDGR project on its components. These reports will assist in developing a database on: (i) survey and documentation of potentially valuable plants, (ii) evaluation of growth characterisation of target species, (iii) diversity of genetic expressions of target species, (iv) training, (v) propagation and cultivation of plant material, (vi) network of contacts, and (vii) demonstration and transfer of knowledge in this area.

Eight countries have prepared detailed country reports on the status of work done on some elements of the BDGR programme according to guidelines developed by the CSC. They are Sri Lanka, Jamaica, India, Kenya, Tanzania, Papua New Guinea, New Zealand and Australia. In addition, the following seven countries have prepared reports on 'key species of ecological and socio-economic importance' on the basis of guidelines developed jointly by the Commonwealth Science Council and World Conservation Union (IUCN): Bangladesh, Grenada, New Zealand, Nigeria, Tanzania, Trinidad & Tobago, and Zambia.

2.7.3 Training Courses and Technical Documentation

(a) Training Courses

To promote, develop and provide hands-on training to scientists and technicians for the study and use of BDGR through inexpensive techniques and methods, the following two courses were designed and launched:

(i) *International Diploma Course in Herbarium Techniques, Royal Botanic Gardens, Kew*

The Commonwealth Science Council (CSC) has been involved in promoting the techniques and methods in the study, use and conservation of biodiversity of plant genetic resources since 1986 and has been closely involved with the training in 'Herbarium Development and Management'.

The aim of the herbarium techniques course is to give the students proficiency skills and to gain an understanding of the principles of herbarium management.

At present the course is held every year for 8-12 weeks at the Kew Herbarium in the Royal Botanic Gardens, Kew, Britain. It covers the following areas:

- Taxonomy
- Development, purpose and types of herbaria
- Herbarium building and specimen storage
- Pests and treatments
- Materials
- Label design and production

The course has two components, one formal and the other optional. The formal (and major) part of the course is concentrated in the first six weeks with practical assignments and options occurring in the last fortnight.

The formal component includes the following lectures and demonstrations:

- Herbarium management, routine and materials
- Plant collecting, preservation and related subjects
- Plant morphology, identification and curation of collections
- General interest subjects

(ii) *Training Course on Conservation Biology*

A training course in Conservation Biology has been developed for senior scientists. The subjects covered are:

Public Policy in Relation to Biological Conservation

- Global biodiversity strategy
- Status of national conservation strategy development

- Harmonising sustainable development with conservation of wild lands
- International legislation supporting conservation of biological diversity

Inventory of Species

- Choice of species
- Criteria for choice of species for conservation; woody plants
- Criteria for selection of conservation areas for preserving forest genetic resources
- Quantitative aspects of the collection and analysis of inventory data

Biosystematics

- Taxonomy, biosystematics and conservation
- Roles and limits of local herbaria in conservation biology
- Training in herbarium development and management

Life Cycles and Population Dynamics

- Plant population and the management of viable plant populations
- Seeds in natural population; their significance for plant conservation
- Plant–animal interactions

Breeding System of Plants

- Sexual systems, pollination mechanisms and genetic diversity in tropical forest plants

Physiology of Plants

- Physiological aspects of *ex situ* seed conservation
- Physiological consideration in conservation with special reference to propagation and growth assessment
- Biologically active natural products of plant origin

Population Maintenance and Monitoring

- The significance of competition in the maintenance and evaluation of plant accession

- Management of plant population and problems of erosion in genetic diversity
- Biological cropping systems and genetic conservation
- Biological techniques in germplasm conservation

Documentation and Data Handling

(b) Technical Documentation

The following technical documentation has been prepared for use by scientists and technicians:

- (i) Training manual on conservation biology
- (ii) Herbarium handbook
- (iii) Training manuals on the investigation of traditional medicine for use in industry:
(a) botanical aspects, (b) pharmacological aspects
- (iv) Training manual on ethnobotany
- (v) A guidebook to the medicinal plants of coastal Guyana
- (vi) Tissue culture directory for the Asia-Pacific region
- (vii) Commonwealth–Government of Guyana programme for sustainable development

Brief descriptions of these documents are given below:

(i) *Training Manual on Conservation Biology*

There are two manuals in this area:

Core manual of techniques used in conservation biology

A training manual on conservation biology was prepared for senior scientists. It covers the following subjects:

- Public Policy for biological conservation
- Inventory of species
- Biosystematics
- Breeding systems
- Life cycles and population dynamics
- Population and maintenance
- Documentation and data handling

International experts working in the areas of conservation, evaluation and study of biological diversity and genetic resources have contributed to the manual and 26 chapters within the above framework have been written.

A training manual for humid tropics

This manual is currently under preparation. It covers the following subjects:

- Biological diversity and conservation
- Target habitats and species
- Life cycles, population dynamics and breeding systems
- Population variability, maintenance and use
- Data handling and documentation curriculum and references

(ii) *Herbarium Handbook*

This book covers the following areas taught in the International Diploma Course in Herbarium Techniques and Management at the Royal Botanic Gardens, Kew, Britain:

- Taxonomy
- Development, purpose and types of herbaria
- The herbarium building, collection and materials
- Herbarium techniques and management
- Additional techniques
- Collecting
- The herbarium in a wider context

The book has been written by the Royal Botanic Gardens, Kew.

(iii) *Training Manuals for the Investigation of Traditional Herbal Medicines for Use by Scientists and Technicians*

Two manuals have been written based on the guidelines developed at a CSC workshop held in 1988 in Guyana to identify standardised methodologies for the use of medicinal plants in the pharmaceutical industry. The first manual deals with the botanical aspects while the second one focuses on the pharmacological aspects. These manuals give standardised methodologies of available investigative procedures which can be used to establish the therapeutic rationale of traditional medicines and help in the identification and use of medicinal plants.

Manual on the botanical aspects

This manual concentrates on the collection and recording of field data in areas

where research facilities may be poor. The investigator is encouraged to have an enquiring mind and to use his knowledge to establish links between the traditional doctor working within the indigenous and modern environment.

The manual has four chapters which describe:

- Development of botanical knowledge of medicinal plants
- Classification and nomenclature
- Plant structure as the basis of classification
- Collection of data on the plants and their uses

Emphasis is given on the training of field investigators, sampling, and collaboration with herbalists.

It also has two appendices which cover:

- Description of important families of flowering plants and give a key for their identification
- Model pro forma data sheets for undertaking surveys of medicinal plants
- Specific ethnobotanical literature
- Selected references on collecting techniques

Manual on pharmacological aspects

This manual gives emphasis to therapeutic values of the constituents of medicinal plants and the way traditional medicines are used in African and Caribbean medicine. There are six chapters: (i) general introduction, (ii) use of ethnomedicine, (iii) use of botanical information, (iv) phytochemical screening, (v) pharmacological screening, and (vi) integrative evaluation. In addition, a list is given of equipment which may be procured for research and development of traditional medicines.

(iv) *Training Manual on Techniques and Methods of Ethnobotany*

The subject areas covered in this manual are as given below:

- The nature and the purpose of ethnobotany
- Approaches to ethnobotany
- Biodiversity
- Maintaining biodiversity *in situ*
- Maintaining biodiversity *ex situ*
- Initiating ethnobotanical study
- Field studies
- Information source and use

- Evaluation
- Communicating ethnobotany
- Training and Advocacy
- Key species: indigenous resources
- Project examples

(v) ***A Guide to the Medicinal Plants of Coastal Guyana***

This publication gives descriptions and illustrations of plants used for healing in one of the Caribbean countries of the Commonwealth. The plants described in this book cover species of: (i) the coastal regions and the banks of great rivers; and (ii) the huge reserves of forests which cover 16.29 million hectares of interior Guyana. The text of this book has entries for 173 native and naturalised Guyanese plants as well as some cultivated species. Of these, line drawings have been given for 148 plants. Each entry relating to a plant has information pertaining to its botanical description, habitat and distribution. Medicinal and bio-dynamic uses of the plants have also been given.

(vi) ***Tissue Culture Directory for the Asia-Pacific Region***

This gives a list of institutions in the region where work is undertaken in different aspects of tissue culture together with a directory of experts working in those areas.

(vii) ***Commonwealth–Government of Guyana Programme for Sustainable Tropical Forestry***

This report is a result of President Hoyte of Guyana's magnanimous and imaginative offer to set aside a part of Guyana's Amazonian forest for use under the Commonwealth auspices to demonstrate methods of sustainable management of tropical forests and for conserving biological diversity for the benefit of the whole international community. The Commonwealth Secretary-General assembled a distinguished multi-disciplinary Commonwealth expert group to carry out the first phase of preparing a project proposal. The project officer in charge of the BDGR project of the CSC was appointed as member secretary.

The recommendations given in the report are concerned with ensuring conservation directly and indirectly through sustainable economic exploitation including use for recreational and educational purposes. The report proposed the establishment in Guyana of the Guyana Programme for Sustainable Tropical Forestry, which would:

- Establish and maintain a wilderness preserve at the project site
- Maintain and manage a part of the project site for yielding economic benefits to the people of Guyana

- Organise an International Centre for Research and Training for the sustainable management of tropical rainforests
- Promote environmental literacy.

2.7.4 Development of a Network of Scientists with Appropriate Nodal Points

As indicated in the conceptual model given in Chapter 2, building of capabilities at all levels is an integral part of the BDGR programme. To help achieve this, it was decided to set up a network of co-ordinators, which is given in Part II (Section III) of this report.

Member countries have appointed a national co-ordinator who works with his national committee on BDGR. The priority project areas for each country are decided by the national committee. These subject areas are given in detail in Chapter 2. The CSC network has seven regional networks:

- West Africa
- East Africa
- Southern Africa
- Asia and the Mediterranean
- South-East Asia
- Pacific
- Caribbean, Canada and Britain

A regional co-ordinator is appointed for each region. He is responsible for regional activities. The functions of the national and regional co-ordinators were agreed at various workshops and have been described earlier.

2.7.5 Project Proposals

Detailed project proposals were developed for:

- (i) Biological Diversity and Genetic Resources of Under-exploited Plants
- (ii) Tropical Forest Ecology
- (iii) Medicinal Plants

These have been developed during international and regional workshops in the related subjects by participating scientists. The objectives were to: (i) prioritise areas that needed urgent action at national and regional levels; and (ii) have ready access to a dossier of implementable projects that could be used by the donor community. Draft project proposals are available in a separate document.

CHAPTER 3

Results of the BDGR Project

The programme has undertaken a number of activities that have achieved the following results (Figure 4):

A. Indigenous Capacity Building (training, workshops, network development, document preparation)

- More than 1,100 professional scientists and technicians have been given training in the following six areas:
 - Conservation biology
 - Germplasm collection
 - Tissue culture
 - Ethnobotany
 - Herbarium techniques
 - Database and documentation

- Four global networks established for:
 - Biodiversity and genetic resources
 - Conservation biology
 - Tropical forest ecology
 - Key species

- Regional networks established for the following subject areas within the three themes and their components:
 - Tissue culture – Asia-Pacific
 - Life support species – Asia-Pacific
 - Medicinal plants – Africa, Caribbean, Asia-Pacific
 - Ethnobotany – Pacific
 - Conservation biology – Africa, Asia-Pacific
 - Herbarium techniques – Pan-Commonwealth countries
 - Documentation and databases – Africa
 - Tropical forest ecology – South Pacific and Asia

- 17 training workshops and courses were held between 1986-1992 on the following subjects:
 - 2 workshops on Tissue Culture for the Asia-Pacific (Malaysia)

- 4 diploma courses on Herbarium Techniques for the Commonwealth (Britain)
 - 3 workshops on Conservation Biology for Africa and Asia (Zambia, Sri Lanka)
 - 1 workshop on Ethnobotany for the Commonwealth (New Zealand)
 - 1 workshop on Documentation and Databases (Nigeria)
 - 3 workshops on Tropical Forest Ecology and Management (Papua New Guinea and Thailand)
 - 3 workshops on Pharmacognostic Authentication and Standardisation of Crude Drugs (Guyana, St Lucia and Sri Lanka)
 - Four International workshops/symposia and review conferences were held on various components of the BDGR project
- Country Reports Prepared
 - Seven countries have prepared detailed country reports on work done on some elements of the BDGR programme
 - Seven countries have prepared reports on key species of ecological and socio-economic importance
 - Project Proposals
 - Thirty-two specific project proposals were developed

B. Programme Development

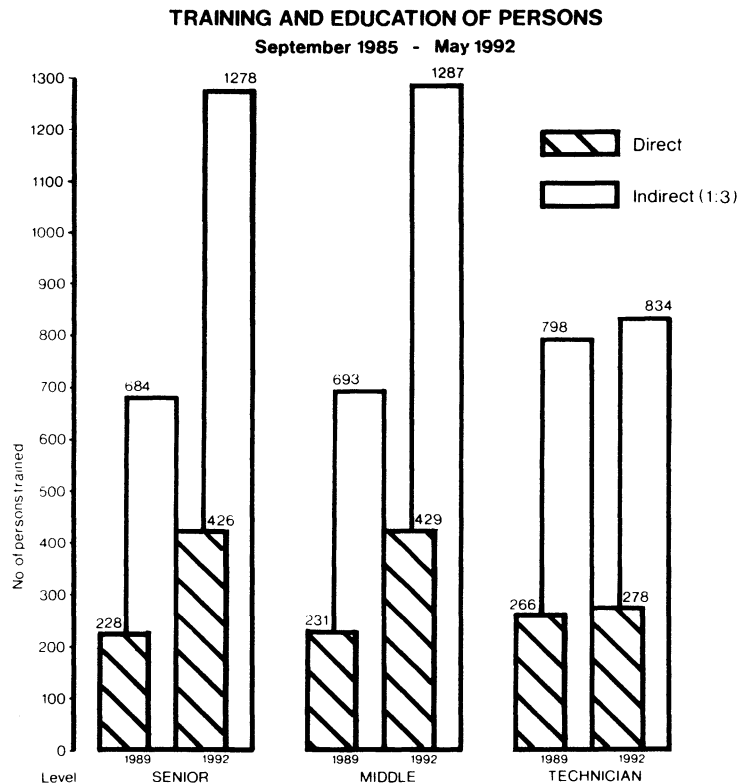
- Commonwealth–Government of Guyana Programme on Sustainable Tropical Forestry

C. International collaboration/co-operation initiated – with eleven organisations:

- CABI Commonwealth Agricultural Bureaux International
- IBRD World Bank
- UNESCO United Nations Education, Scientific and Cultural Organisation
- IUCN World Conservation Union
- ICSU International Council of Scientific Unions
- IBPGR International Board for Plant Genetic Resources
- UNEP United Nations Environment Programme
- FAO Food and Agriculture Organisation
- HIID Harvard Institute for International Development
- BGCSI Botanic Gardens Conservation Secretariat International
- TWAS Third World Academy of Sciences

BIOLOGICAL DIVERSITY AND GENETIC RESOURCES

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TOTAL NUMBER OF PERSONS TRAINED DIRECTLY: 1133 (1989-725)

TRAINING AREAS:

- Conservation Biology
- Taxonomy
- Tissue Culture
- Ethnobotany
- Germplasm Collection
- Documentation
- Data Bases
- Herbarium Techniques

GLOBAL NETWORKS ESTABLISHED: THREE •BDGR •Conservation Biology •Tropical Forest Ecology
(Commonwealth-wide)

REGIONAL NETWORKS ESTABLISHED: NINE (1989 SEVEN)

- Tissue Culture (Asia-Pacific)
- Life Support Species (Asia-Pacific)
- Medicinal Plant (Caribbean, Asia-Pacific)
- Ethnobotany (Pacific)
- Conservation Biology (SADCC Africa, Asia-Pacific)
- Tropical Forest Ecology (Asia-Pacific)
- Documentation & Data Bases (Africa)

COUNTRY REPORTS PREPARED: SEVEN on some elements of the project; **SEVEN** on KEY SPECIES

INTERNATIONAL COLLABORATIONS/COOPERATIONS INITIATED: EIGHT (1989 SEVEN)

- International Council of Scientific Unions (ICSU)
- International Council for Conservation of Nature and Natural Resources (IUCN)
- International Board of Plant Genetic Resources (IBPGR)
- UNESCO • World Bank • FAO • UNEP
- Harvard Institute for International Development (HIID)

NUMBER OF TRAINING WORKSHOPS HELD: TWENTY SIX (1989 FIFTEEN)
(Including Review Conferences/Symposia)

PROJECT PROPOSALS PREPARED: THIRTY TWO (1989 TWENTY EIGHT)

NUMBER OF CURRICULA DEVELOPED FOR TRAINING COURSES: SIX (1989 FIVE)

TRAINING MANUALS PREPARED: FOUR (1989 TWO)

Figure 4
Results of the BDGR Project

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D. Curricula developed – for three courses:

- Herbarium Techniques
- Conservation biology
 - (1) Core-general curricula for senior scientists
 - (2) Regional curricula for SADCC Africa
 - (3) Regional curricula for humid tropics
 - (4) Regional curricula for field extension workers
- Taxonomy

E. Implementation of models developed in the BDGR workshops

- One relating to medicinal plants, and another relating to the use of tissue culture (both in Brunei)
- South-East Asian database developed for legumes at NBRI, Lucknow, India, in collaboration with the International Legume Database Service (ILDIS), Britain

F. Training manuals prepared – for three subject areas:

- Conservation Biology
- Investigation of traditional herbal medicine: (i) Botanical aspects, (ii) Pharmacological aspects
- Ethnobotany

G. Guidebooks – for one subject:

- Medicinal Plants of Coastal Guyana

H. Financial Resources Used and Generated

- Financial inputs provided by the CSC (drawn from CFTC) for the BDGR project were £350,000 over five years. This money was used catalytically to raise funds amounting to £1.2 million from external sources (e.g. international organisations and funding agencies) for supporting the activities of the project
- UNDP has provided US\$3 million for the implementation of the Commonwealth –Guyana Programme on Sustainable Tropical Forestry.

CHAPTER 4

Future Directions

The basic aim of the BDGR project, in line with the UNCED convention, is the conservation of biological resources to ensure sustainable development for survival of the human race on Earth. The components and activities also remain the same. However, they need to encompass the extra dimension of the biodiversity of animals, micro-organisms and their habitats.

The following three recommendations relate to measures that could be taken by Commonwealth member states to conserve their genetic resources and develop a programme for national and regional economic development based on their sustainable utilisation. The components, in contrast to Phase I of the BDGR project, need to encompass the extra dimension of the biodiversity of animals.

- (a) Record the micro-organisms, animal and plant species found in a country and in a biogeographical region in a resource inventory along with their traditional uses, if any, whether as food, fibre or medicine. This will entail compiling a written dictionary or *materia medica* of ethnobotanical knowledge. It is important to involve local people in the gathering and recording of their accumulated understanding of traditional uses of plants and animals, for it is these people who will ultimately be responsible for the conservation of the genetic resources in the wild and who must be provided with incentives to conserve them.
- (b) Develop *in situ* and *ex situ* protected areas, national parks, gene banks and botanical gardens museums as repositories of rare, threatened or endangered germplasm. For example, this could be achieved through expanding the role of the SADCC Regional Gene Bank in Lusaka to cover the entire Africa region. Similarly, a second regional gene bank could be established in another region to conserve species indigenous to the equatorial habitats and ecosystems including the tropical moist forests and dry forests in other areas. While botanical gardens are excellent focal points for plant conservation and related research, they should not be allowed to detract from the conservation of natural habitats.
- (c) Develop the technology and methods to exploit on a sustainable basis the commercial potential of local biodiversity assets. Developing Commonwealth countries already have a strong tradition in the practice of herbal medicine, but the international pharmaceuticals industry is also looking for ways in which it can secure access to the now diminishing genetic resources of developing countries in order to develop novel products. The issue of biotechnology transfer for this very purpose is an area of current debate and is the subject of a biodiversity convention at UNCED. Improving access to the North's technologies which are based on the utilisation of the South's genetic resources will enable developing countries to utilise their genetic resources for their

own benefit. This is a highly contentious area, but one which is of significant importance to the conservation of biodiversity.

Whatever the outcome of UNCED, it is essential that regional bodies such as SPREP, SAARC, ASEAN, PTA, etc., build on their own skills to conserve and develop the indigenous resources of their own nations. Development of biodiversity assets needs can be based upon biotechnology and genetic engineering, and can begin with the harvesting and processing of natural products for the local market.

4.1 Identified Constraints and Challenges in the BDGR Programme

Since its inception in 1985, the CSC's BDGR programme has played a catalytic role in initiating national programmes in some components of the BDGR programme. It has been run on very precarious funding. With only one professional staff and minimal administrative support a major initiative for the conservation and utilisation of our biodiversity in a sustainable manner has been launched. To ensure that the programme does not lose momentum and is able to guide the preparation and implementation of practical action plans it is important that it be put on a secure footing. This is even more important with the signing of the Biodiversity treaty at the Earth Summit when substantial resources will become available for inventoring and conserving our biological wealth. The member countries of the Commonwealth need guidance to ensure that they are able to share their inherited biological wealth as **equal partners**. They stand to gain billions of dollars in new **non-aid** flow of funds while retaining control of their valuable resources. An agency like the Commonwealth Secretariat can, because of its acceptance by the North and the South, have a vital role to play to ensure that in various agreements that are made a fair deal is given to both the owners of the biological resources and the owners of technology and other capacities needed to harness these resources in a sustainable manner.

Extensive field work and interaction at all levels has helped in identifying the following constraints the programme faces at present:

- There is need for more effective integration of national BDGR policies with interfacing subjects such as agriculture, forestry, fisheries, wildlife, landscapes and advances in technologies;
- There is need for sensitising government planning departments to the importance and value of rational utilisation and conservation of indigenous germplasm of all species;
- Implementation of BDGR initiatives in member countries would require a large number of trained personnel. Although inexpensive techniques have been developed through CSC initiatives, their dissemination in the countries appear to be low key;
- Though the programme is advancing scientifically with a high momentum, lack of entrepreneurial and commercial interest, absence of linkages with the industry sector is affecting large-scale application/utilisation;
- National conservation needs and commercial interests/compulsions often tend to work at cross purposes due to lack of formal linkages with industry;
- Facility of access to international funds and national funds from donors and governments to launch effective implementation of specific components of the programme;

- Limited scope of the initial project due to focus only on plants;
- Lack of adequate professional support staff and administrative infrastructure to enable better co-ordination and implementation of the programme by the CSC Office in member countries.

4.2 Proposed Actions for 1992-1995

There are several distinct actions that could be undertaken or assisted by regional bodies such as ASEAN, PTA, SAARC, SADCC, SPREP, etc. The important ones are given below:

- Authentication and development of key species of plants, animals and micro-organisms which may be of considerable ecological and economic benefit;
- Promotion of inexpensive techniques and methods for the study, use and conservation of genetic resources. It would cover areas such as: conservation biology, taxonomy, tissue culture, ethnobotany, germplasm collection, documentation, creation of responsive databases, and herbarium techniques;
- Establishment of regional/national centres for the study and conservation of biodiversity;
- Development of a computerised database on a uniform basis for each of the regional networks to facilitate sharing of critical information, e.g. on medicinal plants within and between the networks;
- Establishment of nodal agencies for undertaking institutional development and dissemination of information;
- Provision of assistance for the training of member state nationals in ecological and economic management of tropical forests;
- Establishment of *in situ* and *ex situ* conservation programmes and facilities, e.g. setting up of gene banks and national parks;
- Provision of assistance for developing BDGR centres at national and regional level, especially for training and research related to survey and authentication of key species in Africa, Caribbean, Asia-Pacific and small islands;
- Formulation and implementation of training courses using standardised methodologies for pharmacognostic authentication and use of medicinal plants in the pharmaceutical industry, initially for Africa with possible extension to Asia;
- Provision of assistance for *in situ* and *ex situ* preservation of priority key species of life support value and economic plants (jointly with IUBS, IUCN, IBPGR and World Bank);
- Use of remote sensing techniques to develop guidelines for estimation of biodiversity in small islands and other tropical countries;
- Development of a Regional Information Service on survey and authentication of indigenous germplasm of potential economic value;
- Establishment of regional centres offering training courses and research facilities for taxonomy and herbarium development for Africa and Asia, jointly with IUBS, FAO and IUCN, with possible extension to the Caribbean region;

- Preparation of international and regional training manuals on conservation biology, ethnobotany and herbarium techniques for Africa and South Asia;
- Establishment of ethnobotanical training and research centres;
- Provision of training in tissue culture through attachments to laboratories;
- Provision of assistance in building national herbaria for small islands and other tropical countries through attachments and material support;
- Development of educational linkages and information networks for each regional centre (audio-visual methods, satellite linkages, computerised databases);
- Technical attachments of scientists from the Caribbean with institutes in other countries in the Commonwealth, e.g. Kenya Medical Research Institute, Kenya and the Central Drug Research Institute, India;
- Training of scientists/technicians for pharmacological, toxicological, screening, phytochemistry and botany in the Caribbean, Africa, Asia and the Pacific;
- Assisting human resource capability building through national training and awareness programmes, involving medical professionals, herbalists and ethnobotanists;
- Development of guidelines and methodologies for identifying key species, jointly with IUCN;
- Development of an action plan which will provide relevant criteria (ecological, agronomical) and indicators for preparing inventories of key species;
- Encouragement and initiation of co-ordinated research on key species using experimental, theoretical and predictive approaches.

For implementing the above action it would be necessary for the CSC to collaborate with other international programmes and agencies and draw on funding sources, e.g. the Global Environment Facility.

4.3 Timeframe and Estimated Costs

Work on the project for the next five years would comprise extensive field surveys, identification and authentication of key species. This would involve a large number of consultants and specialists from each of the seven regional networks and is estimated to cost US\$200,000 per country per annum. Experts would be needed in the fields of taxonomy, biosystematics, conservation biology and ethnobotany. During this period steps would also need to be taken to strengthen the regional and national institutions and on the training of member state nationals. The costs would amount to US\$450,000 per country per annum. Finally, the project would need to establish conservation areas and programmes within a region. This is estimated to cost US\$20 million per annum per region and about US\$110 million for six regions if done in parallel.

The whole of the above programme is considered to be crucial for the protection of fragile and ecologically valuable ecosystems. Requests for funding different components of it will need to be targeted at specific donors and backed up by specific project proposals.

PART II



Summary

The second part of this book contains background information that is needed to get a better understanding of the development of the BDGR programme. To ensure that the programme evolves in a systematic manner uniformly in different member countries, guidelines were developed for each of its components. These are given in Section I of Part II.

As indicated in Chapter 2, interactive dialogue between individuals and organisations involved in the BDGR programme is an essential process of the programme. This was effected by means of workshops whose aim was to explore and equate diverse views on the elements of the programme. The participants were encouraged to discuss ideas they have evolved as a result of their individual and institutional experiences in different areas of concern. The bringing together of leading experts from the disciplines that are relevant for the conservation and sustainable utilisation of biological resources in open dialogue led to greater understanding and assimilation of the key concepts that underpin this subject. As a result of such dialogue the central concepts of the BDGR programme have become accessible to a wide range of persons and institutions. Some of these workshops were directly used for imparting training to scientists (e.g. in Conservation Biology), technicians (e.g. in Herbarium techniques) and indigenous people (e.g. in Ethnobotany) to develop better skills and to strengthen their existing know-how in the concerned subject; while others were used for identifying and clarifying concepts, and for formulating, where possible, outlines of national and regional practical action plans for capacity building, adaptive transfer of technology and development of research programmes. Fourteen workshops have been selected as the key workshops falling into the two categories of: (i) imparting training, and (ii) concept development. Detailed recommendations emanating from these are given in Section II.

The programme was designed to develop in an integral manner by intensive participation and feedback from the field level scientists, technical workers and indigenous persons

from member countries. To ensure that their findings and recommendations influence the decision makers at policy level, a structure consisting of key institutions involved in research and development in the main areas pertaining to biodiversity was established. Scientists working in these institutions were appointed as National Co-ordinators and a pan-Commonwealth network of these co-ordinators was set up. Twenty-eight member countries have identified national co-ordinators who are grouped under seven regional networks covering the Caribbean, West Africa, East Africa, Southern Africa, Asia and the Mediterranean, South-East Asia and the Pacific. Each region is unique in its biogeographical characteristics, thus requiring each regional network to prioritise its own programme of action within the BDGR programme. This facilitates the flow of ideas, concepts and operational details. Section III gives the list of national co-ordinators.

The work undertaken by the CSC and the BDGR network was regularly consolidated in the form of documents prepared by the CSC. Section IV gives a list of these publications together with a suggested reading list for use by scientists and other professionals working in this area.

SECTION I

Guidelines for Developing the Commonwealth Biological Diversity and Genetic Resources Project

To ensure that all member countries follow the same underlying methodology, guidelines were prepared for each component of the BDGR project. These were based on research work undertaken during the period 1975-85. They were discussed and accepted at the first International Workshop on Biological Diversity and Genetic Resources held in 1986, and have been used for developing national status reports and individual projects within the various components of the programme. These guidelines were developed in the form of a questionnaire, as given below:

A. Survey & Documentation of Potentially Valuable Plants

- (1) What sourcebooks or databases exist on the identification of plants of economic importance in the traditional economies of your country?
- (2) What attempts have been made since these sourcebooks or databases to collect and collate information on under-exploited plants of potential economic importance in your country?
- (3) What are the top ten or so indigenous species of potentially important under-exploited plants in your country?
- (4) Which of these species are used traditionally for the following proposed?
 - Food
 - Fodder
 - Fuel
 - Pharmaceuticals
 - Soil Amelioration
 - Industrial Materials
 - Others (specify)
- (5) Which of these uses are of priority importance to social, economic and environmental development in your country?
- (6) Are the distribution and pockets of diversity of these species well documented? Elaborate.
- (7) What protected area systems (if any) exist in your country safeguarding pockets of diversity of each of these species?
- (8) What is the status of each of these protected areas (if any)?

- (9) What attempts have been made to make an inventory of the pockets of diversity of each of these species?
- (10) How do you propose surveying and documenting the diversity of these species in your country? Give a work plan for just one species as an example, indicating physical, human and financial requirements.
- (11) What infrastructure and financial resources are available in your country for surveying and documenting the diversity of these species or the pockets of diversity? Elaborate.
- (12) What kinds of training (and at what levels) are needed in your country to pursue the survey and documentation of potentially valuable plants?

B. Evaluation of Growth Characteristics of Target Key Plant Species

- (1) Which of these economically important under-exploited plants have been evaluated for their growth characteristics in your country? List.
- (2) What information is available on the growth rates of these plant species in your country, and under what conditions? Elaborate.
- (3) What information is available on the ecology and productivity of these plant species? Elaborate.
- (4) What information is available on the flowering, pollination and fruit set of these plant species? Elaborate.
- (5) What information is available on seedling germination, mortality and growth of these plant species? Elaborate.
- (6) What information is available on seed predation, herbivore and pathology of these plant species? Elaborate.
- (7) What experiments have been conducted to evaluate the growth characteristics of these plant species under different soil, hydrological, nutrient and cultural conditions? Elaborate.
- (8) How do you propose evaluating the growth characteristics of these plant species in your country? Give a work plan for just one species as an example, indicating physical, human and financial requirements.
- (9) What infrastructure and financial resources are available in your country for evaluating the growth characteristics of these species? Elaborate.
- (10) What kinds of training (and at what levels) are needed in your country to pursue evaluating the growth characteristics of potentially valuable target plant species?

C. Diversity of Genetic Expression of Target Species

- (1) Which of these economically important under-exploited plants have been the subject of studies on genetic expression? List.

- (2) What information is available on the genetic expression of these plant species?
- (3) How do you propose studying the genetic expression of these plant species in your country? Give a work plan for just one species as an example, indicating physical, human and financial requirements.
- (4) What infrastructure and financial resources are available in your country for conducting studies on the genetic expression of these species? Elaborate.
- (5) What kinds of training (and at what levels) are needed in your country to pursue studies on the genetic expression of potentially valuable target plant species?

D. Training

- (1) What training is available in your country in the areas of plant taxonomy, herbarium development, conservation biology and traditional use (ethnobotany, suggestion of class distinction)? Elaborate in terms of levels, courses, expertise and institutions.
- (2) What kinds of training (and at what levels) are needed in taxonomy, herbarium development, conservation biology and traditional use (ethnobotany, suggestion of class distinction) in your country, so that you may pursue work on the biological diversity of under-exploited plants?

E. Propagation and Cultivation of Plant Material

- (1) What propagation and cultivation techniques are currently used for plant material in your country? List.
- (2) In what groups of plants are these techniques used in your country? Specify in terms of palms, fruit trees, ornamental trees, herbs, etc.
- (3) What institutions (government, academic or industry) are actively propagating and cultivating plant materials in your country? Elaborate in terms of names, addresses and contact points (if any).
- (4) What propagation and cultivation techniques do you need to know in order to enhance the agronomic potential of economically important under-exploited plant species in your country?

F. Network of Contacts

- (1) What local or regional networks or associations exist, which may be useful for information flow on under-exploited plants? Specify with names, addresses and contact points (if any).
- (2) What local or regional newsletters or publications exist for potentially communicating information on under-exploited plants? Specify with names, addresses and contact points (if any).

- (3) What mechanisms or meetings are available nationally or regionally for potentially communicating information on under-exploited plants? Specify with names, addresses and contact points (if any).

G. Demonstration and Transfer

- (1) What experimental farms, gardens, plots, glasshouses or laboratories are available in your country for demonstrating and transferring potentially important under-exploited plant species? Specify details.
- (2) What regulations (especially quarantine) govern the demonstration and transfer of potentially important under-exploited plant species? Elaborate.
- (3) What events (e.g. exhibitions, field days) are conducive to the demonstration and transfer of potentially important under-exploited plant species? Elaborate.

SECTION II

Recommendations of Key Workshops Held Under the BDGR Programme

Twenty-one workshops were held during the period October 1985 to June 1992 in order to: (a) sensitise the decision-makers at both the policy and the operational levels; (b) develop national and regional networks; (c) train scientists involved in research, development and teaching in the relevant technologies (e.g. tissue culture), and technicians in applying appropriate techniques at field level for achieving practical results (e.g. herbarium management, ethnobotany); (d) develop relevant documentation; and (e) identify gaps that may exist in the programme. The titles of the workshops and their nature are given in Table 3, while detailed recommendations of selected workshops are given below.

A. International Workshop on Micro-Propagation and Meristem Culture

An International Workshop on 'Mass Propagation using Tissue Culture and Vegetative Methods' was held in 1986 in Malaysia. The aims and scope and recommendations of the workshop are given below.

Aims

The purpose of this Training Workshop/Symposium was to promote development of capability in micropropagation and meristem culture techniques in the SE Asia and Pacific region. The specific objectives were:

- (1) To review the state of the art on techniques for micropropagation and meristem cultivation available to less advanced countries in the Asia-Pacific region.
- (2) To evaluate the application of tissue culture techniques for both development and commercial purposes.
- (3) To create an interface between micropropagation techniques and:
 - (i) Socio-economic needs of countries
 - (ii) Plant breeding requirements
 - (iii) Agro-ecosystems/Environmental problems
 - (iv) Genetic resource conservation
 - (v) Genetic engineering.
- (4) To develop strategies for upgrading the productivity of plant species used in agricultural and industrial crops, both conventional and under-utilised.

Scope

The scope of the workshop was predominantly concerned with:

- (1) Training of scientists in the following aspects of tissue culture technology:

TABLE 3.

Workshops/Symposia	Year	Place	Remarks C: Development of Concepts O: Operational Development of Projects CO: C plus O
1. Medicinal and aromatic plants	1985	St Kitts-Nevis West Indies	O
2. International workshop on micro-propagation and meristem culture	1986	Kuala Lumpur Malaysia	C Recommendations pp. 47-50
3. International workshop on biological diversity and genetic resources of under-exploited plants	1986	London Britain	CO Recommendations pp. 51-54
4. Pharmacognostic authentication and standardisation of crude drugs	1986	Colombo Sri Lanka	CO Recommendations pp. 55-58
5. International workshop on maintenance and evaluation of life support species	1987	New Delhi India	C Recommendations pp. 59-65
6. Regional workshop on conservation biology in SADCC member countries	1987	Lusaka Zambia	CO Recommendations pp. 66-67
7. International workshop on ethnobotany	1988	Christchurch New Zealand	C Recommendations pp. 73-78
8. Regional training workshop on conservation biology for humid tropics	1988	Peradeniya Sri Lanka	CO Recommendations pp. 79-82
9. Regional workshop on tropical forest ecology and management for Pacific Island nations	1988	Lae Papua New Guinea	CO Recommendations pp. 83-86
10. Training workshop on standardised methodology and guidelines on pharmacognostic and botanical aspects of medicinal plants for uses as drugs in industry	1988	Georgetown Guyana	O

NB: Recommendations of workshops that have a direct impact on training of persons for the building of indigenous capacity, and from which specific training courses, technical documentation and projects have evolved, are given in Section II of this report.

- (i) Rapid multiplication of selected mother plant materials
 - (ii) Plant health, disease elimination and exclusion
 - (iii) Genetic conservation and international distribution of germplasm
 - (iv) Somaclonal variation, anther and pollen culture
 - (v) International transfer and germplasm.
- (2) Developing the capabilities of scientists for exploiting clonal *in vitro* techniques

Workshops/Symposia	Year	Place	Remarks C: Development of Concepts O: Operational Development of Projects CO: C plus O
11. Identification of key species for conservation and socio-economic development	1989	Port of Spain Trinidad & Tobago	C Recommendations pp. 87-92
12. Workshop on standardised methodology for survey and documentation of locally used plant genetic resources	1989	Ibadan Nigeria	O Recommendations pp. 96-97
13. Regional training workshop on conservation biology for SADCC member countries	1989	Lusaka Zambia	O Recommendations pp. 93-95
14. Tropical forest ecology and management in Asia-Pacific region	1989	Lae Papua New Guinea	O
15. International workshop on ecological foundation for sustainable agriculture, biological diversity of invertebrates and micro-organisms	1990	London Britain	C Recommendations pp. 98-101
16. International workshop on biological diversity: Conserving germplasm in botanic gardens	1990	London Britain	C
17. Workshop on conservation through <i>in vitro</i> methods	1990	Kuala Lumpur Malaysia	C Recommendations pp. 102-106
18. Workshop on the biodiversity of traditional and under-utilised plants	1991	Malta	C
19. International conference on bioresources diversity, ethnobotany, development and sustainability	1991	Hawkesbury Australia	C
20. Workshop on tropical forest ecology: Methods of research in social sciences; Research on non-timber products in Asia	1992	Bangkok Thailand	CO
21. Planning meeting of CSC BDGR network	1992	London Britain	C

for application in propagation of tree species, and industrial and agricultural crops.

Conclusions and Recommendations

On the basis of discussions the participants concluded and recommended that:

- (1) CSC should, in collaboration with the governments concerned in the region, continue to promote research activities in this field where appropriate by

organising national, sub-regional, regional or inter-regional meetings, workshops and seminars by drawing resource persons from industrialised states and developing countries from within the region.

- (2) Such meetings be organised at different levels to include officials and scientists both from the government and from private sectors concerned and that such meetings should be organised on request of an individual government or of groups covering activities in this field of research.
- (3) CSC and interested industrialised states, in close collaboration with governments of developing countries within the region, should provide necessary technical assistance by arranging special programmes and courses for training in industrialised countries.
- (4) CSC promote and widen access to and exchange of information for countries within the region with the aim to promote the use of *in vitro* culture technology in upgrading productivity of plant species which are both conventional and under-utilised, e.g. breadfruit, coffee.
- (5) CSC promote the development and application of tissue culture cloning techniques on selected plant species of interest in the Asia-Pacific region. Evaluations of the field performance of these species will need to be exchanged to co-ordinate experiences in the large-scale uses of plant tissue culture propagation.
- (6) CSC promote and facilitate exchange of relevant expertise for the benefit of the member countries in the region.
- (7) A regional network of specialists in this area called 'Asian network for utilising tissue culture cloning techniques' be established.
- (8) CSC give annual award(s) to outstanding scientists in recognition of their contributions to this field of work.
- (9) The participants, upon their return to their home countries, should report their experiences at the workshop to their national offices, and collaborate closely with them for future activities which may be organised by CSC or by national institutions.

B. International Workshop on Biological Diversity and Genetic Resources of Under-exploited Plants

The above workshop was held in October 1986 in Britain with the following aims and scope:

Aims

- (1) To bring together information already available in this field and identify priority areas of planning and action at local, national, regional and international levels.
- (2) To discuss and develop action plans for survey, documentation, evaluation, cultivation, utilisation, etc.
- (3) To finalise a Commonwealth-wide project proposal on selected species of importance which would support the national economies in the areas of agriculture, forestry and industry.

Scope

The workshop concerned scientists, agriculturists and foresters as well as local rural community representatives. It dealt with under-exploited plant resources, with initial emphasis on the family *Leguminosae* for their:

- (1) Identification and evaluation
- (2) Development
- (3) Harnessing/exploitation
- (4) Improvement/manipulation if necessary.

Summary of Recommendations

The following recommendations were arrived at by the participants of the workshop:

(1) General, inter-regional

- (i) The project framework on under-exploited plants, initially proposed by New Zealand, was accepted.
- (ii) Specific endorsements were given to:
 - Training courses on herbarium management, conservation biology, ethnobotany and mass propagation in laboratory and field.
 - A computerised database for information on inventories, seed bank and germplasm management.
 - Action programmes as contained in the national proposals.
- (iii) Preparation of an immediate action programme for development of under-exploited plant resources in the following groups: *Leguminosae*, *Palmae*, root crops, grain crops and tree genetic resources (specific national proposals, if different from the above, to be submitted as national requests).
- (iv) A national survey and documentation of potentially valuable plants to be undertaken for all the countries involved.
- (v) Publication of a book on the under-exploited plant resources of Commonwealth countries by 1988.

- (vi) Publication of a newsletter on biological diversity and genetic resources of under-exploited plants.
- (vii) Establishment of computerised databases for these plant resources; information accumulated in these database centres to be exchanged freely within the participating countries.
- (viii) International funding agencies (IBPGR, UNEP, FAO, IUCN/COSTED, British Council, UNESCO, SIDA, OAS, IDRC, ODA, ICRAF, World Bank and other organisations) to be approached for co-operation and financial assistance in the implementation of the BDGR programme.
- (ix) The establishment of a co-ordinated network with support staff in the programme under the Commonwealth Science Council for monitoring the progress of the programme and for providing help in training aspects.
- (x) The Commonwealth Science Council should function as a centre of contact and information dissemination and as a resource base, as well as an agency through which funding may be arranged and channelled.
- (xi) A follow-up of this international workshop to be organised by the Commonwealth Science Council, preferably in South-East Asia, towards the latter part of 1988.
- (xii) For Africa, it is recommended that a workshop be organised in 1987 on 'conservation methodology' and rational utilisation of African plant genetic resources for the improvement of agriculture, forestry, environment and rural economies. This would be an important follow-up to: (i) the African Ministers' Conference on the Environment (Cairo, December 1985) which decided to establish an African network for the conservation and management of genetic resources and the implementation of 150 pilot villages and 30 pilot arid stock-raising zones for self-sufficiency in food energy, based on local genetic resources and skills; (ii) the SADCC/Nordic countries workshop on the establishment of a plant genetic resources programme for SADCC countries (Lusaka, September 1986); and (iii) this workshop on biological diversity and genetic resources.

(2) Regional Recommendations

(i) West Africa

Countries represented in this group were Nigeria, Ghana and Sierra Leone. They recommended that:

- Joint programme be initiated for the survey and collection of plant material of countries concerned. The genetic resources identified and collected will be kept in the native country but duplicates may be shared by others.
- Evaluation be undertaken of the collected genetic material in the native region or outside, depending on the facilities available.
- National workshops be organised to disseminate gathered information to extension workers and farmers.
- Joint training programmes for farmers in their fields and for extension

workers in appropriate workshops be organised between 1988-1992, for countries of the region.

- All African co-ordinators of the programme to meet to standardise methodology for survey and authentication for this region.

(ii) East Africa and SADCC Countries

Countries represented were Kenya, Malawi, Mauritius, Tanzania and Uganda. They recommended that:

- Commonwealth Science Council invite other countries of East and Southern Africa who were members of the Commonwealth but were not represented at this workshop to join the programme and network.
- National co-ordinators to constitute a task force for the implementation of this programme and other projects emerging from it.
- Regional meeting be held to discuss further the plan of action. Regional co-ordinators should disseminate information on project activities every six months. For this it was suggested that a regional newsletter be published. Malawi offered to act as a regional co-ordinator and it was felt that it would be appropriate to seek funding from international agencies.
- A regional workshop by the end of the second year to be organised by the Commonwealth Science Council.

(iii) Caribbean

Countries represented were Jamaica, St Lucia, Guyana, Trinidad & Tobago, and Canada. They recommended that:

- Botanical inventories of floras of their countries be prepared. Where this information had already been collected it should be updated.
- Extensive ethnobotanical investigations for each country of the region should be undertaken.
- Infrastructure be built for seed storage facilities, arboreta, botanic gardens, tissue culture facilities and cryopreservation facilities.
- Wherever appropriate, germplasm exchange facility be made available for comparative evaluation of genetic diversity.
- The need for establishing herbaria and providing training for taxonomy, conservation biology and ethnobotany be addressed.
- Scholarships be provided for attending such courses, and funding be given for expertise, symposia, workshops, training of curators, technicians and other staff.
- Teachers' training course in conservation biology be developed so that they are equipped to further teach this subject in educational institutions.
- The following plants of high regional importance should be studied, evaluated and developed: Pigeon pea; Breadfruit; *Leucaena*; *Vigna*; Mango; Amaranth.
- Earlier editions of appropriate botanical books be updated, so that a complete botanical inventory of the flora may become available.

(iv) Asia, Pacific and Mediterranean

Countries represented were: Cyprus, India, Sri Lanka, Australia, Papua New Guinea, New Zealand and Nepal. They recommended that:

- An action group be set up in each country, to act as the focal point for the project and for liaising with the Commonwealth Science Council.
- A regional co-ordinator within the CSC be appointed to assist the programme officer in co-ordinating activities of each country and to keep in contact with the Commonwealth Science Council.
- Extensive survey, documentation and ethnobotanical investigations of the under-exploited genetic resources of the regions be undertaken by each country separately with assistance from international agencies.
- They meet again in about 18 months to review the progress.
- Computerised database facilities be set up for germplasm documentation and training for the region. India offered to develop a regional network.

C. Regional Workshop on Pharmacognostic Authentication and Standardisation of Crude Drug Materials Extracted from Plants of Families *Zingiberaceae* and *Rutaceae*

Aims

The above workshop was held in 1986 in Sri Lanka to discuss the project developed on above theme and to identify agreed guidelines for preparing manuals on:

- (a) Phytochemical aspects;
- (b) Pharmacognostic aspects; and
- (c) Botanical aspects.

Recommendations

The meeting recommended that a manual be produced using the following guidelines.

(1) Guidelines for Pharmaceutical Aspects

The manual to cover the following areas:

- (i) General Concepts:
 - Identification Profiles
 - Recommended TLC systems for crude drugs belonging to *Rutaceae* and *Zingiberaceae*.
- (ii) Preparation of Extracts:
 - Essential oils
 - Flavonoids
 - Coumarins
 - Alkaloids
 - Bitter principles
 - Colouring principles.
- (iii) Thin layer chromatography (TLC) – TLC 4,5,6,8,10:
 - Plates
 - Solvents
 - Running distance.
- (iv) Detection:
 - Record colour/daylight, ultraviolet (UV) 254 • 365 nm
 - Record fluorescence/quenching, UV 254 x 365 nm
 - Spray using following reagents: Record LRF values
 - (a) Essential oils
 - (b) Bitter principles
 - (c) Alkaloids
 - (d) Flavonoids
 - (e) Coumarins
 - (f) Colouring principles.

- (v) Select the best three TLC profiles for each drug and check reproducibility by repeating at least three times with different samples.
- (vi) Use standard concentration samples of common compounds belonging to the classes of compounds selected and re-run the TLC.
- (vii) Same procedure should be repeated with known adulterants and substitutes.
- (viii) Use **standard** biochemical screening procedures.

Abbreviations

TLC: Thin Layer Chromatography

Silica gel 60: specific surface area 500 cm²/g; pore volume 0.75 cm³/g; pore diameter 60Å

UV: shorter wavelength ultraviolet light, used to detect substances that quench fluorescence (Silica gel 60F).

(2) Pharmacognostic Aspects

These should cover:

- (i) Studies of the effectiveness of the drug on animals should use similar route of administration used by the indigenous people.
- (ii) Serial extraction (with increasing polarity solvent) to identify the active fraction.
- (iii) Identification of the chemical structure of the active ingredient.
- (iv) Determination of methods of standardisation and bioassay of plant extracts (crude/pure) in established system.
- (v) Synthesis of the chemical and compare chemical and pharmacological properties.
- (vi) Extrapolation of the findings to carrying out detailed clinical trials on crude/pure extract.
- (vii) The therapeutic section should contain:
 - Reported actions and name of the country that claims the action.
 - Reported indications and name of the country where that drug is indicated.
 - Preparations and dosages and name of the country where the dosage forms are used.
 - Scientific studies should contain:
 - (a) Pharmacological studies of drug in animals
 - (b) Toxicological studies.

(3) Botanical Aspects

The manual should cover:

- (i) **Name of Plant – Botanical nomenclature**
 - This will include existing Latin names, synonyms, latest updated names (in that order).

- **Local names:** State the various local names known in each participating country. (In the final draft these names should be written in alphabetical order of languages.)
- **Varieties/races:** State whether there are any varieties/races available locally, i.e. in each participating country.
- **Brief diagnostic information:** Note the diagnostic features of the species. As for the varieties, a brief diagnostic information is sufficient. However, if there are distinct/vast disparities a more detailed description is necessary, as in the species.
- **Herbarium reference:** Each specimen collected must have a herbarium voucher specimen. Hence the herbarium reference number is stated in this section.

(ii) Photographs and drawings

(a) Colour/black and white photographs

For each species described, each participant is required to provide colour/black and white photographs of the plant as follows:

- Plant in its habitat (if possible whole plant)
- Parts of fresh specimens (e.g. rhizome/roots, flowers, etc.)
- Parts used in drugs (e.g. fruits/roots/rhizome, etc.)

(b) Line diagrams

Each participant should provide a complete line diagram/drawing of the species described (i.e. whole plant, flower, bract, etc.)

- (c)** If there is a great difference (in morphology) between the varieties and the species concerned, photographs and line diagrams as stated in (a) and (b) above are also required for the varieties described.

(iii) Definition

The definition should emphasise the following:

- **Parts used**
Mention the parts used in crude drugs in each participating country.
- **Geographical distribution of original plant**
Each participating country will provide information on the geographical distribution of original plant. The final draft will be in the form of a map indicating the total distribution (wherever possible).
- **Geographic distribution of commodity**
Similarly, the final draft will be in the form of a map indicating the distribution of commodity with additional information on the commercial aspects, i.e. export and import.

(iv) Voucher specimens

- Each participant must collect and make herbarium specimens as well as provide information on the ethnobotanical uses of the species from the

place of collection. Each participant is also required to preserve flowers, fruits or even rhizomes in FAA as part of the collection procedure.

- Herbarium specimens: each participant is required to make surveyor duplicates of each herbarium specimen. The number of duplicates should be equal to the number of participating countries plus two extras.
- Each duplicate will be sent to all the participating countries; of the two extras, one will be sent to Kew Herbarium and the other to another herbarium in the Asia-Pacific region, for instance China.

(v) Drug sample

Each participant is required to obtain market samples of the crude drug – if possible several samples so that a sample can be sent to all the participating countries.

(vi) Description

- Macroscopic
Detailed descriptions of the parts used are required both for fresh sample and commercial sample.
- Microscopic
These are mainly anatomical studies and description is required for cross-section of parts used, e.g. of rhizome/root. Wherever possible, materials in the forms of powder should also be described and analysed. In the description, the main diagnostic characteristics should be emphasised. Diagrams and photographs of cross-sections must be provided for each species studied.

Glossary

Abbreviations

Local names – botanical names and vice versa

Preservation of germplasm of medicinal value

Each participant should be aware that the species concerned should be preserved in their respective countries. Effort should be made to maintain them in a botanical institution, or ideally, in botanical gardens.

D. International Workshop on the Maintenance and Evaluation of Life Support Species

An international workshop was held in 1987 in India on 'Maintenance and Evaluation of Life Support Species in Asia and the Pacific Region'.

Aims

The aims and scope of the workshop were to:

- (1) Develop guidelines and methodologies for preparing inventories of life support species under different stress conditions.
- (2) Facilitate evaluation of the growth characteristics of these species under a range of environmental conditions for their harnessing in agriculture, forestry, fisheries, etc., especially through small-scale and integrated rural systems.
- (3) Develop methodologies for the synthesis of information about life support species, and develop a strategy for evaluating growth characteristics of life support species especially for rural and small-scale use.

Summary Recommendations

The following recommendations emerged from the different working groups of the workshop.

(1) Working Group on Life Support Species for Water Stress

The Group felt that a lot of work was already going on in arid parts of India and other countries. Hence, there should be some collaboration on arid species. Though they are slow growing, they have a lot of potential. The following points emerged during discussion:

- (a) Catalogues need to be prepared to list existing work in different countries.
- (b) It will be appropriate to have an International Agricultural Research Institute for the second and third order crops, especially life support species.
- (c) About half a dozen species in each category should find high priority for research and management. Tentatively, these were identified as:

For arid regions:

- (i) Tree species: *Prosopis* species, Eucalyptus (particularly salt tolerant lines), *Casuarina* species, *Quandang* (for fruit)
- (ii) Legumes *Indigofera* species
- (iii) Annual grasses *Cenchrus*
- (iv) Medicinal plants *Citrullus colocynthis*.

For flooded areas:

- (i) Lotus (*Nelumbo nucifera*)
- (ii) *Ipomoea aquatica*
- (iii) *Avicennia* (Mangrove).

(2) Working Group on Life Support Species for Temperature Stress

The following recommendations emerged from this group:

- (i) A classification be made for environments with regard to the interacting components of temperature and drought stress. The categories identified were hot dry habitats, cold dry habitats, hot humid habitats and cold humid habitats.
- (ii) For each of these habitats, a catalogue of life support species be made, with most immediate attention being directed to those areas where there are critical situations of drought and famine. It was accepted that a good amount of knowledge existed, but systematic cataloguing will indicate gaps of knowledge.
- (iii) Immediate action needs to be taken to advance research on species which are already identified to be of life support value. Preliminary lists of species for some of the four habitat characteristics were drawn up on the basis of the knowledge of the working group. It was further suggested that the countries, according to the habitat classes, may draw up their own lists.
- (iv) For each of the species identified for immediate action, existing knowledge be compiled under the following headings:
 - Basic information – taxonomy, distribution, ecological characteristics
 - Products – food, fuel, fibre, soil stabilisation, etc.
 - Knowledge of productivity levels
 - Research needs including selection and management requirements (ethnocultural/ethnobiological)
 - Socio-economic aspects including conservation factors.

(It was indicated that this classification will differ for different countries according to state of knowledge and particular socio-economic factors.)
- (v) Efforts need to be made to set up a ‘life support species network’ between participating countries, providing necessary effective co-ordination, transfer of knowledge and infrastructure to carry forward the recommendations of the workshop. In setting up this network, it was recognised that large countries such as India might choose to set up an internal national network to relate to a single national co-ordinator who would communicate to the international network. Persons involved in the network would be those with specialist involvement on the life support species.
- (vi) Participants in the workshop should endeavour to further expand the aims of the workshop through their participation in bilateral programmes on crop production and ecosystems, fellowships, consultancies, exchange of materials and exchange of scientific information.
- (vii) As a further development, national co-ordination should be encouraged for the habitat classification, i.e. the countries of particular habitat class should most directly co-operate and share knowledge, exchange materials and undertake joint research programmes.

- (viii) It was suggested that momentum for work on life support species could be best obtained by involving post-graduate students, using life support species as subjects for their studies for thesis/dissertation. Participants in the workshop were requested to spread the work on life support species by giving seminars to students and teachers/groups, and discuss with administrators and politicians the importance of life support species.
- (ix) The workers on life support species be mindful of the effects of population so that they can ensure that their efforts are directed to best resolve the problems involved with high human and non-productive densities.

(3) Working Group on Life Support Species for Problem Soils

It was recognised that soil related stresses pose a major constraint in achieving adequate productivity levels to support the increasing population. The major soil related stresses can be classified in the following broad categories:

(i) Salt-affected environments

Excess salts limit production and choice of life support species in several countries. The problems are most acute in arid and semi-arid regions where saline ground is the only source of irrigation. The problems are also widespread in coastal regions influenced by the sea. It is foreseen that problems will become more acute with increase in irrigated areas and as the re-use of available water resources becomes increasingly important.

(ii) Acid environments

Acid soils are widespread in the humid tropics. Acidic soil environments affect plant growth adversely, limiting in many cases the choice of species.

(iii) Mineral-stress environments

Deficiencies of essential nutrients and presence of toxic levels of several ionic species result in loss of productivity and associated hazards for several biosystems.

Recognising the constraints that the major group of environments exert and the need for maintaining/improving the productivity under these adverse environments, the group made the following recommendations:

- Traditional food crops will continue to be grown in large areas under these environments. Study of the genetic variability of these crops and genetic improvement of their adaptation to stress environments should receive high priority.
- Where feasibility of growing food crops is low, the scope of alternate systems having potential for meeting feed, forage and fuel demands is urgently called for.
- Under certain harsh environmental conditions, some biological species, e.g mangroves, have come to play a major role in conservation and maintenance of ecological balance which directly acts as a saver of life support plants. The past decades have witnessed their over-exploitation causing serious concern both to the ecology and the very existence of life support species. *In situ*

conservation and concerted efforts for their rejuvenation and regeneration are urgently needed.

For meeting the above objectives, the following activities were suggested:

- Appropriate agencies, based on resources and facilities, need to be identified for cataloguing, preservation and exchange of germplasm.
- Research efforts to define quantitative relationship between stress parameters and biological responses need to be undertaken at identified selected centres.
- There is need to organise training programmes, both at national and international level, to develop human resources required for identification, evaluation, maintenance and utilisation of germplasm collection.
- There is an urgent need to identify specific genes governing heritable differences in major crops regarding soil-stress tolerance for use in breeding programmes.
- Periodic organisation of symposia/seminars/discussions to exchange information, to review progress and to formulate future strategies would be most desirable.

(4) Working Group on Life Support Species for Emergency Situations

Having discussed and deliberated the life support species for emergencies, the working group considered and adopted the following resolutions:

- (i) The country reports on the state of the art presented in this workshop should be prepared by the respective countries on life support species for emergencies. Each country should have a convener or group who can prepare state of the art reports.
- (ii) It was recommended that life support species should be able to withstand sudden perturbation due to emergencies. Emergency situations were identified as drought, flood, cyclone and epidemics.
- (iii) It was felt that the main areas of work should cover pseudo-cereals, minor millets, minor pulses, minor tubers, multi-use species like bamboos and canes, mangrove species and medicinal plants.
- (iv) Since the germplasm of some of the species is under threat due to habitat loss, *in situ* and *ex situ* conservation should be given high priority.
- (v) Research and developmental efforts should be made to improve and popularise the selected prioritised species for food, fodder, medicine and energy needs.
- (vi) It was considered useful that exchange and dissemination of information is to be undertaken through national conveners or groups. It is appropriate in assessing responsibility of co-ordination to a regional convener.
- (vii) The nodal agencies for each country for crop plant germplasm and wild plant germplasm need to be identified. So far as India is concerned, NBPGR is the nodal agency for the conservation of crop plant germplasm and long-

term storage, evaluation and documentation of priority crops. The nodal agencies for each country for wild plant germplasm should be identified as most wild germplasm is threatened due to habitat loss. So far as India is concerned, the nodal agency for the survey and conservation of wild plant species is the Botanical Survey of India under the Department of Environment.

- (viii) Education and training is necessary for scientists in the areas of: (i) germplasm collection, evaluation and storage, (ii) taxonomy and evaluation, (iii) ethnobotany, and (iv) conservation methodology. India has the necessary facilities in the above-mentioned areas. For extending the facilities of the training programmes and also for exchanging personnel and experts with member countries, proper funding is required for travel, deputation and training facilities.
- (ix) Prioritisation of species was considered essential for effective action. **Multi-purpose Bamboos, Canes, Cucurbits, *Artocarpus* species, pulses (e.g. rice bean), a few minor millets, pseudo-cereals for hills, tuber crops like *Colocasia*, floating species like *Trapa bispinosa* and a few potential medicinal plants depending on regional needs were recommended for emergency requirements. In case of emergency due to perturbation, the agro-cropping pattern based on the multi-species concept should be followed for tiding over emergency situations.**

(5) Working Group on New Frontiers of Science and the Life Support Species

The discussion centred around the possible role of biotechnology in the context of life support species. The following recommendations emerged:

- (i) *In vitro* preservation of germplasm of life support species needs to be done, for which necessary techniques are to be standardised, wherever required.
- (ii) Genomic libraries of important but threatened species need to be established for their future use.
- (iii) Genetic variability through *in vitro* cultures need to be created in respect of a few priority crops for future exploitation.
- (iv) Newly emerging fields like computerised database generation, agronomic manipulation and conservation methodology should develop training courses especially for the life support species.

(6) Plenary Session

The important general recommendations and resolutions adopted in the Plenary Session were:

- (i) Life support species have an important role to play for the betterment of mankind especially under situations of limited natural resources (land, water, nutrients and energy), particularly in view of ever increasing human and livestock population pressures and various stresses. Therefore, life support species must be given due importance as far as scientific and technological inputs are concerned.

- (ii) Major thrust be given to studying these plants in more detail so as to generate required information on their origin, distribution, habitats, agro-climatic requirements, various uses and benefits as well as their scientific utilisation to meet ever increasing needs. Inventories of all life support species need to be prepared and made available to all concerned in the region.
- (iii) It was recommended that a few important species having economic potential for use as food, forage, fuel, energy, medicine and for industrial purposes for specified stress and emergency situations be selected for detailed studies as per the specific needs of the respective countries.
- (iv) Collection, evaluation, documentation and cataloguing of the prioritised life support species need to be taken up systematically so as to ensure their efficient utilisation.
- (v) It was emphasised that the germplasm of various life support species, including those which are threatened with extinction, be conserved on top priority basis both through *in situ* and *ex situ* means.
- (vi) It was recommended that training of scientists with emphasis on the study of different life support species including their collection, evaluation, utilisation, conservation, taxonomy, ethnobotany, etc., will be most essential as well as rewarding. Necessary facilities in this area are available in India at the National Bureau of Plant Genetic Resources, the National Botanical Research Institute, Lucknow, and the Botanical Survey of India, Calcutta, which can profitably be utilised.
- (vii) A suitable funding mechanism at the national, regional and international level through possible support of CSC, FAO, IBPGR, UNEP, UNDP, UNESCO, IUCN, etc., will have to be developed so as to protect the biological life support system.
- (viii) Periodic organisation of symposia/seminars/conferences on life support species so as to exchange information, review the progress and to formulate further strategies was emphasised. It was also recommended that a regional co-ordinator be identified to co-ordinate these activities in collaboration with national co-ordinators. It was further suggested that a regional workshop be convened after two years, preferably by the CSC in collaboration with other agencies concerned, so as to review the progress made.
- (ix) It was recommended that the post-graduate students be encouraged to work on life support species for their thesis/dissertation work and all the concerned institutions/universities in the region be addressed accordingly.
- (x) It was also recommended to bring out films, books, brochures and research journals on life support species for quick dissemination and exchange of information and for generating public awareness.
- (xi) Steps need to be taken to establish a 'network of life support species' between participating countries. Countries such as India might consider establishing a national network involving different organisations engaged in life support species. It was also recommended that a national centre of life

support species be established in different countries, especially in India.

- (xii) It was also recommended that an 'Information System' for Asia and the Pacific Region be developed for more effective linkages and for the dissemination of knowledge as well as materials.
- (xiii) Areas of biotechnology relevant for conserving and utilising these life support species were identified as *in vitro* preservation of germplasm, studies of variation of culture, and these were recommended for use for conservation as well as utilisation of life support species.
- (xiv) The role of biosphere reserves in every bio-climatic zone needs to be emphasised to the respective governments. The biosphere reserves need to be established and information on various aspects such as population dynamics, ethnobotany, etc., needs to be generated.
- (xv) An inventory of active research scientists working on life support species should be prepared and circulated to all concerned. Similarly, for effective linkages, it will be appropriate if a newsletter on life support species is published and circulated periodically either by CSC or IBPGR.

E. Regional Workshop on Conservation Biology

The Commonwealth Science Council organised a regional workshop to develop a training programme and training materials in conservation biology in 1987 in Lusaka, Zambia.

It was recognised at this workshop that senior scientists and extension workers in agriculture, forestry and wildlife management in developing countries needed training in conservation biology if land-use conflicts were to be minimised, while promoting conservation and sustainability of biological diversity. A general main course framework in conservation biology was developed for senior scientists at this workshop which had the following themes:

- (a) Public policy for biological conservation
- (b) Inventory of species
- (c) Biosystematics
- (d) Breeding systems
- (e) Life cycles and population dynamics
- (f) Physiology and biochemistry
- (g) Population maintenance and monitoring
- (h) Documentation and data handling.

Details of Course Structure

- (a) Public policy criteria for biological conservation**
 - (i) World Conservation Strategy
 - (ii) National Conservation Policy
 - 1) National Conservation Strategies
 - 2) Conservation laws (basis of the legislation)
 - (iii) *in situ* and *ex situ* conservation
- (b) Inventory of species**
 - (i) Criteria on choice of conservation area
 - (ii) Criteria on choice of species for conservation
 - (iii) Biometrical sampling techniques, and statistical data treatment and interpretation
 - (iv) Phytogeographical and paleobiographical descriptions
- (c) Biosystematics**
 - (i) Herbarium techniques
 - (ii) Intra-specific diversity (e.g. biotypes and ecotypes)
 - (iii) Physiological and biochemical variations

- (iv) Management implications of ecotypes (i.e. environmental factors)
- (d) Breeding Systems**
 - (i) Types of reproductive strategies
 - (ii) Role of vectors in pollination
 - (iii) Gene flow and maintenance of genetic diversity
- (e) Life Cycles and Population Dynamics**
 - (i) Plant life cycles
 - (ii) Population dynamics monitoring
 - (iii) Plant–animal and plant–plant interactions
 - (iv) Minimum viable populations
 - (v) Seed viability and dormancy
- (f) Physiology and Biochemistry**
 - (i) Chemistry of biological active compounds
 - (ii) Vulnerability of essential physiological processes that cause mutations
 - (iii) Aspects of eco-physiology
 - (iv) Physiological aspects of *ex situ* seed conservation
- (g) Population Maintenance and Monitoring**
 - (i) Forms of cropping systems
 - (ii) Management of populations
 - (iii) Problems of genetic decay
 - (iv) Biotechnology techniques in germplasm conservation and propagation
 - (v) Field trials
 - (vi) Neighbour relations and species interactions (i.e. experimental designs and competition studies)
 - (vii) *in situ* aspects of propagule conservation
- (h) Documentation and Data Handling**
 - (i) Documentation of available literature
 - (ii) Selected case studies on genetic resources conservation
 - (iii) Systems of data collection storage and retrieval.

F. International Diploma Course in Herbarium Techniques, Kew, Britain

The Commonwealth Science Council (CSC) has been involved since 1986 in promoting the techniques and methods for the study, use and conservation of biodiversity and plant genetic resources and has been closely involved with the training in 'Herbarium Development and Management'.

At present a Herbarium Techniques course is held at the Herbarium, Royal Botanic Gardens, Kew, Britain. It is held every year for 8-12 weeks and the following areas are dealt with:

- Taxonomy
- The development, purpose and types of herbaria
- The herbarium building and specimen storage
- Pests and treatments
- Materials
- Label design and production.

The course is divided into two components, (i) formal, and (ii) optional. The formal part constitutes the major component of the course, and is concentrated in the first six weeks with practical assignments and options occurring in the last fortnight.

The formal components include the following lectures and demonstrations:

- (a) Herbarium management, routine and materials
- (b) Plant collecting, preservation and related subjects
- (c) Plant morphology, identification and curation of collections
- (d) General interest subjects.

The above areas are covered under the following headings:

- 1 The development, purpose and types of herbaria
- 2 The role of taxonomy
- 3 Arrangement of herbarium collections
- 4 The herbarium building and specimen storage
- 5 Pests and treatments
- 6 Materials
- 7 Ancillary collections (i) spirit, carpological and wood
- 8 Ancillary collections (ii) illustrations and photographic records
- 9 Centralised accessions, recording and dispatch procedures (GSU introduction) related to these accessions
- 10 Duplicate distribution
- 11 Loans to other institutions
- 12 Preparation for mounting
- 13 Mounting
- 14 Good and bad practice

- 15 Special curation (succulents, *Palmae* and *Pandanaceae*)
- 16 Curation of fungi
- 17 Plant names
- 18 Palynology (lecture and tour of laboratory)
- 19 Incorporation of mounted specimens (laying-in)
- 20 Essential herbarium literature (including tour of library)
- 21 Removal of samples from herbarium sheets
- 22 Arrangement of herbarium collections according to new publications (curation)
- 23 Label design and production (including demonstration of printing press)
- 24 Photographic copying of herbarium sheets (including tour of studios)
- 25 Illustration
- 26 Plant identification and family recognition
- 27 Ecology and taxonomy
- 28 Introduction to computers
- 29 Collecting and preserving specimens
- 30 Notes on the collection and preservation of fungi
- 31 Collecting materials for ancillary disciplines (anatomy, cytology, palynology and phytochemistry)
- 32 The collection and curation of *pteridophytes*
- 33 Collecting living material
- 34 Accessioning living material and phytosanitary regulations
- 35 Photography and field work
- 36 Keys – punched-card and computerised
- 37 Check Lists
- 38 Collectors, itineraries, maps and gazetteer (including a tour of the map room)
- 39 Role of botanic gardens for seed banks (lecture and tour)
- 40 Seed bank
- 41 Conservation and the herbarium
- 42 Economic botany (lecture and museum tour).

Practical Sessions are dealt with either in the form of a one-to-one instruction session with staff members, or are organised in a 'workshop' format. A 'work sheet' is provided to help guide the students through most of the one-to-one sessions where Kew in-house procedures must be strictly followed. Two unaided practical assignments for assessment are also included (see note below).

List of Practical Sessions

- General Services Unit (GSU) – practical work relating to accessioning, recording and dispatch procedures
- Preparation for mounting

- Mounting one-to-one with a staff member (from the mounting team)
- Laying-in plants with the help of a staff member (work sheet provided)
- Collecting
- Pressing, and preparation of data labels
- Preparation for mounting, and mounting
- Vegetative morphology
- Floral morphology, dissecting fresh material
- Floral morphology, dissecting and preserving dried material
- Curation (i.e. the use of a revision to update specimen names)
- Keys – practice with dichotomous and multi-access keys.

Family recognition

- 1 Family sort of East African specimens
- 2 Family sort for Malesian specimens
- 3 *Compositae* workshop
- 4 *Graminae* workshop
- 5 *Rubiaceae* workshop
- 6 *Leguminosae* workshop
- 7 Ferns and fern allies.

Options

This aspect of the course aims to provide the students with an introduction to a supplementary skill which would be of benefit both to the individual and to his/her home institution. The students are offered a choice of five options from which they are asked to indicate their first and second preferences.

List of options

- Option 1 – Additional curation
- Option 2 – Practical plant identification
- Option 3 – Check-list compilation
- Option 4 – Illustration
- Option 5 – An introduction to library management.

Option Choice

The course offers a choice of options designed to give the student the opportunity to acquire additional skills and techniques relevant to herbaria and taxonomy.

Option 1 – Additional herbarium curation

This course gives the opportunity to help rearrange the collections in

accordance with a newly published work and extract loans as requested by other institutions.

Option 2 – Practical plant identification

Plant identification is a skill frequently required of herbarium technicians. Specimens from certain geographical areas and families can be selected to give students practical experience in identification.

Option 3 – Check list compilation

This option is suitable for trainees with some previous experience of herbarium routines and plant identification. If you select this option please state title and parameters of your intended check list.

Option 4 – Illustration

Local or specialised herbaria often do not have the services of a professional illustrator. Students will be encouraged to develop their skill in drawing plants, maps and diagrams.

Option 5 – An introduction to library management

In local or specialised herbaria, the duties of a herbarium technician often include routine library maintenance. This option introduces the student to acquisition, cataloguing and storage (with special reference to tropical conditions).

Changes since 1990

The 'fern and fern allies' workshop has been introduced as a new topic and the amount of time devoted to 'ecology and taxonomy' reduced. Otherwise, the syllabus remains unchanged.

Projects

These are additional to the course and only available to those students who are granted twelve-week subsistence by their sponsor. The students are provided with facilities and given help and guidance as necessary. The projects are not assessed by Kew staff.

Both projects and options should reflect the personal needs of the candidate and the needs of their home institution, and must be chosen with the approval of the candidates' Head of Department or Director. As far as possible, the subject of the project is chosen with the approval of the students' Head of Department or Director.

Project choice for students granted 12 weeks of work

The additional four weeks are not formally considered part of the course, but students are encouraged to spend this time working on a project of their own choice. Kew offers facilities and expert guidance but not full supervision.

The project may be relevant to herbarium techniques or ancillary topics (check lists

production being particularly suitable). Appropriately experienced students may select a taxonomically based subject, but if they are not acquainted with the basic principles this is not recommended. Students can either carry on a project they have already started or chosen what they can complete while at Kew or continue in their home institution.

Four such courses have been held at Kew since 1987.

G. International Workshop on Ethnobotany

An international workshop on ethnobotany was organised in 1988 in New Zealand to develop a training programme in ethnobotany. The workshop provided a forum for interaction between scientists and lay people and gave a clear indication of the ease with which lay people could relate their knowledge and concerns to scientists, and showed how easily scientists can communicate their findings to people not directly engaged in scientific work. The workshop made a number of recommendations which are given below.

Summary of Recommendations

Recommendation 1

Addressed to: Organisers of regional and international workshops

If a similar workshop (Hui) on Ethnobotany is held elsewhere it is important that the resources and knowledge of local people be used. Protocol of the country where the workshop is to be held in should be observed.

Local people need to be regarded as key experts for their region and their requirements to follow particular procedures have to be accommodated. The process used should respect the rights and the culture of the people of the country where such a workshop is held.

Recommendation 2

Addressed to: All workshop delegates

Delegates who return to areas where traditional knowledge and utilisation of plant resources continue, should impress upon other members of their communities the importance of maintaining their existing knowledge and practices in order to preserve, and to preserve on an **as and where basis** as far as possible, those plants that are considered to have high cultural, traditional and economic values. The introduction of new crops, regarded as more economic both by the people who undertake their cultivation as well as the distributors and the people who purchase them from both the indigenous people and the outside world, has frequently led to the unintentional extinction of plants whose existence many had taken for granted.

Recommendation 3

Addressed to: All participants and organisations represented at the workshop

Grave concern was expressed about the continuing and accelerated loss of plant species and genetic diversity and indicated the need to consider a framework for making recommendations. The distinction between global, regional and local aspects and concerns about the depletion of species was emphasised, indicating recommendations should be framed at these levels. A distinction needed to be made between recommendations being directed to the Commonwealth Science Council and those directed

internally to the New Zealand government for its action. Concern about the loss of species is worldwide and cannot be resolved by piecemeal, nation by nation, action, but only through international effort based on fundamental principles of equity and co-operation. There is a continuing and urgent need to recognise the interconnectivity of physical ecological conditions, economic use and social values and to integrate these elements. The New Zealand government should take positive steps to implement IUCN's World Conservation Strategy and a similar strategy by New Zealand, instead of paying lip-service to them. Action is required for implementation of policies. It should be recognised that there are limits to the development of resources and that there is an urgent need to instigate programmes which will lead to the sustainable use of all resources including botanical ones. It was recommended that New Zealand should adopt the findings of the United Nations World Commission on Environment and Development reported in 1987. Implicit in recognising these findings is a need by the New Zealand government to recognise the inherent conflict between market-oriented policies and their implementation through user-pay requirements, which give undue emphasis to economic issues to the detriment of social needs and the integrity of the physical environment.

It was felt that the self-interest and unbridled greed that market-oriented philosophies breed are anathema to a caring world. The occasional meaningless splitting up of government departments, creation of state-owned enterprises with their own narrow central concerns and the introduction of user-pay policies are examples of actions which may work against the integration and co-operative approaches which are necessary to further research and development of our botanical heritage. A call was therefore made for the Ethnobotany Workshop to reject market-oriented and user-pay policies and to inform governments of this rejection.

Recommendation 4

Addressed to: (a) Department of Scientific and Industrial Research (DSIR), New Zealand, (b) Commonwealth Science Council (CSC)

It was said that science should flourish for the benefit of all people and not for the profit of a few as was frequently propounded. Science must be accountable to the people, and they must establish research priorities by means of a thorough and constant consultation.

Training in social responsibility for all DSIR and other government scientists was recommended.

Recommendation 5

Addressed to: CSC and DSIR with regard to its involvement in the CSC Biological Diversity and Genetic Resources Programme

This recommendation was received as two submissions stated together because of their similarity.

- (a) To develop cultural exchange of plant uses among the 15 islands of the Cook Islands by holding two conferences, one in the northern group and one in the southern group of islands. The objective of the conferences would be to bring together the knowledge of plants related to such properties as medicinal, romantic, music, dance, legend, food and technology.
- (b) To prepare a list of all plants used in medicine, technology and nutrition in the Cook Islands.

Recommendation 6

Addressed to: CSC and DSIR

That CSC or DSIR should help to promote further studies on the traditional uses of Fijian plants and specifically support a programme on Kava and Yaqona and then cultural use by the Fijian people.

Recommendation 7

Addressed to: CSC

That CSC assist in undertaking a scientific study of the plants traditionally used in the Solomon Islands.

Specifically, a request was made to construct a Hoava Dictionary of Plants and Animals. The Hoava language is one of the bush languages in Western Solomons. The 400 people who speak this language have a considerable knowledge of the plants and animals of the land they occupy and this needs to be recorded.

Objectives of the proposed study would be:

- (a) To preserve the Hoava language
- (b) To record the local names of plants and animals from the few old people who know these names
- (c) To record the important uses of these plants and animals for food, fibre and medicine and record the means by which these were grown or harvested.

Recommendation 8

Addressed to: DSIR and CSC

This was presented on behalf of Niuean people resident in New Zealand.

It was requested that *Pandanus* be cultivated in New Zealand for weaving and medicinal purposes especially for use by Niuean people resident in New Zealand.

In making this request it was noted that 30,000 Niuean people are resident in New Zealand and only 2,000 in Niue.

Recommendation 9

Addressed to: (a) DSIR, (b) Director, National Museum of New Zealand, (c) Department of Education

It was felt that the following activities were pertinent to the CSC programme on Biological Diversity and Genetic Resources:

- (a) Development of operational policies which incorporate cultural elements, such as traditional use of land and plants. Such policies should also include employment of more Pacific Island staff.
- (b) Establishment of additional scholarships to train Pacific Island curators.
- (c) Determination of approvals entry criteria, selection procedures and the course content for such training. It should reflect an understanding and knowledge of the Pacific region cultures.
- (d) Research be conducted to establish the maximum growing requirements of various Pandanus species commonly used in the Pacific. Results of this should be fed back to women's organisations as well as to government departments concerned.
- (e) That an illustrated record be published of medicinal plants found in the Pacific. This is to include photographs of plants, local and scientific names, plus descriptions of uses.
- (f) That the findings of research into the traditional uses of plants, particularly for medicinal purposes, be publicised widely using the cultural network as well as the normal scientific channels so that:
 - (i) the value of the work done by traditional healers is given appropriate recognition
 - (ii) traditional healers are encouraged and promoted in their work
 - (iii) access to such practices are facilitated more readily.
- (g) That researchers be encouraged to actively promote and encourage the work of individuals such as taulasea or fofo who have been identified for valuable and effective healing practices.
- (h) That school science courses should include a study of the traditional uses of plants for food, clothing, housing, medicine, etc., in the Pacific.

Recommendation 10

Addressed to: (a) CSC, (b) CSIRO Australia, (c) Educational Departments

- (a) In Australia the CSIRO and botanists should work alongside aboriginal people in recording details of traditional plants and designing courses for young aboriginals to allow them to pursue careers requiring this knowledge. This will enable development of new schemes for employment.
- (b) That findings of research into the traditional use of plants for medicinal purposes

be publicised widely using the cultural network as well as the normal scientific procedure of publishing data.

Recommendation 11

Addressed to: CSC

Four recommendations, given below, were presented by the Aotearoa Moananui a Kiwa Weavers, which is a New Zealand national organisation of Maori and Pacific people concerned with the traditional uses of plants for weaving, craft and cultural purposes.

Submission 1 – A hui (workshop) be held near a National Park to allow people to see and discuss the forest plants in their natural habitat. In organising this steps should be taken to include local people and elders of that area, including elders connected to that area who may have moved away. This would require a considerable amount of planning and discussion with the local people.

Submission 2 – A hui (workshop) be held in which attention is focused on one or two plants or flowers. In this hui, each Pacific Island and/or Maori group, would be responsible for a day, or half a day, discussing plants from their island or region. It may be possible to focus on one plant common to all islands, e.g. coconut, by examining all known users, traditions, folklore, music, songs and chants.

Submission 3 – The CSC should examine ways to find support and/or funding to provide assistance to talented lay-persons wanting to learn certain scientific disciplines that will enable them to co-operate effectively in increasing the knowledge of traditional uses of plants.

Submission 4 – A future hui of this type should also involve ‘hands-on’ experience with plants and plant materials. It should take into account the changing use of plants from traditional to modern and involve their use for artistic purposes.

Recommendation 12

Addressed to: Commission for Sesquicentennial Celebrations in 1990

Some of the funds allocated for the sesquicentennial celebrations be used for establishing a national botanical garden as a place where native plants would be maintained. All people who love plants, from whatever background they come, can go to this garden and understand how to use and maintain these plants using existing methods.

It was also suggested that DSIR might take up this recommendation and convene a working group to foster the development of a National Botanic Garden of this type.

It was also suggested that delegates go back to their communities and organisations and contact the Commission for the Sesquicentennial Celebrations of the Department of Internal Affairs in support of setting up a National Botanic Garden.

This recommendation has been implemented.

Recommendation 13

Addressed to: (a) DSIR, (b) Plant Varieties Registrar

It was recommended that all DSIR experimentation relating to native plants be stopped, and that there be no further registrations of native plant varieties under the Plant Variety Rights Act, at least until after DSIR has completed a thorough consultation with the Tangate, concerning their wishes about the use of native plants.

Recommendation 14

Addressed to: DSIR

At an early date, preferably within the next six months, all the information emerging from the Ethnobotany Workshop be made available to all sectors of the Maori community so that they can use it for discussions in the next workshop. If given the opportunity to consider and discuss the subjects to be covered in that workshop the Maori people would be able to either endorse the recommendations made at that workshop or make new submissions for consideration and adoption.

Recommendation 15

Addressed to: DSIR

It was said that DSIR should look to the Treaty of Waitangi and its responsibility under the Treaty in the framing of these guidelines.

Recommendation 16

Addressed to: DSIR

The present DSIR Maori Steering Committee be dissolved and the Maori people be asked to nominate their own steering committee through the runanga structure in their traditional manner.

Guidelines be developed for scientists working in the area of ethnobotany, conservation and sustainable use of the local plant resources to enable them to interact effectively with the indigenous population having knowledge about the indigenous plant resources.

H. Regional Workshop on Conservation Biology for Humid Tropics

This workshop was held in Sri Lanka in 1988 to develop a specific curriculum for a training course in conservation biology for the humid tropics to supplement the main course developed at the Zambia workshop in 1987 (see E).

It was agreed that a regional manual should be developed, as a supplement to the general manual prepared after the 1987 workshop. It should have the following five modules:

- (a) Biological diversity and conservation
- (b) Target habitats and species
- (c) Life cycles, population dynamics and breeding systems
- (d) Population variability, maintenance and use
- (e) Data handling and documentation curriculum and references.

All these modules except (c) above have been prepared.

Details of each of the five modules are given below:

(1) Module 1

- (a) Biological Diversity and Conservation
 - (i) Concepts and definitions
 - (ii) Case Study – Restricted distribution of threatened endemics (IUCN Red Data Book Categories) in wet zone of Sri Lanka
- (b) Introduction to Conservation Strategies and Biological Conservation treaties and laws
 - (i) World Conservation Strategy
 - (ii) Regional and National Conservation Scenarios and Strategies

Exercise: Case Studies

- (i) Conservation Plan for the Sinharaja Forest prepared under WWF/IUCN Project 3307 by the Ministry of Lands and Land Development, Forest Department of Sri Lanka, and WWF/IUCN, Gland, Switzerland (1986)
 - (ii) Management Plan for coastal zone conservation in Sri Lanka prepared by the Department of Coast Conservation, Colombo (1987)
- (c) Distribution of Biological Diversity – Regional and National perspectives, e.g. Ecosystems – vegetation types of Sri Lanka. Crop Plants and their wild relatives – Rice, Rubber, Cinnamon, Oil Palm, Spices and Yams
Exercise: Visits to different Natural Vegetation sites and Agricultural, Plantation and Forestry Research Stations
 - (d) Existing and potential threats to Conservation of Regional Biodiversity
Case Studies: Sinharaja, Mahaweli Scheme – Sri Lanka
Exercise: Field visit to Mahaweli Development Area

(e) Synchronising Development with Conservation

Case Study: Natural Parks & Wild Life Sanctuaries in Mahaweli Development Area – Sri Lanka

Exercise: Field Visit to Mahaweli Development Area (to be combined with work area module 4)

Exercise Details for Module 1:

No. 1 3 Hours

No. 2 3 Hours

No. 3 3 Hours

No. 4 3 Hours

Field visits (in combination with module 2) to study Natural Vegetation Types

Field visit to Mahaweli Development Area.

(2) **Module 2**

(a) Target Habitats and Species for *in situ* conservation

(i) Choice of critical areas – Forest Reserves, Wild Life Parks, Man and Biosphere (MAB) Reserves – examples from the region to be used

(ii) Procedure for declaration of a protected area

(b) *Ex situ* Conservation sites, Establishment and Management

(i) Field/*Vivo* Sites

- Botanic Gardens
- Home Gardens
- Urban Parks
- Field Gene Banks

(ii) *Vitro* Sites

- Seed Gene Banks
- Cryo Preservation
- Tissue Culture

(c) Target Species and Centres of Diversity (criteria for selection)

Collection of information on:

- Traditional **rice** varieties
- Wild relatives of **rice**, fruits, spices
- Under-exploited plants
(*Chenopodium*, *Caryota*)
- Endangered Species (*Dioscorea*)

(d) Economic Analysis of Conserving a Plant Species *ex situ* vs *in situ*

Course work: 3 days

Exercise details: Field visits combined with module 1.

(3) **Module 3**

(i) Life Cycles, Population Dynamics and Breeding Systems

- (a) Plant life cycles
- (b) Population dynamics monitoring
- (c) Plant–animal and plant–plant interactions
- (d) Minimum viable populations
- (e) Seed viability and dormancy
- (f) Types of reproductive strategies
- (g) Role of vectors in pollination
- (h) Gene flow and maintenance of genetic diversity
- (i) Eco-physiology and biochemistry, medicinal plants, spices
- (j) Biological control

Course work: 3 days of course work

Exercise details: Field visits combined with module 1.

(4) **Curriculum for Module 4**

Population variability, maintenance and use

- (a) Exploration and collection
 - (i) Basic population genetics
 - (ii) Inter and intra population variability
 - (iii) Sampling theory for **oil palm, yam, rice and calamus**
- (b) Maintenance and evaluation
 - (i) Theory lecture on evaluation and maintenance
 - (ii) Experimental designs (field trials)
 - (iii) Descriptors list for **oil palm, yam, rice and calamus**
- (c) Utilisation
 - (i) Theory lecture on utilisation
 - (ii) Utilisation of **oil palm, yam, rice and calamus** will be illustrated as course studies

The oil palm, yam, rice and calamus will be used as case studies. The studies will consist of field visits to habitats; demonstrations of field collection and recording techniques; and procedures for carrying out field trials for evaluation and some practical exercises on these. The oil palm study will concentrate on analysis of sample data in the laboratory, while field sites will be for yam, rice and calamus.

Course work: 2 days of Lectures

Exercises: Field visits combined with Module 1.

(5) Module 5

Documentation and information management system for plant genetic resources

- (1) Sri Lanka National Gene Banks information system based on dBase III software should be used
- (2) A system based on an appropriate 4 GL software, e.g. 'Oracle', will be developed by Palm Oil Research Institute of Malaysia for demonstration
- (3) Database set up by the International Board for Plant Genetic Resources (IBPGR) should be used.

I. Workshop on Tropical Forest Ecology

The above workshop was held in Lae, Papua New Guinea, in 1988, to prepare a Tropical Forest Action Plan for integrated research, education and training in many aspects of tropical forest management in the Pacific Island region, with emphasis on both traditional and commercial utilisation of fruits, their conservation and regeneration.

Major problems of inventory, land tenure, unwise exploitation and lack of biological or sociological understanding were identified and discussed in many differing contexts throughout the region. Project proposals incorporating research and training among all levels of forest policy makers, managers, users and occupiers were shaped into an Action Plan for Tropical Rainforest Ecology and Management, within the region.

Objectives of the workshop were:

- (1) To review advances in tropical forest research, especially current concepts of the regeneration dynamics of tropical rainforest ecosystems.
- (2) To discuss current forestry and land resource management of systems, in particular to review their success in terms of resource use, conservation and maintenance of both wood and non-wood values.
- (3) To carry out seminars and training exercises to inform student participants and forest resource managers of recent ecological principles and scientific methods.
- (4) To promote the need for an ecosystem approach to land resource management, training and research, including development of an action plan to implement such an approach.
- (5) To foster personal interactions among land resource managers, social and economic planners and forest scientists.

Specifically, the workshop comprised three phases:

- (i) A five-day training course in Data Collection and Processing in Tropical Rainforests, principally for local and regional participants as foresters and land resource managers.
- (ii) A three-day seminar on Tropical Forest Ecology and Management, using scientific resource persons and senior forest managers to address perspectives of natural and plantation forest silviculture, forest inventory and planning, ecosystem processes and environment protection, social and cultural evaluation of traditional forest management practices, and socio-economic aspects of commercial forest exploitation, in the region.
- (iii) Two-day meeting to discuss collaborative and multi-disciplinary research and training opportunities in the Pacific Island region, concluding with the draft Tropical Forest Action Plan, as appended.

Recommendation: The workshop concluded with the preparation of the draft Tropical

Forest Action Plan which gave specific action in seven areas that need to be taken for sustainable utilisation of the forests in the region. These are given below:

1. Planting/restoration/rehabilitation/redevelopment

Steps need to be taken for:

- (a) Experimental restoration of degraded ecosystems, including logged-over forest, heavily and badly degraded forest and grassland.
- (b) Experimental introduction of valuable species among replicated sites within the region, e.g. *Terminalia kaernbachii*. Introduction of multiple use species.
- (c) Studying cultural impacts of restoration.
- (d) Comparative studies on sustainable utilisation of forests within the region.
- (e) Implementation of a forest tree plantation programme to provide sustainable supply of wood to reduce pressure on natural tropical forests.
- (f) Implementation of social forestry techniques for production of food, and harvest of wood and other forest products, e.g. rattan, fruits, mushrooms, etc., in a sustainable manner.
- (g) Integrating traditional agroforestry techniques with modern logging practices.

2. Protected areas/environmental protection and environmental services

The following tasks are required to be undertaken:

- (a) Investigation and development of potential genetic resources for better utilisation for human well-being.
- (b) Development of a comprehensive system of parks and protected areas in the region for conserving representative tropical forest ecosystems for their potential economic, social and cultural value to mankind.
- (c) Development of workable systems to assign values to tropical forests for all purposes.
- (d) Introduction and use of conservation biology as a discipline for managers, scientists and technicians concerned with managing this sustainable utilisation of forests.
- (e) Study of positive and negative impact of tourism on tropical forests.

3. Social and cultural interactions with forests (including legislation and economic valuation)

Steps should be taken to:

- (a) Encourage the implementation of procedures to promote public participation in decisions affecting the future of tropical rainforests in the region.

- (b) Develop guidelines for appropriate legislative and institutional mechanisms to enable full participation of people in the management of the resources.
- (c) Study traditional land tenure and use rules and see their influence on the long-term management of the total forest resource.
- (d) Develop appropriate means of conserving cultural diversity as well as biological diversity.

4. Natural Forest Management

Steps need to be taken to:

- (a) Carry out a comprehensive resource inventory inclusive of both wood and non-wood components.
- (b) Classify the resources in respect to social, cultural and biological aspects.
- (c) Study biological processes in the ecosystems.
- (d) Develop appropriate management systems for timber production by:
 - (i) applying improved logging techniques to minimise adverse environmental impacts
 - (ii) studying growth and yield
 - (iii) developing appropriate silvicultural systems
 - (iv) studying natural regeneration techniques
 - (v) enrichment planting techniques (nursery practices, rate of arrival, spacing, costs, etc.)
- (e) Promote the understanding of ecological processes and their limits to ensure natural forest management systems are both economically and ecologically sustainable.
- (f) Maintain representative samples of reserves and protected areas within managed forest areas for carrying out studies to understand integrated resource forest management systems and the associated social systems.
- (g) Study the impact of various types of land uses in relation to productivity of soil and nutrient, water resources, wildlife habitat and people.

5. Co-operation for Education and Training among countries in the region

Action should be taken to:

- (a) Develop appropriate training courses for all levels of forestry and forest resource management.
- (b) Identify and promote collaborative research.
- (c) Organise seminars and workshops for decision makers, planners, resource managers and resource owners/users.

6. Development of University of Technology (UNITECH) at Lae as an information centre for the Pacific nations and as a centre for the development of tropical forestry education
 - (a) To collaborate with (University of Papua New Guinea) UPNG, Bulolo College and PNG Forestry Department.
 - (b) To develop library resources.
 - (c) To initiate a three-monthly circulation of 'contents' of journals and to provide a copying service for requests of articles for research and development.
 - (d) To establish a research school for Tropical Rainforest Studies.

7. Establishment of a centre for Tropical Rainforest Studies in the Pacific Island nations

Action was required to:

 - (a) Identify and direct resources into the centre.
 - (b) Promote the study of rainforests as a comprehensive resource leading to a broad concept for the management of the rainforest ecosystems.
 - (c) Affiliate appropriate research persons with the centre.

J. International Workshop on Identification of Key Species for Conservation and Socio-Economic Development

An international workshop was held in 1989 in Trinidad & Tobago on 'Identification of Key Species for Conservation and Socio-economic Development' jointly with IUCN. In view of the importance of the concept of key species relevant details pertaining to the above workshop are given below.

Background

Keystone Species

In most ecosystems, certain species exert a controlling influence out of proportion to their density as biomass over the overall diversity and long-term stability of their ecological communities. Identifying those critical species is one major objective of the IUCN Conservation Science Programme for the next triennium.

Unfortunately, keystone species are difficult to identify: they are not usually the most abundant, nor the most striking or glamorous, members of the community. Further, they do not belong to a particular ecological type: in a given ecosystem, the keystone species might include top carnivores, decomposers, herbivores, pollinators or some of the plants. Up to now, except for a few celebrated experiments, keystone species have been discovered accidentally, following their removal – via harvesting, or replacement by an introduced species – from the habitat.

The workshop was organised to examine how to undertake a systematic analysis of all such cases, to decipher the underlying mechanisms at play so that it would allow us to predict, within reliable limits, the potential keystone species in the major biomes and habitats. A likely spin-off of this effort is to develop a co-ordinated research programme, based on controlled experimental perturbation, to verify such predictions in an integrated programme worldwide.

Life Support Species

Many species display distinct adaptations to environmental extremes, as they are able to grow and reproduce under such conditions as drought and desertification, flood, water pollution, soil toxicity and high salinity. Among such species a number can provide sources of food, materials and energy to human, livestock and other animals, and so are of considerable potential benefit to man. Those species are referred to as life support species. As such, they naturally include keystone species since these hold the key to the integrity of landscapes which include both the diversity of living biota and the human communities.

The potential value of life support species is only now beginning to be appreciated, and has yet to receive the proper attention of agroforesters, aquaculturalists, and more generally from ecological and environmental scientists. For example, of a global total of some 80,000 edible terrestrial plants, only about 150 species have ever been cultivated on a large scale, and over 90% of the world's food is produced from less than 20 species.

In CSC's regional workshop on 'Maintenance and Evaluation of Life Support Species' in 1987 it was highlighted that there are no integrated inventories and studies available worldwide to allow for the use of life-support species. It was observed that there was, therefore, an urgent need to develop a strategy for action to collect information, and focus research priorities on key species that are most critical as:

- (a) keystone species to maintain the ecological integrity of ecosystems; and
- (b) life support species to ensure human survival under environmental stress (e.g. drought, water pollution, soil pollution, etc.)

In spite of their far-reaching potential, key species as a whole have never been systematically studied. Three key areas of study are:

- (i) identification and monitoring
- (ii) preparation of inventories
- (iii) application in native environment and the potential for introduction to new environments to promote national socio-economic goals.

To prepare the necessary groundwork, a workshop was organised jointly by IUCN and CSC in which 20 leading international experts on the subject were invited from the respective networks of both organisations (Commission on Ecology and Species Survival Commission for IUCN, Network on Biodiversity and Genetic Resources for CSC).

Workshop objective

The workshop objective was to examine and develop guidelines and methodologies as follows:

- (a) to develop systematic analysis of key species which play a controlling influence on biotic communities (including human) especially in terms of stability, resistance and resilience through their important linkages.
- (b) to identify and develop priority action on those species which present life-support value to rural people (especially in tropical environments).
- (c) to develop the application of information for use in the identification mechanisms and processes underlying occurrence, maintenance and survival of these key species by initiating co-ordinating research on (1) theoretical/predictive approaches, (2) experimental approaches and (3) socio-economic approaches.
- (d) to develop specific research programmes for terrestrial (forests, agro-ecosystems, etc.) and aquatic environments with emphasis on problems of (1) drought, (2) emergency, (3) flooding, (4) toxicity of soil, (5) water and soil pollution, etc.

Several observations for preparing an Action Plan for the identification of key species were made. These are given below:

- (1) Along with the degradation of ecosystems worldwide, thousands of species, and even more genetic variants, are being lost. The main causes of this destruction are rapid

growth in human population, unsustainable levels of resource consumption by the relatively affluent, and the impact of the increasing numbers of people struggling to survive.

- (2) Some of the species (or species groups) under threat possess special economic or cultural significance, and are essential for the survival of the ecosystems and landscapes in which they occur. They are therefore regarded as 'key' species.
- (3) Conservation and integrated development strategies are needed to halt the biological impoverishment of the planet. Unless human numbers are stabilised and consumption levels are brought into balance with environmental capacities, any conservation strategies will be ineffective.
- (4) Conservation efforts to save species and maintain ecosystems have expanded in recent years. Historically, these efforts have tended to focus on the rare and the beautiful species. Today, there is increasing concern for species having particular ecological, economic and cultural significance. Although conservation priorities are recognised for species of obvious economic importance, such as rice, eucalyptus, cows or catfish, many other species of key ecological and socio-economic importance will be lost unless action is taken urgently, within the next five years.
- (5) The objectives of the workshop were considered in the following three ways:
 - (a) to begin to identify such species
 - (b) to define the most urgent research priorities
 - (c) to identify priorities for conservation/development action.
- (6) A small, but unknown fraction of the world's total of several million species has a disproportionately important role in the ecological processes that maintain the totality of life on this planet. It is important to relate human life and biological diversity to the sustainable ecological and social systems of the Earth. The species that do this are called 'ecological key species' (or 'amplifier species').
- (7) Similarly, another unknown fraction of the world's species, used by people for food or for their culture, makes a disproportionate contribution to people's social and economic well-being. Such species are called 'socio-economic key species' (or 'service species').
- (8) Both ecological and socio-economic key species are 'Life Support Species'. Conservation of these key species will result in the conservation of many other species and assists in the survival of human communities.
- (9) Ecological key species and species groups are key with respect to certain major natural processes, particularly:
 - (a) organic production
 - (b) nutrient accumulation
 - (c) habitat structuring
 - (d) colonisation
 - (e) herbivory
 - (f) pollination

- (g) seed dispersal
 - (h) decomposition
 - (i) predation
 - (j) defence against parasites and predators.
- (10) Socio-economic key species and species groups are key with respect to certain categories of use, particularly:
- (a) commodities (important economic products such as food, animal feed, fibre and medicines)
 - (b) genetic resources (source of new domesticates and of improvements to established domesticates, and of potential value in biotechnology)
 - (c) cultural value (significant contribution to the spiritual, emotional, and/or psychological lives of people)
 - (d) environmental management (use by people to modify, stabilise or rehabilitate environments).
- (11) Certain species and species groups are key both ecologically and socio-economically (and some ecological and socio-economic key species are important in more than one of the categories listed in (9) and (10) above).
- (12) Key species and species groups are usually specific to particular ecological, cultural and economic circumstances. In other words, there are few, if any, universally key species. Likewise, one cannot anticipate which species, or which genetic variants, might become significant in the future. In other words, species not considered important today may become key tomorrow.
- (13) Although we know a large number of socio-economic species, knowledge of key species among them is highly fragmented and often limited to their immediate users. We know much less about ecological key species and can identify only a few. Improving our knowledge of key species is essential; the starting point is in their recognition.
- (14) Because of the rapid loss of species and reduction of genetic variability, direct conservation action is needed now, not next year or sometime in the future. At the same time, international research co-ordination to identify key species is called for. The sooner the results of research can guide action, the better it will be for the sustainability of human life on this planet.

Recommendations

The workshop recommended that:

- A strategy for conservation and sustainable use of key species and species groups should include the following six points:
 - (a) Management and protection of those areas where key species and species groups occur should ensure their long-term survival, at the same time recognising the needs and rights of the local human population.

- (b) Conservation plans to identify and maintain migratory key species should be developed.
- (c) In human-modified ecosystems, the contribution of agriculture, silviculture and aquaculture to the maintenance and genetic improvement of socio-economic key species should be encouraged.
- (d) In degraded land, restoration through the use of key species and species groups, particularly nutrient accumulators and colonisers, should be promoted.
- (e) The most efficient and best adapted species (and genetic variants of such species and other species) should be identified.
- (f) Native species and genetic variants of native species should be investigated and tested before using exotic species.

Particular attention should be paid to three groups of key species:

- (i) species that serve as both ecological and socio-economic key species
- (ii) threatened ecological and socio-economic key species
- (iii) key species with known, yet unfulfilled, socio-economic potential.

- Governments should promote the identification of both ecological and socio-economic key species, and assess their ecological and socio-economic contribution, within their own countries.
- Governments should support those local socio-economic systems that are actually or potentially compatible with the maintenance of key species, and explore with the local people involved ways of supporting such systems sustainably.
- Governments should determine which key species are adequately maintained in the protected area system of their country, and should as a matter of priority make adequate provision for the conservation of those species that are not adequately protected.
- Governments should ensure that the germplasm of key species is properly collected, conserved and made available including, where appropriate, through captive breeding programmes.
- Regardless of their socio-economic importance, species should not be translocated to new biogeographic provinces (whether marine or continental) without stringent evaluation of the likely ecological consequences.
- The relevant international agencies should promote the international co-ordination of research programmes and information systems concerning key species.
- National and international NGOs should consider and advocate the most effective way to promote the conservation of key species.
- NGOs should promote the information gathering process on, and the conservation of, key species at the local community level, with particular emphasis on the perceptions and practices of indigenous peoples, recognising especially the contribution that women make in this process.
- A major research effort is required to identify ecological key species in natural and

semi-natural ecosystems. A much better understanding of how key species influence the diversity and structure of major ecosystems is needed.

- Research should be carried out on ways of using native key species, exploiting their fullest genetic variability, for socio-economic development activities such as in silviculture, cyclical agriculture, aquaculture and land rehabilitation.
- The range of genetic diversity in key species be assessed for its potential use and conserved in perpetuity, incorporating modern developments in biotechnology as appropriate.
- Research on the ecological implications of global change must be closely integrated with research on key species and their conservation in a changing environment.

K. Regional Workshop on Conservation Biology

The above workshop was held in 1989 in Lusaka, Zambia. At this workshop, the draft edition of the general training manual on Conservation Biology was reviewed. Also, two additional curricula for regional training courses and training manuals on conservation biology for the SADCC Africa region targeted for senior scientists and field extension workers were prepared. Details of these are given below.

Details of Course Contents Developed for a Regional Training Manual in Conservation Biology

Manual Aimed for Trainers of Field Extension Workers

The course will consist of a common 'stem' course which can be followed by optional specialist sections (e.g. genetic conservation, wildlife conservation or forest conservation).

Principles of Resource Conservation

- a) Definition of natural resources (e.g. renewable, non-renewable, land, water, biological)
- (b) Use of natural resources (uses in agriculture, forestry, fisheries)
- (c) Objectives in resource use (short-term and long-term returns).

Socio-economic Implications of Conservation

- (a) Definition of development (economic and ecological)
- (b) Human population growth patterns and resource carrying capacity
- (c) Environmental impact assessments and their role in conservation
- (d) International trade in biological resources and its implications on conservation.

Ecological Principles of Resource Management

- (a) Energy flow
- (b) Nutrient cycling
- (c) Biotic interactions (competition, production, etc.)
- (d) Community dynamics (succession, etc.)
- (e) Population and species dynamics
- (f) Biological diversity.

Quantifying Resources

- (a) Land inventories and allocation
- (b) Inventories of biological resources (communities and species)
- (c) Changing patterns of resource use (changing patterns of land, energy, etc.)

Uses of Land

- (a) Agriculture (environmental, economic and social constraints)
- (b) Forestry (systems of forest production, constraints to production)
- (c) Water capture (water catchments, rocks and reservoirs)
- (d) Fisheries (types of fisheries and their management)
- (e) Game management
- (f) Range management
- (g) National reserves.

Interactive Land Uses

- (a) Agriculture and forestry
- (b) Agriculture, forestry and wildlife
- (c) Agriculture, forestry and water capture.

Uses of Biological Resources

- (a) Plant resources in agriculture (crop and grassland species)
- (b) Animal resources in agriculture
- (c) Plant resources in forestry
- (d) Plant and animal resources in fisheries
- (e) Wildlife management
- (f) Range management
- (g) Soil as a living resource.

Conservation of Biological Diversity

- (a) Current and future values of biological diversity
- (b) Objectives in conserving biological diversity
- (c) Types of conservation (*in situ* and *ex situ*)
- (d) Levels of diversity and casual factors.

Methods of Genetic Conservation

- (a) Sampling of *ex situ* conservation
- (b) Sampling for *in situ* conservation
- (c) Preserving seed material; preserving vegetation material (e.g. tissue culture)
- (d) Multiplication of material
- (e) Evaluation of material
- (f) Documentation.

Guidelines for Preparation of Papers

The main guidelines are covered in the syllabus of the Regional Training Manual.

(a) Purpose of Manual

The global core training manual for conservation biology has adequately covered the theory and principles of conservation biology. It is most useful for training scientists and trainers. There is need to supplement it with practical regional and local examples that are essential in training extension workers and land users. For which a supplementary manual, i.e. regional training manual for Southern Africa, is therefore necessary as a basis for strengthening training in conservation biology in the region especially for trainers of field extension workers.

This manual is targeted at resource managers in the region with a minimum qualification of at least a diploma in biological sciences and/or agricultural sciences. The main objective of the manual is to provide guidance to trainees in the conservation of biological resources, including fields such as agriculture, forestry, wildlife, range management, soil conservation and genetic resources. In order to meet this objective, papers prepared for the manual should emphasise the practical aspects of conservation biology with a minimum of theory. The papers should draw upon local conservation examples and practices. This will greatly enhance its relevance as a practical training manual.

(b) Length of Papers

Papers should be written in simple English with a maximum of 15 typed pages at double spacing.

(c) Content

Each paper should attempt to answer the following questions with the aid of as many examples as possible:

- (i) What is conservation?
- (ii) Why do local people conserve a particular resource?
- (iii) What are the existing uses of the resource?
- (iv) How do the local people manage the resource?
- (v) Is the management objective aimed at short-term or long-term benefits?
- (vi) How can the management strategy be improved in order to achieve optimum use and long-term sustainable utilisation of the resource?
- (vii) What are the linkages between the particular resource utilisation pattern and the uses of other biological resources?
- (viii) How can the proposed management strategy assist in the conservation of biodiversity and/or genetic resources?

L. A Training Workshop on Standardised Methodologies for Survey and Documentation of Locally Used Plant Genetic Resources in Africa

This workshop was held in May 1989, in Ibadan, Nigeria. The workshop's aim was to identify training needs and develop project proposals for the survey and documentation of locally used plant genetic resources. The following recommendations were made:

- (1) A survey of all African countries be conducted on the existence of gene banks or institutions working on under-exploited plant species and the status of the existing collections.
- (2) Survey of the availability of existing gene banks that can preserve the germplasm of under-exploited crops.
- (3) Research or survey be made on the most efficient method of propagating the materials for multiplication and maintenance.
- (4) It was pointed out during the workshop that it is possible to preserve seeds of some species for long periods (up to 50 years or more) in a very economical way. This is to dry seeds to a very low moisture content of 4% (for orthodox seeds), then seal the seeds in airtight containers and store at a temperature of 20°C, which can be achieved by the ordinary wall or split-type office airconditioners. National programmes of the developing countries should explore this method of conserving national germplasm.
- (5) Survey and research on seed and *in vitro* conservation standards or methods.
- (6) To formulate strategy of establishing national *in situ* conservation programmes.
- (7) It is essential that any available material be documented for at least the passport data. The characterisation and evaluation data should be documented when available.
- (8) The simplest way of documenting the passport information is by recording the information in a log book or cards if a computer facility is not available.
- (9) It is essential to use a computer facility to document large volumes of germplasm data. Minicomputers as well as many types of software suitable for data documentation and retrieval are now available on the market and are not too expensive to acquire. National programmes with limited resources are encouraged to use minicomputers for germplasm documentation.
- (10) It is useful to establish an international standardisation documentation system including software packages for worldwide exchange of information. Institutions such as IBPGR may be requested to co-ordinate this activity.
- (11) It is recognised that some African countries lack qualified and experienced personnel in both conservation and documentation. Accordingly, it is suggested that development of trained manpower is important.

Training Needs

The great potential for the utilisation of under-exploited plants has been recognised. They can be used to extend productive agriculture into areas that are now unsuitable for cultivation. Improvement of plant species adapted intrinsically to fragile ecosystems, e.g. arid areas, for

better performance will solve some of the inherent problems of such countries and areas. The limited resources of poor nations can be used to build a simple agricultural base with the under-exploited plants rather than embracing technological agriculture.

There has been a concerted effort to collect, conserve and utilise the genetic resources of major crops. This effort in Africa has been the responsibility of the International Agriculture Research Center (IARC). The International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), with headquarters in Andhra Pradesh, India, and regional centres in Malawi and Zimbabwe, etc., are also involved in this effort. However, there is urgent need to collect and conserve the genetics resources of the under-utilised plants.

The need for surveys and collection programmes is becoming critical as the genetic resources of these plants face imminent genetic erosion. This is due to several factors including natural disasters, overgrazing, destruction of natural habitats and competing demands for land as a result of population growth and development.

One of the major constraints to the effective conservation and utilisation of plant genetic resources in Africa is the shortage of trained manpower at the different levels of involvement in plant genetic resources conservation. There is therefore urgent need for a centre in Africa for short-, medium- and long-term training of personnel geared towards individual country needs.

M. International Workshop on the Biodiversity of Micro-organisms and Invertebrates, and Its Role in Sustainable Agriculture

An international workshop on 'The Biodiversity of Micro-organisms and Invertebrates, and its Role in Sustainable Agriculture' was organised in 1990 in Britain, jointly with CAB International. The workshop reviewed the status of biodiversity among invertebrates and micro-organisms, assessed how agricultural and other changes are affecting it now and may affect it in the future and made recommendations about what action needs to be taken by scientists and governments to improve knowledge and determine future action.

Recommendations

There is a well-recognised need to maintain a stable base for agricultural production, which is increasingly jeopardised by the worldwide changes in land use, population growth and its demands on the environment and the threat of climatic change. The range of diversity contained among the fauna and flora, and certain special habitats, are at particular risk.

Much attention has been focused on the loss of biodiversity among vertebrates and higher plants, where changes in habitat produce easily observed losses in the diversity of species present. Actual losses in numbers of species are likely to be much greater among the less readily observed invertebrates and micro-organisms living in the soil and within the forest canopy. These organisms, while less ornamental, play an exceedingly important role in maintaining and promoting soil fertility by recycling the nutrients contained in decaying organic matter, by fixing nitrogen from the air and by detoxifying pesticides and other waste products. They are also an essential source of many valuable products, such as antibiotics and other pharmaceuticals, and have an important role in most biotechnological and bio-industrial processes.

The workshop reviewed the importance of biodiversity among invertebrates and micro-organisms, what is involved, why it is useful and how it can be preserved and better used. The following summarises the main findings (which should be of interest to scientists and policy makers alike):

- (1) The needs of human populations for food, fuel and fibre have historically been supported, directly or indirectly, by genetic diversity among the micro-organisms and invertebrates. These organisms perform functions which prime and fuel the metabolism of soils, plants and animals. The development of sustainable agro-ecosystems and the enhancement of agricultural productivity will depend increasingly on the maintenance of such diversity for:
 - (i) The improvement of soil structure and fertility, through the decomposition of organic material added to the soil, and the detoxification of pesticides and other pollutants
 - (ii) The provision of biological controls for insect pests and diseases of plants and animals
 - (iii) Processing and enhancing the nutritional value of foods
 - (iv) Maximising the potential for novel products for use in the pharmaceutical and other industries.

- (2) We need to increase our knowledge of the nature, extent, functions and potential usefulness of the genetic resources to be found in micro-organisms and invertebrates and how to protect different ecosystems as reservoirs of such biodiversity.
- (3) To do this will require that:
 - (i) Existing genetic potential in invertebrates and micro-organisms is conserved by the preservation of natural and man-made systems and sites, and where there are difficulties in recovering micro-organisms from the environment, by maintaining culture collections of organisms of current potential value*
 - (ii) Research is undertaken on the measurement of the diversity of organisms, and of the gene contained, and to identify the ecological interactions and the role played by different organisms in agricultural and natural systems. This is particularly pertinent for pest management and, for example, in the role of fossil organisms involved in the restoration of degraded lands, the decomposition of carbon compounds and the evolution of carbon dioxide and other greenhouse gases. The likely effects of climatic change on the activities and conservation of invertebrates and micro-organisms, their migration and the development of new associations are, as yet, almost wholly undeciphered. While their involvement in the release of carbon dioxide and other greenhouse gases is well established, much remains to be learnt of the factors controlling the quantities and rates of release, and of the organisms involved.
- (4) Knowledge of the functional role of many micro-organisms and invertebrates in agricultural and other ecosystems is inadequate. Limited understanding of their role in ensuring the continued stability of ecosystems requires that much more research be conducted to obtain the information which will enable the importance of biodiversity to be assessed and managed so as to promote the sustainability of agricultural production.
- (5) The promotion of biodiversity alone will not eliminate the need for improvements in production and husbandry measures. It will, however, contribute to the development of diverse systems able to sustain a low level of production on marginal lands, while making more sustainable the robust, high production systems of more fertile areas, and minimising the need for external inputs.
- (6) Habitat disturbance, pollution and climate change all cause changes in the biological population, particularly in ecologically sensitive areas. Invertebrates and micro-organisms need to be monitored to follow the effects of these changes. They can be used as indicators of the stress applied to the environment.
- (7) Current capabilities for the recognition, characterisation and study of micro-organisms and invertebrates are insufficient to meet current needs. The need to support effective conservation and utilisation of biodiversity requires development of skills in biosystematics and related disciplines worldwide.

* The Workshop noted the work of IUCN (the World Conservation Union) and the World Federation for Culture Collections (WFCC) on these topics, and stressed the need to consider micro-organisms and invertebrates more fully in the selection of reserves.

The shortage of biosystematists can be accommodated in the short term only by the fullest collaboration between centres of expertise. This may best be done through the establishment of a formal Network of Biosystematic Centres. This will involve the strengthening of existing centres of activity, and the development of new centres through training, infrastructure building and information transfer.

- (8) The benefits to the human race of retaining a wealth and diversity of biological resources should be more clearly recognised. There is particular need to promote an understanding of the potential of invertebrates and micro-organisms for advancing human welfare. It is known that improved management of land and other resources, through the imaginative use of biodiversity, can increase the efficiency of agricultural production and so improve social and economic welfare. Soil organisms have provided a wealth of valuable products such as antibiotics, and much remains to be learnt of the value of the products which may be obtained from the vast biological resources of the natural world.
- (9) Education and training must reflect the need to increase awareness of the significance of biodiversity in agriculture and the environment, including the problems of protecting ecologically vulnerable areas. This may be achieved by regional and national policies for primary and secondary education. The media and local natural history and conservation societies also have an important role in complementing and augmenting such policies, and may help to stimulate their initiation.
- (10) Information systems are essential for recording, interpreting and making available the accumulated knowledge on biodiversity. The specific needs include:
 - (i) Research on the most appropriate ways of recording, collecting and interpreting data and for disseminating information through participatory networks
 - (ii) Standardising methodologies for the collection and recording of information
 - (iii) Co-ordinating and implementing the acquisition of information
 - (iv) Co-ordinating and implementing the dissemination and networking of information.

The standards being developed by the International Union of Biological Sciences (IUBS) through its Taxonomic Databases Working Group may be particularly valuable in relation to the needs.

- (11) Biodiversity covers immense and complex issues in which many agencies and institutions are active worldwide. There exists a need for an international mechanism to co-ordinate, analyse and disseminate the relevant information. This will include:
 - (a) The standardisation of scientific and information methodologies
 - (b) The processing of information on the significant hazards to the protection of biodiversity
 - (c) The monitoring of worldwide activity relevant to biodiversity and its application

- (d) Promoting protocols for the control of the release of exotic unfamiliar organisms
 - (e) Recommending courses of action to ensure the protection of indigenous property rights and assurance of fairness for those whose survival, social and economic welfare depend on the conservation and prudent employment of natural resources
 - (f) Ensuring that resources are directed to enable developing countries to implement an optimum course for the sustainable utilisation of their natural resources.
- (12) It is hoped that these findings will be considered for inclusion in the Agenda of the United Nations Conference on Environment and Development in 1992, and other appropriate initiatives.

N. Workshop on Conservation through *In Vitro* Methods

The above workshop was held in May 1990 in Kuala Lumpur, Malaysia.

Aims and Scope of the Workshop

- (1) Plan and formulate strategies for the conservation of biodiversity and plant genetic resources in the Asia-Pacific region through *in vitro* methods.
- (2) Review and standardise protocols for genetic conservation through tissue culture techniques and molecular biology, and to facilitate germplasm exchange.
- (3) Develop course material for future training and manpower in conservation of genetic resources through tissue culture and molecular biology.

Observations and Recommendations

The workshop observations and recommendations are grouped into the following categories:

- (a) Plant species priorities
- (b) Characterisation of genetic diversity and diagnostics
- (c) *In vitro* technology
- (d) Storage of germplasm
- (e) Human resources development and training.

Plant Species Priorities

(1) *Gaps in application of technology and future prospects*

In some crop and tree species the techniques for conservation are available, but not in others. The technology needs to be transferred to countries where the technique is just being developed. It was felt that the technique of disease elimination and indexing is available in some centres but the technology should be made available to developing countries. It is also necessary to do some characterisation and testing of the generated plants.

(2) *Prioritisation of plant species*

The plant species were classified into three groups. The first group consists of plants with endangered field gene banks (arboreta, botanic gardens and others). These include taro, sweet potato, yam, banana, sugarcane, mango, durian, timber species, rattan, bamboo, *pandanus*, industrial and medicinal plants. The second group consists of plants located in endangered natural populations due to shifting cultivation, deforestation and over-exploitation. Timber species, fruit trees, medicinal plants and wild relatives of cultivated plants fall into this group. The third group consists of unidentified potential species.

It was agreed that *in vitro* technology should be explored for those plants which cannot be conserved by conventional means.

(3) Centres of excellence

The three research institutions in Malaysia, RRIM, PORIM and FRIM, were identified as centres of excellence for rubber, oil palm and forestry. MARDI is noted for research in other crops. In the Philippines, IRRI is well known for research on rice, UPLB for tissue culture in general, PRCRC for root crops and sugarcane and the Philippines Coconut Authority for coconut. In India, CIMAP is known for medicinal plants, National Botanic Research Institute, Lucknow, for economic plants and NCL, Pune, for tree and plantation crops.

(4) Linkages with on-going programmes in the region

It is necessary to survey the existing activities in the region and to explore the possibility of promoting linkages among different agencies and countries where the relevant technologies are available.

Characterisation of Genetic Diversity and Diagnostics

Diagnostics deals with disease and past resistance whilst characterisation normally refers to general terms of characterisation of genetic diversity.

Currently, characterisation techniques are morphological (e.g. qualitative characters), physiological (e.g. isozymes, storage proteins), cytological (e.g. chromosome count, cDNA banding) and molecular (e.g. RFLPs). Techniques for diagnostics are nearly the same as that for characterisation except for some others like ELISA. Nearly all of these are well established, except for RFLPs which have been worked out in certain crops such as cereals (rice, wheat, barley and corn), vegetables (tomatoes and lettuce) and several field crops (sugar beet, soybean and potatoes). Some attempts to use RFLPs have also been made in tropical plantation species such as rubber and palm oil.

Most of the advances in the development of the above techniques were made in the developed countries or in the various international agricultural research centres. There is, therefore, a need to establish a linkage between researchers in the developing countries and their peers located in these institutions. It is also recognised that there should be a regular exchange of information among scientists using the above techniques, e.g. through a newsletter, which may give very useful hints and thereby save a lot of time and money. Regular scientific meetings and/or short courses at the regional or national levels should be organised from time to time.

***In Vitro* Technology**

(1) Recommendations

- (i) The community at large should be educated on the importance of conserving germplasm. It was realised that the scope of this recommendation may not be within the purview of this conference. However, it was felt that in order to ensure that germplasm is recognised as being important, basic educational programmes should be established not only in this region but throughout the world.

- (ii) *In vitro* conservation should not be separated from other conventional methods of conservation, most of which are already in existence. *In vitro* technology does have a place in conservation but it must be incorporated into an overall strategy in which other conventional methods are being used.
- (iii) Basic *in vitro* studies need to be undertaken of the plant systems that need to be conserved, in order to maximise the success of conservation.

(2) Uses of *In Vitro* Technology

Uses of *in vitro* technology were discussed under three headings: culture and regeneration, utility in terms of propagation and somatic exchange, and *in vitro* collection.

(i) Culture and Regeneration

■ Routine techniques

In terms of culture and regeneration, there are a series of routine methods that can be used. There was no universal method to regenerate plant systems in all species. In South-East Asia much progress has been made in the culture and regeneration of crop, forest and herbaceous plants, and a high level of expertise has been developed in this area. In order to preserve genetic fidelity, rigorous screening of the plants needs to be undertaken. This will ensure that abnormalities are minimised. *In vitro* approaches may give rise to variation but it will still allow a significant proportion of the germplasm to be preserved.

■ Successes

Several examples of successes in the regeneration of plantlets were cited for cassava, sweet potato and banana.

■ New emerging techniques

A technique which is not widely used in South-East Asia is electro-enhancement of tissues. This could be used to further stimulate regeneration of species which show limited regeneration in culture.

■ Information dissemination

Each country needs some form of organisation to collect and disseminate information on the progress made on *in vitro* studies, particularly on the techniques used for germplasm storage. Above all, a network should be established in each country so that information could be disseminated rapidly between workers. There are commercial implications of this but this has to be dealt with at the commercial organisation level. Sufficient technical workers are active in this area who could transfer information, meet on a regular basis, discuss and disseminate information and solve problems jointly.

(ii) Utility

It was felt that micropropagation was well established for many species except the tree species. Tissue culture work should not be separated from aspects of collection/evaluation/utilisation and conservation.

Research into *in vitro* technology should be part of an overall scheme and brought into the implementation strategy of the programme. It was recognised that germplasm exchange needs to be related to long-term breeding programmes.

(iii) *In Vitro* Collection

It was recommended that simplified facilities be made available for the collection of important germplasm, particularly in relation to recalcitrant seeds and bulky plant materials. Workers should be trained to put these materials into culture in the field.

Training

As far as training for *in vitro* technology is concerned, it was considered that the basics are already in place in most countries and therefore, there is no need to have any comprehensive training programmes on tissue culture *per se*; but there is a need to update tissue culturists with more sophisticated applications in the area of genetic manipulation.

Storage of Germplasm

Genetic conservation is a long-term process and this applies to conventional as well as *in vitro* storage techniques. Therefore, a long-term commitment on the part of policy-makers and researchers is essential. Once established, the programmes must be sustained in terms of resources and ancillary support particularly in information and technology transfer. Further, it is recognised that conservation can only be assured by the use of complementary techniques, and that use of any single technique was unsatisfactory as it put the conserved material at risk.

There is a need for collection and dissemination of research information. This information needs to be collated at the national, regional and international levels. It is also recommended that a specialised computerised database, taking information at these various levels, and from other existing databases and information networks, would be the preferred mechanism on a long-term basis. A mechanism should also be created to link curators, technologists and end-users in a particular region with a support network of experts from the international scientific community. This mechanism would include advisory visits and scientific meetings. There is a need to develop specialised training in *in vitro* storage technology. Courses should be based regionally to ensure wide access and would lead to the establishment of training activities at a local level.

Human Resources Development and Training

Training should be carried out in four broad areas, namely: collection, gene bank management, *in vitro* techniques and characterisation, and evaluation and documentation.

(1) Collection

Region-specific methodology for exploration and collection are emphasised as problems of collection in the tropical areas are quite unique. Courses should be conducted

by experts who are working in this region and familiar with the taxonomy of the plants and also with the various difficulties encountered in collecting live material. Institutions which can offer such training are as follows: Bogor Botanic Gardens (Indonesia), FRIM (Malaysia), Kew Gardens (Britain) and the National Bureau of Plant Genetic Resources (India).

(2) Gene Bank Management

Personnel at the pilot *in vitro* gene banks established with the collaboration of IBPGR, such as that in CIP (Peru) and CIAT (Columbia), could provide expertise for training.

(3) *In Vitro* Techniques

There are several established centres for such training, e.g. National Chemical Laboratory (Pune), National Botanical Research Institute (Lucknow), Central Institute for Medicinal and Aromatic Plants (Lucknow), Institute of Biotechnology (Los Banos) and MARDI (Malaysia). In addition to the available sources of funding such as FAO, JICA, ICRO, IDRC, IBPGR, AIDAB and GTZ, user countries should tap their own resources, as conservation of biodiversity and plant genetic resources are crucial for sustainable development in these countries.

(4) Characterisation, Evaluation and Documentation

A major lacuna exists in these areas. It needs to be filled up expeditiously. As details of evaluation and documentation have been already developed by IBPGR, model training courses suitable to the region may be designed by utilising the expertise available.

Disease detection and quarantine measures for virus indexing of tissue culture-derived clonal material are important. A training programme may be organised to impart the necessary skills by ASEAN PLANTI, Malaysia. The National Botanical Research Institute, Lucknow, may also be approached to provide training facilities.

For developing competence in using modern methods of documentation, a training programme in the use of computers and preparation of databases and retrieval of information is also recommended.

(5) Modality of the Training Programme

To ensure quality, the intake in each training programme must be restricted to 10-12 trainees. The centres of training should be well-equipped and staffed.

With regard to modern technologies for evaluation of germplasm, it is suggested that special training be organised for RFLP mapping and other techniques essential for ensuring the genetic stability and proper identification of the *in vitro* genetic materials. This course can be organised locally with help from experts from the international scientific community.

Conclusion

Experience from the two international workshops co-organised by the CSC has shown that there is a tremendous scope for the introduction and development of *in vitro* methods to conserve and sustainably utilise plant genetic resources.

SECTION III

List of National Co-ordinators of the BDGR Programme

Country	Co-ordinator
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Australia	Dr J V Possingham Chief of Division CSIRO Division of Horticultural Research Box 350, GPO Adelaide South Australia 5001
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BIOLOGICAL DIVERSITY AND GENETIC RESOURCES

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THE PROGRAMME OF THE COMMONWEALTH SCIENCE COUNCIL
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BIOLOGICAL DIVERSITY AND GENETIC RESOURCES

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THE PROGRAMME OF THE COMMONWEALTH SCIENCE COUNCIL
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Zambia	Dr S M Silangwa Secretary-General National Council for Scientific Research PO Box CH 158 Chelston Lusaka
Zimbabwe	Dr J M Gopo Chairman Biological Sciences University of Zimbabwe MP1670 Mount Pleasant Harare

SECTION IV

List of Publications

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Text of the Convention on Biological Diversity

Preamble

The Contracting Parties,

Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components,

Conscious also of the importance of biological diversity for evolution and for maintaining life sustaining systems of the biosphere,

Affirming that the conservation of biological diversity is a common concern of humankind,

Reaffirming that States have sovereign rights over their own biological resources,

Reaffirming also that States are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner,

Concerned that biological diversity is being significantly reduced by certain human activities,

Aware of the general lack of information and knowledge regarding biological diversity and of the urgent need to develop scientific, technical and institutional capacities to provide the basic understanding upon which to plan and implement appropriate measures,

Noting that it is vital to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source,

Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat,

Noting further that the fundamental requirement for the conservation of biological diversity is the *in situ* conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings,

Noting further that *ex situ* measures, preferably in the country of origin, also have an important role to play,

Recognising the close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources, and the desirability of sharing equitably benefits arising from the use of traditional knowledge, innovations and practices relevant to the conservation of biological diversity and the sustainable use of its components,

Recognising also the vital role that women play in the conservation and sustainable use of biological diversity and affirming the need for the full participation of women at all levels of policy-making and implementation for biological diversity conservation,

Stressing the importance of, and the need to promote, international, regional and global co-operation among States and intergovernmental organisations and the non-governmental sector for the conservation of biological diversity and the sustainable use of its components,

Acknowledging that the provision of new and additional financial resources and appropriate access to relevant technologies can be expected to make a substantial difference in the world's ability to address the loss of biological diversity,

Acknowledging further that special provision is required to meet the needs of developing countries, including the provision of new and additional financial resources and appropriate access to relevant technologies,

Noting in this regard the special conditions of the least developed countries and small island States,

Acknowledging that substantial investments are required to conserve biological diversity and that there is the expectation of a broad range of environmental, economic and social benefits from those investments,

Recognising that economic and social development and poverty eradication are the first and overriding priorities of developing countries,

Aware that conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population, for which purpose access to and sharing of both genetic resources and technologies are essential,

Noting that, ultimately, the conservation and sustainable use of biological diversity will strengthen friendly relations among States and contribute to peace for humankind,

Desiring to enhance and complement existing international arrangements for the conservation of biological diversity and sustainable use of its components, and

Determined to conserve and sustainably use biological diversity for the benefit of present and future generations,

Have agreed as follows:

Article 1. Objectives

The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Article 2. Use of Terms

For the purpose of this convention:

“*Biological diversity*” means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

“*Biological resources*” includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

“*Biotechnology*” means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

“*Country of origin of genetic resources*” means the country which possesses those genetic resources in *in situ* conditions.

“*Country providing genetic resources*” means the country supplying genetic resources collected from *in situ* sources, including populations of both wild and domesticated species, or taken from *ex situ* sources, which may or may not have originated in that country.

“*Domesticated or cultivated species*” means species in which the evolutionary process has been influenced by humans to meet their needs.

“*Ecosystem*” means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

“*Ex situ conservation*” means the conservation of components of biological diversity outside their natural habitats.

“*Genetic material*” means any material of plant, animal, microbial or other origin containing functional units of heredity.

“*Genetic resources*” means genetic material of actual or potential value.

“*Habitat*” means the place or type of site where an organism or population naturally occurs.

“*In situ conditions*” means conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

“*In situ conservation*” means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

“*Protected area*” means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

“Regional economic integration organisation” means an organisation constituted by sovereign States of a given region, to which its member States have transferred competence in respect of matters governed by this Convention and which has been duly authorised, in accordance with its internal procedures, to sign, ratify, accept, approve or accede to it.

“Sustainable use” means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

“Technology” includes biotechnology.

Article 3. Principle

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Article 4. Jurisdictional Scope

Subject to the right of other States, and except as otherwise expressly provided in this Convention, the provisions of this Convention apply, in relation to each Contracting Party:

- (a) In the case of components of biological diversity, in areas within the limits of its national jurisdiction; and
- (b) In the case of processes and activities, regardless of where their effects occur, carried out under its jurisdiction or control, within the area of its national jurisdiction or beyond the limits of national jurisdiction.

Article 5. Co-operation

Each Contracting Party shall, as far as possible and as appropriate, co-operate with other Contracting Parties, directly or, where appropriate, through competent international organisations, in respect of areas beyond national jurisdiction and on other matters of mutual interest, for the conservation and sustainable use of biological diversity.

Article 6. General Measures for Conservation and Sustainable Use

Each Contracting Party shall, in accordance with its particular conditions and capabilities:

- a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or

programmes which shall reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party concerned; and

- (b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

- (a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I;
- (b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;
- (c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and
- (d) Maintain and organise, by any mechanism, data derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Article 8. *In Situ* Conservation

Each Contracting Party shall, as far as possible and as appropriate:

- (a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;
- (b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity;
- (c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;
- (d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
- (e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;

- (f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, *inter alia*, through the development and implementation of plans or other management strategies;
- (g) Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health;
- (h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;
- (i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;
- (j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilisation of such knowledge, innovations and practices;
- (k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;
- (l) Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories or activities; and
- (m) Co-operate in providing financial and other support for *in situ* conservation outlined in subparagraphs (a) to (l) above, particularly to developing countries.

Article 9. *Ex Situ* Conservation

Each Contracting Party shall, as far as possible and as appropriate, and predominantly for the purpose of complementing *in situ* measures:

- (a) Adopt measures for the *ex situ* conservation of components of biological diversity, preferably in the country of origin of such components;
- (b) Establish and maintain facilities for *ex situ* conservation of and research on plants, animals and micro-organisms, preferably in the country of origin of genetic resources;
- (c) Adopt measures for the recovery and rehabilitation of threatened species and for their re-introduction into their natural habitats under appropriate conditions;
- (d) Regulate and manage collection of biological resources from natural habitats for *ex situ* conservation purposes so as not to threaten ecosystems and *in situ* populations of species, except where special temporary *ex situ* measures are required under subparagraph (c) above; and

- (e) Co-operate in providing financial and other support for *ex situ* conservation outlined in subparagraphs (a) to (d) above and in the establishment and maintenance of *ex situ* conservation facilities in developing countries.

Article 10. Sustainable Use of Components of Biological Diversity

Each Contracting Party shall, as far as possible and as appropriate:

- (a) Integrate consideration of the conservation and sustainable use of biological resources into national decision making;
- (b) Adopt measures relating to the use of biological resources to avoid or minimise adverse impacts on biological diversity;
- (c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;
- (d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and
- (e) Encourage co-operation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

Article 11. Incentive Measures

Each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity.

Article 12. Research and Training

The Contracting Parties, taking into account the special needs of developing countries, shall:

- (a) Establish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components and provide support for such education and training for the specific needs of developing countries;
- (b) Promote and encourage research which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, *inter alia*, in accordance with decisions of the Conference of the Parties taken in consequence of recommendations of the Subsidiary Body on Scientific, Technical and Technological Advice; and
- (c) In keeping with the provisions of Articles 16, 18 and 20, promote and co-operate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

Article 13. Public Education and Awareness

The Contracting Parties shall:

- (a) Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes; and
- (b) Co-operate, as appropriate, with other States and international organisations in developing educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity.

Article 14. Impact Assessment and Minimising Adverse Impacts

1. Each Contracting Party, as far as possible and as appropriate, shall:
 - (a) Introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimising such effects and, where appropriate, allow for public participation in such procedures;
 - (b) Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account;
 - (c) Promote, on the basis of reciprocity, notification, exchange of information and consultation on activities under their jurisdiction or control which are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, by encouraging the conclusion of bilateral, regional or multilateral arrangements, as appropriate;
 - (d) In the case of imminent or grave danger or damage, originating under its jurisdiction or control, to biological diversity within the area under jurisdiction of other States or in areas beyond the limits of national jurisdiction, notify immediately the potentially affected States of such danger or damage, as well as initiate action to prevent or minimise such danger or damage; and
 - (e) Promote national arrangements for emergency responses to activities or events, whether caused naturally or otherwise, which present a grave and imminent danger to biological diversity and encourage international co-operation to supplement such national efforts and, where appropriate and agreed by the States or regional economic integration organisations concerned, to establish joint contingency plans.
2. The conference of the Parties shall examine, on the basis of studies to be carried out, the issue of liability and redress, including restoration and compensation, for damage to biological diversity, except where such liability is a purely internal matter.

Article 15. Access to Genetic Resources

1. Recognising the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.
2. Each Contracting Party shall endeavour to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of this Convention.
3. For the purpose of this Convention, the genetic resources being provided by a Contracting Party, as referred to in this Article and Articles 16 and 19, are only those that are provided by Contracting Parties that are countries of origin of such resources or by the Parties that have acquired the genetic resources in accordance with this Convention.
4. Access, where granted, shall be on mutually agreed terms and subject to the provisions of this Article.
5. Access to genetic resources shall be subject to prior informed consent of the Contracting Party providing such resources, unless otherwise determined by that Party.
6. Each Contracting Party shall endeavour to develop and carry out scientific research based on genetic resources provided by other Contracting Parties with the full participation of, and where possible in, such Contracting Parties.
7. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19 and, where necessary, through the financial mechanism established by Articles 20 and 21 with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilisation of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms.

Article 16. Access to and Transfer of Technology

1. Each Contracting Party, recognising that technology includes biotechnology, and that both access to and transfer of technology among Contracting Parties are essential elements for the attainment of the objectives of this Convention, undertakes subject to the provisions of this Article to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment.
2. Access to and transfer of technology referred to in paragraph 1 above to developing countries shall be provided and/or facilitated under fair and most favourable terms, including on concessional and preferential terms where mutually agreed, and, where necessary, in accordance with the financial mechanism established by Articles 20 and 21. In the case of technology subject to patents and other intellectual property rights, such access and transfer shall be provided on terms which recognise and are consistent

with the adequate and effective protection of intellectual property rights. The application of this paragraph shall be consistent with paragraphs 3, 4 and 5 below.

3. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that Contracting Parties, in particular those that are developing countries, which provide genetic resources are provided access to and transfer of technology which makes use of those resources, on mutually agreed terms, including technology protected by patents and other intellectual property rights, where necessary, through the provisions of Articles 20 and 21 and in accordance with international law and consistent with paragraphs 4 and 5 below.
4. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that the private sector facilitates access to, joint development and transfer of technology referred to in paragraph 1 above for the benefit of both governmental institutions and the private sector of developing countries and in this regard shall abide by the obligations included in paragraphs 1, 2 and 3 above.
5. The Contracting Parties, recognising that patents and other intellectual property rights may have an influence on the implementation of this Convention, shall co-operate in this regard subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to its objectives.

Article 17. Exchange of Information

1. The Contracting Parties shall facilitate the exchange of information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity, taking into account the special needs of developing countries.
2. Such exchange of information shall include exchange of results of technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialised knowledge, indigenous and traditional knowledge as such and in combination with the technologies referred to in Article 16, paragraph 1. It shall also, where feasible, include repatriation of information.

Article 18. Technical and Scientific Co-operation

1. The Contracting Parties shall promote international technical and scientific co-operation in the field of conservation and sustainable use of biological diversity, where necessary, through the appropriate international and national institutions.
2. Each Contracting Party shall promote technical and scientific co-operation with other Contracting Parties, in particular developing countries, in implementing this Convention, *inter alia*, through the development and implementation of national policies. In promoting such co-operation, special attention should be given to the development and strengthening of national capabilities, by means of human resources development and institution building.

3. The Conference of the Parties, at its first meeting, shall determine how to establish a clearing-house mechanism to promote and facilitate technical and scientific co-operation.
4. The Contracting Parties shall, in accordance with national legislation and policies, encourage and develop methods of co-operation for the development and use of technologies, including indigenous and traditional technologies, in pursuance of the objectives of this Convention. For this purpose, the Contracting Parties shall also promote co-operation in the training of personnel and exchange of experts.
5. The Contracting Parties shall, subject to mutual agreement, promote the establishment of joint research programmes and joint ventures for the development of technologies relevant to the objectives of this Convention.

Article 19. Handling of Biotechnology and Distribution of its Benefits

1. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, to provide for the effective participation in biotechnological research activities by those Contracting Parties, especially developing countries, which provide the genetic resources for such research, and where feasible in such Contracting Parties.
2. Each Contracting Party shall take all practicable measures to promote and advance priority access on a fair and equitable basis by Contracting Parties, especially developing countries, to the results and benefits arising from biotechnologies based upon genetic resources provided by those Contracting Parties. Such access shall be on mutually agreed terms.
3. The Parties shall consider the need for and modalities of a protocol setting out appropriate procedures, including, in particular, advance informed agreement, in the field of the safe transfer, handling and use of any living modified organism resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity.
4. Each Contracting Party shall, directly or by requiring any natural or legal person under its jurisdiction providing the organisms referred to in paragraph 3 above, provide any available information about the use and safety regulations required by that Contracting Party in handling such organisms, as well as any available information on the potential adverse impact of the specific organisms concerned to the Contracting Party into which those organisms are to be introduced.

Article 20. Financial Resources

1. Each Contracting Party undertakes to provide, in accordance with its capabilities, financial support and incentives in respect of those national activities which are intended to achieve the objectives of this Convention, in accordance with its national plans, priorities and programmes.

2. The developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them of implementing measures which fulfil the obligations of this Convention and to benefit from its provisions and which costs are agreed between a developing country Party and the institutional structure referred to in Article 21, in accordance with policy, strategy, programme priorities and eligibility criteria and an indicative list of incremental costs established by the Conference of the Parties. Other Parties, including countries undergoing the process of transition to a market economy, may voluntarily assume the obligations of the developed country Parties. For the purpose of this Article, the Conference of the Parties, shall at its first meeting establish a list of developed country Parties and other Parties which voluntarily assume the obligations of the developed country Parties. The Conference of the Parties shall periodically review and if necessary amend the list. Contributions from other countries and sources on a voluntary basis would also be encouraged. The implementation of these commitments shall take into account the need for adequacy, predictability and timely flow of funds and the importance of burden-sharing among the contributing Parties included in the list.
3. The developed country Parties may also provide, and developing country Parties avail themselves of, financial resources related to the implementation of this Convention through bilateral, regional and other multilateral channels.
4. The extent to which developing country Parties will effectively implement their commitments under this Convention will depend on the effective implementation by developed country Parties of their commitments under this Convention related to financial resources and transfer of technology and will take fully into account the fact that economic and social development and eradication of poverty are the first and overriding priorities of the developing country Parties.
5. The Parties shall take full account of the specific needs and special situation of least developed countries in their actions with regard to funding and transfer of technology.
6. The Contracting Parties shall also take into consideration the special conditions resulting from the dependence on, distribution and location of, biological diversity within developing country Parties, in particular small island States.
7. Consideration shall also be given to the special situation of developing countries, including those that are most environmentally vulnerable, such as those with arid and semi-arid zones, coastal and mountainous areas.

Article 21. Financial Mechanism

1. There shall be a mechanism for the provision of financial resources to developing country Parties for purposes of this Convention on a grant or concessional basis the essential elements of which are described in this Article. The mechanism shall function under the authority and guidance of, and be accountable to, the Conference of the Parties for purposes of this Convention. The operations of the mechanism shall be carried out by such institutional structure as may be decided upon by the Conference

of the Parties at its first meeting. For purposes of this Convention, the Conference of the Parties shall determine the policy, strategy, programme priorities and eligibility criteria relating to the access to and utilisation of such resources. The contributions shall be such as to take into account the need for predictability, adequacy and timely flow of funds referred to in Article 20 in accordance with the amount of resources needed to be decided periodically by the Conference of the Parties and the importance of burden-sharing among the contributing Parties included in the list referred to in Article 20, paragraph 2. Voluntary contributions may also be made by developed country Parties and by other countries and sources. The mechanism shall operate within a democratic and transparent system of governance.

2. Pursuant to the objectives of this Convention, the Conference of the Parties shall at its first meeting determine the policy, strategy and programme priorities, as well as detailed criteria and guidelines for eligibility for access to and utilisation of the financial resources including monitoring and evaluation on a regular basis of such utilisation. The Conference of the Parties shall decide on the arrangements to give effect to paragraph 1 above after consultation with the institutional structure entrusted with the operation of the financial mechanism.
3. The Conference of the Parties shall review the effectiveness of the mechanism established under this Article, including the criteria and guidelines referred to in paragraph 2 above, not less than two years after the entry into force of this Convention and thereafter on a regular basis. Based on such review, it shall take appropriate action to improve the effectiveness of the mechanism if necessary.
4. The Contracting Parties shall consider strengthening existing financial institutions to provide financial resources for the conservation and sustainable use of biological diversity.

Article 22. Relationship with Other International Conventions

1. The provisions of this Convention shall not affect the rights and obligations of any Contracting Party deriving from any existing international agreement, except where the exercise of those rights and obligations would cause a serious damage or threat to biological diversity.
2. Contracting Parties shall implement this Convention with respect to the marine environment consistently with the rights and obligations of States under the law of the sea.

Article 23. Conference of the Parties

1. Conference of the Parties is hereby established. The first meeting of the Conference of the Parties shall be convened by the Executive Director of the United Nations Environment Programme not later than one year after the entry into force of this Convention. Thereafter, ordinary meetings of the Conference of the Parties shall be held at regular intervals to be determined by the Conference at its first meeting.

2. Extraordinary meetings of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any Party, provided that, within six months of the request being communicated to them by the Secretariat, it is supported by at least one-third of the Parties.
3. The Conference of the Parties shall by consensus agree upon and adopt rules of procedure for itself and for any subsidiary body it may establish, as well as financial rules governing the funding of the Secretariat. At each ordinary meeting, it shall adopt a budget for the financial period until the next ordinary meeting.
4. The Conference of the Parties shall keep under review the implementation of this Convention, and, for this purpose, shall:
 - (a) Establish the form and the intervals for transmitting the information to be submitted in accordance with Article 26 and consider such information as well as reports submitted by any subsidiary body;
 - (b) Review scientific, technical and technological advice on biological diversity provided in accordance with Article 25;
 - (c) Consider and adopt, as required, protocols in accordance with Article 28;
 - (d) Consider and adopt, as required, in accordance with Articles 29 and 30, amendments to this Convention and its annexes;
 - (e) Consider amendments to any protocol, as well as to any annexes thereto, and, if so decided, recommend their adoption to the parties to the protocol concerned;
 - (f) Consider and adopt, as required, in accordance with Article 30, additional annexes to this Convention;
 - (g) Establish such subsidiary bodies, particularly to provide scientific and technical advice, as are deemed necessary for the implementation of this Convention;
 - (h) Contact, through the Secretariat, the executive bodies of conventions dealing with matters covered by this Convention with a view to establishing appropriate forms of co-operation with them; and
 - (i) Consider and undertake any additional action that may be required for the achievement of the purposes of this Convention in the light of experience gained in its operation.
5. The United Nations, its specialised agencies and the International Atomic Energy Agency, as well as any State not Party to this Convention, may be represented as observers at meetings of the Conference of the Parties. Any other body or agency, whether governmental or non-governmental, qualified in fields relating to conservation and sustainable use of biological diversity, which has informed the Secretariat of its wish to be represented as an observer at a meeting of the Conference of the Parties, may be admitted unless at least one-third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Conference of the Parties.

Article 24. Secretariat

1. A secretariat is hereby established. Its functions shall be:
 - (a) To arrange for and service meetings of the Conference of the Parties provided for in Article 23;
 - (b) To perform the functions assigned to it by any protocol;
 - (c) To prepare reports on the execution of its functions under this Convention and present them to the Conference of the Parties;
 - (d) To co-ordinate with other relevant international bodies and, in particular, to enter into such administrative and contractual arrangements as may be required for the effective discharge of its functions; and
 - (e) To perform such other functions as may be determined by the Conference of the Parties.
2. At its first ordinary meeting, the Conference of the Parties shall designate the secretariat from amongst those existing competent international organisations which have signified their willingness to carry out the secretariat functions under this Convention.

Article 25. Subsidiary Body on Scientific, Technical and Technological Advice

1. A subsidiary body for the provision of scientific, technical and technological advice is hereby established to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely advice relating to the implementation of this Convention. This body shall be open to participation by all Parties and shall be multi-disciplinary. It shall comprise government representatives competent in the relevant field of expertise. It shall report regularly to the Conference of the Parties on all aspects of its work.
2. Under the authority of and in accordance with guidelines laid down by the Conference of the Parties, and upon its request, this body shall:
 - (a) Provide scientific and technical assessments of the status of biological diversity;
 - (b) Prepare scientific and technical assessments of the effects of types of measures taken in accordance with the provisions of this Convention;
 - (c) Identify innovative, efficient and state-of-the-art technologies and know-how relating to the conservation and sustainable use of biological diversity and advise on the ways and means of promoting development and/or transferring such technologies;
 - (d) Provide advice on scientific programmes and international co-operation in research and development related to conservation and sustainable use of biological diversity; and

- (e) Respond to scientific, technical, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body.
3. The functions, terms of reference, organisation and operation of this body may be further elaborated by the Conference of the Parties.

Article 26. Reports

Each Contracting Party shall, at intervals to be determined by the Conference of the Parties, present to the Conference of the Parties, reports on measure which it has taken for the implementation of the provisions of this Convention and their effectiveness in meeting the objectives of this Convention.

Article 27. Settlement of Disputes

1. In the event of a dispute between Contracting Parties concerning the interpretation or application of this Convention, the parties concerned shall seek solution by negotiation.
2. If the parties concerned cannot reach agreement by negotiation, they may jointly seek the good offices of, or request mediation by, a third party.
3. When ratifying, accepting, approving or acceding to this Convention, or at any time thereafter, a State or regional economic integration organisation may declare in writing to the Depository that for a dispute not resolved in accordance with paragraph 1 or paragraph 2 above, it accepts one or both of the following means of dispute settlement as compulsory:
 - (a) Arbitration in accordance with the procedure laid down in Part 1 of Annex II;
 - (b) Submission of the dispute to the International Court of Justice.
4. If the parties to the dispute have not, in accordance with paragraph 3 above, accepted the same or any procedure, the dispute shall be submitted to conciliation in accordance with Part 2 of Annex II unless the parties otherwise agree.
5. The provisions of this Article shall apply with respect to any protocol except as otherwise provided in the protocol concerned.

Article 28. Adoption of Protocols

1. The Contracting Parties shall co-operate in the formulation and adoption of protocols to this Convention.
2. Protocols shall be adopted at a meeting of the Conference of the Parties.
3. The text of any proposed protocol shall be communicated to the Contracting Parties by the Secretariat at least six months before such a meeting.

Article 29. Amendment of the Convention or Protocols

1. Amendments to this Convention may be proposed by any Contracting Party. Amendments to any protocol may be proposed by any Party to that protocol.
2. Amendments to this Convention shall be adopted at a meeting of the Conference of the Parties. Amendments to any protocol shall be adopted at a meeting of the Parties to the Protocol in question. The text of any proposed amendment to this Convention or to any protocol, except as may otherwise be provided in such protocol, shall be communicated to the Parties to the instrument in question by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate proposed amendments to the signatories to this Convention for information.
3. The Parties shall make every effort to reach agreement on any proposed amendment to this Convention or to any protocol by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a two-third majority vote of the Parties to the instrument in question present and voting at the meeting, and shall be submitted by the Depositary to all Parties for ratification, acceptance or approval.
4. Ratification, acceptance or approval of amendments shall be notified to the Depositary in writing. Amendments adopted in accordance with paragraph 3 above shall enter into force among Parties having accepted them on the ninetieth day after the deposit of instruments of ratification, acceptance or approval by at least two thirds of the Contracting Parties to this Convention or of the Parties to the protocol concerned, except as may otherwise be provided in such protocol. Thereafter the amendments shall enter into force for any other Party on the ninetieth day after that Party deposits its instrument of ratification, acceptance or approval of the amendments.
5. For the purposes of this Article, "Parties present and voting" means Parties present and casting an affirmative or negative vote.

Article 30. Adoption and Amendment of Annexes

1. The annexes to this Convention or to any protocol shall form an integral part of the Convention or of such protocol, as the case may be, and, unless expressly provided otherwise, a reference to this Convention or its protocols constitutes at the same time a reference to any annexes thereto. Such annexes shall be restricted to procedural, scientific, technical and administrative matters.
2. Except as may be otherwise provided in any protocol with respect to its annexes, the following procedure shall apply to the proposal, adoption and entry into force of additional annexes to this Convention or of annexes to any protocol:
 - (a) Annexes to this Convention or to any protocol shall be proposed and adopted according to the procedure laid down in Article 29;
 - (b) Any party that is unable to approve an additional annex to this Convention or an annex to any protocol to which it is Party shall so notify the Depositary, in writing,

within one year from the date of the communication of the adoption by the Depositary. The Depositary shall without delay notify all Parties of any such notification received. A Party may at any time withdraw a previous declaration of objection and the annexes shall thereupon enter into force for that Party subject to subparagraph (c) below;

- (c) On the expiry of one year from the date of the communication of the adoption by the Depositary, the annex shall enter into force for all Parties to this Convention or to any protocol concerned which have not submitted a notification in accordance with the provisions of subparagraph (b) above.
3. The proposal, adoption and entry into force of amendments to annexes to this Convention or to any protocol shall be subject to the same procedure as for the proposal, adoption and entry into force of annexes to the Convention or annexes to any protocol.
4. If any additional annex or an amendment to an annex is related to an amendment to this Convention or to any protocol, the additional annex or amendment shall not enter into force until such time as the amendment to the Convention or to the protocol concerned enters into force.

Article 31. Right to Vote

1. Except as provided for in paragraph 2 below, each Contracting Party to this Convention or to any protocol shall have one vote.
2. Regional economic integration organisations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States which are Contracting Parties to this Convention or the relevant protocol. Such organisations shall not exercise their right to vote if their member States exercise theirs, and vice versa.

Article 32. Relationship between this Convention and Its Protocols

1. A State or a regional economic integration organisation may not become a Party to a protocol unless it is, or becomes at the same time, a Contracting Party to this Convention.
2. Decisions under any protocol shall be taken only by the Parties to the protocol concerned. Any Contracting Party that has not ratified, accepted or approved a protocol may participate as an observer in any meeting of the parties to that protocol.

Article 33. Signature

This Convention shall be open for signature at Rio de Janeiro by all States and any regional economic integration organisation from 5 June 1992 until 14 June 1992, and at the United Nations Headquarters in New York from 15 June 1992 to 4 June 1993.

Article 34. Ratification, Acceptance or Approval

1. This Convention and any protocol shall be subjected to ratification, acceptance or approval by States and by regional economic integration organisations. Instruments of ratification, acceptance or approval shall be deposited with the Depositary.
2. Any organisation referred to in paragraph 1 above which becomes a Contracting Party to this Convention or any protocol without any of its member states being a Contracting Party shall be bound by all the obligations under the Convention or the protocol, as the case may be. In the case of such organisations, one or more of whose member States is a Contracting Party to this Convention or relevant protocol, the organisation and its member States shall decide on their respective responsibilities for the performance of their obligations under the Convention or protocol, as the case may be. In such cases, the organisation and the member States shall not be entitled to exercise rights under the Convention or relevant protocol concurrently.
3. In their instruments of ratification, acceptance or approval, the organisations referred to in paragraph 1 above shall declare the extent of their competence with respect to the matters governed by the Convention or the relevant protocol. The organisations shall also inform the Depositary of any relevant modification in the extent of their competence.

Article 35. Accession

1. This Convention and any protocol shall be open for accession by States and by regional economic integration organisations from the date on which the Convention or the protocol concerned is closed for signature. The instruments of accession shall be deposited with the Depositary.
2. In their instruments of accession, the organisations referred to in paragraph 1 above shall declare the extent of their competence with respect to the matters governed by the Convention or the relevant protocol. These organisations shall also inform the Depositary of any relevant modification in the extent of their competence.
3. The provisions of Article 34, paragraph 2, shall apply to regional economic integration organisations which accede to this Convention or any protocol.

Article 36. Entry Into Force

1. This Convention shall enter into force on the ninetieth day after the date of deposit of the thirtieth instrument of ratification, acceptance, approval or accession.
2. Any protocol shall enter into force on the ninetieth day after the date of deposit of the number of instruments of ratification, acceptance, approval or accession, specified in that protocol, has been deposited.

3. For each Contracting Party which ratifies, accepts or approves this Convention or accedes thereto after the deposit of the thirtieth instrument of ratification, acceptance, approval or accession, it shall enter into force on the ninetieth day after the date of deposit by such Contracting Party of its instrument of ratification, acceptance, approval or accession.
4. Any protocol, except as otherwise provided in such protocol, shall enter into force for a Contracting Party that ratifies, accepts or approves that protocol or accedes thereto after its entry into force pursuant to paragraph 2 above, on the ninetieth day after the date on which that Contracting Party deposits its instrument of ratification, acceptance, approval or accession, or on the date on which this Convention enters into force for that Contracting Party, whichever shall be the later.
5. For the purpose of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organisation shall not be counted as additional to those deposited by member States of such organisation.

Article 37. Reservations

No reservations may be made to this Convention.

Article 38. Withdrawals

1. At any time after two years from the date on which this Convention has entered into force for a Contracting Party, that Contracting Party may withdraw from the Convention by giving written notification to the Depositary.
2. Any such withdrawal shall take place upon expiry of one year after the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.
3. Any Contracting Party which withdraws from this Convention shall be considered as also having withdrawn from any protocol to which it is party.

Article 39. Financial Interim Arrangements

Provided that it has been fully restructured in accordance with the requirements of Article 21, the Global Environment Facility of the United Nations Development Programme, the United Nations Environment Programme and the International Bank for Reconstruction and Development shall be the institutional structure referred to in Article 21 on an interim basis, for the period between the entry into force of this Convention and the first meeting of the Conference of the Parties or until the Conference of the Parties decides which institutional structure will be designated in accordance with Article 21.

Article 40. Secretariat Interim Arrangements

The secretariat to be provided by the Executive Director of the United Nations Environment Programme shall be the secretariat referred to in Article 24, paragraph 2, on an interim basis for the period between the entry into force of this Convention and the first meeting of the Conference of the Parties.

Article 41. Depositary

The Secretary-General of the United Nations shall assume the functions of Depositary of this Convention and any protocols.

Article 42. Authentic Texts

The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorised to that effect, have signed this Convention.

Done at Rio de Janeiro on this fifth day of June, one thousand nine hundred and ninety two.

ANNEX I

IDENTIFICATION AND MONITORING

1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes;
2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and
3. Described genomes and genes of social, scientific or economic importance.

ANNEX II

Part 1

ARBITRATION

Article 1

The claimant party shall notify the secretariat that the parties are referring a dispute to arbitration pursuant to Article 27. The notification shall state the subject-matter of arbitration and include, in particular, the articles of the Convention or the protocol, the interpretation or application of which are at issue. If the parties do not agree on the subject matter of the dispute before the President of the tribunal is designated, the arbitral tribunal shall determine the subject matter. The secretariat shall forward the information thus received to all Contracting Parties to this Convention or to the protocol concerned.

Article 2

1. In disputes between two parties, the arbitral tribunal shall consist of three members. Each of the parties to the dispute shall appoint an arbitrator and the two arbitrators so appointed shall designate by common agreement the third arbitrator who shall be the President of the tribunal. The latter shall not be a national of one of the parties to the dispute, nor have his or her usual place of residence in the territory of one of these parties, nor be employed by any of them, nor have dealt with the case in any other capacity.
2. In disputes between more than two parties, parties in the same interest shall appoint one arbitrator jointly by agreement.
3. Any vacancy shall be filled in the manner prescribed for the initial appointment.

Article 3

1. If the President of the arbitral tribunal has not been designated within two months of the appointment of the second arbitrator, the Secretary-General of the United Nations shall, at the request of a party, designate the President within a further two-month period.
2. If one of the parties to the dispute does not appoint an arbitrator within two months of receipt of the request, the other party may inform the Secretary-General who shall make the designation within a further two-month period.

Article 4

The arbitral tribunal shall render its decisions in accordance with the provisions of this Convention, any protocols concerned, and international law.

Article 5

Unless the parties to the dispute otherwise agree, the arbitral tribunal shall determine its own rules of procedure.

Article 6

The arbitral tribunal may, at the request of one of the parties, recommend essential interim measures of protection.

Article 7

The parties to the dispute shall facilitate the work of the arbitral tribunal and, in particular, using all means at their disposal, shall:

- (a) Provide it with all relevant documents, information and facilities; and
- (b) Enable it, when necessary, to call witnesses or experts and receive their evidence.

Article 8

The parties and arbitrators are under an obligation to protect the confidentiality of any information they receive in confidence during the proceedings of the arbitral tribunal.

Article 9

Unless the arbitral tribunal determines otherwise because of the particular circumstances of the case, the costs of the tribunal shall be borne by the parties to the dispute in equal shares. The tribunal shall keep a record of all its costs, and shall furnish a final statement thereof to the parties.

Article 10

Any Contracting Party that has an interest of a legal nature in the subject-matter of the dispute which may be affected by the decision in the case, may intervene in the proceedings with consent of the tribunal.

Article 11

The tribunal may hear and determine counterclaims arising directly out of the subject matter of the dispute.

Article 12

Decisions both on procedure and substance of the arbitral tribunal shall be taken by a majority vote of its members.

Article 13

If one of the parties to the dispute does not appear before the arbitral tribunal or fails to defend its case, the other party may request the tribunal to continue the proceedings and to make its award. Absence of a party or a failure of a party to defend its case shall not constitute a bar to the proceedings. Before rendering its final decision, the arbitral tribunal must satisfy itself that the claim is well founded in fact and law.

Article 14

The tribunal shall render its final decision within five months of the date on which it is fully constituted unless it finds it necessary to extend the time limit for a period which should not exceed five more months.

Article 15

The final decision of the arbitral tribunal shall be confined to the subject matter of the dispute and shall state the reasons on which it is based. It shall contain the names of the members who have participated and the date of the final decision. Any member of the tribunal may attach a separate or dissenting opinion to the final decision.

Article 16

The award shall be binding on the parties to the dispute. It shall be without appeal unless the parties to the dispute have agreed in advance to an appellate procedure.

Article 17

Any controversy which may arise between the parties to the dispute as regards the interpretation or manner of implementation of the final decision may be submitted by either party for decision to the arbitral tribunal which rendered it.

Part 2

CONCILIATION

Article 1

A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall, unless the parties otherwise agree, be composed of five members, two appointed by each Party concerned and a President chosen jointly by those members.

Article 2

In disputes between more than two parties, parties in the same interest shall appoint their members of the commission jointly by agreement. Where two or more parties have separate interests or there is a disagreement as to whether they are of the same interest, they shall appoint their members separately.

Article 3

If any appointments by the parties are not made within two months of the date of the request to create a conciliation commission, the Secretary-General of the United Nations shall, if asked to do so by the party that made the request, make those appointments within a further two-month period.

Article 4

If a President of the conciliation commission has not been chosen within two months of the last of the members of the commission being appointed, the Secretary-General of the United Nations shall, if asked to do so by a party, designate a President within a further two-month period.

Article 5

The conciliation commission shall take its decisions by majority vote of its members. It shall, unless the parties to the dispute otherwise agree, determine its own procedure. It shall render a proposal for resolution of the dispute, which the parties shall consider in good faith.

Article 6

A disagreement as to whether the conciliation commission has competence shall be decided by the commission.

GLOSSARY

- Accession.** A sample of a crop variety collected at a specific location and time; may be of any size.
- Biodiversity.** The totality of genes, species and ecosystems in a region or the world.
- Biogeography.** The scientific study of the geographic distribution of organisms.
- Biological Resources.** Those components of biodiversity of direct, indirect or potential use to humanity. (Used interchangeably with '*Biotic Resources*'.)
- Biome.** A major portion of the living environment of a particular region (such as fir forest or grassland), characterised by its distinctive vegetation and maintained by local climatic conditions.
- Bioregion.** A territory defined by a combination of biological, social and geographic criteria, rather than geographical considerations; generally, a system of related, interconnected ecosystems.
- Biota.** All of the organisms, including animals, plants, fungi and micro-organisms, found in a given area.
- Biotechnology.** Any technology that is applied to living organisms to make them more valuable to people.
- Biotic.** Pertaining to any aspect of life, especially to characteristics of entire populations or ecosystems.
- Carrying Capacity.** The maximum number of people, or individuals of a particular species, that a given part of the environment can maintain indefinitely.
- Common Property Resource Management.** The management of a specific resource (such as a forest or pasture) by a well-defined group of resource users with the authority to regulate its use by members and outsiders.
- Comparative Advantage.** Relative superiority with which a region or state may produce a good or service.
- Conservation.** The management of human use of the biosphere so that it may yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilisation, restoration and using biodiversity.
- Cultivar.** A cultivated variety (genetic strain) of a domesticated crop plant.
- Cultural Diversity.** Variety or multiformity of human social structures, belief systems, and strategies for adapting to situations in different parts of the world.
- Ecosystem.** A dynamic complex of plant, animal, fungal, and micro-organisms communities and their associated non-living environment interacting as an ecological unit.

Endemic. Restricted to a specified region of locality.

Ex Situ Conservation. Keeping components of biodiversity alive outside of their original habitat or natural environment.

Fauna. All of the animals found in a given area.

Flora. All of the plants found in a given area.

Gene. The functional unit of heredity; the part of the DNA molecule that encodes a single enzyme or structural protein unit.

Gene Bank. A facility established for the *ex situ* conservation of individuals (seeds), tissues or reproductive cells of plants or animals.

Genetic Diversity. Variation in the genetic composition of individuals within or among species; the heritable genetic variation within and among populations.

Germplasm. The genetic material, especially its specific molecular and chemical constitution, that comprises the physical basis of the inherited qualities of an organism.

Grassroots [organisations or movements]. People or society at a level, rather than at the centre of major political activity.

Habitat. The environment in which an organism lives. Habitat can also refer to the organisms and physical environment in a particular place.

Hybridisation. Crossing of individuals from genetically different strains, populations or species.

In Situ Conservation. The conservation of biodiversity within the evolutionary dynamic ecosystems of the original habitat or natural environment.

Indicator Species. A species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem.

Indigenous Peoples. People whose ancestors inhabited a place or country when persons from another culture or ethnic background arrived on the scene and dominated them through conquest, settlement or other means, and who today live more in conformity with their own social, economic and cultural customs and traditions than with those of the country of which they now form a part. (Also: 'native peoples' or 'tribal peoples'.)

Intellectual Property Right. A right enabling an inventor to exclude imitators from the market for a limited time.

Introduced Species. A species occurring in an area outside of its historical known natural range as a result of intentional or accidental dispersal by human activities.

Keystone Species. A species whose loss from an ecosystem would cause a greater than average change in other species populations or ecosystem processes.

Landraces. A crop cultivar or animal breed that evolved with and has been genetically improved by traditional agriculturists, but has not been influenced by modern breeding practices.

Minimum Viable Population. The smallest isolated population that has a good chance of surviving for a given number of years despite the foreseeable effects of demographic,

environmental and genetic events and natural catastrophes. (The probability of persistence and the time of persistence are often taken to be 99% and 1,000 years, respectively.)

Native Species. Plants, animals, fungi and micro-organisms that occur naturally in a given area or region.

Nitrogen Fixation. A process whereby *nitrogen fixing bacteria* living in mutualistic associations with plants convert atmospheric nitrogen to nitrogen compounds that plants can utilise directly.

Non-governmental Organisation (NGO). A non-profit group or association organised outside of institutionalised political structures to realise particular social objectives (such as environmental protection) or serve particular constituencies (such as indigenous peoples). NGO activities range from research, information distribution, training, local organisation and community service to legal advocacy, lobbying for legislative change and civil disobedience. NGOs range in size from small groups within a particular community to huge membership groups with a national or international scope.

Patent. A government grant of temporary monopoly rights on innovative processes or products.

Population. A group of individuals with common ancestry that are much more likely to mate with one another than with individuals from another such group.

Primary [or Natural] Forest. A forest largely undisturbed by human activities.

Primary Productivity. The transformation of chemical or solar energy to biomass. Most primary production occurs through photosynthesis, whereby green plants convert solar energy, carbon dioxide and water to glucose and eventually to plant tissue. In addition, some bacteria in the deep sea can convert chemical energy to biomass through chemosynthesis.

Recalcitrant Seed. Seed that does not survive drying and freezing.

Rehabilitation. The recovery of specific ecosystem services in a degraded ecosystem or habitat.

Restoration. The return of an ecosystem or habitat to its original community structure, natural complement of species and natural functions.

Seed Bank. A facility designed for the *ex situ* conservation of individual plant varieties through seed preservation and storage.

Selection. Natural selection is the differential contribution of offspring to the next generation by various genetic types belonging to the same populations. Artificial selection is the intentional manipulation by man of the fitness of individuals in a population to produce a desired evolutionary response.

Species. A group of organisms capable of interbreeding freely with each other but not with members of other species.

Species Richness. The number of species within a region. (A term commonly used as a measure of species diversity, but technically only one aspect of diversity.)

Sustainable Development. Development that meets the needs and aspirations of the current generation without compromising the ability to meet those of future generations.

Systematics. The study of the historical evolutionary and genetic relationships among organisms and of their phenotypic similarities and differences.

Taxon (pl. Taxa). The named classification unit (e.g. *Homo sapiens*, *Hominidae*, or *Mammalia*) to which individuals, or sets of species, are assigned. *Higher taxa* are those above the species level.

Taxonomy. The naming and assignment of organisms to *taxa*.

Trophic Level. Position in the food chain, determined by the number of energy-transfer steps to that level.

Variety. A cultivated variety of a domesticated plant.

Conservation of biodiversity and the sustainable use of genetic resources have been priority issues for a number of countries and international organisations over the past decade. We have begun to realise that the rapid rate of development at all costs has generated forces that are threatening to destroy the very substratum of life on Earth.

Biological diversity is the building block of the myriad life forms on our planet and our defence against global climate change. Wider acceptance of this truth has given an impetus to the need for further work at political and scientific levels. However, little information is available on how to study, use and conserve our biological and genetic resources.

The Commonwealth Science Council's programme on biological diversity and genetic resources attempts to redress this imbalance. Launched in 1986, this programme recognises that good policies for conservation of our genetic resources require not only public investment but a systematic approach for institutionalising the key process of such conservation. The programme supports the development of appropriate courses, documents and training materials for capacity building at the local level.

This book discusses the programme and aims to contribute significantly towards establishing relevant mechanisms and developing practical action plans for conserving and sustainably using our rapidly vanishing biological diversity.

ISBN 0 85092 388 3

CSC (92) RNR-18

PD 293



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ISBN 978-1-84859-495-1



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