Rajasthan
Biodiversity
Strategy & Action Plan

Prepared Under
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Centre for Management Studies
HCM Rajasthan Institute of Public Administration, Jaipur

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Abbreviations

AFRI	Arid Forest Research Institute
BSAP	Biodiversity Strategy & Action Plan
BSI	Botanical Survey of India
CA	Closed Area
CAR	Comprehensive Adequate & Representative (*of PAs*)
CAZRI	Central Arid Zone Research Institute
CBD	Convention on Biological Diversity
CPA	Community Protected Area
EIA	Environmental Impact Assessment
GDP	Gross Domestic Production
GEF	Global Environment Facility
GIS	Geographical Information System
HRD	Human Resource Development
ICS	International Classification System
IDA	Interagency Development Assistance
IPM	Integrated Pest Management
IUCN	International Union for the Conservation of Nature
JFM	Joint Forest Management
MAB	Man And Biosphere Programme
NBSAP	National Biodiversity Strategy & Action Plan
NBPGR	National Bureau of Plant Genetic Resources
PA	Protected Area
PRI	Panchayati Raj Institution
RET	Rare Endangered Threatened
SAP	Strategy & Action Plan
Spp	Species
SSC	State Steering Committee
TPCG	Technical and Policy Core Group
UNEP	United Nation Environment Programme
UNESCO	United Nations Educational Scientific & Cultural Organization
VFPMCs	Village Forest Protection and Management Committees
WG	Working Group
WWF	World Wildlife Fund
ZSI	Zoological Survey of India

Preface

Biological resources play a key role in the economic, social and cultural life of the people of the state. The productivity of the state's natural resources hinges upon the health and security of the underlying ecosystems. Protection of watersheds, direct benefits of biodiversity to communities in and around forest areas, maintenance of soils and water regime, and potential market and non-market value of the unique species and genetic resources of the state are some of the economic and non-economic values that we draw from our biological resources. Considering that the state has a rich heritage of biodiversity and a strong dependence on this resource, the conservation of biological diversity is of highest concern to the state.

The present document is the state *Biodiversity Strategy & Action Plan* (BSAP) report initiated under the process of preparation of *National Biodiversity Strategy & Action Plan* (NBSAP) currently under way in the entire country. The *Centre for Management Studies* at the *HCM Rajasthan Institute of Public Administration* was entrusted this task in the first quarter of the year 2001. Considering that biodiversity affects and is affected by activities of all sectors of society, a conscious effort has been made to make the process of preparing this document as participatory as possible by holding consultations with ecologists, foresters, wildlife experts, agriculture scientists, farmers, villagers in general, people's representative, academicians, media persons, and government officers working in different development departments.

The report is intended to provide the framework around which long term planning of biodiversity conservation programmes in the state will be designed. It will stimulate interest in all the departments of the state government, the non-government organisations, community organisations and others who are concerned with conservation of the states biological diversity.

I hope the report will be helpful in advancing the cause of biodiversity conservation in the state which is so important in sustainable development of the state.

A K Pande
Feb 15, 2002

CONTENTS

3 CURRENT STATUS OF BIODIVERSITY

4 CAUSES OF BIODIVERSITY LOSS

APPENDICES

CHAPTER 1

INTRODUCTION

The *Biodiversity Strategy & Action Plan* for the state of Rajasthan is a part of the larger process of preparation of India's *National Biodiversity Strategy & Action Plan* in pursuance to the aims and objectives set in the *Convention on Biological Diversity*. The task of co-ordinating the process and preparing the report document was first offered to the *Institute of Development Studies*, Jaipur, but was eventually assigned to the *Centre for Management Studies* at the *HCM Rajasthan Institute of Public Administration*, Jaipur. The present report is in accordance with the larger guidelines prepared by the Technical & Policy Core Group for the NBSAP. The process of preparing this report started in February 2001 with constitution of a state level State Steering Committee (SSC) and a Working Group for the BSAP. A large number of independent experts, NGOs and community organisations working in biodiversity-related fields were identified and were invited to contribute their views, comments, papers and reports. The entire gamut of government machinery, including the district collectors were also invited to take part in the process of the SAP for the state.

Members of the Working Group also participated in national workshops organised by the TPCG in New Delhi. A series of workshops, meetings and expert consultation meetings were organised by the Nodal Agency in Jaipur. Apart from this, all the contributors and expert consultants also organised meetings, workshops and community level consultations through participatory appraisal methods in different parts of the state. The outcome of all these activities is reflected in the present report. Appendix 2 contains more further details of the process followed in arriving at the conclusions contained in this report.

Scope of the SAP

The present SAP for the state of Rajasthan covers the geographical area of the state. The state of Rajasthan is a rich depository of biodiversity with many endemic biodiversity rich regions and the distinct ecological zones such as the Thar Desert and the Aravalli Hill Ranges. Of these the latter, namely, the Aravallis have been treated as an inter-state ecoregion in the national process and has thus been also treated separately by an independent working group assigned by the TPCG. For the sake of enabling intensive coverage of all the areas of the state, the geographical area of the state was divided into three parts, namely, the Thar Desert, The Aravallis, and the East-of-Aravalli region. Each of these regions were assigned to independent experts who studied the issues of biodiversity in these areas in great depth and provided detailed reports. The finding of these reports have been integrated into this state level report.

The Need for the SAP

The state of Rajasthan realizes that though it has a rich heritage of biodiversity, the status of this precious resource and the processes affecting it are far from safe and secure into the future. The threat to this heritage in the long term as well as the present loss of this resource are a legitimate cause for worry. As such, the state's biodiversity is in urgent need of being managed scientifically and prudently for the future generations as well as for drawing the best benefits for the people of the state at present. Specifically the following are the reasons why the state has undertaken the present exercise to prepare the Biodiversity Strategy & Action Plan:

The state of Rajasthan recognises not only the intrinsic value of biological diversity, it is also aware of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components.

1. The biological diversity of the state is critically important for maintaining life sustaining systems of the biosphere and their productivity.
2. Conservation of biological diversity is a common national concern and the state, while sharing this concern, commits itself to align its programmes with the national goals in this regard.
3. It is the responsibility of the state to act for conserving its biological diversity and for using its biological resources in a sustainable manner.
4. The biological diversity and biological resources of the state are being significantly reduced by certain human activities.
5. There is a general lack of scientific information and knowledge regarding biological diversity in the state, and there is a clear and urgent need to develop scientific, technical and institutional capacities to provide the basic understanding upon which to plan and implement appropriate measures.
6. There is a general lack of public policies and political understanding in the state regarding the importance of conservation of its biological resources and their diversity.
7. There is an urgent need to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source.
8. There is 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.
9. Within the state there is a close and traditional dependence of many indigenous and local communities on biological resources, and it is necessary to ensure 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.
10. There is a need for new and additional financial resources and appropriate access to relevant technologies to address the problem of loss of biological diversity,
11. Conservation of biodiversity can synergize well with the programmes of economic and social development and poverty eradication, which are the first and overriding priorities of the state.
12. Conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of its growing population.

In view of the above reasons, the state of Rajasthan considers it an extremely important task to prepare a comprehensive strategy and action plan to conserve its biodiversity and biological resources. Preparation of the present *Biodiversity Strategy & Action Plan* is an opportunity that the state has seized to achieve this important task.

Aims & Objectives of the SAP

Broad Aims

In conformity with the Convention on Biological Diversity and the national objectives, the SAP of the state of Rajasthan has been prepared to achieve the following overall goals:

1. To conserve, and where necessary, to augment, the biological diversity and the biological resources of the state,
2. To put in place processes, mechanisms and institutions for ensuring sustainable use of its components, and
3. To put in place processes, mechanisms and institutions for ensuring fair and equitable sharing of the benefits arising out of the utilization of the biodiversity and the biological resources of the state.

It may be noted that the above three broad goals of the SAP also correspond with the three parallel dimensions of all programs of sustainable development as understood generally, namely, the environmental dimension (maintain environmental integrity), the economic dimension (improving economic efficiency) and the social dimension (developing social equity). In other words, the BSAP of the state is a re-statement of the principles of sustainable development (as proposed by the Brundtland Commission) applied to the specific concern of conserving biological diversity.

Specific Objectives

To be more specific, the SAP has the following immediate and concrete objectives (some of which may need to be modified with time) to achieve:

1. Conserving biological diversity in the state;
2. Integrating biological diversity conservation and natural resource management;
3. Managing biodiversity-threatening processes, especially by integrating biodiversity conservation concerns into the sectoral plans and processes;
4. Improving knowledge, data, information and incorporating local people's ethnic knowledge into the mainstream planning for biodiversity, and building human and institutional capacity in this respect;
5. Involving communities, especially their empowerment and participation in decision-making processes at local as well as state level;
6. Promoting an understanding of the need to conserve biodiversity and to use biological resources in a sustainable manner;
7. Defining the state's role in the national programme of conservation of biological diversity; and
8. Setting priorities for implementable actions for achieving the overall goals set out in the preceding para above.

Contents of the SAP

The present document begins with an overall view of the biological diversity and biological resources of the state of Rajasthan. While it is not intended to be a comprehensive database (or manual) of species and communities, it does purport to provide an overall picture of what is unique and special about these resources of the state. This is followed by a summary how this resource is being used in the state and what processes and what kind of stakeholders are the key actors in these processes.

Chapter 5 presents a summary of the present programmes being implemented for conservation of biodiversity in the state. A brief review of policies and institutions (and what could perhaps be lacking in some of these fields) follows.

Chapter 6 then lays down the action plan for achieving these objectives. The plan is organised around a thematic matrix of 6 principal areas of concern including cross-cutting themes that have been comprehensively treated with a range of possible interventions in each class or theme.

At the end of the report one find references of the resources cited in this document and a useful bibliography of resources. The appendices also contain valuable data about the biodiversity resources and institutional infrastructure of the state in this respect.

CHAPTER 2

PROFILE OF THE STATE

This chapter discusses the geographical and socio-economic profile of the state of Rajasthan. Conservation of natural resources has been a very old concern for the people of this state. Communities are known to have sacrificed their lives and built whole religio-cultural faiths around the theme of conservation and compassion for living beings including plants and animals. The process of state-led development programmes have not been so meticulous or concerned about this aspect however. A historical delineation of these processes and how they have adversely impacted the biological resource base of the state will lead to a better understanding of the future plans and processes and their expected responses and success.

Geographical Profile

The state of Rajasthan is located in the north-western part of the country. It is bounded on the west and northwest by Pakistan, on the north and northeast by the states of Punjab, Haryana, and Uttar Pradesh, on the east and southeast by the states of Uttar Pradesh and Madhya Pradesh, and on the southwest by the state of Gujarat. The Tropic of Cancer passes through its southern tip in the Banswara district. The state has an area of 342,239 square kilometres and is the largest state of India.

The Aravallis

The topography of Rajasthan is dominated by the Aravalli Hills, which form a line across the state, running roughly from Guru Shikhar (Mount Abu) at 1,722 m in the southwest to the town of Khetri in the northeast. Aravalli Range is one of the oldest hill systems of northern India, running north-easterly for 560 km through the state of Rajasthan. Isolated rocky offshoots continue to just south of Delhi. The series of peaks and ridges, with breadths varying from 10 to 100 km are generally between 300 and 900 m in elevation. The system is divided into two sections—the Sambhar-Sirohi ranges, taller and including Guru Shikhar on Mount Abu, the highest peak in the Aravalli Range (1,722m), and the Sambhar-Khetri ranges, consisting of three ridges that are discontinuous. The Aravalli Range is rich in natural resources (including minerals) and serves as a check to the growth of the western desert. It gives rise to several rivers, including the Banas, Luni, Ruparel, Sakhi, and Sabarmati. Though heavily forested in the south, it is generally bare and thinly populated, consisting of large areas of sandstone and of masses of rose-coloured quartzite

East Rajasthan Uplands

The south-eastern part of the state is dominated by uplands, with an area of about 60,000 square km, east of the Aravalli Range. The uplands range in height from 250 m in the northeast to 495 m in the southwest and form the northern part of the Central Highlands. The East Rajasthan Uplands, formed by past fluvial erosion and

by geologically recent desert erosion, are bounded by the Indo-Gangetic Plain on the north, the Malwa region on the south, the Madhya Bharat Plateau on the east, and the Aravalli Range on the west. The uplands are wide and stony, with a sandy central region. The valleys between the hill ranges are wide and stretch for many miles; flattened hilltops form small plateaus. Teak, *dhok*, and acacia trees and bamboo grow on the lower slopes of hills, and grasslands and pastures are found on the hilltops. The Banas River, rising in the eastern flank of the Aravalli, is the main waterway in the highlands; whereas the Banganga river flows eastward.

The South-eastern Pathar (Hadoti Plateau)

This plateau covers the eastern part along the Chambal river. It includes two physiographically distinct features: Vindhyan scarplands and Deccan plateau. The Vindhyan scarps are formed of massive sandstones separated by shale and face south-east between the Banas and the Chambal and extend towards the east over Bundelkhand. The western part of the Vindhyan plateau of Madhya Pradesh extends as a triple plateau of three concentric scarps. This physiographic feature of south-eastern Rajasthan is known as 'pathar' (stony land) or 'uparmal' (higher lands). It is wide and stony upland and includes Kota-Bundi section. This is a part of the Deccan plateau.

The Thar Desert

Over half the geographical area of the state is occupied by The Great Indian Desert (also known as Thar Desert), a tract of rolling sand dunes extending right through Pakistan. Covering 209,000 sq km of territory, it is bordered by the irrigated Indus plain to the west, the Aravalli Range to the southeast, the Rann of Kachchh to the

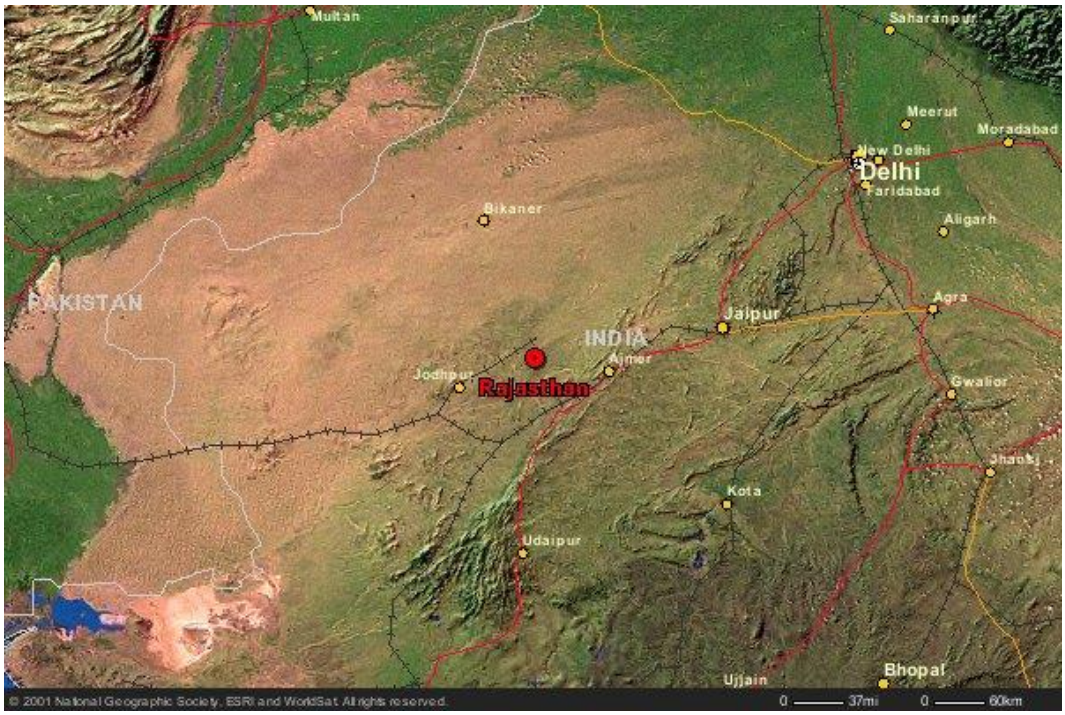


Figure 2-1 The Aravalli Hills can be seen as the most distinct topographic mark of the state. [Map from *National Geographic*]

south, and the Punjab plain to the north and northeast. Thar Desert is an extension of Sahara desert, through Arabian and Persian deserts. In India, it extends from Punjab, Haryana, Rajasthan to Gujarat state. The desert results from the dryness of the prevailing monsoon winds, which do not bring sufficient rain to keep the region moist. The name Thar is derived from t'hul, the general term for the region's sand ridges.

The desert sands cover early Precambrian gneiss (granite like metamorphic rocks formed in the oldest geologic era, which began 3.8 billion years ago), sedimentary rocks from about 2.5 billion to 570 million years old, and more recent material deposited by rivers (alluvium). The surface sand is aeolian (wind-deposited) sand of the Quaternary Period (the most recent geologic period, which began about 1.6 million years ago).

The desert presents an undulating surface, with high and low sand dunes separated by sandy plains and low, barren hills, or *bhakar*s, which rise abruptly from the surrounding plains. The dunes are in continual motion and take on varying shapes and sizes. Older dunes, however, are in a semi-stabilized or stabilized condition, and many rise to a height of almost 500 feet (150 m). Several saline lakes, locally known as *dhand*s, are scattered throughout the region.

Drainage

The Aravallis form Rajasthan's most important watershed. The drainage to the east of this range flows northeast, as does the Chambal, which is the only large and perennial river in the state. Its principal tributary, the Banas, rises in the

Table 2-1: Principal drainage catchments in the state [*From* Mishra V C, 1977]

S. No	Catchments and sub-catchments	Area in sq. km.	Percentage of total area
1.	The Yamuna - Ganga Catchment	5,126.49	1.5
2.	The Chambal Catchment (72,032.05 sq. km.)		
	a) The Kul Catchment	2,943.90	
	b) The Kali Sindh and Parwan Catchment	11,444.72	0.8
	c) The Chambal Catchment	18,446.45	3.3
	d) The Bansi Catchment	33,760.05	5.4
	e) The Morel Catchment	5,436.93	9.8
			1.6
3.	The Mahi Catchment	16,551.18	4.8
4.	The Luni Catchment (34,866.40 sq. km or 10.3 per cent)	3,327.46	
	a) The Sagi Catchment	8,866.88	1.0
	b) The Jawai Catchment	22,672.06	2.6
	c) The Sukri and Bandi Catchment		6.7
5.	The Sabarmati Catchment	3,288.68	1.0
6.	The Banas Catchment	2,837.81	0.9
7.	Zone of Inland Drainage (385,587.21 sq. km or 60.2 per cent)	4,667.80	
	a) The Kanti basin	5,793.88	1.4
	b) The Sota and Sahibi basin	3,516.50	1.7
	c) The Barah basin	6,742.57	1.0
	d) The Ramganga basin	157,272.42	2.0
	e) The Misfit streams	27,594.04	46.0
	f) The Misfit streams of the Luni basin		8.1

Aravallis near Kumbhalgarh and collects all the drainage of the Mewar Plateau. Farther north, the Banganga, after rising near Jaipur, flows east toward the Yamuna before disappearing. The Luni is the only significant river west of the Aravallis. It rises in the Pushkar Valley of Ajmer and flows 320 kilometres west-southwest into the Rann of Kachchh. Northeast of the Luni basin, in the Shekhawati tract, is an area of internal drainage characterized by salt lakes, the largest of which is Sambhar Salt Lake. Farther to the west lies the true Marusthali ("Land of the Dead"), the barren wastelands and areas of sand dunes that form the heart of the Great Indian Desert.

Climate

There is a wide range of climate, varying from extremely arid to humid. Except in the hills, the heat in summer is great everywhere, with a mean daytime maximum temperature hovering at about 43 C in many locations. On occasional days the maximum temperature may go as high as 49 C in some places (Jaisalmer in the west and Dholpur in the east being the hottest places in the state). Mean daily winter temperatures vary from 20 to 24 C, though occasionally the minimum temperature can go below freezing point also (in Churu district, for example). Hot winds and dust storms occur, especially in the desert tract, where rainfall averages 100 mm annually. In the southwest, rainfall is higher (500-700 mm), in part owing to the summer monsoon winds off the Arabian Sea and Bay of Bengal.

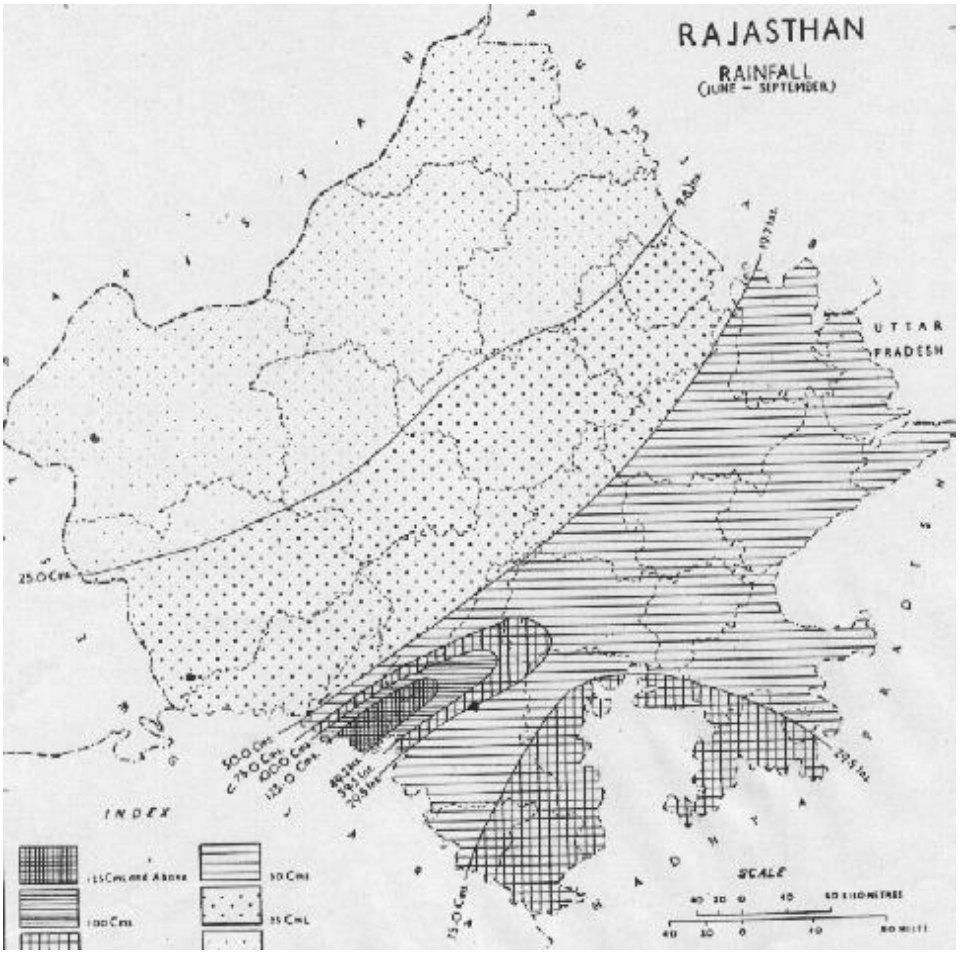


Fig. 2-2 Rainfall distribution in the state [*Op. cit.*]

Precipitation is highly erratic, and there are wide fluctuations in the amount from year to year. About 90 percent of the total annual rain occurs during the season of the southwest monsoon, from July to September. In other seasons the wind blows from the northeast. May and June are the hottest months of the year, with temperatures rising to 49 C. During January, the coldest month, the mean minimum temperature ranges between 5 and 10 C, and frost is frequent. Dust storms and dust-raising winds, often blowing with velocities of 140 to 150 km per hour, are common in May and June.

Socio-economic Profile

The People

Numerous indigenous groups make up population of the state, including the Minas, the Mevs, the Banjaras, and the Bhils (one of the oldest tribes in India, known for their skill in archery). Others include the Gadia Lohars, the Kalbelias, and the Garasias. Sahariyas are found in the Kota district, and the Rebaris of the Marwar region are cattle breeders.

The principal language of the state is Rajasthani, comprising a group of Indo-Aryan dialects derived from Dingal. The use of Rajasthani is declining, however, being replaced by Hindi. Hinduism is the dominant religion, although Jainism is also important, and there are Muslim, Christian, and Sikh minorities in the state. Rajasthan is sparsely populated and essentially rural in character, although its urban population, and the city of Jaipur in particular, has grown rapidly in recent years.

Nomadic groups such as the rebaris and gadia lohars, bhaats, and banjaras are still following nomadic lifestyles. Rebaris and gujjars migrate with their livestock usually every monsoon season from the western parts of the state to the eastern and southern parts where they find better forage for grazing their herds in forests, fallows and other wastelands. Some of traditionally hunting groups such as the bhopas, bhils, mogiyas, aheris, tirgars, and van baorias still follow this lifestyle though a vast majority of these groups have now settled in other professions.

The state has a sizable proportion of Scheduled Castes and Scheduled Tribes (20% and 15% respectively), which still are in the process of finding their place in the mainstream of political, economic, and social life in the state. Ensuring protection of rights of these vulnerable communities is an important element in all the state-led development programmes and policies.

Language

The principal language of the state is Rajasthani, comprising a group of Indo-Aryan dialects derived from Dingal, a tongue in which bards once sang of the glories of their masters. The four main dialects are Marwari (in western Rajasthan), Jaipuri or Dhundhari (in the east and southeast), Malwi (in the southeast), Bagdi (in the south) and, Mewati (in Alwar), which shades off into Brij Bhasa in Bharatpur district. The use of Rajasthani is declining with the spread of modern education, and its place is being taken by Hindi (the official state language of the state).

Religion

Hinduism, the religion of most of the population, is generally practiced through the worship of Brahma, Shiva, Shakti, Vishnu, and other gods and goddesses. Nathdwara is an important religious centre for the Vallabhacharya sect of Krishna followers. There are also followers of the Arya Samaj, a reforming sect of modern Hinduism, as well as other forms of that religion. Jainism is also important; it has not been the religion of the rulers of Rajasthan but has followers among the trading class and the wealthy section of society. Mahavirji, Ranakpur, Rishabhdev, and Nakoraji are the chief centres of Jain pilgrimage. Another important religious sect is formed by the Dadupanthis, the followers of Dadu (d. 1603), who preached the equality of all men, strict vegetarianism, total abstinence from intoxicating liquor, and lifelong celibacy.

Islam, the religion of the state's second largest religious community, expanded in Rajasthan with the conquest of Ajmer by Muslim invaders in the late 12th century. Khwajah Mu'in-ud-Din Chishti, the Muslim missionary, had his headquarters at Ajmer, and Muslim traders, craftsmen, and soldiers settled there. The state's population of Christians and Sikhs is small.

Folk Heroes and Deities

Rajasthan is notable for its folk heroes as much as for the great patriotic heroes like Rana Pratap of Mewar and Prithiviraj, the Ruler of Ajmer. A rich cultural folklore sings the lives of folk heroes and saints. It is remarkable that most of these heroes and most of their great exploits centred around pastoral lifestyles. Lives of Vir Tejaji, Pabuji, Ramdeoji, Gogaji, and Jambheshwarji are all associated with protection of cows. Two of them are also perceived as snake gods and are believed to possess miracle powers to curing snake bites. Jambheshwarji who founded the new sect of *bishnois* who believe in protection of animals and trees as one of their central tenets. The story of Khejarli where men and women lost their lives in defence of *khejri* trees is a unique example of sacrifice in the history of the world. The religious-cultural landscape of the state is also marked by many saintly persons who are now revered as deities. Among them are Gorakhnath (among whose disciples was Jambheshwarji), Mallinath (a protector of cows, in whose memory is held the famous cattle fair of Tilwara in Barmer district), Mavaji (god venerated by Bhils in Banswara), Makadji-Devji (or deonarayanji) venerated by the Gujjars, Mahavirji the protector of wells, the bhomiyas who protect the boundaries of the village, Khetrapal who is associated with *khejri*, Sheetalamata the goddess of 'coolness' who protects its followers against small-pox, and many other gods and goddesses who are intimately linked with people's lives.

Habitation

Rajasthan is one of the least densely populated states in India. The urban population has been growing faster than the rural, but even so there are only a few large towns, including Jaipur, Ajmer, Jodhpur, Udaipur, Kota, Bikaner, and Alwar. There are industrial complexes at Jaipur, Kota, Udaipur, Alwar, Bhiwadi, Kishangarh, and Bhilwara.

Rural houses are huts with mud walls and roofs thatched with straw. They have a single door, but no windows or ventilators. The houses of well-to-do farmers and artisans in larger villages have more than one room. They are roofed with tiles and

have a veranda and a large courtyard, whose main door will admit a loaded bull cart. The earthen floors are coated with mud and dung. Of late, houses in rural areas are more and more made of stone masonry and stone-slab roofs. This is one of the signs of economic progress of the populace on the one hand, and lack of traditional building materials such as wood.

Agriculture

Rajasthan is a predominantly agricultural and pastoral state and exports food grains and vegetables, and animal products such as milk, meat, poultry, hide and wool. Despite a low and erratic rainfall, nearly all types of crops are grown; in the desert area, *bajra* (millet); in Kota, *jowar* (sorghum); and in Udaipur, mainly corn (maize). Wheat and barley are fairly well distributed (except in the desert area), as are pulses (the edible seeds of legumes, such as peas, beans, and lentils), sugarcane, and oilseeds. Improved varieties of rice have been introduced, and acreage of this crop has expanded in the areas of the Chambal Valley and Indira Gandhi canal projects. Local basmati variety of Bundi is in great demand and is being exported. Sugarcane is cultivated in northern and south-eastern districts of Sriganganagar and Kota. Cotton and tobacco are important cash crops. Soya is now grown increasingly in Kota region. Mustard is grown almost all over the state, including the eastern region of Bharatpur and Alwar. The state of Rajasthan is the largest producer of mustard in the country.

Livestock

Although most of its area is arid or semiarid, Rajasthan has a large livestock population and is the largest wool-producing state. It has a monopoly in camels and in draft animals of various breeds.

There are five major breeds of cattle in the Thar tract. Among these, the Tharparkar breed is the highest milk yielder, while the Kankrel breed is good both as a beast of burden and as a milk producer. Sheep are bred for both medium-fine and rough wool. The camel is commonly used for transport, as well as for ploughing the land and other agricultural purposes. However, over the years use of camel is being replaced by mechanised means of transport. For this reason and for lack of adequate pastures and grazing lands camel population in the state is declining . Fisheries and poultry are also significant activities, mainly exporting these products to cities outside the state.

Although the population of livestock in the state is high, the livestock's productivity leaves much to be desired. The ecological impact of this vast livestock population is increasingly negative and is leading to sharp conflicts among various communities (especially faced by the migrant cattle and sheep breeders). The state's forests are declining in quality due to grazing pressures far beyond their carrying capacity. Irrigation

Having much arid land, Rajasthan needs extensive irrigation. It receives water from the Punjab rivers and also from the Western Yamuna (Haryana). There are thousands of tanks (village ponds or lakes), but they suffer from drought and silt. Rajasthan shares the Bhakra Nangal project with the Punjab and the Chambal Valley project

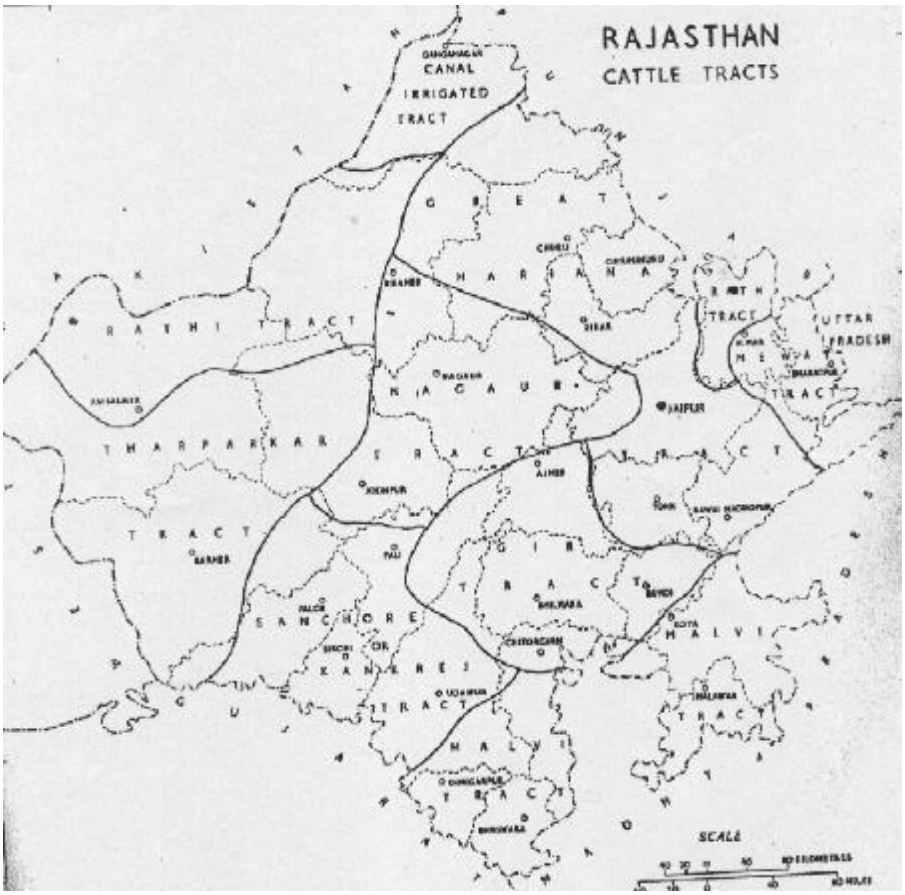


Fig 2-3 Livestock tracts of the state [*Op. cit.*]

with Madhya Pradesh; both are used to supply water for irrigation and for drinking purposes. The Rajasthan Canal, renamed *Indira Gandhi Nahar* in the mid-1980s after the late prime minister Smt Indira Gandhi, carries water from the Beas and Sutlej rivers in Punjab some 600 km to irrigate desert land in north-western and western Rajasthan.

Minerals

Rajasthan is the second richest state in the country in terms of its mineral wealth. It produces India's entire output of lead and zinc concentrates, emeralds, and garnets. More than 90 percent of the country's gypsum and silver ore are also produced in Rajasthan. Oil and natural gas have been found in Rajasthan, and other mineral deposits include feldspars, mica, asbestos, copper, zinc, limestone, dolomite, salt, soapstone, and marble. The Zawar mines of Udaipur are famous for zinc. Natural gas and coal reserves have been recently discovered in the western part of the state.

Energy & Transport

Electricity needs of the state are met from coal-based thermal power stations at Kota and Suratgarh and gas-based power station at Ramgarh (in Jaisalmer district). The state has partnership with the neighbouring state of Madhya Pradesh in hydel power projects located on Bhakra-Beas and Chambal river systems as well as in Satpura

thermal power station in Madhya Pradesh. There is a nuclear energy plant at Rawatbhata, near Kota which supplies power to the state and to other states via the Northern Power Grid. The balance of electricity is purchased by the state from various national power generating companies.

Although the state does not have much potential of coal-based and hydropower generation, it has some potential for wind-based power generation and a great potential for solar power generation. Licences have been issued to two companies for setting up solar power generating facilities, though no significant progress has yet been made by these companies. A combined cycle power plant of 140 MW is being planned at Mathania (in district Jodhpur) wherein 35 MW power is to be generated from solar energy and the rest from liquid fuels.

Road building has also increased, and there are air connections between Jaipur, Jodhpur, Udaipur, New Delhi, Bombay, and Agra.

Industry

The main industries are based on textiles, vegetable oil, wool, minerals, and chemicals, while handicrafts, such as leather goods, marble work, jewellery, pottery, and embossed brass have earned much foreign exchange. Various industrial concerns received substantial loans and subsidies from the government and from the Rajasthan Finance Corporation, a semi-governmental agency. Kota, which is the industrial capital of the state, has a nylon factory and a precision-instruments factory, as well as plants for the manufacture of calcium carbide, caustic soda, and rayon tyre cord. There is a zinc smelter plant near Udaipur.

Education and welfare

There are a number of educational establishments in Rajasthan, including state-run universities at Jaipur, Udaipur, Jodhpur, Bikaner and Ajmer; the Open University at Kota; and the Birla Institute of Technology and Science at Pilani. There are several state hospitals and dispensaries. There are also many Ayurvedic, Unani (medicinal systems using prescribed herbs and shrubs), and homeopathic institutions. The state incurs heavy expenditure on education, on maternity and child welfare, on rural and urban water supplies, and on the welfare of the disadvantaged.

Fairs & Festivals

Hardly a month passes in Rajasthan without a religious festival, the Hindus and Muslims joining in each others' festivals. A remarkable one is called Gangor, during which women worship clay images of Mahadev and Parvati (representing the benevolent aspects of the Hindu mother goddess) for 15 days. Another important festival is held at Pushkar (near Ajmer), taking the form of a mixed religious celebration and livestock fair. It is visited by farmers from all over the state (bringing their camels and cattle) and by pilgrims seeking a religious experience. Ajmer is also known for the *urs*, the annual congregation at the *dargah* of Khwaja Mu'in-ud-Din Chishti which draws Muslim devotees from all over the world. Among the important fairs in the state may be named the camel fair of Bikaner (held in January each year), the Chaksu Fair (Jaipur), the Nagaur Fair (known for bullocks and other cattle wealth), the Desert Festival (Jaisalmer), Shri Mahavirji Fair (Sawai Madhopur),

the Chandrabhaga Fair (Jhalawar), the Pushkar Fair (Ajmer), the Mallinath Fair (Barmer), the Jasol Fair (Barmer), and the Karni Mata Fair (Bikaner).

The typical folk dance of Rajasthan is the *ghoomar,* performed only by women. The *gair* dance (performed by both sexes), the *panihari* (a graceful dance for women), and the *kacchi ghori* (in which male dancers ride dummy horses) are also popular. The most famous song is the *Kurjã,* which tells the story of a woman who wishes to send a message through the *kurj* birds (demoiselle crane)), which are promised a priceless reward for this service. Rajasthan has a rich literary tradition, especially of bardic poetry, and the state abounds in objects of antiquarian interest--Jain temples, mosques, and tombs. Indeed, Rajasthan is India's most popular area for foreign tourists.

Political Profile

Government

The state has a unicameral Legislative Assembly (Vidhan Sabha), which has 200 members. The state is divided into 32 districts: Ajmer, Alwar, Banswara, Baran, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittorgarh, Churu, Dausa, Dholpur, Dungarpur, Sriganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhalawar, Jhunjhunun, Jodhpur, Karauli, Kota, Nagaur, Pali, Rajsamand, Sawai Madhopur, Sikar, Sirohi, Tonk, and Udaipur.

In each district the Collector, who is also the district magistrate, is the principal representative of the administration. He functions in close cooperation with the Superintendent of Police to maintain law and order in the district; he is the principal revenue officer; he coordinates the activities of the other departments in the district; and he acts as a link between the state government and the people.

Local Self Government

Rajasthan was the first state to experiment with *panchayat raj* (rule by *panchayat*, or village council), having enacted (1959) the legislation necessary to implement this bold experiment in democratic decentralization. The system, embracing Gandhian concepts of the importance of traditional village institutions in Indian society, created three levels of local government within the state based on elected village *panchaya*t. Villages were grouped into administrative units called community development blocks, each having a *panchayat samiti* (block council) composed of the chairmen of the *panchayat*s, elected directors, and ex officio members. There were also district-level councils (*Zila Parishad*s), composed of the chairmen of the *panchayat samiti*s, elected board members along with representatives of special interests (*e.g.,* women, Scheduled Tribes, and Scheduled Castes) and local members of the state and national legislatures. The key level in this organization is the community development block, which was assigned the responsibility for planning and implementing a wide range of community and development programs. *Panchayat raj* initially achieved a considerable measure of success, but, with increasing politicisation of the system and conflicting interests with state-led development agencies, the system has fallen into abeyance.

Ecological Profile

Soils

The soils in the Ajmer district in central Rajasthan are sandy; clay content varies between 3 and 9 percent. In the Jaipur and Alwar districts in the east, soils vary from sandy loam to loamy sand. In the Kota, Bundi, and Jhalawar tract, they are in general black and deep and are well drained. In Udaipur, Chittorgarh, Dungarpur, Banswara, and Bhilwara districts, eastern areas have mixed red and black and western areas red to yellow soils.

The soils in Thar Desert consist of seven main groups--desert soils, red desert soils, sierozems (brownish grey soils), the red and yellow soils of the foothills, the saline soils of the depressions, and the lithosols (shallow, weathered soils) and regosols (soft, loose soils) found in the hills. All these soils are predominantly coarse-textured, well-drained, and calcareous (calcium-bearing). A thick accumulation of lime (kankar pan) often occurs at varying depths. The soils are generally infertile and, because of severe wind erosion, are overblown with sand.

Flora

The main floral feature is scrub jungle. Toward the west there are plants characteristic of the arid zone, such as tamarisk and thorny plants. Trees are scarce, found only in the Aravallis and in eastern Rajasthan.

The desert vegetation is mostly herbaceous, or of stunted scrub; trees occasionally dot the landscape. On the hills, gum Arabic, acacias and euphorbias may be found. The *khejri* (*Prosopis cineraria*) tree grows throughout the plains. Another economically valuable tree though less common is the *rohida* tree (Tecomella undulata) which has come to acquire the epithet of 'Marwar teak' in views of the superior quality of its timber.

The grasses form the main natural resource of the desert. They provide nutritive and palatable pasturage, as well as medicines used locally by the inhabitants. Water is very scarce. Whatever seasonal rain falls is collected in tanks and reservoirs and is used for drinking and domestic purposes. Most groundwater cannot be utilized because it lies deep underground and is often saline. Good aquifers have been detected in the central part of the desert.

Fauna

Tigers are found in the Aravallis and in some districts. Leopards, sloth bears, sambhar (dark brown Indian deer), and chital (spotted deer) occur in the hills and forests, where nilgais (blue bulls) are also found in parts; blackbuck and gazelles are numerous in the plains. Snipe, quail, partridge, and wild duck occur. The Bikaner region is well known for several species of sandgrouse. Several migratory waterfowls are known to visit the state.

The thinly populated grasslands support the blackbuck, the chinkara (gazelle), and some birds, notably the quail and the partridge. Among the migratory birds sand grouse, ducks, cranes, and geese are common. The desert is also the home of the

vanishing great Indian bustard. Rajasthan has declared *chinkara* and the great Indian bustard as the state animal and state bird respectively.

Twenty three wildlife sanctuaries and two national parks have been established in the state. Among the most important ones are the Keoladeo National Parks in Bharatpur, the Ranthambhor Tiger Reserve in Sawai Madhopur, the Sariska Tiger Reserve near Alwar, and the proposed Desert National Park in Jaisalmer and Barmer districts.

CHAPTER 3

CURRENT STATUS OF BIODIVERSITY RESOURCES AND THEIR USE

This chapter provides a brief account of the biological resources of the state, their diversity, and their use and management. It covers both the natural ecosystems (wild biodiversity) and the managed ecosystems (the domesticated biodiversity). An overview of how the resources are being utilized, impacted adversely, threatened or being exploited unsustainably is also provided. An account of the institutional arrangements for managing and conserving conservation of biodiversity has been given. The biological resources are so diverse, widespread and important in the state's economic, social and cultural life that the range of stakeholders and key players affecting the future of biodiversity is vast and complex.

Natural ecosystems and wild species

The state's natural ecosystems are diverse and rich in terms of diversity of species and ecological communities. The following sections present an account of each of the elements of biodiversity at different levels, namely, bioregions and landscapes, ecosystem categories, ecological communities, and species. The state is covered by 2 of the Global 200 ecosystems identified by the WWF International.

These ecoregions are: 1. The Thar Desert and 2. The Kathiawar-Gir Dry Deciduous Forests. The state is also rich in endemic species of plants, animals and micro-organisms, especially those found in the desert. There are two internationally recognised sites of special significance under the Ramsar Convention, viz the Keoladeo National Park, Bharatpur and the Sambhar Lake in district Nagaur.

The Aravallis

The Aravallis constitute a major physiographic as well as bioregional feature playing a vital role in the ecology of the state. These ranges constitute all the major watershed and most rivers originate from these ranges. The state's major part of natural forests are in this region. Protection of these ranges is crucial to the state's predominantly agricultural economy. The major river basins of state are spread on the eastern side of these ranges whereas one river namely the Luni drains the western aspects of these ranges.

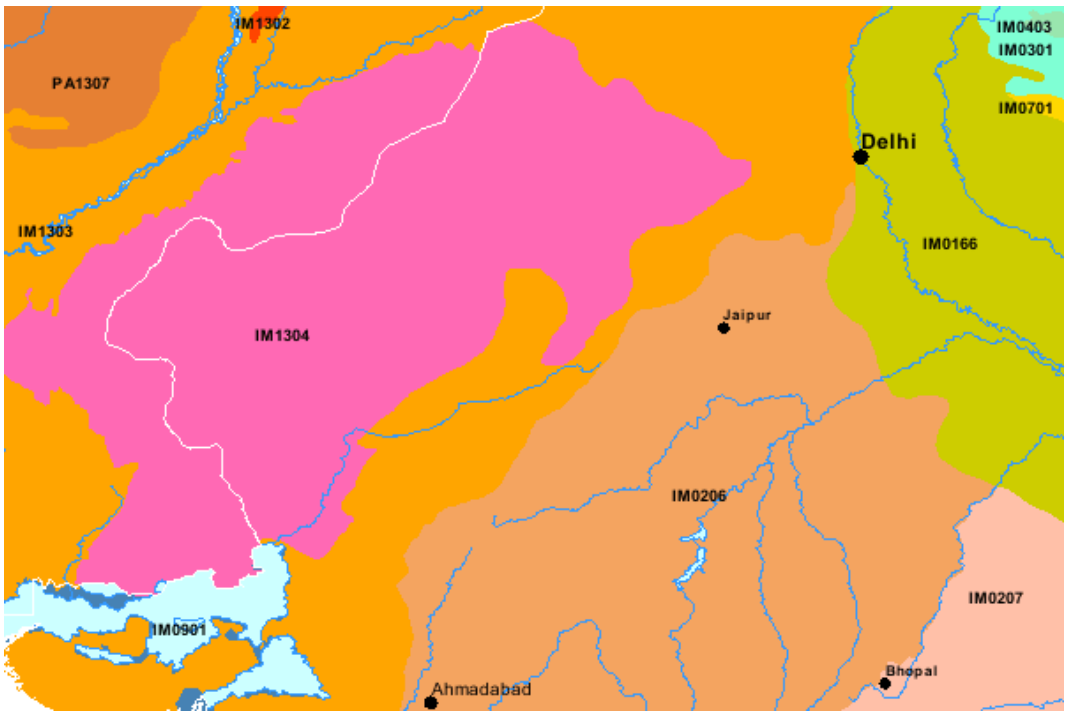


Figure 3-1 Principal ecoregions of the state [WWF *Global 200 Programme*]

The Thar Desert

The Thar Desert is another important bioregion comprising about 61 percent of the state's total geographical area. It is one of the most living deserts of the world and houses distinct and unique ecosystems, landscapes and species of plants and animals in the country. It is characterised by geomorphic forms and landscapes such as dunes, *magras*, *dhands* and *bhakars* each with a distinct ecology of its own.

Eastern Uplands and Hadoti Plateau

Another biogeographic region of the state is constituted by the eastern uplands and the Hadoti plateau. Encompassed on the eastern side by the ravinous plains, this region has the largest percentage of surviving forests. The region is dominated by pastoral practices and has one major agricultural area served by the Chambal river.

Ecosystem Types

On another plane, the state can be divided into major categories of ecosystems characterised by the community ecology, including but not limited to forests, grasslands, and wetlands. The state has three predominant agricultural areas or regions each marked by the coverage of a canal system: the Chambal command area in the east, the Gang Canal area in the north and the Indira Gandhi Canal area in the north-west. Each of these have different agroclimatic features and constitute major types of agro-ecosystems in the state.

Forests

Extent

Forests constitute about 9 percent of the geographical area in the state (3.19 million hectare against 34.22 mha). The actual cover of forests varying widely from well-stocked forests to open scrubs and wastelands. The geographic distribution of forests is uneven. Most of the forests are concentrated in the Aravalli and Vindhyan hill systems. The western part of the state is particularly devoid of forests, though there are many good grasslands in this area. Of the total 32 districts in the state only 7 have actual forest cover exceeding one-tenth of their total area. It is worth noting that a substantial part of forests also exist on public lands not recorded as forest lands and therefore not included in these data.

Composition

A majority of the state's forests are of dry deciduous type. Going down to level of associations and stands reveals many more categories. The richness of biodiversity in the forests is high as is the case with most tropical forests. The forests have for the most part been worked for extraction of firewood, charcoal, timber and other forest produce. As a result there are very few pristine or frontier forests in the state.

Figure 2-2 Forested landscape in Ranthambhor National Park

Status

The degree of stocking and the richness of original species varies a great deal across the forests. Only 12 percent of the state's forests are well-stocked (dense, that is with a crown density of 0.40 and above) and in their natural state. In the rest, the stock is either degraded (open forest, 30 percent of total forest area, having crown density of 0.10 to 0.30), or scrub and barren (58 percent) with density less than 0.10 [FSI 2000]. The species composition of forests varies from the full native biodiversity to mono-species invasions of exotics such as the mesquite *Prosopis juliflora* (*P. chilensis*) to a few species propagated during plantation programmes. Significant portions of forest lands have lost

soil cover as a result of erosion caused by water, heat and wind forces. Often these areas are now beyond the stage of rehabilitation, or the cost of reforestation is prohibitive. Similarly the areas that have been degraded of late still have the soil cover intact and are in a position of being rehabilitated with suitable reforestation programme.

Management

Almost all the forests in the state are owned and managed by the state. Forests have been worked until mid-1980s for extraction of firewood, timber, charcoal and other produce such as *kutha* and gum. At present, however, working of forests is regulated by the provisions of the Forest (Conservation) Act 1980 (a central Act, passed by the Parliament) as in other states in the country. As a result, working (or management) plans of forests must be sanctioned and approved by the Central government. Except for the plantations in the IGNP canal, most forests are managed for multiple use benefits rather than for any single produce such as timber. The forests are classified as Reserved Forests (39%) , Protected Forests (50%). Village Forests is a category defined under the Act but not implemented. Rest of the forests are not yet classified according to the provisions of the Act and are treated as unclassed forests (11%). These categories represent a graded level of control and regulation in respect to access and exploitation. However, a substantial proportion of lands with varying density of forest cover, including natural forests with high diversity, have not been formally classified as forests. These lands remain under the notional management of the Revenue (land or estate) department but there is hardly any management existing in practice. In one exercise carried out in Bundi district, for example, it was found that over 20,000 hectare of lands with good forest cover lie outside the formal forest reserve. Often boundaries of forest blocks cut across well-forested tracts leaving these partially out of the declared reserve. The intention during settlement operation had perhaps been to provide relief to the local communities by partially leaving out these lands for their use, but with the concept of community ownership of all forests this leads to uncalled-for fragmentation of forest lands.

Processes and trends

The forest cover in the state has been increasing over the last ten years. The increase is attributed partly to increased accuracy in the methodology and in part to the increasing area covered by invasive exotics such as *Prosopis juliflora* and *Lantana* sp . The contribution of reforestation programmes implemented during the last two decades is also significant. One the other hand, degradation and impoverishment of forests, especially of ground vegetation and soils, is continuing mainly because of overgrazing, fuel gathering and extraction of minor forest produce. Shift in species composition because of plantation programmes in which local species get replaced by other species is also an important trend.

Grasslands

The state has several types of grasslands. In the western part extensive *sewan* (*Lasiurus indicus*) grasslands occupy a large proportion of the total landscape. These are unique ecosystems with species of animals (wild as well as domesticated) which have evolved over the ages to the harsh conditions of the region. Another important grasslands are comprised almost entirely of *karad* (*Dicanthium annulatum*), occupying mostly the areas with heavier soils in the south and eastern part of the state. In the central region of the state grasslands dominated by *dhaman* (*Cenchrus ciliaris*) occupy a substantial proportion of

land area. Most grasslands are managed traditionally (as *jors* or *birs* or *charnots* or *orans)* by local communities through *panchayats*. A large number of grassland *birs* are classified as forest lands and are managed by the forest department. The status of these grasslands is far from satisfactory. Overgrazing, encroachment, and infestation with alien species such as *P. juliflora* has led to adverse changes in composition, ecology and productivity of the grasslands. In the Biodiversity Conservation Prioritization Project (BCPP) of the WWF conducted in 1998-1999, eight grassland ecosystems were identified as of special important in terms of conservation priority. These are: Bap (Jodhpur), Desert National Park (Jaisalmer & Barmer), Diyatra-Khetolai (Sriganganagar), Keoladeo National Park (Bharatpur), Ramgarh (Jaisalmer), Shergarh (Baran), Talchhapar (Churu) and Sultana (Jaisalmer).

Wetlands

In spite of an arid climate and extensive desert area, the state has many ecologically significant and unique wetlands. There are 55 major wetlands (*see* Appendix) which occupy 1230 sq km of area scattered all over the state. According to another source there are nine wetlands in the state that are natural wetlands (comprising 14027 ha in area) and 85 manmade wetlands comprising of 100,217 ha In the western part of the desert salt lakes or marshes, known locally as *dhands*, are also found, whereas in the foothills and plains of the Aravallis several freshwater lakes occupy an important place in the economic life of the people. Among the riverine category the Chambal river occupies a special place as the only perennial river of the state and a home to the crocodiles and *ghadials*. Many of the state's man-made reservoirs, including several dams built on the Chambal and other rivers, are important for the harbouring bird, fish and other aquatic life forms. Two of the state's wetlands, namely, Ghana (Bharatpur) and Sambhar are recognised as wetlands of international importance under the Ramsar Convention. Deedwana, Pachbhadra, and Jaisamand lake are other important wetlands of the state.

Deserts.

Extent

The Thar Desert occupies about 209 000 sq km of area constituting 61 percent of the total geographical area of the state. It roughly covers the area north-west of the Aravallis. The principal geomorphologic formations are dunes (highly mobile sands), *magras* (local uplands constituting important watersheds) and *bhakars* (hillocks suddenly rising in the midst of plains), each with unique biological communities and ecological processes. There are 11 districts out of the state's total 32 which are predominantly covered by these landforms with desert ecosystems.

Ecology

Thar is considered to be an unique desert because of its location at the crossing where Palaearctic, Oriental and Saharan elements of biodiversity both at species level and at the level of ecological communities are found. This desert has sustained great civilization particularly in Ghaggar and Indus River basins. The ecology of dunes is different from that of the other land forms, e.g. the *magras*. The number of species of plants and animals may be low but their xerophytic characteristics make some of them of special taxonomic significance in the country. Animals and plants have developed to adapt to the difficult

climatic conditions with extreme temperatures and lack of moisture. In the *magras*, many species and communities are those found in other parts of the state, especially the hills.

Figure 3-3: A Thar desert landscape. [*Op..cit.*.]

But composition of the communities is skewed towards the xerophytes, many of which have also come to be discovered as of economic value, particularly as medicinal plants.

Status

Excessive biotic pressure has led to considerable decrease in the native vegetation of the desert region on the one hand and increase of invasive alien species on the other. Human population in desert is increasing by more than 3 percent annually. The rapid increase in the population of livestock has also resulted in the loss of grassland and too much pressure on other limited natural resources. Thar is most thickly populated desert (86-104 persons/sq km against nine in other desert). The livestock population is very high (46-226 per sq km).

In certain regions selected species of economic importance (e.g. phog *Calligonum polygonoides* are being harvested at an accelerated pace consequently pushing them to the edge of extinction. Mining, agriculture and pasturing are major land uses posing severe threat to the biodiversity of the region.

Management

Unfortunately, there is no institutional mechanism devised for management of these areas. Except for the small patches of vegetation on hills and grasslands *birs*, there are no notified forests. Vast majority of public lands are owned by government on paper but in field there is no agency to take care of these lands. The lands are either held by the agricultural tenants, or are commons being used by the local people communities for grazing and herding their livestock and collection of fuelwood. A few areas, notably among them the proposed Desert National Park and the Talchhapar Wildlife Sanctuary are in the process of being brought under the formal protected area network. Many other areas known for concentration of particular wild animals were declared *closed areas* (closed

against hunting) under earlier provisions of the Wildlife (Protection) Act. However, in absence of proper resources, clear management objectives and sound management plans, there is no significant activity being undertaken except detection of the occasional poacher and his prosecution. Even so, the biological resources in a vast proportion of the desert lands (over 95%) are not being looked after since the only custodian of these lands namely the tehsildar (local estate officer) is neither informed of nor equipped for implementing conservation programmes.

Processes and trends

During the past few decades the desert ecosystem has been modified greatly by human activity. Traditionally local communities did not impact the ecosystems adversely as their charge on the vegetation was limited to their subsistence needs. For the last few decades, however, rural people lacking means of livelihood have been exploiting the desert vegetation from the commons and selling produce in markets of nearby towns and large village habitations. This process has greatly accelerated resource extraction because of rising populations both in the rural areas and in the towns. Species such as the *phog* (*Calligonum polygonoides*) (which makes excellent soil binder and is a keystone species in the ecosystem) is being removed with its roots and sold by hundreds of cartloads (in a town like Bikaner, for example). Sparse trees dotting the landscape have almost all been removed and gone into the towns. Two major public-funded programmes of afforestation, under Desert Development Programme and the Indira Gandhi Nahar Pariyojana (IGNP), have led to large-scale introduction of alien species, notably of *Prosopis juliflora* and *Acacia tortilis*.

The emergence of the major irrigation project of IGNP has also brought in far-reaching changes in the ecology of the region by creating salinity and water logging and modifying the microclimate. The canal originates in Punjab and enters Rajasthan. The main canal is 649 km from Punjab to Jaisalmer and along with the feeder canals adds up to about 8000 km in length. After completion of the project, 11% area of western Rajasthan will be irrigated. Though the canal system has transformed more than 11% un-inhabitable desert grassland into fertile land, the native biodiversity has come under threat because the canal has changed the soil moisture, soil texture, and vegetation composition, and has led to rise in the water table. These conditions have been responsible for the invasion of new agricultural pests, introduction of new human diseases, increase the weeds, and depletion of xeric biodiversity.

Sites of Special Significance

Ramsar Sites. Two of the state's wetlands have been listed under the Convention on Wetlands of International Importance (popularly known as Ramsar Conventions). These sites are the Keoladeo National Park Ghana (in district Bharatpur) and the Sambhar Lake (in district Nagaur). The former has also been listed as a World Heritage Site under the World Heritage Convention of the Man & Biosphere Programme (MAB) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

Protected Areas

Formal Protected Area System

The state has two national parks and 23 wildlife sanctuaries as established under the provisions of the Wildlife (Protection) Act 1972. Apart from these legally notified protected areas there are other areas at different stages in the process of being formally declared as protected areas. As many as 32 sites of conservation importance have been identified as closed areas (closed to hunting) which were earlier so declared under the provisions of the Wildlife (Protection) Act 1972. The Act now no longer recognises closed areas as a separate management category, but all of these areas are rich in local flora and fauna and are in need of being brought under the formal system of management. Some of the more important protected areas are being described below.

KEOLADEO NATIONAL PARK

Located at Bharatpur, the Keoladeo National Park can be truly termed as a "Bird Paradise". It has more than 370 species of birds and about 130 of them breed inside the park. Being a unique habitat for avifauna the UNESCO has recognized it as a "World Heritage Site". It is also one of the six wetlands in the country listed under the Ramsar Convention. The park has a total area of 29 sq km of which 11 sq km is wetland, predominantly marshland.

RANTHAMBHOR NATIONAL PARK

Located at Sawai Madhopur and spread over an area of 392 sq km of thick forest with nallahs and water falls, this park forms a part of the greater Ranthambhor Tiger Reserve which has an area of 800 sq km. Apart from tiger, sambhar deer is the pride of the park. There is no other park in Asia where the largest of all Asiatic deer can be seen so frequently during day time. Other main herbivores are chital, bluebull and chinkara. Wild boars and langurs are a common sight here. The tiger is the biggest attraction of this park. Naturalists recognize it as one of the best parks in the country for observing and photographing the activities of the tiger. Other carnivores in the park include leopard, hyena, jackal, fox, caracal, jungle cat, ratel and sloth bear. Among the reptiles crocodiles and gavials can be seen basking in the sun near the lakes.

SARISKA TIGER RESERVE

Located about 37 km. from Alwar, it sprawls over an area of 800 sq. km. in the northern part of Aravalli hills. It is one of the oldest sanctuaries, which came into being in 1955 and later was declared a Tiger Reserve in 1979. Sambhars, chitals, nilgais, jackals, wild boars, langurs, chausinghas, etc. abound here. Besides tiger, leopard, hyena, jungle cat and wild dog are other carnivores. Sariska is famous for chausingha - exclusively Indian and the only known buck with four horns. The sanctuary is also known for its population of common langur and the rhesus monkeys.

DESERT NATIONAL PARK

Located about 30 km from Jaisalmer the sanctuary is spread over an area of 3,162 sq. km. in the Thar desert. Sand-dunes form around 20 per cent of the sanctuary. Chinkara and blackbuck are the most common antelopes of this park. Its other notable inhabitants are the desert fox, Bengal fox, wolf, desert cat and desert hare. The park is also very rich in

reptiles. Spiny tail lizard, monitor lizard, saw sealed viper, russel's viper, sind krait, toad agama and sand fish are found in large number.

TAL CHHAPAR

Located in Churu district, this sanctuary is spread over only 8 sq km of area. It has been specially established for conserving the blackbuck where over a thousand blackbuck does and fawns move around freely. Besides these, fox, desert cat, nilgai, hare, mongoose, etc. can also be seen.

KUMBHALGARH-RANAKPUR SANCTUARY

Located in Rajsamand and Pali districts, it is spread over an area of 578 sq. km. It is the only sanctuary in Rajasthan where Indian wolf breeds successfully. This is the best place to observe activities of the rarely found wolf. The four-horned antelope (chausingha) is another species found here. Other common fauna of this sanctuary is sloth bare, leopard, jackal, nilgai, wild boar, sambhar, etc.

SITAMATA SANCTUARY

Located at Pratapgarh in Chittorgarh district this sanctuary is spread over an area of 423 sq. km. The most conspicuous animal of the sanctuary is the highly endangered flying squirrel, a nocturnal animal. Other animals found here are leopard, hyena, jackal, fox, jungle cat, porcupine, spotted deer, four-horned antelope, nilgai, wild boar, etc.

DARRAH SANCTUARY

Located about 60 km form Kota this picturesque sanctuary covers 266 sq km of area. Its dry deciduous forests provide shelter to leopard, jackal hyena, jungle cat, sambhar, spotted deer, mongoose, nilgai, etc. This sanctuary is surrounded on all sides by the rivers Chambal, Kalisindh, Amjar and Ahu which form its natural boundaries.

RAMGARH VISHDHARI

Located near Bundi, it sprawls over an area of 307 km. It is a home to leopards though being close to the Ranthambhor Tiger Reserve, tiger is also occasionally seen here. It is also known for wild dear, jackal, hyena, and nilgai.

JAISAMAND

Located about 50 km form Udaipur on the bank of Jaisamand lake, the sanctuary extends over an area of 52 sq km of thick forests. Its fauna consists of chital, chinkara, sambhar, Langur, leopard, hyena, fox, jungle cat, wolf, etc. The Jaisamand lake is an abode of crocodiles, turtles and a variety of fish.

PHUWARI-KI-NAL

Located about 82 km from Udaipur, it extend over 511 sq km. Among the carnivores leopard is the chief animal. Other common predators are hyena, wolf and jungle cat. The main herbivores include chital, wild boar, four-horned antelope and chinkara. The pangolin, palm civet and ratel are also spotted here.

MOUNT ABU SANCTUARY

This sanctuary is located at the fascinating hill station of Rajasthan extending over 299 sq km. Leopard, sloth bear, wild boar, sambhar, chinkara, langur etc. form its main fauna.

CHAMBAL GHADIAL SANCTUARY

This sanctuary is spread over 280 sq km. all along river Chambal in Kota district. The ghadials nest and bask in winter sun on the river banks. These can be seen from boats. Crocodiles and ghadials breed here.

VAN VIHAR

It extends over an area of 90 sq km on the bank of Ramsagar in Dholpur district. It abounds in deer, jackal, chinkara, sambhar and nilgai.

JAMWA RAMGARH

Located in Jaipur district, it extends over 300 sq km of area. Dhok forests in Aravalli hills provide shelter to sambhar, chital, nilgai, langur etc.

BHAINSRORGARH SANCTUARY

Located in Chittorgarh district, it covers an area of 230 sq. km. The fauna includes leopard, chinkara, chausingha, sambhar, chital, nilgai, hyena, crocodile etc.

TATGARH RAOLI SANCTUARY

Located in Ajmer district it extend over 495 sq km. of area. It shelters leopard, jackal, sloth bear, fox, sambhar, nilgai, wild bear, langur etc.

SAWAI MAN SINGH SANCTUARY

Located about 10 km. from Sawai Madhopur it covers an area of 103 sq. km. This sanctuary is just an adjunct to Ranthambhor National Park and is a part of the Ranthambhor Tiger Reserve.

BUND BARETHA

Located in Bharatpur district, it is spread around the famous lake of the same name extending over 193 sq km of area. The fauna mainly consists of sambhar, jackal, porcupine, nilgai, mongoose, a variety of snakes etc.

BASSI

Located about 35 km. from Chittorgarh it extends over an area of 193 sq. km. The fauna mainly comprises leopard, jackal, jungle cat, sambhar, nilgai, porcupine etc.

Apart from the above there are several other sanctuaries and closed areas in the state which harbour significant flora and fauna of the state. A more complete list of these can be found in Appendix D.

Community protected areas

Apart from the system of formally declared and managed protected areas, there are many known and unknown community protected areas ranging from a few hectares to many hundred hectares. One of the most important category of these is the *orans* (derived from the Sanskrit word *aranya* meaning wilderness) which are the traditional pastures or grazing lands which also act as watersheds and have been traditionally managed by the local communities. These lands are now under the supervision of the *panchayats*. Unfortunately *panchayats,* being political institutions with artificially constituted units of communities or villages with divergent agendas and social and economic identities, have

failed to manage these areas. As a result most of the *orans* (especially in the desert region of the state where the *orans* are largest in size and number; according to one source, in the district of Jodhpur alone, for example, there are over 4000 orans[1]) are today highly degraded and have lost most of their vegetative cover.

Figure 3-4: View of Ranthambhor Tiger Reserve

Areas Of Cultural, Religious, Historical Interest

The state has many sites of religious and historical importance which are located inside well forested areas. Many times these have helped save the surrounding forests. In historical places, efforts in form of plantations programmes have also helped maintain the green cover, though this has often changed the original structure and species composition. The Ranakpur Temple in Pali district, Sitabari in Baran, or the Kailadevi Temple in Karauli district, for example, are places of great tourist, religious and cultural importance. In the latter over half a million people congregate within a week during the *mela* held in March-April every year. Many times it is the exotic location and intact wilderness around that marks out a place of tourist and religious interest. Thus the heritage value and ecological value of these places reinforce each other.

Ex-situ Biodiversity

Significant biodiversity is housed in the zoos, botanical gardens, and graders and parks of the state. Apart from these urban institutions, floral biodiversity is also housed in public and private lands outside natural habitats, e.g. roadside avenues, silvipastoral plantations, open spaces within urban areas and institutions, military cantonments (usually the best maintained green spaces) and the like. Many of the state's gardens and parks for example date back to medieval Mughal period. These have evolved over the years into unique little pockets of vegetation and niche ecosystems. The more important of these are described here.

[1] Personal communication from Harish Choudhary, Arid Forest Research Institute, Jodhpur.

Zoological Gardens

JAIPUR ZOO

This is located in Ram Niwas Garden near Albert Hall. Maharaja Sawai Ram Singh founded it in 1877. The zoo happens to be the oldest, best and most frequented zoo in the State. It is spread over an area of 8 hectares having over 1500 animals and birds. It has the distinction of being the first zoo in the word to collect the breeding data of crocodile in captivity and also to successfully provide hormone therapy to old male crocodile. It is the first zoo in the country to breed in captivity the swin hoe's peasant, Indian python and Douroucouli monkey.

JODHPUR ZOO

This is situated in Ummed Public Park covering an area of four hectares. It was established in 1936 AD. This zoo has the highest number of animals in the state, i.e., over 1,600 animals, It is world famous for keeping Great Indian Bustard in captivity for the first time.

BIKANER ZOO

This zoo is situated in Ganga Niwas Public Park covering an area of 136 hectares. It was founded by Maharaja Sardul Singh in 1928 AD. This zoo has about 600 animals.

UDAIPUR ZOO

It is located in Sajjan Niwas Garden, spread over an area of five hectares. Created in 1878, the zoo has about 500 animals.

KOTA ZOO

It is a small zoo located in Chhatra Vilas Garden having only about 200 animals.

Apart from the five gardens each housing a zoo, there are many other gardens in the state which house considerable floral diversity. Among these may be named Sisodia Rani Garden (Jaipur), Vidyadhar Ka Bagh (Jaipur), Chambal Garden (Kota), Chhatra Vilas Garden (Kota), Traffic Training Park (Kota), Mandore Gardens (Jodhpur), Ummed Park (Near Chittorgarh), Purjan Vihar or Company Garden (Alwar), Ganga Niwas Public Park (Bikaner), Saheliyon Ki Bari (Udaipur), Gulab Bagh (Udaipur), Nehru Park (Udaipur), Sajjan Niwas Garden (Udaipur), Dhandolai Park (Bhilwara), Luv Kush Udyan (Ajmer), Mahavir Park (Barmer), Neemard (Near Barmer), Sawa (Near Chittorgarh), Deeg (Bharatpur).

Species level diversity

The state of Rajasthan is home to about 3000 known species of plants and animals and a large number of insects, butterflies and micro-organisms not yet documented. Many of these species are highly evolved to survive in limited conditions of extremes of hot, dry desert areas. Similarly, many of the species of plants and animals are endemic to the Thar desert and the Aravallis which are one of the world's oldest hill ranges.

The phytogeographic composition of the state consists of four distinct elements: Indian element (33%), Perso-Arabian element (30%), Indo-Malayan element (13%), general element (24%) [*Flora of Raj. Vol 1* Shetty B V et al, BSI 1987]. There are 1974 angiosperms, one gymnosperm, 35 pteridophytes, 37 thallophytes, and 42 mosses that

are known to be indigenous to the state. However, the floral diversity of lower plants (algae, fungi, bacteria, viruses etc) is not adequately known and could be significantly endemic. The genetic diversity of plants of economic importance is high in the state with 111 varieties of cereals, 65 of legumes, 41 of family compositacae, 35 of convolvulacae, 28 of malvacae and 36 sedges, 19 cucurbits and 5 plums are endemic to the state, mostly in the desert ecoregion. There are 35 wild relatives of cultivated plants and all of these are need of conservation.

A vast majority of the state's indigenous plants are of known economic importance and are being used by local communities. Plants yield a wide range of economic products such as fibre (50 species), fodder (21), firewood (58), gums and resins (17), tannin (11), dyes (18), timber (112), food (149), non-edible oils (15), medicines (365), poisons (223), and other (181) products. There are 23 species of plants that are endemic to the state.

It is estimated that 100 species of plants (including 61 of desert region) are threatened in view of their conservation status. All the 19 endemic species are threatened, and so are all the 35 wild relatives of cultivated plants.

Floral Diversity

Three physiographic regions may be recognised in Rajasthan for the study of flora and floral composition of the area, namely the western sandy desert, the eastern gravely-rocky plateau with outliers of Aravallis and the main Aravalli range itself.

1. THE WESTERN SANDY DESERT:

The western arid and semi-arid region, commonly known as the Rajasthan desert or the Thar de4sert, covers a total area of 1,96,150 sq. km in the west of Aravalli range. The vegetation in arid regions consists mainly of stunted, thorny or prickly shrubs and perennial herbs capable of drought resistance. Trees are few and scattered. The ephemerals come up during the monsoons and in coming summer bulk of the area is once more transformed into open sandy plain, desolate and barren. Since the climate is more or less homogeneous, the vegetation variation can better be said to be edaphic induced. The vegetation of the desert can be categorised under the following heads:

(a) Sand- dunes and interdual areas: This is by far the most common habitat of this region. Sand- dunes of different types, size and orientation are encountered. They may be stabilised, partially stabilised or active and bare. The common trees and shrubs found on stabilised and unstabilised sand-dunes are: *Calligonun polygonoides, Clerodendrum phlomidies, Haloxylon salicornicum, Lycium barbarum* etc. On some of the dunes, trees like *Acacia senegal, Prosopis cineraria, salvadora oleoides* etc. aes also common. The other common inhabitants of sand-dunes include *Aerva javanica, Citrullus colocynthis, Crotalaria burhia, Dipterygium glaucum, Farsetia hamiltonii, Indigofera argentea, I cordifolia, I. Linifolia, Leptadenia pyrotechnica, Melhania denhamii, Sericostemma pauciflorum, Tephrosia falciformis, Tribulus longipetalus* etc. The common grasses and sedges which play a vital role in soil conservation are: *Aristida adscensionis, A, funiculata, Cenchrus biflorus, C. ciliaris, C. prieurii, C. setigerus, Cymbopogon jwarancusa, Dactyloctenium aegyptium, D. scindicum, Desmostachya bipinnata, Eragrostis species, Lasiurus sindicus, Latipes senegalensis, Ochthochloa compressa, Panicum antidotale, P. turgidum, Sporobolus helvolus, Stipagrostis hirtigluma, Cyperus atkinsonii, C. conglomerates etc.*

The interdunal gaps support more luxuriant vegetation due to greater availability of moisture. The common trees and shrubs are: *Acacia jacquemontii, A. senegal, Prosopis*

cineraria, Salvadora oleoides, Tecomella undulata, Calotropis procera, Capparis deciduas, and *Ziziphus nummularia*. In addition, almost all the plants found on sand-dunes grow more profusely in the interdunal area.

The unstabilised sand-dunes are least covered with plants, However, *Cyperus arenarius, Crotalaria burhia, Aerva javanica,* and *Leptadenia pyrotechnica* are some of the pioneer species to colonize these dunes. The very crest of such sand-dunes is often colonized by varying frequency of *Lasiurus sindicus* and *Citrullus colocynthis*.

(b) Sandy and hummocky plains: Sandy and hummocky plains constitute the major part of the desert and plants growing in such habitats form some of the characteristic associations of the region. The common trees and shrubs are: *Acacia Senegal, Calligonum polygonoides, Calotropis procera, Capparis deciduas, Maytenus emarginatus, Prosopis cineraria, Salvadora oleoides, S. persica, Tecomella undulata* and *Ziziphus nummularia.* In addition, under-shrubs and herbs like *Aerva javanica, Arnebia hispidissima, Boerhavia diffusa, B. elegans, Convolvulus microphyllus, Crotalaria burhia, Farseta hamiltonii, Heliotropium strigosum, Indigofera cordifolia, Leptadenia pyrotechnica, Tephrosia purpurea* etc. are also common. The most commomn creepers are *Citrullus colocynthis, C. lanatus, Cucumis melo* and *C. prophetarum,* and of climbers mention may be made of *Coccinia grandis, Momordica dioica, Mukia maderaspatana* and *Pergularia daemi.* Most of these plants possess well developed root system and occur in open clump formations with plenty of vacant spaces between them which are occupied by several ephemerals and grasses like the species of *Aristida* and *Cenchrus,* and *Dactyloctenium scindicum, Lasiurus sindicus, Ochthochloa compressa, Panicum antidotale,* and *Stipagrostis hirtigluma*, along with sedges like *Cyperus atkinsonii and C. conglomerates.* The shifting dunes are often successful in over-running the low vegetation.

(c) Gravelly/ rocky plains: Gravel covers fairly large areas of the region. Some of the common plants of these habitats are: *Cleome vahliana, C. gracilis, Fagonia indica, Dactyloctenium aristatum, Indigofera linnaei, Heliotropium rariflorum, Leptadenia pyrotechnica, Blepharis sindica, Sericostemma pauciflorum, Bouchnera marubifolia,* and *Salvia aegyptia*. Certain plants of gravel are prostrate and star like with the branches remaining apressed to the ground, e.g. *Euphorbia clarkeana, E. granulata, Indigofera cordifolia, I. hochstetteri, Mollugo cerviana, M. nudicaulis, Tribulus terrestris* etc. the common trees and shrubs of this habitat are : *Calotropis procera, Capparis deciduas, Euphorbia caducifolia, Maytenus emarginatus, Prosopis cineraria, Salvadora oleoides, Zizyphus nummularia* etc. At certain spots, the gravel plains maintain characteristic grass-legume associations. The common grasses are: *Enneapogon brachystachyus, E. schimperanus, Melanocenchris abyssinica, M. jacquemontii, Oropetium thomaeum, Tragus roxburghii.*

The gravel plains are marked by deep valleys or shallow depressions, particularly near the foot of hills; the typical rock plants which become prominent in such habitats are: *Ephedra foliata, Asparagus racemosus* etc. The rocks in the area represent various geological formations. The rocky plains maintain sparse vegetation without any true forests. *Anogeissus pendula, Asparagus racemosus, Balanites aegyptiaca, Corallocarpus epigaeus, Rivea hypocrateriformis* etc. are the common plants of these habitats.

(d) Isolated hills and orck outcrops: The region in the west of Aravalli consists isolated hills of low elevation and of various origin. These hills are usually bare at the top; occasionally, however, *Boswellia serrata*, *Rhusmysurensis* among woody plants and *Convolvulus stocksii* and *Violacinerea* var. *stocksii* among herbaceous ones are found. The hill-slopes with better water holding capacity harbour: *Acacia senegal, Anogeissus pendula, Capparis deciduas,*

Commiphora wightii, Euphorbia caducifolia, Grewia tenax, Maytenus emarginatus, Ziziphus nummularia etc.

Among climbers, *Abrus precatorius, Asparagus racemosus, Boerhavia verticillata, Rhynchosia minima, Rivea hypocrateriformis* are characteristic. The undergrowth is characterized by the presence of *Anticharis senegalensis, Barleria acanthoides, B. prionitis, Blepharis linaraefolia, Boerhavia diffusa, Cleome brachycarpa, Fagonia indica, Heliotropium bacciferum, Seetzenia lanata, Sida cordata etc.*

The vegetation is comparatively more dense at the foot of hill and nearby area. *Acacia senegal* is the main jungle forming tree is such habitats. Other characteristic elements include *Blepharis sindica, Lipidagathis trinervis, Melhania denhamii, Monsonia senegalensis, Pavonia zeylanica, Schweinfurthia papilionacea, Seddera latifolia, Tepharosia purpurea, Tridax procumbens, Aristida adscensionis, Enneapogon brachystachyus, Melanocenchris jacquemontii, Oropetium thomaeum, Stipagrostis hirtigluma, S. pogonoptila,* and *Tragus roxburghii.*

Lepidagathis bhandarensis and *Corbichonia decumbens,* the typical lithophytes of this region, are found in crevices of rocks. *Commelina albescens* and *Lindenbergia indica* are some of the other species growing from the crevices of rocks.

(e) Saline tracts: There are many saline tracts spread throughout the desert. The common plants of these habitats are: *Cressa cretica, Haloxylon recurvum, H. salicornicum, Portulaca oleracea, Salsola baryosma, Sesuvium sesuvioides, Suaeda fruticosa, Tamarix indica, Trianthema triquetra, Zaleya govindea,* and *Zygophyllum simplex.*

(f) Aquatic and Marshland habitats: The area maintains considerable number of fresh water, artificial, salt lakes and tanks with rocky substratum. These support a reasonable number of aquatic species like *Hydrilla verticillata, Lemma paucicostata, Najas graminea, N. welwistschii, Potamogeto crispus, P. pectinatus, Spirodela polyrhiza, Vallisneria spiralis, Wolffia* species etc. *Eichhornia cressipes* is also encountered in certain ponds and lakes.

(g) Miscellaneous habitats: The desert area has a number of old and historical buildings, forts, palaces etc. On the walls of such buildings, plants like *Lindenbergia indic, Ficus religiosa, salvadora oleoides, Teprosia strigosa, Vernonia cinerea* are frequent. *Icistanche tubulosa* is a common root parasite particularly on *Capparis, Calotropis, Salvadora* and *Prosopis* species. *Ephedra foliata* is the only living gymnosperm found in this region.

Certain species have escaped from cultivation and naturalised near habitations e.g. *Citrullus lanatus* var. *fistulosus, Lycopersicon exculentum,* and *Momordica charantia.*

A brief description of the Desert National Park has already been given above. The Akal Fossil wood park, located at Hirchindani in Jaisalmer district, has further enhanced the importance of the thar desert by the discovery of fossil wood logs of the lower Jurassic age.

(h) Endemic and rare taxa: The desertic zone due to its characteristic topography, geology, edaphic and climatic factor maintains a peculiar type of vegetation, not found elsewhere in India. About 16 taxa of angiosperms are endemic to the desert. They are: *Cenchrus rajasthanenis, Convoluus blatteri, Farestia macrantha, Publicaria rajputanae, Zizjphus truncata, Abutilon bidentatum* var. *chrysocarpa, alysicarpus monilifer* var. *venosa, Barlaria prionitis* var. *diacantha, Cenchru prieurii* var. *iscabra, cleome gynandra* var. *nana, Convolvulus auricomus* var. *ferruginosus, Ipomoea carica* var. *semine-glabra, Pavonia arabica*Var. *Glutinosa* and *P. arabica* var. *massuriensis.*

Most of these endemic taxas have very restricted distribution probably due to the greatly disturbed ecosystems in the deesert and due to the limited range of adaptability to these taxa.

Besides these, the over exploitation of certain species for various uses in the desert pose a serious threat to them e.g. *Citrullus colocynthis, Commiphora wightii, Ephedra foliata, Tecomella undulata* etc.

The other rare taxa found in Rajasthan are: *Ammannia desertorum, Glossonema varians, Heliotropium rariflorum, Lineum indicum, Moringa concanensis, Seddera latifolia, Sesuvium sesuvioides, Tephrosia falciformis* and *Tribulus rajasthanensis.*

2. ARAVALLI RANGE:

The second physiographic region of interest is the Aravalli range which runs diagonally across the state extending from champaner in Gujarat in the south-west to near Delhi in the north-east for a distance of about 692 km. Within Rajasthan, the range runs from Khed Brahma in the south-west to Khetri in the north-east for a length of about 550 km. The elevation of the Aravalli range gradually rise in the south-west direction and so also the vegetation pattern and floral composition chages due to the changes in climatic nad edaphic factors. On Khetri hills (792 m) the vegetation is scrubby and in degraded stage. The top of the hills are practically barren while on the slopes, where some sand and moisture accumulate, growth of plants such as *Acacia leucophloea, A. Senegal, Balanites aegyptiaca, Capparis deciduas, Euphorbia nivulia, Grewia tenax, Justicia adhatoda, Securinega leucopyrus* etc. is noticed. On Harshnath hills (913 m), the floral composition up to 600m is similar to that of Khetri hills; but above 600 m, plants like species of *Calotropis, Clerodendrum, Justicia* etc. disappear and their places are taken by elements like *Dichrostachys cinerea, Euphorbia neriifolia, Triumfetta rhomboidea* etc. Trees like *Anogeissus latifolia, A. pendula, Balanites aegyptiaca, Prosopis cinerarea, Wrightia arborea* etc. which are stuned at lower elevations become more and more prominent.

Further south-westwards at Kho (920m), Raghunathgarh (1055 m) and Todgarh in Ajmer district the scrub vegetation merges to some extent with the deciduous type. The floral composition of these hills include *Anogeissus pendula, Acacia leucophloea, Bauhinia racemosa, Boswellia serrata, Commiphora wightii, Dichrostachys cinerea, Mimosa hamata, Prosopis cineraria, Rhus mysorensis, Securinega leucopyrus, Sterculia urens etc.*

From Bijapur forest range (1100 m) in Plai district to further south-west, the hills are covered with mixed deciduous type of forests dominated by *Anogeissus pendula.* The other commos associates at Bijapur are *Aegle marmelos, Anogeissus latifolia, Bauhinia racemosa, Boswellia serrata, Butea monosperma, Cassia fistula, Diospyros melanoxylon, Mitragyna parvifolia,* and *Wrightia tinctoria.*

Mt. Abu (1722 m at the Gurushikhar peak) at he south-western border of the state is the highest peak not only of the Aravallis but also between western Himalayas and Nilgiri hills. The vegetation here falls into fairly distinct elevational zones though the zones are intermingled to certain extent. The chief components up to 1300 m are the same as between Bijapur and Mt. Abu with only a little changes to subtropical evergreen type with species like *Boswellia serrata, Carvia callosa, Crateva nurvala, Flacourtia indiaca, Girardinia eylenica, Jasminum humile, Lannea coromandelica, Mallotus philippensis, Mangifera indica, Rosa brunoni, R. involucrate, Sterculiz urens, Syzygium cumini etc.* At certain places *Albizia* spp.,

Erythrina spp., *Emblica officinalis, Kydia calycina, and Trema orientalis* are also found at higher elevations. Serveral species of ferns and fern-allies also occur at Mt. Abu.

The ground cover comprising of *Acanthospermum hispidum, Blainvillea acmella, Sclerocarpus africanus,* species of *Alysicarpus, Cassia* and *Desmodium, Borreria articularis, B. pusilla,* and many grasses, becomes very dense at lower elevations at Mt. Abu. In the north-eastern direction from Bijapur, right up to Khetri hills, not only the density of the above mentioned taxa decreases but species like *Boerhavia diffusa, Borreria articularis, Dactyloctenium aegyptium, Evolvulus alsinoides, Glossocardia bosvallea* and species of some ferns like *Actinopteris, Adiantum* etc. become more common.

Endemic and *Threatened plants:* Mt. Abu. Maintains a characteristic vegetation due to the relatively high altitude coupled with the climatic and edaphic factors. The endemic taxa of Mt. Abu. are *Bonnaya bracteoides, Dicliptera abuensis, Oldenlandia clausa, Strobilanthes hallbergii* and *Veronica anagallis* var. *bracteosa.* These taxa were described by Blatter and Hallberg between 1981-1931 with the help of specimens deposited in Blatter Herbarium, Bombay (BLAT). Since then many botanists have explored Mt. Abu, but none could collect these taxa; probably they have become extinct.

3. THE AREA IN THE EAST OF ARAVALLI :

The area situated east of the Aravalli ranges constitutes the third physiographic region of the state. From Ajmer onwards several parallel outliers of Aravallis become conspicuous and begin to spread to the south and southeast. This area may be subdivided into the following physiographic units for a better understanding of the flora and floral composition.

(a) Bhorat plateau: The eastern part of Sirohi, major part of Udaipur and the entire Dungarpur district fall under 'Bhorat Plateau'. The highest section of the outliers of the Aravallis lies to the north-west of Udaipur between Kumbalgarh and Gogunda. The average elevation of this plateau is 1225 m. The vegetation on the hills is of mixed deciduous type, showing three altitudinal zones with the higher elevations dominated by *Boswellia serrata,* associated with *Anogeissus latifolia, Lannea coromandelica,* and *Sterculia urens*. In the middle zone *Anogeissus pendula is dominant* and it is associated with *Albizia odoratissima, Diospyros melanoxylon, Holoptelea integrifolia,* and *Wrightia tinctoria*. The lower elevations are dominated by *Cassia auriculata,* in association with *Annona squamosa, Butea monosperma, Dichrostachys cinerea,* and *Diospyros cordifolia. S*hrubs and undershrubs are usually not affected by elevation, the common ones being *Capparis sepiaria, Dyerophytum indicum, Grewia flavescens, Justicia adhatoda, Spermadictyon suaveloens,* and *Woodfordia fruticosa*.

(b) Banas basin: The eastern part of Udaipur, western Chittorgarh, Bhilwara, western Ajmer, Tonk, Jaipur, western Sawaimadhopur and southern part of Alwar district constitute 'Banas Basin'. The maximum height of hills is about 582 m near Deogarh. The forests located here are of with *Acacia senegal, Bauhinia racemosa, Boswellia serrata, Capparis sepiaria, Cassia fistula, Dichrostachys cinerea, Diospyros melanoxylon, Lannea coromandelica, Wrightia tinctoria* etc. There is no significant elevational effect on the vegetation of Banas basin except that *Boswellia serrata* becomes more abundant at the summit of the hills and *Butea monosperma* and *Cassia auriculata* on the outskirts. *Sterculia urens* is usually found at the top or on higher slopes. The vegetation is comparatively denser in the valleys of the hills.

(c) Chhappan plateau: South-eastern part of Udaipur, southern Chittorgarh and Banswara districts constitute the "Chhappan plateau". The average height of the plateau is 350 m

and the outliers hardly exceed 700 m. The forests are of deciduous type, dominated mainly by *Tectona grandis*. The altitude does not have much effect on the zonation of vegetation except that on higher slopes teak is replaced by species like *Bauhinia racemosa, Boswellia serrata, Dalbergia latifolia, Emblica officinalis, Lannea coromandelica,* and *Sterculia urens*. The vegetation is richer on the gentle slopes, where additional associates of teak like *Adina cordifolia, Aegle marmelos, Albizia odoratissima, Diospyros melanoxylon, Hymenodictyon excelsum, Lagerstroemia parviflora, Madhuca longifolia, Mitragyna parvifolia, Terminalia arjuna,* and *Wrightia tinctoria* occur. *Dendrocalamus strictus* grows in isolated patches. The steep slopes with big boulders of rocks support *Euphorbia neriifolia, E. nivulia* etc. At the foot of the hills *Nyctanthes arbortristis* is abundant. On the outskirts, dry teak is found with *Acacia chundra, A. leucophloea, Butea monosperma, Holarhena pubescens* etc.

(d) Deccan plateau: The western part of the Deccan plateau extends to the south-eastern part of Rajasthan over Kota, Bundi and Jhalawar districts with the Vindhyan and Aravalli outliers. The forests here are of mixed deciduous type, showing altitudinal zonation of the vegetation to the extent that *Adina, Aegle, Boswellia, Buchanania lanzen, Cassia fistula, Dendrocalamus, Diospyros, Lagerstroemia, Lannea, Sterculia* etc. are more abundant in the middle zone, while *Acacia leucophloea, Butea monosperma* etc. are abundant at the foot or outskirts. *Anogeissus pendula* is the dominant species of these forests extending right from the base to the top of the hills.

A natural belt of teak is found in the flat terrain along Parbati river from Atru to Kishanganj in Baran district. In the east of Kishanganj, the terrain becomes hilly and the forests mixed deciduous of *Anogeissus pendula* type. There are three peripheral zones of vegetation in this flat terrain. The inner part is of pure *Tectona grandis,* with isolated trees of *Diospyros melanoxylon* and *Hardwickia binata* and naked ground floor. In the peripheral region, the destruction of the forest has resulted in scrub woodlands consisting of *Acacia catechu, A. nilotica* subsp. i*ndica, A. leucophloea, Balanites aegyptiaca, Betea monosperma, Diospyros melanoxylon* etc. Shrubs and undershrubs are also abundant in the marginal zone. Separating the two, there is a thick belt of *Acacia catechu, A. nilotica* and *Zizyphus mauritiana* associated with teak.

(e) Vindhyan scarpland: The Vindhyan scarpland having an average elevation between 350-580 m covers the area between Banas and Chambal rivers and Bharatpur districts, most of the area is either under cultivation or is in the form of ravines and badlands. The hillocks harbour some forests, however, and the trees attain considerable height, the common ones being *Acacia leucophloea, A. nilotica, Anogeissus pendula, Balanites aegyptiaca, Kirganelia reticulata, Maytenus emarginatus, Prosopis juliflora, Salvador oleoides, S. persica* etc. In addition, *Dichrostachys cinerea, Sterculia urens* etc. are also found.

The vegetation of wastelands is identical to other regions except that *Tamarix aphylla* and *Alhagi maurorum* are very common throughout the area. It is interesting to note that thick populations of *Carissa spinarum* are encountered near Sikandra village along the foot of the hills (Bayana, Bharatpur). The area also maintains many aquatic and marshland plants, including algal flora.

(f) North-eastern hilly region: North-eastern hilly region (Alwar district) is traversed in the north and northeast to south and southeast by a number of parallel outliers of Aravallis rising up to 800 m. This region is open towards northwest and southwest with flat plains at 300-400 m. The hill slopes are excessively stony and the vegetation shows three distinct elevation zones, dominated by *Boswellia serrata,* associated with *Crateva nurvala,*

Euhorbia neriifolia, Holoptelea integrifolia, Mallotus phiippensis, Terminalia bellerica etc. at higher elevations. The middle zone is dominated by *Anogeissus pendula,* associated with *Commiphora wightii, Lannea coromandelica, Wrightia tinctoria* etc. In the basal zone *Acacia niotica, Dichrostachys cinerea, Butea monosperma, Tecomella undulata* etc. grow almost in equal proportions. In the cool and shady valley *Colebrookea oppositifolia, Dendrocalamus strictus, Mitragyna parvifolia,* and *Wrightia arborea* grow in abundance.

The ruthless destruction of vegetation in various ways has resulted in the naked hills with big boulders of rocks throughout eastern Rajasthan. The vegetation in such habitats is very sparse, stunted and bushy with plants like spiny *Euphorbias and Acacias, Diospyros cordifolia, D. montana* etc.

(g) Wasteland vegetation in the east of the Aravallis: The vegetation of wastelands is almost identical in all the physiographic subdivisions in the east of the Aravallis. It is semi-xerophytic with a sparse tree layer. The common trees are: *Acacia leucoploea, A. nilotica, Aegle marmelos, Azadirachta Indica, Balanites aegyptiaca, Butea monosperma, Cordia dichotoma, Dolichandrone falcate, Ficus benghalensis, F. religiosa, Mangifera indica, Phoenix sylvestris, Pithecellobium dulce, Prosopis cineraria, Salvadora persica* and *Ziziphus mauritiana*. The progressive regeneration of most of the trees, both by seeds and coppice, is negligible due to great biotic pressure on them. *Prosopis juliflora* is the only species which shows highest survival percentage under adverse climatic and biotic conditions.

The westeland habitats are more favourable for shrubs and undershrubs which form a comparatively dense layer. The most common shrubs are: *Abutilon indicum, Acacia farnesiana, A. jacquemontii, Calotropis procera, Capparis deciduas, C. sepiaria, C. zeylanica, Clerodendrum phlomidis, Dichrostachys cinerea, Ficus palmate, Kirganelia reticulata, Lantana camara, Leptadenia pyrotechnica, Mimosa hamata, Opuntia elatior, Solanum incanum, Ziziphus nummularia* etc. These shrubs usually grow in clumps with trees and in vacant spaces.

A large number of undershrubs also grow in the wastelands, the most common ones are: *Cassia auriculata, C. occidentalis, Desmodium gangeticum, Malvastrum coromadelianum, Pavonia zeylanica, Pupalia lappacea, Sida alba, S. cordifolia, S. ovata, Triumfetta pentandra, T. rotundifolia, Urena lobata, Xanthium strumarium* etc.

The most common climbers are: *Abrus precatorius, Argyreia sericea, Cissampelos pareira, Cocculus hirsutus, Cryptostegia grandiflora, Leptadenia reticulata, Masdenia tenacissima, Mucuna pruriens, Pergularia daemia, Rivea hypocrateriformis, Teramnus labialis, Wattakaka volubilis* etc. They usually grow among the trees and shrubs, particularly on the boundaries of fields and gardens.

Besides these, a large number of annual and perennial herbs are encountered in the wastelands. With the onset of winter a considerable number of compositaceous meadow herbs, in association with *Acalypha ciliata, Achyranthes aspera, Argemone mexicana, Leucas cephalotes, Nepeta hindostana, Solanum nigrum* etc. come into bloom. The most common compositaceous herbs are: *Ageratum conyzoides, Echinops echinatus, Eclipta alba, Gnaphalium polycaulon, Lagascea mollis, Launaea procumbens, Pulicaria angustifolia, Sonchus oleraceus* and *Sphaeranthus indicus;* the last mentioned species often forms dense mats at certain places.

Decreasing moisture content, increasing temperature and high velocity winds during March and April result in the disappearance of most meadow herbs except those growing in somewhat moist habitats. The dry meadow herbs appearing during summer months are very few e.g. *Alhagi maurorum, Chrozophora rottleri, Solanum surrattense, Tridax procumbens*

and *Dipcadi serotinum* which posses underground bulbs and become visible above the ground only during the summers.

During the rainy season, the area presents a glorious appearance of a green carpet of semi-xerophytic and meadow herbs which help in increasing the humus content of the soil and extend the vegetation to the barren areas. The life-cycle of most of the herbs comes to a close before the winter sets in. The rainy season herbs are dominated by leguminous plants like species of *Alysicarpus, Cassia, Crotalaria, Indigofea, Psoralea, Tephrosia, Vigna* etc. The common associates of the above are: *Aristolochia bracteolate, Borreria articularis, Cleome gynandra, C. viscose, Convolvulus prostrates, Evolvulus alsinoides, Glossocardia bosvallea, Merremia tridentate, Polygala erioptera, Tridax procumbens* and several grasses among which *Aristida, Cenchrus, Chloris, Eragrostis, Tragus, Urochloa* etc. are more common.

On the boundaries of fields, gardens, and orchards, one finds *Antigonon leptopus, Canavalia ensiformis, Cardiospeermum halicacabum, Coccinia grandis, Dioscorea bulbifera, Momordica dioica,* and *Mukia maderaspatana*. Besides reducing wind velocity these plants also act as an obstacle in the path of moving sand particles.

A few sciophytic humus and shade loving herbs fairly distributed in the gardens, orchards and other similar habitats are: *Baliospermum montanum, Biophytum sensitivum, Chenopodium album, Corchorus olitorius, Euphorbia hirta, Hybanthus enneaspermus, Lindernia crustacea, Oldenlandia corymbosa, Oxalis corniculata, Phyllanthus fraternus, Physalis minima, Solanum nigrum* etc.

The neglected corners of fields and gardens which escape ploughing and have lower percentage of nitrates, humus, and low water holding capacity are most suitable for the growth of lime loving species like *Chenopodium album, Desmostachya bipinnata, Echinops echinatus, Euphorbia hirta, Perotis indica, saccharum spontaneum,* and *Vetiveria zizanioides*.

Parks and play grounds are most suitable localities for many grasses which form a dense mantle and act as an efficient soilbinder e.g. *Bothriochloa pertusa, Cynodon dactylon, Dichanthium annulatum, Imperata cylindrical, Iseilema laxum,* and *Tragus roxburghii*.

Inhabiting semi-demolished walls of ancient buildings and monuments, there are well recognizable associations of meadow herbs like *Bidens biternata, Euphorbia hirta, Glossocardia bosvallea, Haplanthodes verticillata, Indonessiella echioides, Lindenbergia indica, Tridax procumbens* etc. The seedlings of *Ficus benghalensis* and *F. religiosa* cause damage to the buildings by sending their roots deep down into the walls.

Utricularia exoleta and *U. stellaris* are the insectivorous representatives of the area. *Aerides crispum* and *Vanda tassallata* are the common epiphytes inhabiting the region.

The floristic composition of the wastelands i.e. the presence of sparse ground cover during winter and summer, abundant ground cover during rainy season, distantly scattered deciduous trees and comparatively dense growth of xerophytic shrubs suggest semi-arid climate in the area.

(h) Grasslands in the east of the Aravallis: The grasslands, managed for grass production and subsequent grazing and to check the exposure of soil to the action of rain and high velocity winds, are few. They are usually managed on the outskirts of the forests, on naked hillocks, in the degraded forests, protected forests, wastelands etc. The grasslands of such habitats are dominated by tall grasses like *Aristida adscensionis, Bothriochloa pertusa, Cenchrus ciliaris, Chloris barbata, Cymbopogon martini, Dichanthium caricosum, Digitaria adscendens,*

Dinebra retroflexa, Eragrostis unioloides, Heteropogon contortus, Iseilema laxum, Pennisetum hordeoides, Sehima nervosum, Themeda quadrivalvis, and *Tripogon jacquemontii.*

Besides many-stemmed, crooked, and branchy trees of *Bauhini recemosa, Dichrostachys cinerea, Mimosa hamata, Tectona grandis, Ziziphus mauritiana* etc. which are sparsely distributed in the grasslands, some weed species like *Alysicarpus tetragonolobus, Celosia argentea, Cleome simplicifolia, Crotalaria hirsute, Ipomoea sindica,* and *Cyperus rotundus* also compete with grasses in several ways and are harmful to the grasslands.

Another category of grasslands occupy large, open undulating rocky terrain. These grasslands have deteriorated for want of protection against grazing and also due to spread of undesirable thorny bushes and a number of weeds. The most common grasses of these habitats are : *Alloteropsis cimicina,* species of *Aristida, Cenchrus ciliaris, Chloris Montana, Cynodon dactylon, Dactyloctenium aegyptium,* species of *Eragrostis, Hackelochloa granularis, Melanocenchris jacquemontii, Setaria tomentosa, Sporobolus tenuissimus, Tetrapogon villosus, Tragus roxburghii, Tripogon purpirascens,* and *Urochloa panicoides*. Besides these, many characteristic long-stemmed grass species of the first category also form distant patches.

(i) Aquatic and marshland vegetation in the east of the Aravallis: The area in the east of the Aravallis receives enough rainfall, the water table is normal, a number of rivers pass through the terrain and maintains a large number of temporary and permanent lakes, tanks, ponds, puddles, etc. These habitats provide veritable emporia for the growth of aquatic and marshland plants. It has been observed that in the deep water habitats mostly used for irrigation etc., the vegetation is poor in comparision to shallow tanks and ponds.

On the basis of their contact with soil water and air, the hydrophytes of the area may be broadly classified into the following life forms.

Free floating: Species like *Pistia stratiotes, Utricularia stellaris* etc. come in this group.

Attached with floating leaves and/or shoots: Species like *Ipomoea aquatica, Nymphaea nouchali, N. pubescens, Nymphoides cristata, Potamogeton nodosus* etc. fall in this category.

Suspended submerged: Species like *Ceratophyllum demersum, Hudrilla verticillata, Najas minor, Nechamandra alternifolia, Potanmogeton pectinatus, Zannichellia palustris* etc. come in this category.

Attached submerged: Species like *Ottelia alismoides, potamogeton crispus, Vallisneria spiralis* etc. fall in this category.

Aquatic and/or amphibious emerged: *Aeschynomene indica, Hydrolea zeylanica, Limmophila indica, Polygonum glabrum, Sagittaria sagittifolia, Typha angustata* etc. constitute this group of hydrophytes.

Marshland: A large number of plants grow in marshland habitats, particularly in low lands, rice fields and road-side puddles. The most common ones are: *ammannia baccifera, Hygrophila auriculata, Phylanodiflora,* most of the sedges and few grasses like *Coix lacryma-jobi, Hemarthria compressa,* species of *Paspalidium, Paspalum* etc.

The area apparently unsuitable for the growth of luxuriant vegetation is rich in marshland species. The paucity of aquatic species may be due to rocky bottom and wide amplitude of water level in reservoirs. Most of the aquatic and marshland species grow in a number of associations excepting few like *Pistia, Typha,* etc. which often form pure stands. *Eicchornia crassipes* is a troublesome American weed widely distributed throughout the

area in different habitats. Most often it completely covers the reservoirs and gives a beautiful appearance both in vegetative and blooming state. [*Op.cit.*]

Weeds and aliens

A large number of weeds grow with the crops. Most of them are well equipped for dissemination by wind, water, man and animals. In the winter season the highest weed density may be noted during the months of January and February. The typical weeds of the winter crops are: *Ageratum conyzoides, Anagallis arvensis, Asphodelus tenuifolius, Chenopodium album, Cynodon dactylon, Euphorba dracunculoides, Fumaria indica, Lepidium sativum, Lathyrus aphaca, Melilotus alba, M. indicus, Oxalis corniculata, Polpogon monspeliensis,* and *Striga angustifolia*.

The typical weeds associated with the summer crops are *Alhagi maurorum Gomphrena celosioides, Solanim nigrum, S. surrattense, Tribulus terrestris, Ziziphus nummularia* etc. The paucity in the number of summer weeds is due to unfavourable climatic and soil conditions. Some winter season weeds like *Euphoriba dracunculoides. Cynodon dactylon,* and *Cyperus rotundus* which have lower susceptibility to receding soil moisture and to the rise of temperature give considerable cover during summers.

The density and frequency of rainy season weeds is higher due to high moisture content during this period. The common weeds of Kharif crop are: *Aerva lantam, Alysicarpus longifolius, Ammannia baccifera, Caesulia axillaries, Celosia argentea, Commelina benghalensis, Corchorus aestuans, C. olitorius, C. trilocularis, Cyperus rotudus, Digera muricata, Eclipta alba, Euphorbia hirta, Launaea procumbens, Leucas cephalotes, L. nutans, Oldenlandia corymbosa, Oxalis corniculata, Trianthema portulacastrum,* and *Vernonia cinerea*.

It is interesting to note that the majority of weeds are annual and therophytes, excepting *Cynodon dactylon, Cyperus rotundus, Oxalis corniculata* and *Ziziphus nummularia* which propagate by means of seeds as well as rootstocks. Some weeds like *Ageratum, Eclipta* and *Oxalis* show wide range of adaptability.

Further, with the advent of Indira Gandhi Nahar Pariyojana (IGNP) and increasing canal irrigation facilities, a large number of weeds have migrated from Punjab to the canal command area is western Rajasthan. These species are: *Antirrhinum orontium, Arenaria serpyllifolia, Astragalus tribuloides, Centaurium centaurioides, Gastrocotyle hispida, Hypecoum procumbens, Kochia indica, Lophcohloa pumila, Macolmia africana, Malva sylvestris, Oenanthe javanica, Phalaris minor, Plantago amplexicaulis, Polygonum lanigerum,* and *Pasammogeton canescens*.

Exotic and cultivated plants

1. *Cultivated crops:* Three main seasonal crops, namely Rabi crop during winter season, Zayad crop during summer season and Kharif crop during rainy season are cultivated on a commercial scale.

The food crop of the winher season include the cereals, mainly *Triticum aestivum* and *Hordeum vulagare* and few pulses like *Cicer arientium* and *Pisum sativum*. Important vegetables of winter season are *Brassica campestris* var. *rapa,* different varieties of *Brassica oleracea, Daucus carota, Lycopersicon esculentum, Solanum tuberosum, Trigonella faenum-graecum* etc.

The condimental crops include *Coriandrum sativum* and *Foeniculum vulgare*. The oil-yielding crops include *Brassica campestris* var. *sarson* and *B. nigra Saccharum officinarum, Nicotiana tobacum* and *Papaver sommiferum* are the cash crops of winter season.

In the desertic zones the cultivation of Rabi and Zayad crop is limited to a very small area where irrigation facilities are available. The population of this area mainly depends on rainy season crops.

During summers, when the soil and climate are dry, a few cucurbitaceous plants are cultivated for fruits and vegetables in the fields and on the sandy river-beds. The most common ones are the species of *Citrullus, Cucumis, Cucurbita, Lageneria, Luffa, Momordica* etc.

The food crops of the rainy season include cereals like *Echinochloa frumentacea, Oryza sativa, Pennisetum typhoides, Setaria italica, Sorghum saccharatum, Zea mays* etc. and pulses like *Cajanus cajan* and several species of *Vigna.*

The important vegetables of the rainy season are *Abelmoschus esculentus, Capsicum annuum, Lablab purpureus, Cucumis melo* var. *culta* and *Solanum melongena, Cyamopsis tetragonoloba,* besides providing edible pods and fodder, is the main source of Gaur gum particularly in desertic zones.

Oil-yielding crops include *Arachis hypogaea, Gossypium* species and *Sesamum indicum, Crotalaria juncea, Gossypium* species and *Hibiscus cannabinus* constitute the fiber-yielding crops.

2. *Orchards and gardens:* A large number of orchards and gardens are scattered throughout the area, particularly in the east of Aravalli. The common fruit-yielding plants are: *Aegle marmelos, Annona reticulata, A. squamosa, Carica papaya, Citrus spp., Mangifera indica, Psidium guajava, Punica granatum, Syzygium cumini, Ziziphus mauritiana* etc.

3. *Ornamental/ Avenue plants:* Much of the greenery of the area is provided by a large number of avenue and ornamental trees, shrubs and climbers which have been planted along the roads, canals, in the gardens and parks. The common ones are:

(a) Trees: Acacia pinnata, Adansonia digitata, Ailanthus excellsa, Albizia lebbeck, Bombax ceiba, Cassia fistula, C. siamaea, Crateva nurvala, Delonix regia, Eucalyptus species, *Gardenia resinifera, Melia azedarach, Morinda tomentosa, Pithecellobium dulce, Polyalthia longifolia, Sapindus laurifolius* etc.

(b) Shrubs: Clerodendrum inerme, Dodonaea viscose, Euphorbia pulcherima, Hibiscus spp., *Lagerstroemia indica, Lawsonia inermis, Murraya paniculata, Nerium indicum, Rosa* spp., *Tabernaemontana divaricata, Thevetia peruviana* etc.

(c) Climbers: Antigonon leptopus, Bougainvillea spectabilis, Clitoria ternatea, Ipomoea Palmata, Jasminum grandiflorum etc.

Besides these, a large number of seasonal herbs and climbers are cultivated in the gardens and parks for their decorative flowers. It is interesting to note that most of the cultigens are introductions from Madagascar, South Africa, South America, Java, Malaya, Burma, China, Australia, Brazil etc.

Faunal diversity

Almost all the major phyla (vertebrates and invertebrates) ranging from. Protozoa to Mammalia are found. Though the vertebrates are now more or less known taxonomically, perhaps 5 times or more of the existing invertebrate fauna still remains to be discovered. Roonwal (1982) reported nearly 1100 species from the arid districts of Rajasthan. "*Faunal Diversity in the Thar Desert : Gaps in Research*" edited by Ghosh, Baqri &

Prakash (1996) reports about 2043 species. Of these, 619 species are of vertebrates and the rest are invertebrates. The occurrence of *Plasmodium falciparum* and *Leishmania* has been attributed to IGNP. Important species of protozoans are *Fasciola* sp., *Schistosoma* sp., *Taenia solium* and *T. saginata.*

Siginificant gaps remain in identification of PLATYHELMINTHES, NEMATODA, ANNELIDA, INSECTA, ACARI, FISHES, AMPHIBIA, REPTILES, BIRDS. Important animals which need conservation attention in the state are Jackal, Bengal Fox, Hyaena, Jungle Cat, Wild Boar, Houbara Bustard, Demoiselle Crane, Common Crane, Sandgrouse (*Pterocles* spp), Raptors (Vultures), Amphibians, All Lobsters.

Table 3-1 Invertebrate fauna of Rajasthan [Baqri Q H: *Status Repo.*]

PROTOZOA	: 30 species, 26 genera
SPONGES	: 5 species, 4 genera
LEECHES	: 6 species, 5 genera
MOLLUSCA	: 28 species, 21 genera
CRUSTACEA	: 45 species, 18 genera
TERMITES	: 19 species, 12 genera
AQUATIC BEETLES	: 22 species, 13 genera

Agricultural and Domesticated Biodiversity

The state has a rich diversity of cultivated crops and their relatives, of vegetables, fruits, fish, livestock and wild food that is traditionally used by a large number of indigenous communities. The genetic variety of the cultivated crops in the Aravalli ranges alone demonstrates high level of evolution of agricutural practices in the state. Most of this knowledge is with the resprctive communities who cultivate these. While the scientific work in the organised sector focuses on the new and hybrid varieities receiving official public support, the knolwledge of the existence and the properties, and the methods of cultivation of the tradtional varieties rests with the local persons and is in the dange of being lost for efver.

Table 3-2: Crop Varieties Cultivated Traditionally In Aravalli Region Of The State

1	Wheat	Arjun, Farmy, Tedia, Vajia, Kathia, Kanak, Gajji, Gunj, Kharchi, Katha, Kendesori, Larma Roja, Shabarmati sonara, Sonarab
2	Paddy	Kamod, Ropadi, Basmati(Local) Kolam, Kali, Kamod/Raj-Bakol, Bhog, Sutar, Sunar, Tukeri, Patheria, Teliaso, Samli, Dagar, Kajal, Mahudi, Rati sal, Batki, Sal sutar, Zeera, Hegra, Nawabi kolam, Dholi sal, pataria, Palaria, Barusal, Mahulia, Popatio, Vaddi, Panna, Kotaparmal
3	Maize	Malan, Sathi, Dholi, Sathi pilli, Dudh nogra, Farm sameri, Nani Gangdi, Nani pilli, Mo, Pilli
4	Chickpea	Dohad yellow, Kabuli, Maru (Pila Chana) Annigeri, Ujjain-24, Ujain-21
5	Urd	Khutadia, Validia, Dungia, Taliya, Bhuriya
6	Cotton	Khandwa-1, Digvijay, Devirraj, Deshi Cotton, Maly-3, Nerma
7	Pigeon pea	Kushalgarh local
8	Bajra	Jakharana, Sikary,
9	Jawar	Safed Lal, Malvi, Merta selection.
10	Jav	Modia
11	Sarso	Laturia, Lotani

Source: Sharma, VD:Aravalli Ecoregion BSAP

New improved and high yielding variety of seeds developed for agricultural crops have been introduced. Important varieties introduced are given in Table 3-2.

Table 3-2: Improved and high yielding variety of seeds developed for agricultural crops

Crop	Improved variety
Wheat	Raj-3765, Raj-3077, Raj-1482, Raj-1555, Kalyansona, Lok-1, WH-147
Barley	RD-2035, RD-2052, RD-2503, RD-2508, RD-2552, RD-31, RD-103, BL-2
Mustard	Varun, Pusa Bold, RH-30, PR-15, Bio-902
Chickpea	RSG-44,GNG-146,GNG-663, C-235, G-130, H-208, RSG-2
Pearl millet	RHB-30, RHB-90, Raj-171, HHB-60,HHB-67
Maize	Mahi Kanchan, Mahi Dhawal, Ageti-76, Ganga-2
Pigeonpea	Prabhat, Gwalior-3, T-21
Groundnut	RG-141, MA-10, M-13, RSB-87
Sorghum	CSH-6, CSH-9, CSV-10, CSV-15
Clusterbean	RGC-936, RGC-197, RGC-1003, RGC-986
Sesame	RT-46, RT-54, RT-125
Cotton	RS-875, Raj HH-16, RST-9, RG-8, Bikaneri Narma
Mungbean	RMG-62, RMG-268
Cowpea	RC-19, FS-68, C-152
Mothbean	FMM-96, RMO-40, IPCMO-912, RMO-435
Urdbean	Krisna, T-9
Paddy	Chambal BK-190, BK-79, P, Bes-1, Ratna, Jaya, 1R-64, Pusaz-21, Mahi Sugan, IET 13549, Dhan vagad, Dhan GR-17, Kalinga III

Source: Sharma, VD:Aravalli Ecoregion BSAP

Introduction of these varieties have substantially increased the productivity of the crops. A Even so a vast potential of possible increase in yield of various varieties is yet to be realised. Wild and local genetic resource is of great value in future improvem of germplasm as well as agronomic practices and technology.

Dr. Saxena and Dr. Bhatnagar of Rajasthan Agriculture University Agriculture Research Station Jaipur, reported that inspite of introduction of these new high yielding varieties and new technologies there is a vast gap in the realizable production and the actual production in various crops. The Table 3-3 below highlights this difference.

The information collected from villages indicates that 67 types of agriculture produces are cultivated in the Aravallis alone.

Apart from crops several varieties of fruit trees are cultivated. Among the important fruits are Mango, Jamun, Khajur (*Phoenix sylvestris*), Karonda, Sitaphal (Custard apple)- *Annona squamosa,* Ber (*Ziziphus mauritiana*), Aonwla (*Emblica officinalis*), Kair (*Capparis decidua*), Amrood – *Psidium guajava,* Gonda – *Cordia dichotoma,* Gondi – *Cordia gharaf,* Timru – *Diospyros melanoxylon,* Tamarind – *Tamarindus indica,* Mahuwa – *Madhuca indica,* Piloo – *Salvadora persica,* Gangeran – *Grewia tenax, K*aith – *Feronia limonia,* Bel – *Aegle marmelos,* Sangri – *Prosopis cineraria,* Dansan – *Rhus mysurensis,* Banana – *Musa paradisiaca,* Wild Banana – *Ensete superbum,* Kakar – *Flacourtia indica,* Papaya – *Carica papaya,* Falsa – *Grewia asiatica,* Bad – *Ficus benghalensis,* Anjir – *Ficus carica, G*oolar – *Ficus glomerata* , Nimbu – *Citrus lemon,* and Maha nimbu – *C. grandis*

Condiments and spices:

Fenugreek (*Trigonella foenumgraecum),* Red chilies *(Capsicum annum*), Turmeric (*Curcuma longa*), and Ginger (*Zingiber officinale*) are cultivated on commercial scale in central and southern regions.

Coarse Cereals and small millets:

Coarse cereals and small millets are cultivated from time immemorial. They have good genetic variability. With the overall change in agriculture, scenario emphasis on growing of small millets has decreased considerably. The coarse cereals, particularly Maize and Bajara, still continue as staple food. Similarly, small millets namely finger millet (*Eleusine coracana*), Fox-tail millet (*Setaria italica*), Kodo millet (*Paspalum scrobiculatum*), Proso millet (*Panicum miliaceum*), Banyard millet (*Echinocloa frumentacea*) and Little millet (*Panicum miliare*) are grown for food by tribals in Udaipur, Dungarpur, and Sirohi districts. These are considered as famine food of the region. Out of these six small millets, the finger millet 'Ragi' occupies a pride position and it is among indispensable component of dry land farming. The fodder of this crop is also useful. The flour of finger millet provides good proteins, minerals and essential vitamins.

Kodo millet is highly drought resistant crop and grows in very poor and light soils. It is grown pure crop as well as mixed with other crops. The grain is very coarse with a horny seed coat, which is removed before cooking. The de-husked grain is cooked like rice or made into flour for porridge or chapattis.

Common millet is quick maturing, highly drought resistant grain crop, often grown during famine and scarcities. This is grown in poor soils as an un-irrigated crop, which matures in 90-100 days. The husk forms about 35% of the grain yield and the husked grain is cooked and eaten or used for making chapattis. The straw is somewhat coarse but is used as fodder for cattle in emergency.

Banyard millet closely resembles to a weed commonly found in dry lands and in rice fields. It is capable of withstanding both drought as well as water logging. The crop is quick growing, robust, tufted annual grass grown in Kharif season. When the crop is ripe it is cut and stacked in the field for a week before threshing. The threshability of the grain is quite good. The fodder of the crop is poor in nutritional quality.

Cultivation of these crops is rapidly going down. This reduction in area is because of number of factors like:

1. Change in food habits.
2. Less remunerative market, because it is consumed by local tribal population only.
3. Subsistence level of farming.
4. Constructing of water reservoirs making more water available for irrigation.
5. Non-availability of seeds of improved varieties.

The area under these crops is now shifted for cultivating pulses, soya bean, paddy, maize, and other more remunerative crops, which have higher water requirements.

These crops are drought tolerant and can survive droughts. These crops are therefore indispensable for dryland agriculture. To protect them from extinction and maintain their biodiversity efforts should be made to preserve maximum germplasm of local types.

Because of their use in preparation of fortified foods, its use for the development of a food industry should also be explored.

CHAPTER 4

CAUSES OF BIODIVERSITY LOSS

This chapter considers the underlying causes (the *root causes*) of biodiversity loss and degradation of the environment such as overpopulation; over consumption; negative externalities and ineffective structures of institutions, inappropriate policies and attitudes. Also considered are the impacts of human activities on sustainability of biological resources in general and biodiversity in particular.

Adverse impacts of human activities (Threats)

The biodiversity of the state is impacted adversely by human activities in many different ways, such as habitat destruction, over harvesting, environmental pollution (air pollution, land pollution, eutrophication, and water pollution from industries and urban centres), commercial trade, subsistence use of rare plants and animals, and introductions of alien species.

Habitat destruction

Destruction of habitats for all kinds of purposes, including agriculture, mining, construction of roads, canals, dams and urban sprawls as well clearing of native vegetation for agriculture and pasturing is probably the most important threat to biodiversity.

Some of well-intentioned internationally aided development projects in the state have led to loss of biodiversity or alteration of native vegetation. These projects are often intended to benefit one segment of the economy; but, because ecological advice is generally not sought and because the broad effects of the proposed development interventions on the environment are inseparable, the ill effects of these projects often diminish their value substantially or, at times, even outweigh the benefits derived from them. Examples can be cited of the *Indira Gandhi Nahar Pariyojana* in the desert region and of the externally aided projects in forestry sector that have encouraged spread of alien species. While the need to increase the supply of water for irrigation and drinking water have been fulfilled to some extent, the environmental side effects, however, have been enormous and include the spread of the diseases such as malaria and schistosomiasis, loss of land by water-logging and salinization, and a variety of other consequences. Similarly, plantation forestry in the state has altered in many cases the composition of native vegetation by introduction of alien and invasive species such as *Prosopis juliflora* and *Acacia tortilis*.

Activities in other sectors such as industrial development, mining and urban growth have taken a heavy toll of the biodiversity of the state. Apart from net loss of habitats destroyed, the remaining habitats are heavily fragmented due to sporadic siting of these activities. Fragmented habitats cannot sustain many important species of flora and fauna and therefore are on their path to degradation. Habitat alteration and impoverishments is also caused by widespread overgrazing and collection of fuelwood from ecologically fragile areas. Agricultural practices on marginal lands (by way of encroachment) on forest fringes and breaking of other fallow lands has considerably decreased the extent of native vegetation and consequently biodiversity of these areas.

Overharvesting

Overharvesting, overcultivation or overexploitation of natural resources in the state is the second most important threat to biodiversity. Overharvesting refers to a rate of exploitation that exceeds the carrying capacity of the resource base. The forests and pastures of the state are severely overgrazed and exploited for extraction of fuelwood and other forest produce. Most grasslands have been completed depleted by now and have turned into barren fields. Native vegetation on wastelands as well as privately held lands have disappeared because of over harvesting of wood and related materials.

Overharvesting has equally led to impoverishment of the underlying support system, that is, the physical environment. Loss of soils, loss of groundwater and loss of lands because of salinity caused by careless overirrigation has led to loss or alteration of plant and animal habitats.

Desertification

Excessive and inappropriate cultivation of lands as well as loss of vegetation cover has led to significant extent of loss of lands to desertification in the state. Desertification takes place in dryland areas where the land is especially fragile, where rainfall is very low and the climate is harsh. The result is the destruction of topsoil followed by loss of the land's ability to sustain crops, livestock or human activity. Deforestation removes native vegetation that holds the soil in place. Overgrazing of livestock strips the land of grasses and shrubs. The site of barren hills with not a blade of grass or a speck of soil on top is not rare in the state. Most of these lands are lost for ever since these have crossed the threshold of restoration. Many of sites turned into desert might have been habitat to unique elements of biodiversity which might now have been lost for ever.

The costs of desertification are more than just loss of biodiversity and of land resources. Dust from deserts and dryland blown into rural and urban habitations, on roads, canals, and railways is a serious consequence of desertification leading to costly investment of human effort and financial resources. This leaves less resources available for programmes of conservation for a state that is perpetually strapped of resources to fulfil even the basic human needs.

Environmental pollution

Unplanned industrial growth has been a major cause of pollution of water resources and of land. Lands bearing native vegetation have been inundated with untreated industrial and urban waste water turning them into wastelands bereft of vegetation. Uncontrolled and sporadic mining activities spread across the entire rural landscape of the state have played havoc with the ecosystems not only by way of destroying vegetation by dumping of overburden, spoils, and mining industry wastes but also by fragmentation of habitats and disruption of local hydrological cycle.

Though level of intensive cultivation in the state is not as high as in many other states because of limited irrigation facilities, lands and ecosystems have still suffered from unwise and indiscriminate use of pesticides. Water and air pollution has also been a cause of eutrophication of soils and water bodies and loss of vigour and health of vegetation in the hinterland of urban and industrial centres. Industries such as cement manufacturing (*e.g.* Lakheri cement works at Lakheri in Bundi district)) and power plants (*e.g.* Kota

thermal power station in Kota)) have had significant adverse effects on the surround ecosystems including plants, animals and their physical environment.

Commercial trade of plant and animal species

Commercial trade of living animals and plants as well as in products derived from these is also a severe threat to biodiversity in the state. Demand for medicinal plants in the market can never be satiated. In absence of any concrete plans (and measures or regulation by the government) the trade and industry circles directly tie up with forest dwellers, particularly the tribal and the poor people, for exploitation of plants and plant products from the forests of the state. Unspecified and unknown quantities of produce is harvested from the forests which is a serious threat to the sustainability of the resource base. Clandestine links of local people, especially the hunting communities and forest dwelling communities, with commercial interests involved in illicit trade in animal products such as skins, horns, bones, and meat and animal oils, are common. This is a very serious threat to the rare and endangered fauna of the state. Commercial markets of fuelwood are another threat to the vegetation of the state in general and the forest resources in particular. Poverty combined with demand for fuelwood in urban areas and industries causes a heavy drain on the woods and forests, apart form the huge charge of subsistence needs of fuelwood for the predominantly rural populace of the state.

Introductions of non-native (alien) species

Introduction or accidental emergence of alien species is a significant threat to the native vegetation of the state. One of the earliest alien species to establish in the state has been *Prosopis juliflora*. Its origin in the state is so old that it is now as familiar as native plants. Its economic benefits to the local populations, particularly as a source of fuelwood, has been significant but there is no doubt that there have been matching or even exceeding ecological costs. Many habitats have been completely taken over by this species, with native vegetation totally displaced. Several important national parks and sanctuaries have been infested with this species. It might require huge investments now to eradicate this recalcitrant species from these valuable habitats. Many of these habitats are also invaded by another invasive alien species *Lantana camara*. Another weed known as 'congress grass' (*Parthenium histophorum*), which was introduced accidentally during import of foodgrains under the PL/480 programme, occupies extensive fields in urban and rural areas and has been a health risk to the residents as an allergen.

Some of the species have been introduced as part of official programmes aimed at solving economic problems but their true contribution to improvement of productivity of the ecosystems is debatable. Plants of Israeli babul *Acacia tortilis* and subabool *Leucaena leucocephala* were considered promising wonder plants and were discovered as a result of a lot of research and investment of public money. But eventually these species have not performed any better than many of the native tree species. On the other hand, the ecological costs of these species have certainly been high.

The urban areas have seen greatest number of exotic species of trees, shrubs and grasses. Manicuring of lawns and lacing of gardens with cornucopia of exotics has caused significant loss of biodiversity in urban areas and their hinterland.

Introduction of exotic fishes like *Tilapia mossambica* in water bodies of the state has adversely affected the production of indigenous fish species. The population of the introduced varieties in some water bodies has now reached 80% of the total fish

population. As a result of lack of knowledge and adequate human capacity to identify and weed-out undesirable species from the fish released as seed in the Jaisamand Lake of the state has led to increase in the number of undesirable fish and has adversely affected the fish fauna of this largest lake of the state.

Monoculture and intensive agriculture practices

The trend in development of agriculture and animal husbandry in the state has been one of promoting a limited number of varieties of crops and breeds of animals. Many times such breeds or crops are out of place in the agroclimatic background of the areas where these are introduced. This emphasis on a few species or varieties has led to neglect of the other precious genetic resource of the state such as the land races of grains and the local animal breeds having a better potential of serving the needs of the state in the long run. Similarly, intensive agriculture with emphasis on high input in form of chemical fertilisers and pesticides has led to deterioration of soil structure and loss of soil microflora and microfauna due to changed soil environment. Changes in soil environment has triggered further ecological changes including displacement of local species by weeds and aliens. This leads to erosion of the valuable domesticated biodiversity resources of the state.

Root Causes of Biodiversity Loss

Population Growth and Increasing Biotic Pressure

Growth of human and livestock population is one of the most important root causes of decline of biodiversity just as of all environmental problems. The state's population has more than doubled from 26 million in 1971 to 56 million in 2001. Livestock population, though traditionally high, has also grown from 37 million in 1966 to 49 million in 1992. Apart from growth of the numbers, the patterns and levels of resource consumption have changed. Most subsistence use practices have outgrown into commercial exploitation with links to markets, especially in the burgeoning urban centres. Increasing population has diminished the extent of forest and other uncultivated lands, depleted lands of native vegetation and spoiled the remaining lands and ecosystems by disposal of waste and other forms of pollution. Increasing pressure of livestock on all kinds of public and private lands has left these bereft of any vegetation. Soils have been degraded and compacted and their productivity has severely declined. The pressure of growing population also strains the institutions charged with management of natural resources and reduces their effectiveness. Close dependence of populations on natural resources of the state for their livelihood has intensified the process of resource degradation.

Poverty and Inequity of Resource Distribution

Poverty has contributed to loss of biodiversity in the state in many direct and indirect ways. Public policy in the state has been guided by the assumption that poverty eradication is an objective with higher priority than protection of environment. This kind of misinformed advocacy of a cause at the cost of another cause which undermines the first one has led to neglect of environmental concerns in the rush for economic development. In the end, of course, both the objectives—of poverty eradication and of protection of environment—have suffered.

The direct link between poverty and biological resources is strong in the state. Whether poor people are forced to hunt rare and endangered animals and sell in the illicit market

(at prices far below market prices) or they are forced to cut all the trees in their farms in order to make a living in hard times (of drought and famine), this directly goes against the cause of biodiversity conservation. Options for making a livelihood are severely limited in the state and yet each of these (wood collection, working in a local stone quarry, encroaching for cultivation on a patch of forest, rearing livestock on basis of annual migration into forests, selling forest produce in local market or clandestinely to agents of illicit trade) causes direct loss of biodiversity. Diminishing productivity of the degraded resource base further requires the poor people to increase the scale of their activity or change it in some other direction. However, their inability to get out of the poverty trap also underlies their inability to appreciate the importance of ecological security that is necessary for their continued survival.

Unequal access to public resources has further vitiated the relationship between poor people and the resource. It is not rare to find informed communities living close to forests who understand the critical dependence of their economic survival on local forests and also understand the ecological process that support productivity of these forests. The problem is that they neither own nor control these resources. They have no idea when the policies of management of these forests may change and how these come to be determined. This hiatus between the users and owners of resources leads to lack of commitment on part of the users towards conservation of the resource. The *ad hoc* arrangement (in form of annual grazing receipts, for example) forces the communities' time horizon to be very short and consequently no long-term commitment can be expected from them. Inequities in resource access and use exist in complex patterns and at different levels such as between the state and the local people, among the rich and the poor, among men and women, and between the social classes among the poor themselves.

Ignorance About Species and Ecosystems

Knowledge about the extent, status, and role of species, natural habitats, and ecosystems in supporting human life is lacking especially in the public domain. Public policy has not been informed by the underlying ecological processes that support the economic production and ensure security of the resource base. In scientific circles significant work has perhaps been done, especially in the academia and by independent experts, but it has been of little value in influencing policy formulation since it has not been integrated into the public domain. Wide gaps remain even in scientific studies regarding the links between human society and the natural resources. Decision making in planning of economic development in the state has been a process in isolation of ground realities regarding status of the natural resource base. Ecological costs have never been considered while planning economic development. As a result, the negative externalities of the development process have impoverished the biological resources of the state considerably.

Lack of information on the condition and value of biodiversity as well as on use processes and patterns has meant that no significant initiatives and management measures have been taken for its conservation. Changing cultural patterns and perceptions have led to a worse situation where lifestyles of people knowledgeable about value of biodiversity are viewed as primitive and ignorance about plant and animal resources is considered 'modern'. Traditional knowledge has considerably eroded as a result of this cultural shift and for lack of official recognition of this valuable asset. On

one hand, there is shortage of knowledge and trained scientists in the domain of biological diversity, and on the other hand, the traditional knowledge has not been recognised in the mainstream public domain. This unfortunate situation has contributed significantly to loss of biodiversity in the state.

Interaction Between Subsistence and Market Economies

The close link between the local communities and the biological resources has undergone transformation under the inducement of the external human, and institutional environment. Local markets as well as illicit trade in products of biological origin has led to formation of partnerships between the unscrupulous elements (such as the hoteliers clandestinely serving wild meat or the local tribesmen peddling skins of wild animals) on both the sides on one hand, and changed the expectations of genuine resource user on the other. Market forces have influenced decision making of both individuals and entire communities in respect of use of natural resources. This change has not been healthy and more in the interest of the cunning trader than in favour of the innocent rural or forest dweller. It has opened another channel of increased flow of resources from the rightful owner to the usurpers. Government policies have done little to address this new development on the front of resource misuse and appropriation.

Failure to Account for the Value of Biodiversity

Both market forces and public policy have tended to underplay the true economic and ecological value of biodiversity in the state. In spite of being the foundation of the productivity of the natural resource base of the state, biologically resources have never been taken into account in public policies except by way of attaching a financial tag to the amount of timber or other such produce removed from public forests. Loss of species, disruption of ecological services, and impoverishment of the resource base have not been taken into account while formulating public policies and sectoral development programmes. On the contrary, public polices such as perverse subsidies and credits programmes have tended to reinforce the driving forces behind loss of biodiversity. Environmental externalities of state-supported programmes and projects have been huge and deep-running. Similarly, uncertainty of property rights and policies of alienation of resource users from its legitimate owners have accelerated the process of degradation of resource base and loss of biodiversity.

Inappropriate Policies, Institutions and Structures

The process of policy development and decision making in public domain in the state remains highly insular. The objectives of policy formulation as well as the possible options have not been publicly debated. The voice of people with high dependence upon natural resources, such as indigenous communities, has not mattered in formulation of relevant polices. State's institutions such as the various departments and agencies are closed to access of common man on pretext of official secrecy and such other purported grounds. There is lack of intersectoral and interagency coordination among the various departments and agencies entrusted with management of the natural resources of the state. Some of the institutions charged with managing natural resources such as the *panchayats* have neither been motivated nor equipped for the task entrusted to them. In others, the attitudes of individuals and institutions equally have been rather insular in scope and imagination.

The legal provisions in respect of management of natural resources are antiquated and out of context. Yet in other cases court battles based on these laws have been used by individuals against public interests and to the detriment of the objective of conservation. On the other end of the spectrum laws and policies viewed by people as lacking legitimacy have faced opposition from public resistance. Absence of institutions and policies aimed at integrated natural resource management functions such as land use plans and conservation of biological resources has led to a fragmented sectoral approach leading to internally contradictory programmes. Failure to levy realistic levies on users of natural resources (such as grazing fees, fuelwood collection fees) and subsidised supply of electricity and irrigation water not only drain public exchequer (with no funds left for environmental management), but these policies (mainly because of poor governance structures and lack of political will) has encouraged waste and misuse of such resources. The overall result of poor governance has been poor husbandry of the state's natural resources and consequent loss of biodiversity.

The policy environment in the state is also influenced by international policies on development aid. Many programmes and projects funded with international aid have caused much loss of biodiversity by sponsoring ill-conceived and poorly planned development interventions. Programmes in the sectors such as agriculture, forestry, mining, infrastructure, irrigation and the like lead to intensive and narrowly focussed activities of alteration of habitats and creation of perverse economic expectations and incentives in the minds of the local communities. For example, in the countryside of the state one may find many tractors financed under World Bank projects and but the economic and social status of the beneficiaries has not always changed favourably, despite the fact that inappropriate technologies so promoted have led to erosion of traditional knowledge and destruction or alteration of habitats and natural environments without securing matching benefits in the long run.

Interaction of Root Causes

The root causes described above are responsible for triggering various threats (some of which were described earlier) to the biodiversity of the state. However, the root causes do not operate in isolation. They tend to act with and exacerbate one another. For example, intensity of pressure on the forests of the state has increased because the governments have avoided the unpopular task of increasing grazing fees or otherwise regulating grazing in forests. As a result, loss of productivity of forest floors in terms of forage and grass reduces the *supply* of the produce and a greater portion of *demand* remains unmet leading to longer periods of migratory livestock in forests and larger areas of forests covered, including the ones constituting protected areas. When supply of this service (grazing) dips, the resulting acute concern on part of the livestock rearers leads to stronger lobbies in political circles to resist any move to increase levies for grazing or other measures of regulation and to open additional forest areas to grazing. This mutual reinforcement of the two root causes has led to a downward spiral of degradation of the forest resources and with it loss of biodiversity.

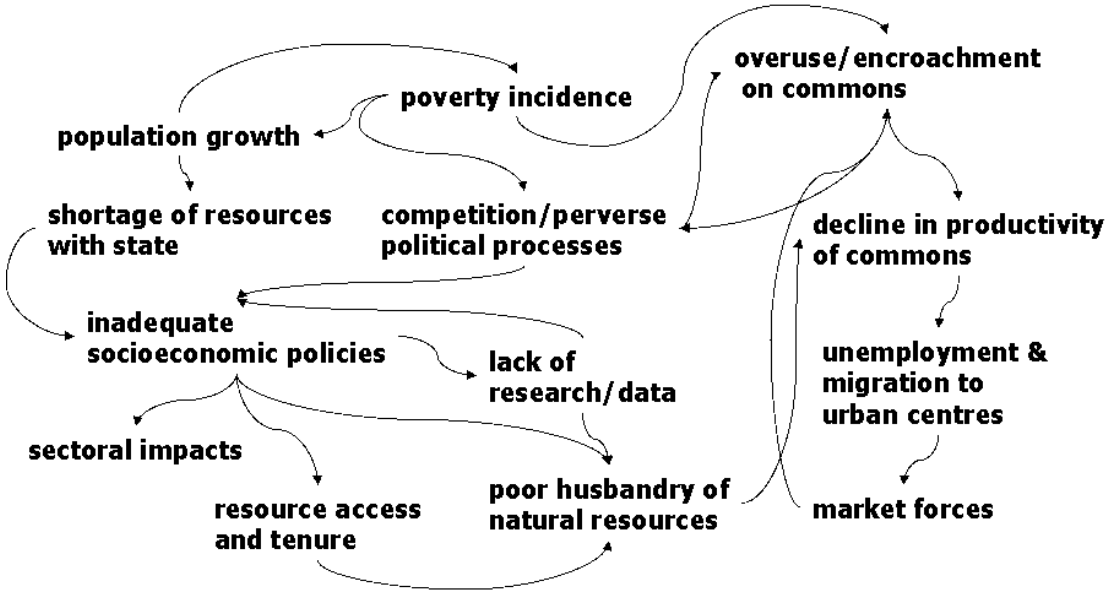


Fig 4.1 Causal loop diagram indicating interactions of root causes

A similar cycle can be cited wherein encroachments on forest lands are regularised by governments, which heightens the expectations of other people who have been left out of the race and motivates them to encroach upon lands with even greater determination. Many such interactions of root causes can be identified. It is important to understand that the vicious circles constituted by the factors described have entrenched into the governance of natural resources in the state and have put the state in a difficult as well as a risky situation.

CHAPTER 5

ONGOING PROGRAMMES AND INITIATIVES

Biodiversity has not yet been recognised as a concern in its own right in the state. There is no state level body or institutional mechanism whose domain includes management of biodiversity across protected areas, forests, pastures, farms, ponds, rivers, lakes and different kinds of public lands in an integrated manner. As a result, there are no initiatives or programmes that are explicitly designated as biodiversity conservation initiatives. Nevertheless, certain sectoral programmes and activities are being taken up in different sectors either with conservation of biodiversity as main focus or biodiversity conservation as part of their objective or a by-product (positive side-effect) of sectoral objectives. This chapter aims to summarise such initiatives currently under way in the state.

Protected Areas

Protected areas are viewed as the main repositories of biodiversity in the state. These areas have been established under the provisions of the Wildlife (Protection) Act 1972 and focus their management objectives on conservation of wildlife, usually one or a few flagship species. There are 25 sanctuaries and 2 national parks in the state. There are also 32 closed areas (*see* Appendix) which, though not currently recognised as a separate category of management areas under the Act, are areas of significant density of wildlife species. Most protected area institutions are limited in their management functions to merely delineating the area, checking poaching of wild animals, and occasional programmes of habitat improvement such as creation of water points, seeding with grasses, and restoring degraded forests. Most are acutely strapped of funds and are being managed in a socially hostile environment with very limited human and technological resources.

There have been some recent shifts and new initiatives in management of protected areas of the state. People's participation, especially in form of setting up ecodevelopment committees, is an offshoot of the JFM movement in the state and has been actuated by externally aided projects, notably the IDA-GEF assisted *India Ecodevelopment Project* being implemented in the *Ranthambhor Tiger Reserve* under which ecodevelopment is a major activity with more than 50% investment directed at this. Though ecodevelopment is yet to spread across the remaining protected areas of the state, it is still acting as a source of ideological shift or shift in management approach in theory across the state.

Wildlife Outside Protected Areas

The Wildlife (Protection) Act 1972 specifies species of animals and plants in its schedules that are protected from harvesting. It does not matter where these species grow or are found. However, the state has more wild animals outside the formal protected areas than inside these. This is due to the fact that the state's PAs constitute a mere 2% of the its total area whereas a large proportion of lands managed (or not managed) as wastelands, pastures, cultivation fields, forests and habitation areas also harbour many important species of wild animals. Thus more *chinkaras* live on farms and fields than in sanctuaries. More black bucks and *nilgais* (or quails and partridges) live in forests and fallows than in PAs. One of the significant conservation activities in the state is aimed at protection of

these animals. The institutional framework consists of the authority of wildlife wardens (and wildlife flying squads) in the state who are empowered to check hunting of scheduled animals across all areas in the state. Seeking cooperation of local communities in sharing of information and intelligence, for example, is one of the new initiatives in wildlife protection which is aimed at improving effectiveness of the agency. The institution of 'honorary wildlife warden,' which aims at getting support of wildlife enthusiasts and conservationists among citizens, has proved to be useful.

Joint Forest Management

Forest areas of the state are an important source of biodiversity in the state. One of the most important movement under way in forest management is the Joint Forest Management (JFM) movement. Under this programme local communities are involved in management of forests. The JFM movement is over a decade old in the state and has made considerable progress. There are over 2700 *Village Forest Protection And Management Committees* (VFPMCs) which have been constituted under the state government's guidelines issued in this regard. Many of these committees are generating revenue from fees imposed on collection of non-timber forest produce. The state has also put in statutory mechanism recently which entitles the local communities, through the *panchayats*, rights to minor forest produce from local forests. It is hoped that this programme of involving local people in management of forests will help regenerate the forests of the state and thereby enhance their biodiversity.

Cataloguing Plant Genetic Resources

The National Bureau of Plant Genetic Resources has a Regional Station at Jodhpur. The main task assigned to this station is to carry out plant genetic resources (PGR) activities and it's sustainable availability for the users in the development of this region in general and in their crop improvement programmes for the development of agriculture in arid and semi-arid regions in particular. More details on its work have been included in the Appendix.

Community initiatives and institutions

Conservation of plants and animals is an ancient tradition among the communities of Rajasthan. There are several traditional institutions that have helped preserve the flora and fauna which are of economic importance to the predominantly rural populations of the state. Some of these institutions are the baug, the deo-vans or temple forests, the orans and other sacred groves and sacred trees. The baug (lit. meaning the garden) is often a garden of planted and natural trees near human settlements created for fruit, medicine and shade. Often patronage of the village headman was the chief institutional mechanism for management of the baugs. Many of the baugs left over are nowadays private properties of the village thakurs or some other rich families. Their common use by the villagers however is still allowed. In many of these baugs very old trees often of jamun, mahua, feronia, mango, tamarind, date palm, etc.

Deo-vans or *banis* are sacred groves surrounding places of worship. Often these are deities worshipped by particular caste or by the village folk in general. The *banis* of the gujjars around temples of *deonarayanji* are very common in the Hadoti region of the state.

Numerous communities protect patches of forests by dedicating them to local deities and ancestral spirits. In Udaipur and Dungarpur districts, the tribal people perform a ritual of sprinkling of *kesar* (saffron) water over the trees over a patch of forests to protect its trees from felling, pollarding etc. The process is called *kesarchhanta*. Kesar for this purpose is brought from the temple of *Kesariyaji*. The ritual is performed by the village *bhopa* (pious man) in the presence of villagers with beating of drums and blowing of conch to propitiate *Kesariyaji*. The villagers take a vow of not cutting or damaging the tree growth of the area in any way for a period of five years to begin with. The villagers believe that their deity will administer punishment to any one indulging in cutting or damaging the trees in the area. It is believed that the punishment is mostly in the form of death of the offender.

In a number of villages the local people have constituted forest protection committees to regenerate the forests in their villages. Local forest officers have played an important role in encouraging the villagers in the constitution and functioning of the societies. Some examples are:

Salukhera village with a mixed population of different communities is about 55 km from Udaipur on Jhadole road. The officials for Forest department constituted a Village Forest Protection and Management committee on February 1, 1993. A ten-member working committee was constituted. One of the villagers, Lal Singh Jhala, was elected as the chairman. The Deputy Conservator of Forests (Central Division), Udaipur, officially registered the VFPMC on 25-11-1993. From 1993 to 1996, the VFPMC successfully raised plantations over an area of 200 hectares of barren hills. The committee also was instrumental in removing illegal encroachments from this forestland. The committee did exemplary work in protection of the forests and in equitable distribution of grass and other non-timber produce. Statistics of the extraction of fodder by the villagers indicate that the collection of fodder increased from 8.6 quintals per family in the first year to 23.4 quintals per family in the fourth year of the formation of the VFPMC**.** The Salukhera VFPMC also successfully protected about 350 hectares of forests of the forest range Jhadole and 736 hectares of Naraini forest block. It also plays an important role in the overall development of the village and its economy. Salukhera village provides a good example of healthy and active co-operation between the forest department and the members of VFPMC. In one case, some villagers had encroached upon a piece of degraded forest land. Although the Forest department had registered an offence against them but these people did not leave the possession of the encroachment. The VFPMC members morally persuaded these members to vacate their illegal possessions. The Forest department, from its resources had provided the villagers with a diesel flourmill. The members of VFPMC are now operating this flourmill. The VFPMC has taken a number of steps in the improvement of the village economy. An approach road has been constructed and fish farming was successfully introduced in the anicut constructed in the forest area. Bamboo seedlings planted in the degraded forests by the committee have done well in the area. The regular harvest of the bamboo crop from the plantations will provide a regular source of income to the society members. In recognition of the exemplary work of protection of the forests the village committee was awarded "*Indira Priyadarshini Vrikshamitra Award*" in 1996.

Nayakhera is a small village located at a distance of about 15 km from Udaipur city. The local forest ranger took initiative and persuaded the villagers to constitute a VFPMC. The village elders also favoured the idea of protecting their own forests to meet their basic

needs of fodder and fuel and supported the idea. The VFPMC was registered on 13-06-1995. It has successfully raised plantations over 315 ha of degraded forest land adjoining the village. The survival and rate of growth of the planted seedlings and other vegetation in the area has been excellent. The villagers now take pride in showing the dense growth of bamboo and other plants in the afforested areas. In addition to these plantations, the VFPMC is also protecting another 120 ha of natural forests in their area. The grass produced in the area has a ready market. An anicut, built with the assistance of forest department, has not only helped in raising of water table in the village wells but has also been useful in directly irrigating some agricultural fields. The Forest Department has contributed funds for installation of two hand pumps for drinking water in the village and construction of a link road in the village. Recently, the state prize for the forest protection was awarded to Nayakhera VFPMC.

There are a number of such examples all over the state.

Initiatives of NGOs

Several NGOs are active in the state whose activities contribute significantly to conservation of natural resources and protection of environment. Tarun Bharat Sangh in Alwar, Astha and Seva Mandir in Udaipur, Urmul in the western part of the state, and similar other NGOs are active in promoting the cause of conservation with active participation of the local communities. The Bombay Natural History Society (BNHS) has been working on birds conservation and their status in the desert areas of the state.

Tarun Bharat Sangh, founded some 16 years ago, has emerged as a leader in accelerating rural development through the restoration of ecology. Based in Bhikampura Kishori of Alwar district in Rajasthan, the NGO is known for reviving traditional methods of rain water harvesting. It has been a catalyst in constructing more than 4500 check dams in Rajasthan. The art of making such earthen structures was propagated through an unusual, but effective word-of-mouth communication between friends and relatives from one village to the other. More than 1200 villages have benefited so far. Along with water conservation, the organization has begun helping women in the villages to set up micro-credit banks and self-help finance groups for their socio-economic empowerment. The efforts of its leader Mr Rajendra Singh got him the Magsaysay Award for 2001 in the field of community service. In the course of NBSAP, Tarun Bharat Sangh has also prepared the biodiversity strategy and action plan for the Aravari watershed of Alwar district.

The Uttari Rajasthan Milk Union Limited (URMUL Trust) is another successful NGO in Rajasthan. URMUL started as a dairy cooperative union. During a drought and resulting famine in the north-western part of Rajasthan, near Bikaner, they decided to develop alternative forms of non-agricultural income. Since there is ample wool in the region surrounding Bikaner, URMUL started a wool-spinning project. This quickly resulted in a vast amount of wool yarn, at which point it was decided to venture into weaving. A group of traditional weavers from another part of Rajasthan were brought to Bikaner to teach weaving. A distinctive weaving style soon emerged, with marketable products. Moreover, the teaching group, while in Bikaner, received training in marketing, organization and business management. On their return to their own district (between Jodhpur and Jaisalmer), they were able to organize their own community. This was the genesis of the URMUL crafts movement. There are now a number of crafts groups

loosely affiliated with URMUL. All receive training and ongoing assistance from URMUL, but otherwise function independently. URMUL organizes large annual exhibitions in Delhi and sometimes in other cities, in which products from all the URMUL groups are sold.

Seva Mandir was established in 1966 by the late Dr. Mohan Singh Mehta. This organisation works in economically and socially depressed tribal belt of Udaipur district where there is a close dependence of the people upon natural resources, particularly bioresources. Its activities are spread over 535 villages in 6 tehsils (Jhadol, Girwa, Badgaon, Kherwara, Kotra and Gogunda) of Udaipur district. Main activities are in the field of natural resource development, education, health, women and child development and institution building. The long-term objective of Seva Mandir is to foster village associations and institutions that would be autonomous of state control and exploitative patrons, thereby creating space that will facilitate a demand driven agenda for development from within the village community. The organisation has 207 fulltime workers and 750 paraworkers who provide services and leadership directly to the village community. Major programmes of the organisation are strengthening sustainable livelihoods of village communities; building local capabilities to achieve well-being in terms of health, education and gender-equal relationships; and creating autonomous village level institutions and supporting organic leadership. Seva Mandir has been involved in a number of Biodiversity studies undertaken earlier in the Aravalli region such as the Biodiversity Conservation Prioritization Project (BCPP), in 1997; documentation of people's knowledge and perception about biodiversity conservation across depleted ecosystems and agro-ecological zones; strategy for conserving biodiversity in Mahad cluster in Phulwari-Ki-Nal wildlife sanctuary in Kotra Block of Udaipur district

Foundation for Ecological Security (earlier known as Tree Grower Co operative Federation) was promoted by National Dairy Development Board. It has a long experience by now in the field of agroforestry. It has undertaken an initiative for greening of degraded forest areas and other wastelands with JFM approach in Mansi Wankal Watershed of Udaipur district.

BAIF Development is a Pune based NGO that has certain ongoing activities in the state of Rajasthan. The role of BAIF, a participant NGO, in a small village in Bhilwara district provides an excellent example of how improved natural resource management can dramatically improve people's lives. In an area, which has traditionally depended on cows and buffaloes, productivity slumped as a result of over-grazing and the neglect of pasture land. BAIF's agricultural advisors and extension workers began to work with the villagers and introduced the idea of fencing off an area for the livestock and undertaking soil conservation measures to reclaim the pasture land. Forage seed was sown and, for the first time in years, the grass grew again. Further improvements were made using bio-fertilisers, which enriched the soil and increased the growth of forage trees. The villagers now enjoy increased milk yields and harvest surplus grass, branches and the grass seed for sale locally.

Civil society organisations, including NGOs, can play an important role in biodiversity conservation in the state and this potential is largely unutilised as of today. These

organisations can act via advocacy, improved resource use and economic returns (including crafts, marketing support, training), better natural resource management, and direct action for protection of biodiversity (such as the Bishnois guarding against poaching). NGOs working in fields of rural development, education and health, watershed development, and other areas, need to integrate the concern of biodiversity conservation into their programmes as much as it is wanted in the case of the sectoral programmes of the government agencies.

Research Institutions

Several research institutions are working in the state on compilation, cataloguing and conservation of the biological resources of the state. The Botanical Survey of India and the Zoological Survey of the India both have their regional stations in the state. The Central Arid Zone Research Institute (CAZRI) and the Arid Forest Research Institute (AFRI), working under the Indian Council for Agriculture Research (ICAR) and the Indian Council of Forestry Research & Education (ICFRE) respectively, are located in the state. The research activities of these institutions have led to significant build up of knowledge about the species and their distribution in the state. Similarly the botany and zoology departments of the various universities and the concerned departments of the agriculture universities in the state are also working in their respective fields. The Rajasthan State Remote Sensing Application Centre as well as the Regional Remote Sensing Centre of the Department of Space of Government of India is also located in the state.

Agriculture

The main aim of the government policy is to augment_the agricultural production. To ensure production and availability of quality and improved seeds to the cultivators the agriculture department is putting emphasis on strengthening seed certification and seed production programme. It is also encouraging research on location-specific, crop-specific technology, and adoption of dry farming technologies to augment agricultural production in the rain-fed areas. Balanced use of chemical fertilizers and integrated pest management approach are also being suggested. It is also trying to enforce judicious use of ground-water through sprinklers and drip-irrigation. In order to harness maximum return per unit of water, emphasis is also given on growing low-water-duty crops i.e. pulses and oil-seed as compared to cereals.

The agriculture department, however, does not in any way provide incentives to the cultivators for growing indigenous varieties of crops and other land races. On the other land, emphasis is given on cultivation of high-yielding varieties of crops with necessary inputs of fertilizers, and pesticides.

Agriculture is primarily rain-fed. Monsoon period is short. The rainfall is aberrant and uncertain. Monsoon is generally late in its arrival and early in departure compared to other parts of the country. Irrigation by tube wells is causing lowering of water table in the area. The main crops cultivated are wheat, bajra, maize, and jowar along with mustard and linseed. Other oil seeds namely groundnut and soybean are also getting popular. Cotton and sugarcane are confined to small areas.

Animal Husbandry

At present, the emphasis of animal husbandry department is on the improvement of the breed of the cattle. In past, the policy of the animal husbandry department was to improve the productivity of local cattle by cross breeding it with high milk yielding exotic varieties. This policy has failed in most of the areas because of non-availability of nutritive fodder and veterinary care. Some limited success has, however, been achieved in urban areas, where the cross –breed is reared for dairying. The animal husbandry department is now emphasizing on selective breeding of indigenous breeds by artificial insemination. The implementation of this scheme is very weak.

Animal husbandry is an important activity and plays a vital role in the rural economy by providing employment and stabilizing the household income. Livestock management is labour-intensive. Women manage most of the activities in livestock management. This activity directly benefits the women of the family.

Livestock population in the state is very large. The low productivity of degraded forests and other grazing grounds in the area has aggravated the shortage of quality fodder for the animals. The milk yield of the cattle is therefore very low.

Fisheries

The main emphasis of the fisheries department is on setting up of hatcheries for increasing the production of fish. The emphasis is also on increasing the fish-seed and its production. There is no programme of increasing the indigenous varieties of fish in the region, however. Exotic fishes are being introduced without considering the requirements of the highly valued indigenous fishes.

CHAPTER 6

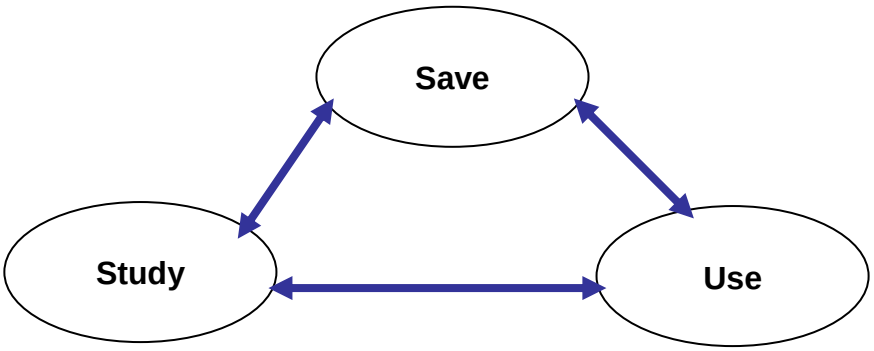
STRATEGIES AND ACTIONS TO FILL THE GAPS

In view of the challenges outlined in the previous chapters and the importance of biological resources and their conservation in the state, it becomes necessary to devise a comprehensive strategic plan of action. This chapter presents a structured summary of the strategies and actions that are required in the immediate future as well in the long term. This strategy addresses full range of causes of destruction of biodiversity and embraces widest opportunities that a conservation programme may provide for realising the maximum human welfare from the biological resources of the state. The strategy and action plan presented here forms a foundation for conservation of biodiversity in the state for future. Although this baseline action plan will have to be reviewed from time to time as and when the need arises, yet it will provide a framework in which to base all the broad programmes and policies.

Conservation: A Cyclic Process

The state's strategy for conservation of its biological resources and their diversity rests on three pillars (Fig 6.1) and the three processes linking these focal activities. The activities are:

- Save the biological resources and their diversity.
- Study these resources and the underlying environmental, ecological, and socioeconomic processes to understand better the dynamics.
- Use the resources in a sustainable manner.



The dynamics

Save-Study: Preventing loss of biodiversity and saving it requires greater understanding of its role and use in maintaining ecosystem health and human life. Conversely, to gain a better understanding of the full spectrum of present and potential functions of species and ecosystems in protection of our planet and human welfare, the full range of representative samples of ecosystems, species, and genetic varieties must be preserved.

Save-Use: Greater incentives will exist to slow the loss of biodiversity if its immediate utility to humanity is increased. Conversely, the many actual and potential benefits that species and ecosystems can provide to humanity cannot be sustained unless the biological resource base is maintained.

Use-Study: Developing sustainable uses of biodiversity requires the application of traditional and modern knowledge of biodiversity and biotechnology. Conversely, user needs of biodiversity should help establish appropriate research priorities.

Figure 6.1: Conservation of biodiversity as a cyclic process

The three processes are mutually interactive: Unless resources are saved, we can't study (the extinct species for example), the better we understand the value, the dynamics and the characteristics of species and ecosystems the more effective our programmes for saving these will be. Unless we have sufficient knowledge about the resources, we can't use them effectively, efficiently and sustainably, and unless we use these resources for human welfare there is neither an incentive nor a possibility for saving these. Finally, sustainable and intelligent use of the resources will help us save these for our future generations, and conservation of the resources alone will afford us an opportunity to use these to our full benefit.

The three processes or activities are briefly described below:

Save

Saving the diversity and the extent of the biological resources has many aspects to it. First, the diversity of the resource comprises of genes, species, and ecosystems and must be preserved at each of these levels. In other words, sufficient representative replications of the rare and endangered diversity must be preserved while the health and productivity of the systems not threatened is also maintained for their secure future. Adequate incentives must exist to gain political and public support for saving the resource since without such a support a conservation programme will not succeed. In order to bring out those incentives, to prove the (present and potential) value of the resource to the society, it will be necessary both to assess the extent and status of the resources and to understand the ecological and social dynamics that affect the resource. It is necessary, therefore, that saving the resource also implies the correct knowledge of the extent and status of the resource.

Study

The knowledge about the biological resources, of both the scientific aspects and the socio-economic aspects, is the raison d'etre of its conservation. To formulate conservation strategies, or to justify them, and to gain public support for such efforts it is necessary that we fully understand the nature and the importance of these resources and the processes affecting their conservation and sustenance. Scientific research about diversity of the resource and its adequacy, use, dynamics, as well as accurate data about the existing species and ecosystems must be studied and understood well. The deeper the understanding we have of this resource and its condition, the better we are placed to devise, support and implement strategies for their conservation.

Use

The one most important factor that may determine the fate of our biological resources is their direct (economic) importance to the society. After all, the ultimate aim of conservation is human welfare. While economic and developmental activities in many sectors are focused on finding out the beneficial uses of biodiversity to mankind, it is necessary that the proponents of its conservation understand the process of its utilization in totality. Apart from specific uses of plants and animals, the aspects such as rate of harvest and regeneration, biosafety, non-extractive use and its value, and equity in use and access are concerns that all must be addressed properly.

Salient Features of The Conservation Strategy

Looking to the three-fold conceptual model of the dynamics driving the fate of the biodiversity of the state, the following practical model (Fig 6.2) is proposed for the

overarching conservation strategy. The model indicates the two pillars of *Resources* and *Sustainable Use* on the top, supported by the *Processes* (explicit and underlying) that will decide the balance between these two entities. The state of the resources (and that of utilization practices) will determine the strategic goals/objectives and the state of the support processes, as well as of the undermining processes, will determine whether and how we can achieve those objectives. All the three elements constitute a dynamic whole (a system) whose future path will be determined by the interactions within this whole and to some extent on its external environment (funding, exit options, interactions). The three broad aspects of conservation are further divided into themes each having either an associated government agency looking after it (the sector theme) or implying a unified set of activities of specific kind. Thus there are seven strategic themes under the head *Resources*, five under the head *Sustainable Use* and sixteen under the head *Processes*. The salient features of this strategy are indicated briefly in what follows.

Adaptive Management

Scientific research and policy research are both continually needed on all the three strategic fronts. This research, to begin with, has perforce to be based (as are all the actions proposed here) upon a minimal understanding of the state of the biological resources of the state arising out of the limited data available. As the process of research and of implementation of policies and programmes continues, and as monitoring and feedback upon these actions provides new data and new understanding of the ecosystems, the species, and their use and the relevant processes under way, the strategy and the management actions will be continually modified. This kind of an *adaptive management* approach is better suited to managing conservation programmes since the managers will never have the complete information about the resource they are managing. The traditional engineering approach of *linear management* will not yield optimum results and will be beset with underlying uncertainties owing to lack of complete knowledge. Adaptive management presumes that ecosystems being extremely complex human understanding of these is rudimentary at best. Human activities may harm these complex systems without realising these damages, and therefore management decisions should always be on the conservative side, erring on the minimal risk to ecosystems.

Resource-based Approach

The state's strategy takes a resource based approach rather than an ecosystem approach. A resource approach has the following advantages in the context of the state:

- This approach dovetails better with the existing infrastructure, human resources and organisations and institutions. In case of most of the thematic 'types' of resources (e.g. forests, protected areas) there are organisations (departments) and institutions (services, legislation) that are in charge of managing these resources.
- This approach raises pan-sectoral awareness among the respective resource managers, and enhances their understanding and commitment to biodiversity.

The approach leads to better chances of ownership of programmes by the sector organisations (though not by all the stakeholders concerned).

Apart from the six principal resource-based sectors, there are the processes that affect all the resources and sectors and hence these cross-cutting themes have been addressed in detail and may form a greater part of the overall strategy, despite the focus on the resource-wise strategies.

Community Based Conservation

An important requirement of a conservation programme so closely linked to the daily lives of people is that it must adopt a participatory approach if it is to succeed and be sustainable in the long run. Conservation is ultimately aimed at making difference to the people's lives and not merely for the sake of scientific or altruistic interest. The action in conservation programmes takes place at grassroots level where it is the local communities whose role will determine the success or failure of this action. As a result, the present strategy aims to ensure that local communities play a central role in decision making at all levels including planning and implementation of activities, projects, and initiatives. For this, the tools and techniques of ensuring participatory working, such as stakeholder analysis and PRA, will be a constant element across all the actions proposed to be undertaken under this strategy.

Participation of communities also implies that attention has to be paid to the different vulnerable community groups whose dependence upon biological resources and whose vulnerability to actions proposed under this report may be higher but whose say in decision making in the given social milieu may be much lower. Affirmative action ensuring that such marginalised groups among communities are able to take effective part in decision making at all levels of planning and implementation of actions proposed here is a mandatory element of the proposed approach.

Ensuring Gender Equity

Of particular concern is the issue of gender equity, that is, participation of women vis-à-vis men. Women are more concerned about and more deeply affected by the status of biodiversity in the environment in which they live and work. Whether it is a matter of fuel wood collection, ethnic medicine, minor forest produce, drinking water, or local craft and cottage industry, women are the predominant group affected by loss of biodiversity and by limiting access to such resources. In particular, while planning for implementation of actions proposed in this report the following issues (which are only illustrative and by no means limiting) should be addressed throughout:

- While planning vegetation regeneration programmes in public lands and community lands (e.g. forest lands, pastures, government wastelands etc), species composition should be based on the subsistence (and possibly gainful employment via craft and cottage industry) needs of women and other weaker groups of local communities (consider neem, karanj, mahua, tendu, sal, arjun, tamarind vs. a vs. the male choices such as the eucalypts, shisham, teak and the like). Lack of women's voice in planning and decision making in these programmes often leads to choice of species that are perceived to be more economically important, sometimes in terms of the produce generated for local markets. This should be consciously avoided. Commercial produce should be grown on private lands rather than on public lands with public investment.
- Possibilities should in all cases be explored of supporting women's groups (such as cooperatives, societies, user groups or self-help groups) by entrusting them with implementation of local initiatives, programmes, and projects, of biodiversity conservation whether such programmes entail gathering data and information, regenerating local species of plants or breeding animals, sustainable use of produce flowing from these, utilisation of biological produce, regulation of gathering produce from certain areas or any such other initiatives. It will, of course, be necessary to support such women's groups with training, capacity building, organisational assistance, and making multilateral arrangements with

NGOs, and government agencies working at service of such groups if these are to become successful. This is an important step towards empowering women and for ensuring long term ownership and sustainability of assets and activities so generated.

- Surveys should be conducted of women workers, their number and percentage, working in forests on their own for meeting subsistence needs, or as labourers or employees in social forestry programmes, and the price or wage that such women workers might be getting from markets or from employment, as compared to similar male workers. Consequent to these surveys corrective actions should be taken to ensure that women get not only a fair representation in employment but also equitable price for their produce and just value for their labour.
- It is a fact that the number of women employees in the forest department, for example, is negligible. Steps should be taken to recruit more women employees at levels ranging from forest guard to the top echelons of service. This will enhance the capacity of the forest departments as an organisation to better implement programmes on gender equity and justice.
- Fair representation of women should also be ensured on all JFM committees, and in any form of participatory community based institutional structures that form part of the decision making process. Preference should be given to the voice of women in such organisations, and separate women's sub-committees at various levels should be constituted if local social conditions so warrant. Women workers as individuals should be given priority in volunteering for professional work such as local taxonomic reference person or local person in charge of the village biodiversity register, for example.
- Launch programmes of gender sensitization of forest bureaucracy in particular and all government bureaucracy in general, as well as of the political representatives, the scientific community (vis-à-vis the knowledge held by local women vs. men and the recognition thereof by these scientists, for example), and all the other relevant actors taking part in the process of biodiversity conservation.

Transition To Bioregional Approach

Bioregional planning must be the ultimate basis of any biodiversity conservation strategy and the state's strategy and eventual management of its biodiversity should be geared slowly to meet this requirement. As the state's capacity (both in terms of the availability of required data and knowledge of its ecosystems and human-institutional capacity) is built up over the years, a shift towards an integrated ecosystem-based approach is planned. Activities that harm or promote the interests of biodiversity may take place at various levels such as farm, village, watershed, bioregion, and state level. It then implies that adoption of a bioregional approach cuts across the traditional boundaries of administrative units and corresponding agencies. To adopt a bioregional approach also assumes availability of information and data to survey and identify the bioregions, setting up of bioregional agendas and institutional mechanisms. It will certainly mean a much tighter integration of the various sectoral agencies of the government. A shift to bioregional planning and working by bioregions (and ecosystems) will require a fundamental shift in the structure of government departments and related institutions.

Coordination With Regional And National Programmes

Adoption of a bioregional approach leads to the important issue of management of transboundary impacts and interstate ecosystems. For example, the Aravalli hill ranges cut across the boundaries of three states namely Gujarat, Rajasthan and Haryana. An integrated policy and programmed for management of biodiversity in the Aravallis will require cooperation of and joint programmes with the neighouring states. Many other ecosystems of vital importance cut across boundaries with Madhya Pradesh, for example. The bioregional approach is based upon and draws its strength from the fact that political boundaries would not fragment the integrity of the physical ecosystems and geographical areas. As such, transboundary issues can best be addressed by joining hands with the neighbouring states and setting up suitable institutional mechanism to deal with these areas. Such an approach will also have the added advantage of learning from each other's experience. Joint management and joint monitoring of programmes, coordinating anti-poaching activities across borders, joint research programmes and joint funding of ecosystem management programmes are some examples of how such a coordination could be implemented in practice.

Under the present strategy, the state proposes also to take active participation and keen interest in the national programme of biodiversity conservation. Exchange of information and financial support from the central programme are important underpinnings upon which this strategy relies. Since the present strategy and action plan is a part of the larger national process, a tighter coordination with the national process during its implementation will help reorient the programme and. A substantial amount of funding can be resourced from international development aid agencies for which a close coordination with the central government is required. The state being fund strapped for its multifarious economic development needs, external aid (under the framework of the CBD) for its conservation programmes will remain an important source of financing such programmes.

Biodiversity: A Security Against Drought

This conservation strategy recognises that diversity of the biological resources is the best bet for fighting drought to which the state of Rajasthan is so prone. Every seven years out of ten is a drought year here. Apart from the fact that the local vegetation, landraces of crops, and animal breeds have evolved over thousands of years to adapt for survival in this particularly doughty environment, and the people have evolved cultural practices and lifestyles in harmony with this environment, biodiversity has many other direct implications in fighting the drought.

The stability and resilience of grassland ecosystem productivity in response to droughts is highly dependent on plant biodiversity (Tilman and Downing 1994). It has been observed in scientific experiments, for example, that decline in productivity (compared to its pre-drought average) due to drought in the least diverse plots is twice as much as in the most diverse plots. Biodiversity increases drought resistance and resilience because more diverse plots are more likely to contain drought-resistant species that grow and in turn compensate for the loss of drought-sensitive species.

Second, though drought also causes local extinction of plant species (rare species being much more susceptible to loss), productivity recovers rapidly in relatively species-rich plots (Tilman and El Haddi 1992). In this way, biodiversity produces an insurance effect against loss of species, and not just contains loss of productivity of the ecosystem. This

implies that if diversity of plants and animals reduces beyond a critical threshold, recovery of the ecosystem from accelerated (positive feedback driven) degradation might be impossible, leading to total loss of habitat in a very short period.

Thirdly, being a rain-scarcity state, the state's predominantly agricultural-pastoral economy depends critically upon the health of its watersheds. The safety of these watersheds is in turn dependent upon the vegetation and its diversity. Watershed protection is the most important ecological function and economic service that biological resources of the state perform. In areas with severe loss of native vegetation, there already is a severe crisis of shortage water availability, and accentuated xeric conditions. This has adversely affected agricultural productivity in many areas in the state.

Fourthly, livestock rearing is the only alternative of livelihood for a large number of people in the state. When crops fail due to lack of rains, people fall back upon livestock rearing as their last hope. Livestock rearing depends upon condition of productivity of the state's pastures, and upon crop residues left in farms. While locally grown land races of crops are eminently suitable as animal fodder in case of crop failure, the newly introduced hybrid varieties of crops fail to perform this support function. The condition of the state's grasslands and pastures directly depends upon the diversity of native vegetation and therefore biodiversity underpins much of the livelihood security from this perspective also.

Fifthly, local crop seeds and land races are better adapted to drought conditions then newly introduced hybrid seeds. The traditional pattern of diverse cropping is an insurance against drought which unfortunately is missing in case of new varieties grown over larger areas in monoculture. It is only the well-off farmers who have taken to the new hybrid seeds and input-intensive agricultural practices. The subsistence farmer is still very much dependent upon rains, diversity of crops, and the alternative of livestock rearing for his livelihood security. Biodiversity in agricultural fields is therefore crucial in helping fight drought for the people of the state.

Finally, large populations, especially tribal and forest dwelling communities, fall back upon the traditional non-timber forest produce for food security in case of failure of crops. Availability of local species of forest vegetation yielding desired produce depends directly upon conservation of the native species of plants. A change in forest composition in any direction will disrupt this important service that forests provide to these vulnerable communities and will worsen the prospects of livelihood security of these people.

Long-term and Short-term Actions

Like all natural resource management concerns, biodiversity conservation is a long-term task requiring a long-term commitment. The results of many of the actions, policies and programmes may lie deep within future and may not be immediately evident. Designing new policies and programmes, changing attitudes, raising awareness among public at large, building human capacity, conducting research and building resource inventories, all this cannot happen immediately. These 'soft' actions are to provide a context in which other direct actions have better chances of succeeding. Nevertheless, there are certain immediate actions that must be taken if loss of habitats, ecosystems and species is to be avoided. As a result the present strategy provides both the long-term and the short-term measures needed to save the state's biological resources.

Guiding principles

In order to make the process of biodiversity conservation planning a flexible one with and tailor to local socio-economic context there must be some underlying guiding principles that would act as a guidelines in cases of doubt and also as basic means of verifying soundness of the actions proposed. The general principles that should guide planning and implementation of biodiversity conservation programmes in the state are as follows.

1. Compatibility of biodiversity objectives with the larger development objectives

Biodiversity conservation (and for that matter all conservation programmes) should be viewed as a part of the larger process of environmental management programme which itself should be viewed as a part of the larger process of development encompassing the social, cultural, and economic objectives. In the framework of sustainable development all the activities or components of development need to be harmonised with each other so that each reinforces the other objectives. This harmonisation of objectives a necessary precondition for achieving real, lasting and meaningful progress or development. Thus if a particular biodiversity conservation programme goes contrary to some of the other objectives of social, cultural or economic development, this contradiction should be carefully resolved.

2. Protecting all natural areas, not just a selected few

Biodiversity lives all around us. There are no specific areas where one could point out and say there lives the biodiversity. While areas may vary in terms of their richness, their fragility and other criteria of priority conservation, there are no areas that are of no importance in terms of biodiversity. Even wastelands, barren hills, and the most desolate places harbour biodiversity, many times such as it may be unique habitat. Therefore while planning for conservation it is necessary to take a holistic views of the total territory of the state rather than focus on a few areas and ignore the rest.

3. Protection of complete ecosystems including the supporting physical environment and processes

It is necessary to aim conservation efforts at whole communities, ecosystems and the range of habitats that they are found in. It is not just the organisms and communities, the physical environment including soil, water, landscapes, level of air pollution, habitat integrity and all such factors should be considered in conservation planning.

4. Basing all site-based decisions on ecological context

Whether it is the development projects or conservation programmes that we are planning, the local ecological context should be the background in which to base all our decisions.

5. Minimising landscape fragmentation due to development planning and projects

Biodiversity exists not just in time and in its components but also in its spatial scale. Many times the idea of compensating a lost habitat or natural site by creating an equivalent reserve elsewhere in lieu of the development site is used as a substitute for conserving the ecosystem. This may not always work since the ecosystems have a very long range of influence and any obtrusion into this seemingly invisible range can fragment the landscape and thereby disrupt many of the underlying ecological processes, leading to eventual disappearance of the ecosystem habitat.

6. Recognising different habitat requirements of different species

Each species has a unique habitat requirement. Altering the habitat in a crucial way that affects the species in a crucial way or shrinking the habitat or otherwise making it unfit t for the species would lead to disappearance o that species. It is necessary thus to ensure that each species has its required habitat in place in good condition and not threatened spoiled or fragmented.

7. Conserving biodiversity in-situ in its natural environment

It must be recognised that the socioeconomic as well as ecological context of the state has little potential for ex situ conservation of species, genes and species and ecosystems. The prime reliance therefore is on in situ conservation of biodiversity. This thrust and main direction of the conservation programme must be clearly understood and recognised.

8. Ensuring development activities minimise disturbance to natural systems

Planning and implementation of development proposals in the state must be carried out with a view to minimising ecological damage. This would in all cases require a detailed knowledge, information, and know-how both in terms of the ecosystems of the state had the development planning process and institutions capacity building.

9. Promoting native species and avoiding introduction of non-native species

Alien species introduction is something that must be done vary carefully not just with the idea of their direct economic utility or productivity. Total ecological costs of the species is often very high. On top of that there always is a very large uncertainty about the effect of these species in the long term. Therefore the golden rule is to avoid introduction of alien species as far as possible, not in any case until it has been shown that no native species can match such planned introduction as is planned.

10. Applying a precautionary approach in case of likely irreversible damage to ecosystems

Many development interventions either due to their nature and scale of manipulation of physical environment or due to the fragility of the local ecological context can lead to irreversible damage to the ecosystems. All such interventions should be strictly avoided as a rule.

11. Protecting rare and ecologically important species

The species level management of biodiversity should recognise that not all species are of equal importance in the scheme of biodiversity conservation. Certain species that re rare, endangered or threatened need to be treated differently. Similarly species might be out of danger of being threatened but they are keystone species performing occupying playing a crucial role in the dynamic balance processes of the ecosystem. A conservation plan should take these differential into account.

12. Protecting unique and sensitive/fragile environments

Biodiversity conservation at the level of landscape should consider the uniqueness and fragility of the environments. Identifying such habitats, landscapes, and environments should be a priority task in a programme of conservation. Environments may be unique or fragile in view of the biotic as well as biotic constituent factors (such as landform, rocks) or both.

13. Monitoring impact and status of biodiversity over time

Temporal monitoring of the trends and processes affecting the biodiversity of the state is a must. Changes that occur gradually at first can suddenly trigger hit thresholds and lead to catastrophic precipitous processes leading to transformation or disappearance of certain elements of ecosystems or even entire ecosystems. The parameters to be monitored should be identified carefully in relation to each site, habitat, species, and ecosystem in view and these be monitored over time.

14. Building in both incentive and regulatory mechanisms for implementing conservation objectives plans

No planning for conservation can be effective unless it is backed with a sound implementation plan. Incentives for local support and local initiatives as well as enforcement or regulation of certain basic rules and procedures is a minimal requirement for any implementation of a conservation programme. A careful review of these and consideration of these aspects can go a long way in effectively implementing conservation programmes.

15. Integrating biodiversity conservation into the land use and management plans

A state-wide land-use plan is the minimum requirement for conservation of biodiversity as also of the all the other natural resources of the state. A land use plan will take into consideration the various natural habitats, species and ecosystems and their status and vulnerability and then allocate different development interventions or used of lands in complimentarily with the need of conservation and economic returns. In absence of such a plan, total economic returns might as well be negative of development interventions in cases where the ecological costs are too high on account of the vulnerability of the ecosystems being put to an inappropriate land use.

16. Securing landscape level biodiversity conservation through a comprehensive, adequate and representative reserve system

A principal tool for managing in situ management conservation of biodiversity as well in order to reduce the costs of conservation to minimum is to design a representative network of reserves. The scientific and socioeconomic criteria and considerations on which such a design should be based are fairly well understood and the state should incorporate all these knowledge in design of its own network of reserves that is comprehensive adequate and representative (CAR).

17. Managing threat process by identifying, preventing and mitigating causes of biodiversity loss

Although all development interventions lead to some loss or threat to biodiversity, there are certain processes that pose more serious threat to this resource than others. It is necessary to identify those processes that are serious threat or causes of decline of biodiversity and manage contain these their impacts so as to minimise loss or impacts. This is necessary to also to reduce the cost of conservation since focusing on all development interventions equally may mean a lot of cost in terms of the conservation planning needed for this. The differential threat potentials of al the different development programmes interventions manipulations activities should be put into different categories and then addressed accordingly (see appendix for such a categorisation according to impact intensity of activity).

Key Strategic Objectives

In order to summarise and focus the diverse range of actions needed it will be useful to consider five key strategic objectives that the present action plan aims to address. It will be seen that most of the actions described later offer possibilities of achieving some or the other of these strategic objectives.

Policy framework

The first strategic objective is development of policy framework that fosters sustainable use of biological resources and maintain their diversity. The economic policies, legal framework and institutional support for management of the biological resources are a key beginning for any conservation programme. This affects choices and decisions ranging from recognising the value and survival importance of biodiversity to influencing the patterns of exploitation of resources and sharing of the benefits among the users. Trade patterns and practices, both within the state and outside, as well as the dependence of the local communities upon these resources needs to be addressed with a conscious policy rather than allowed to drift their natural way.

Local action

The second strategic objective is to create conditions and incentives for local action in favour of conservation of biodiversity. Biodiversity spans the entire landscape of the state, including forests, farms, pastures, urban areas and roadside lands. At each of these sites it is the local action that directly affects biodiversity. The farmers, livestock rearers, tribal and forest-dwelling communities, urban dwellers and the like, make thousands of choices everyday that affect the future of the sustainability of biological resources and their diversity. In order to win the larger war, these thousand little battles must be won first. It is therefore extremely important to integrate these local actors into the overall strategy of the state. Actions such as seeking their knowledge and opinion, discussing with them the state's mission and strategy, supporting their initiatives, and above all, obtaining their help in monitoring status of the resources, and building their capacity to act individually and collectively in the interest of biodiversity conservation, are actions of paramount importance. Policy measures such as ensuring right to use of resources, unambiguous land tenure, partnerships in management of protected areas, empowerment of community organisations in management of natural resources, and development of new resource-management skills and adaptation of traditional practices to present conditions are some of the other important actions needed to achieve this objective.

Tools and techniques

The third strategic objective is that the tools and techniques for conservation of biodiversity must be strengthened and applied more widely. One of the most important tools for managing biodiversity is the protected area network (PAN) of the state. The protected areas in the state need to be strengthened, given a wider base to ensure representation of the full spectrum of ecosystems and habitats found in the state, and be managed more intensively both from technical and socio-economic angles. Capacity of the park management organisations should be scaled up. To integrate the PAs with the local social and economic needs, a new management approach with partnerships with the local communities at heart should be brought in. Off-site conservation institutions such

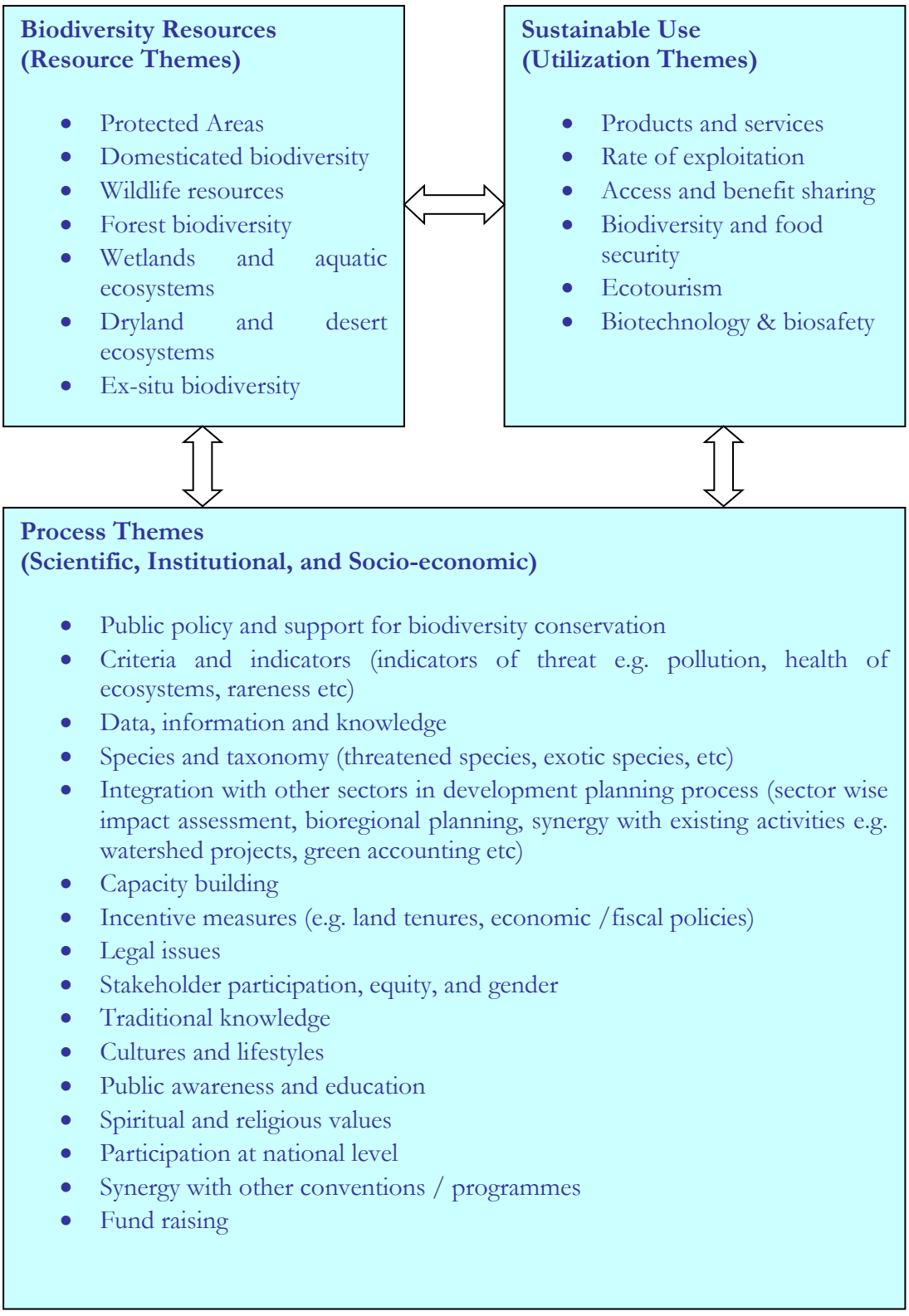


Figure 6.2: Model of strategic approach for biodiversity conservation

as zoos, biological parks, botanical gardens, and urban forests, need to be better managed and their network needs to be expanded and strengthened. Bioregional planning, another important tool for conservation, must be given its due place in government's scheme of

things. Inter-sectoral integration is one of the approaches that should eventually facilitate transition to bioregional planning.

Capacity building

The fourth strategic objective is to strengthen the human capacity for conserving and using biodiversity sustainably. The spectrum of experts needed to effectively design and implement conservation programmes ranges from taxonomic scientists to sociologists to natural resource economists to wildlife scientists to anthropologists. Similarly institutional base would range from a state level body to the local level community organisation that is equipped for collection of data and for implementing local programmes. The actors in the field of biodiversity in various institutions and departments need to be networked so that effective exchange of information keeps them all abreast of developments affecting biodiversity. Policy makers' capacity needs to be upgraded so that they better appreciate the true value of biodiversity and do not consider investments in this field a waste of money. Capacity for research in scientific areas as well as policy research needs to be strengthened so that necessary data is available for planning and for avoiding catastrophic loss of species and genetic diversity.

Resource mobilization

The fifth and final strategic objective is mobilization of adequate resources for conservation of biodiversity. In an atmosphere of sectoral approach each sector considers itself more important than others. A road builder might say that biodiversity is way behind his programme since building roads directly improves lives of the people, and thus lobby for his cause (justified in his own way). A similar resourcing drive is needed to implement the actions of the present strategy, many of which would not be implemented without some kind of external help. The state's role at mobilizing national budget commitments, and its own willingness to set apart substantial funds for conservation of its biological resources are crucial actions needed under this objective. Funds may be raised from private donors in the state, the industries and corporate houses, as also from the international donor agencies depending upon the soundness of the overall strategy and effectiveness of fund-raising drive.

Catalytic actions

There are certain actions that are necessary to set the ball rolling in the first place. Fortunately, this does not require particularly large sums of money to implement. These catalytic actions, it is hoped, will trigger other actions that are needed eventually to yield the full benefits of the conservation programme. The catalytic actions needed in this respect are described herein below.

Adoption of the BSAP

First of all the BSAP as presented in this document must be adopted as the baseline plan of the state. Adoption here means more than simply approving it through a formal process of file-swapping in the secretariat of the government. It means the state government owns up this plan and commits itself to implement immediately the issues that are urgent and eventually in its entirety. Once adopted, widest possible circulation of the document not only in the official circles but also in the public at large should be ensured so that a larger awareness and a sense of direction is created.

Creation of institutional mechanism

Creation of institutional mechanism including a state level advisory body (State Council for Biodiversity Conservation, for example) is necessary to guide and help set priorities for implementation of this plan and to oversee implementation of actions and activities at various levels. The institutional networks should comprise of district, village and eventually at bioregion level bodies also. The constitution of these bodies is to be representative of all the major stakeholders and actors influencing the fate of biodiversity in the state. It is important to see these institutions should be real institutions equipped with adequate mandate, powers, endowed with competence and financial resources. Creating a notional network of paperwork institutions without any empowerment and resources will be of no value and will indeed be a waste of public effort whatever goes into bringing that into existence.

Establishing early warning network

Within the network of institutions and outside it, it is necessary to establish centres of information gathering about the actual status of the biological resources of the state, particularly about the risks and threats being faced or imminent to its existence. This is a kind of early warning system that should alert the state about immediate dangers of losing species, ecosystems and genetic diversity. Threat monitoring is thus a crucial action in terms of its urgency since the state cannot wait for the whole BSAP to be implemented before it loses some of its important elements of biodiversity.

Integrating biodiversity across sectors

It is of utmost importance, and urgency, to integrate the concerns of biodiversity into the various sectoral agencies of the government. Integration of biodiversity conservation into state level planning across all the sectors is also necessary because many of the threats arise out of action plans and programmes of governmental agencies or so-called 'development' departments. This action will require a strong political will and commitment to conservation of biodiversity. But it nevertheless remains an important cornerstones, and preconditions, of success of any biodiversity conservation programme.

Immediate implementation of certain actions

Finally, immediate action should be taken to implement those activities that do not need additional resources. These actions are a matter of correcting policies and making better informed decisions within the existing programmes in different sectors and at different levels. These actions will by themselves act as catalysts of more actions following therefrom. (This does not mean that the activities needing additional resources should be ignored at the cost of these 'free' activities, but that the latter should be implemented without any lapse of time.)

Strategies, objectives and actions

This plan follows a tiered approach to delineating the thematic strategies, objectives and the actions needed to realise the objectives. This tiered approach provides a structure to the assemblage of a large number of actions that must be implemented in a synchronised manner in order to effectively implement the plan. A tiered structure provides two key attributes of scalability of activities and programmes and avoids the possibility of actions or activities working at cross purposes to each other.

Strategic Themes

As noted above the level of strategic themes derives its unique significance on account of any of the two characteristics: some of the resources that constitute a category of ecosystem or are managed by a particular agency or department of the government are each recognised as a theme. On the other hand, activities delineated on the basis of nature of skills, or type of interventions needed define certain functional or process-oriented themes. As mentioned above, there are twenty-eight strategic themes (Fig 6.2) in all that need to be addressed. Thematic level grouping of activities will also enable mapping of a structure of institutional arrangements such as the specialised committees looking after each of the themes. This thus provides a logical basis for division of work which is a must looking to the amount of work needed to be done under the BSAP.

Strategic Objectives

Objectives provide a sense of direction in which things should move if progress is to made in implementation of the programme. They are more general than individual activities but more specific than thematic areas of action. It may be noted that the boundary between the objectives and the actions in what follows is rather subjective. Many of the actions, if considered important enough to comprise of more sub-actions, could be promoted to the level of objectives, and conversely, some of the objectives could be demoted as actions under some other objectives which they better align with. This hierarchy is, thus, a matter of scaling the concern or importance (including complexity) of a particular action being taken up.

Actions

Actions are the smallest pieces of activities that can be understood as a meaningful activity helping achieve a particular goal (or sometimes a set of goals). Actions are more concrete in the sense that they are easily mapped into the agent who will perform it and are more closely defined in terms of scope, both temporal and spatial. Actions have a focused scope in terms of implementing agencies and resources required. The actions in this report have been specified with a set of mandatory parameters that completely determine the actions and their process of implementation to some extent. Each action is here described in terms of the following attributes or specifications:

- Basis for action (concerns, data, pressures, litigation, research)
- Activities defining action
- Agencies to implement, including lead agency, partners, collaborators
- Time frame or schedule
- Resources required: financial, technological, human, institutional
- Expected results
- Indicators of performance, monitoring plan
- Assumptions, risks, and uncertainties
- Related actions: what other actions reinforce this action

Theme: Protected Areas

The state's protected areas harbour key elements of biodiversity. Modifying their management and selection of new protected areas can enhance the contribution of PAs to biodiversity conservation. Clear conservation objectives of each PA need to be laid out in greater detail and these need to be set in the social, environmental and economic context in which the PAs exist. Protected areas in the state face some constraints which must be tackled on priority.

First, often establishment of protected areas causes resentment among the local communities for which there are many reasons but restriction of access to resources is often the most important of all. While society at large benefits from establishment of protected areas, the local communities only bear the costs. This leads to direct conflicts between the protected area management and the local farmers, graziers, miners, hunters and wood collectors.

Second, PAs in the state face lack of support in terms of budget, manpower and policy support (changing policies and budgets) from government. Powerful lobbies for economically lucrative activities such as mining and agriculture or livestock raising often try to have the protected areas "opened up" while the local traders or villagers may want to have new roads built through these.

Thirdly, protected areas are not getting the kind of scientific management that hey should if they are to be effective tools of biodiversity conservation. PAs need intensive management in terms of protection and improvement of habitats, monitoring and management of populations of species, managing transboundary areas to mitigate external adverse impacts and to safeguard the areas against potential risks of poachers and hunters. All these management activities need trained personnel and ecological knowledge which are in short supply.

Fourth, budgetary support for the protected areas of the state is far inadequate. An occasional project supported by international agencies may create a temporary glut of funds for which the management is neither prepared nor equipped to utilise. Often such funds come with a set of conditions that the management finds difficult (or at times unwilling) to comply with. Apart from these projects, there are hardly any funds allocated on sustained basis in the state government's plan. Even the funds generated by tourism and other activities in the protected areas are not guaranteed to be ploughed back into their management.

Finally, protected areas in the state haven't yet got public (and political) acceptance. They are seen as exotic holidaying or touristic destinations and not as an essential element of sustainable development. The fact that protected areas underpin the economic production system of the state and contribute to society's welfare in many diverse ways needs to be better appreciated by the policy makers, political class, and the public at large.

In view of these challenges, a comprehensive strategy for reviewing, managing, upgrading and revitalizing the protected area network of the state is of utmost importance. In what follows, the strategic actions required have been described in greater detail.

Objective:
Consolidate the structure and management of the existing protected area network.

Action 1. Complete the legal process of boundary demarcation and settlement of rights in the existing protected areas.

Basis for action. Under the legal provisions of the Wildlife (Protection) Act 1972, a national park or wildlife sanctuary must go through a process of demarcation of boundaries and determination of rights of local people inside and around it. This process is not complete in most of the protected areas of the state, while in some of these the process has not

even been set in motion. Lack of compliance with the legal requirements poses many problems and uncertainties to cope with. This also creates a sense of uncertainty among the local communities who may infer that protected areas are an attempt to cut short their rights of access to the resources and are not fully justified. Many times, this leads to encouragement of encroachment on the lands of protected areas, especially in and around the peripheral boundaries.

Activities. Demarcation of boundaries has two aspects. First, boundaries must be physically surveyed and verified and mapped. Second, it should be ensured that lands assumed to form part of a protected area are actually available for this purpose and are not under possession of others or being used for other purposes. Under the Act, this requires publication of a notification under Sec 20 and after hearing the objections the finalised boundaries are sent to the government for formally declaring the reserves in its official gazette.

Lead agency. The lead agency in this action is the Forest Department, specifically the Chief Wildlife Warden of the state. The department has to set the process into motion by moving the necessary papers and detailing out the urgency, the need and the importance of the process of settlement.

Collaborators. In this action, the district Collector, on whom the bonus of determining the rights of the people is cast under the Act, is the collaborating agency. Partnerships must also be built with the local communities affected by determination of the boundaries. Consultations with ecologists, local people with ecological knowledge and social scientists, political leaders should also be associated in the process.

Expected results. At the end of this activity, validated and possibly interactive boundary maps of all the protected areas in the state will be available. Along with these, the rights of people in and around the areas will be clearer, well-understood and recorded.

Indicators. The accuracy and quality of the maps generated and the quality of consultations taking place in the process of settlement of boundaries and rights will be important indicators of the effectiveness of the activity. As the work progresses, these indicators can be used to improve the process and the outcome when required.

Risks and uncertainties. An important risk is lack of political will at the state level. Local political interests might lobby contrary to establishment of the protected areas. Similarly, there is a risk of loss of livelihoods of people who are closely dependent upon these areas. The best way to contain these risks is to increase the awareness of all the stakeholders and to provide them with complete information about the reasons for creating protected areas and about the importance of biodiversity in their social and economic life. It is also necessary to ensure that they are provided with (or have access to) alternative means of livelihood. Consultative process, if implemented in true spirit, will help avoid conflicts.

Related actions. Action 2 and 3.

Action 2. Prepare management plans for all the PAs incorporating long term and short actions and get them appraised in a consultative and participatory process.

Basis for action. Most of the existing PAs in the state lack even clearly defined objectives, let alone detailed management plans. As a result, the managers and the communities alike are in the dark about the reasons for establishment as well as the future of these areas. Management plans are the basis of all the activities in and around the protected areas. It is clear that these plans should be prepared on top priority without loss of time.

Activities. The objectives of setting up a protected area and developing the strategies and determining the priority management actions in case of each protected area must be determined in a participatory manner. All the stakeholders interested in or affected by management of the protected areas must be consulted during development of the management plans. The main activities involved are thus objective setting, setting off a process of consultations (including identification of the stakeholders), evolving strategies, listing out options, finalising actions and prioritising these actions in a participatory process throughout.

Lead agency. The Forest Department through the office of the Chief Wildlife Warden would be the lead agency for this action.

Collaborators. Collaboration of biodiversity experts, ecologists, environmental experts, leading persons from the local academia (including schools, colleges, universities and other institutions), and NGOs, media, and local communities is necessary during the process of evolving the management of each protected area. The state level biodiversity council (when created) should also be associated with this activity. It would be ideal if this body prepares comprehensive guidelines for preparation of these management plans before the action begins in field.

Expected results. After completion of this action each of the protected areas in the state will have clear objectives and a clear management plan. These documents would also be finally approved by the state level mechanism whatever is set up for this purpose.

Indicators. Clear process documentation will provide clues to the kind of planning exercise that might have gone into preparation of each plan. The soundness of the plans can be ascertained in view of the basic objectives laid out in this report and ultimately as enunciated in the Convention on Biological Diversity (CBD).

Risks and uncertainties. Existing practices and organisation of the lead agency, that is the forest department might lead to one-way dialogue and lack of consultations with all the stakeholders. Plans prepared without wider consensus of stakeholders will stand risk of eventual failure or of non-implementation. This aspect will have to be watched out for.

Related actions. Actions 1, 7, and 9.

Action 3. Provide for adequate infrastructure, human and financial resources to strengthen the management of the existing protected areas.

Basis for action. At present most of the protected areas are being looked after by units of the forest department that are grossly under-staffed, both numerically and qualitatively. The average age of the staff working, their educational qualifications, their motivation and technical competence, and the conditions in which they are working—everything is out of synch with the task of conservation. Nothing short of an overhaul of the staffing pattern of the PAs is required to achieve the objectives of conservation. Financial resources allocated to management of the PAs compare highly unfavourably even within the forest department. Basic infrastructure in form of buildings, equipment and technology, and support vehicles and other equipment is highly inadequate. Demand for improvement in this respect has been voiced by the people working in the wildlife units, as well as people outside the department concerned about loss of biodiversity.

Activities. Activities involved under this action include re-appraising the human resource needs of each PA, evolving guidelines for selection of people who should work for the PAs, and assessment of the financial and technological needs for managing each PA. Subsequently, the results indicated in these appraisal exercises should be implemented by posting the right number of the right kind of persons, providing adequate financial

support each year on sustained basis, and gradually upgrading the infrastructure and the technological and logistical support.

Lead agency. The planning and finance department of the state are the lead agency for this action. These organisations alone have the necessary wherewithal of changing the scenario. The State Council for Biodiversity Conservation (SCBC) should also be associated as the main consulting and advising body, taking lead in formulating detailed plan of action.

Collaborators. The Forest Department, the department of personnel are two government organisations who will help assess the needs. Independent NGOs, representatives of the political leadership (especially those who take keen interest in conservation), and representatives of communities affected by the decisions taken under this process should also be involved in this process.

Expected results. At the end of this action, a new cadre of competent, committed and motivated people should be in charge of management of the protected areas of the state. The PA management units will also be better equipped in terms of infrastructure, logistic, and technological support.

Indicators. The extent to which the people working in the PA have been changed, their skills upgraded, their morale improved. Also, the kind and the size of support in terms of buildings, vehicles, computers, radio equipment for research, etc will be an indicator of the success of this action

Risks and uncertainties. The major risk is lack of political and administrative support and the level of priority accorded by the government of the day. In these days when every department of government is hard pressed for funds, it is likely that the interest of biodiversity conservation gets a second rung priority and therefore for lack of sustained commitment on part of government, this may fail.

Related actions. Actions 1, 2 and 5.

Objective:

Prepare a long-term plan of comprehensive, adequate and representative network of protected areas in the state.

In the long run, protected areas are the best strategy suited to the state's socio-economic context, given the constraints of technological and financial resources for relying on *ex-situ* conservation. The state's PA network should be designed with the objective of building complementarities with the other biological resources, especially the domesticated agricultural and *ex-stiu* biodiversity. As laid out in the CBD, a protected area network should be designed based on the basic ecological and conservation principals with the state's long term conservation objectives in mind.

Action 4. Assess the adequacy of the present network of protected areas and draw up a long-term plan to make the network CAR, and to enhance its role in biodiversity conservation.

Basis for action. Conservationists, ecologists, and other experts have developed principles on which to design a comprehensive, adequate and representative network of protected areas so as to capture all elements of biodiversity, that is, landscapes, ecosystems, species

and genetic variations within species. Going by prevalent scientific guidelines and current conservation practices, the state's PA network is not comprehensive, adequate and representative (CAR) of all the ecosystem types in the state. There are many unique ecosystems that do not occur in present PAs, such as the *magras* of the desert, saline wetlands, or freshwater lakes. The total area of PAs in the state amounts to 2% of the total geographical area, whereas looking to the unique ecosystems and the level of endemism of species in the state, at least 10% of the geographical area should be managed under protected area network. The network's viability is also questioned in many ways, especially in respect of lack of corridors connecting the crucial PAs. This clearly points to the need for a comprehensive review of the system of PAs and for augmentation of the same.

Activities. Review of the existing PA network and its adequacy; determining the broad biogeographical regions of the state; design of a CAR system of PA network that meets the requirement of biodiversity conservation with least cost while complementing other actions and strategies such as the network of forest reserves, agrobiodiversity, and *ex-situ* conservation. Subsequent to these activities it will be necessary to validate this network through a process of public consultations.

Lead agency. The state level agency State Council of Biodiversity Conservation, along with the Forest Department of the state.

Collaborators. Experts in the field of conservation at state, national, and international levels should be associated with this exercise. The state's political leadership and representatives of communities affected by the proposed network of PAs should also be involved in the process.

Expected results. At the end of this action, a detailed design of a comprehensive, adequate and representative network of protected areas will be with the state.

Indicators. Quality of process of consultation, quality of report in terms of its soundness to meet the objectives.

Risks and uncertainties. Political will to create new PAs is difficult to come about. There is also the risk of communities interests being ignored unless a genuinely participatory process is followed.

Related actions. Action 5, 6, and 8.

Action 5. Develop policy measures and incentives for establishment of private and community protected areas in the state and their legal recognition and support.

Basis for action. The formal state-led system of protected areas cannot by itself protect all the elements of biodiversity in the state. It is best complemented by protected areas established by private or non-governmental organisations. In the state, there are strong traditions of community managed forest reserves known variously as *dev-vans*, *banis*, and *orans*. Similarly, many private land-holders own land that has been left as wilderness reserve. Often the size of these areas is too small to be of significance by themselves, but if these people can be organised to form a network of small areas, substantial results can be achieved in this direction. Apart from these lands, publicly owned lands can be entrusted to private or non-government organisations to be managed as protected areas, with some overriding conditions. This would make the need for protected areas better understood among public, lead to a widely dispersed network of areas, and provide a

Great Indian Bustard

The Great Indian Bustard *Ardeotis nigriceps* is the most famous endangered bird of India. In olden days it was widely distributed in almost all the arid and semi-arid plains from Uttar Pradesh in the North to Tamil Nadu in the South, and, from Rajasthan-Gujarat in the west to Orissa in the east. Spread of agriculture, destruction of its habitat by overgrazing by livestock, and indiscriminate shooting has made the bustard a highly endangered species. However it still survives in six states: Rajasthan, Gujarat, Madhya Pradesh, Maharasthra, Karnataka and Andhra Pradash. Rajasthan state holds more than half of the Great Indian Bustard population in India.

The main strong hold of this bird in Rajasthan is the western portion consisting the Thar Desert. Some birds are found in Kota, Ajmer and Bhilwara districts. The birds are surviving in the desert regions of Bikaner, Jodhpur, Jaisalmer, Barmer and Jalore districts mainly because human population is comparatively low and agricultural activities are minimal. Nevertheless, with the development of the *Indira Gandhi Canal* in western Rajasthan more and more bustard habitats will go under the plough.

The distribution of Great Indian Bustard in Rajasthan is in these districts: Ajmer (Shokhaliya, Karera), Bikaner (Diyatra Khitolie, Jhajhu siana, Bethnok, Gajner, Bannergaon), Jodhpur (Bap, Nausar, Dhawa), Jaisalmer (Nachana, Ramdevra, Pokhran, Ramgarh, Akalpur, Devikot, Chandan, Digha, Sankara, Tanot) and Baran (Sorsan).

A large number of bustard are present in the Desert National Park (DNP). This 3162 sq. km. park covers two districts : Jaisalmer and Barmer. Almost at every 20 km of the boundary of DNP, there is a forest *chowki* and an enclosure. The size of the enclosure varies from 400 ha. (e.g. Phulia) to 800 ha. (e.g. Sam). A few of these enclosures have a waterhole inside, which attracts bustards and other wildlife.

The greatest danger to the Great Indian Bustard in Rajasthan is loss of habitat and shooting. Since the bird was declared *state bird of Rajasthan* on 21.5.82, it is receiving sufficient publicity as a result of which a large number of villagers and nomads, apart from the educated people, know about the bird. Even in schools, importance of "Godawan" is taught.

Development of the Indira Gandhi Canal in western Rajasthan has added urgency to locate bustard habitats away from the command area of the canal to protect them on a long-term basis. Some of the areas of the DNP will be affected by this canal. As a result it is essential to carry out detailed Environmental Impact Assessment to minimise dangers to bustard habitats.

Source: Rajasthan Forest Department: www.rajforest.gov.in

learning ground in the field of conservation, apart from removing a sense of complacency in the state agency responsible for management of the official protected areas.

Activities. Initiating dialogue with a wide range of possible groups such as gram panchayats, industry, landlords, NGOs and educational & research institutions to investigate possibilities of managing wild lands as protected areas; developing policies and guidelines to exploit such possibilities and encourage action in this direction; launching programmes of regeneration of the *orans*, *dev-vans*, and other community preserved areas.

Lead agency. The state level agency State Council of Biodiversity Conservation, and its sub-committees.

Collaborators. The Forest Department; experts in ecology, conservation and related fields of sociology, social work; interested NGOs, and the Land Revenue Department of the state government.

Expected results. A better appraisal of possibility of contribution of private initiatives in the field of establishing and managing protected areas in the state. Some private initiatives may already take roots. Community managed areas will be better protected, at their further degradation will be halted. A better understanding of importance of protected areas will be generated among the concerned segments of society.

Indicators. The extent to which the potential for private participation in protected areas is realised; the quality of consultation process.

Risks and uncertainties. Loss of enthusiasm on part of the sponsoring agency may occur at first since it takes time and patience to make the idea understood to the private agencies.

Related actions. Actions 4 and 6.

Objective:

Develop policies and practices to ensure long-term sustainability of protected areas and their contribution to biodiversity conservation.

A protected area must be well-integrated ecologically, socially and economically into the surrounding region if it is to be sustainable in the long run. Creating protected areas in the face of hostility of local communities or to the detriment of their economic interests may appear to be success in the beginning but may not last long. Nor is this approach efficient in terms of resources required to maintain a protected area in a hostile environment. The image of "fortresses" beyond reach of the layman must be demolished if the PAs are to be accepted widely and understood as valuable by public at large and the local people in particular. Hence the need for reorienting the management approach towards a participatory one and for integrating the protected areas into the region's economy.

Action 6. Broaden community participation in management of the PAs, through actions and initiatives such as ecodevelopment plans.

Basis for action. Local people's involvement should be sought and achieved both in preparation of management plans and in day-to-day decision making. Often PAs are viewed by the local people as responsible for obstructing "development" from coming through in the region. This vision gap can be addressed partly by accommodating the genuine requirements of the local people and partly by making them partners in the management of the parks. At present, the level of community participation in management of the PAs of the state is rather low. Often mistrust and hostility underlies the relationship between the PA managers and the local people. As a result, the need for bringing a participatory approach with wide range of stakeholders such as NGOs and local communities living in the surrounding areas is of great urgency.

Activities. Identification of people affected by PAs, organising them into ecodevelopment committees or whatever form of institution; developing guidelines and agreements for

building partnerships in management; devolution of some of the management rights to local people; implementation of such guidelines.

Lead agency. The Forest Department through the office of the Chief Wildlife Warden.

Collaborators. Experts in sociology, participatory action research, local NGOs and local political leadership should have active role in development of the guidelines.

Expected results. At the end of this activity, it is expected that there will be state-wide guidelines outlining new approach to managing parks and sanctuaries. Moreover, there will be participatory arrangements put in place at all protected areas. Communities will have greater say in management of these areas. Relations between park authorities and communities will be improved.

Indicators. The kind of devolution of powers to local people; the extent to which multi-agency collaboration of NGOs, communities and park authorities is successfully put in place; the kind of consultation process for arriving at the new arrangements.

Risks and uncertainties. Willingness of PA authorities to give up some of their powers and ability of the personnel to see the need for such a change may be limited.

Related actions. Action 7, and 8.

Action 7. Broaden the objectives of management of PAs to include the full range of issues enshrined in the CBD.

Basis for action. At present the protected areas of the state are managed and viewed, consciously or implicitly, by the managers as well as by the public, as wildlife preservation areas. This is a natural conclusion given that the agency responsible for management of these areas is called the "wildlife" wing of the forest department and the legal framework under which these have been set up is the Wildlife (Protection) Act 1972. Although one could raise a "what's in the name" kind of argument here, but the nomenclature, as well the mandate, does limit the practical significance of these areas. On the ground, however, many of these areas are ecosystems rich in plant and animal diversity. Therefore, there is a need to redefine the objectives and the scope of management. Some of the important activities which should be undertaken by the PA management are: identify the components of biodiversity within these areas and their importance and use (especially local use); assess relative abundance or rareness of these elements; monitor changes in the habitat and the physical environment; monitor populations of all designated plants and animals; watch out for and control alien species; preserve sites of cultural heritage located within the areas; study socio-economic and cultural interdependent of communities and the biological resources; set up research plan with collaboration of local universities; launch educational and awareness programmes about the park; devise ways to increase flow of economic benefits to local people without affecting the conservation objectives.

Activities. Setting wider objectives to encompass all the activities necessary for conservation of biodiversity; redefining the framework within which the management plans should be prepared; diversifying the types of management interventions; organising consultative meetings and events in the process.

Lead agency. The Forest Department through the office of the Chief Wildlife Warden.

Collaborators. The task of objective setting and expanding scope of management activities is best achieved in participation with the scientific community, academia, the NGOs and the local communities.

Expected results. Expanded set of objectives identified; wider scope for management identified and put into practice at the level of individual protected areas. Better utilization of resources invested.

Indicators. Timeliness of change; comprehensiveness and relevance of revised objectives and management interventions; quality of technical and sociological consultations and inputs gone into the process.

Risks and uncertainties. The capacity of the existing staff working in PAs is limited, so the expanded scope of actions may not really lead to practical change in field. Action 4 if implemented concurrently will overcome this limitation.

Related actions. Action 4, 3 and 6.

Action 8. Create a better physical and human context for managing the protected areas.

Basis for action. Many of the important protected areas in the state are beset with the problem of achieving the incompatible goals of meeting conservation and human needs. Isolated human settlements in the midst of protected areas cause conflicts and lead to fragmentation of habitats. This neither leads to successful conservation nor to human welfare. People living around the areas also face similar problems. In view of this, it is necessary to set the protected areas in a favourable human and physical environment where the hostilities of local people and fragmentation or physical threat to highly valued elements of biodiversity is reduced. Effective action is therefore needed for relocation of human settlements and transboundary management strategies. Restoration of wastelands inside and around the parks especially in the corridors of protected areas is also important aspect of this.

Activities. Identification of human habitations that must be relocated outside the areas; subsequent relocation of these settlements, ecological restoration of wastelands within protected areas to improve habitat; land purchasing or acquisition for zoning or buffer areas; transboundary management initiatives such as creating buffer zones, corridors, wasteland reclamation through local communities groups and NGOs, and providing incentives for conservation on private lands bordering protected areas.

Lead agency. The Forest Department through the office of the Chief Wildlife Warden.

Collaborators. Cooperative participation of local political leadership, community representatives, the Land Revenue Department, and of the NGOs and scientific communities will be necessary.

Expected results. No human settlements in core areas of PAs, especially national parks; reduced conflicts between economic and conservation interests; better transboundary environment for sustainable management of protected areas.

Indicators. Extent to which the identified settlements have been relocated; comprehensiveness and effectiveness of transboundary programmes; quality of participatory action research gone into the process.

Risks and uncertainties. Resettlement of human habitations is a socially and politically sensitive issue and therefore may not happen unless handled with care. Political will may not exist to allot alternative lands to the relocated families.

Related actions. Action 9.

Action 9. Enhance the ecological and social value of the protected areas by increasing level of benefits flowing to the people in and around these areas.

Basis for action. Protected areas are viewed as roadblocks rather than as assets by the local people around. This view is genuinely justified in most cases since the communities in and around have to forego many of the benefits of development which flow to people in other places not hindered by location of national parks and sanctuaries. In view of this adverse relationship of needs of conservation and economic interests of local people, it is necessary to increase the value of the protected areas to the local people. For this there may be many options such as compensation (money, alternative lands, jobs) to the local people for losses suffered because of location of parks; social and economic development (ecodevelopment, ecotourism, investments in natural resource management outside protected areas) on priority; and granting them rights to sustainable resource extraction (such as non-timber forest produce) that would be possible without prejudice to conservation objectives. It is important that all these options are examined in a participatory manner and benefits conceded to the local people that are viewed as justified, rightful, and fair.

Activities. Review each of the PAs in respect of hardships and economic loss it may cause to local people; conduct participatory appraisal to identify solutions aimed at enhancing value of PAs to these communities; implement the solutions through amendments in policies, rules and practices. Options such as vocational trainings, market value enhancement of local forest produce, priority to recruiting local guards, especially women, should be identified and subsequently be implemented.

Lead agency. The Forest Department through the office of the Chief Wildlife Warden in association with the State Council for Biodiversity Conservation.

Collaborators. Involvement of representatives of local communities, of local political leadership, NGOs and scientific experts in conservation should be ensured.

Expected results. Local people will identify themselves with the cause of conservation; better relationship between park management and the people; increased value of benefits flowing to local people from the PAs.

Indicators. The extent to which the benefits flowing have increased (direct and indirect); level of cooperation between park management and local people; quality of participatory action research gone into identification and implementation of initiatives.

Risks and uncertainties. The will and the capacity of the park management as well as the required level of financial support may be difficult to come about.

Related actions. Action 30.

Action 10. Set up a mechanism for continuous monitoring of the status, processes, trends, and management needs and practices in the protected areas of the state.

Basis for action. Under the present dispensation there exists no mechanism for periodic or continuous monitoring of the conditions of habitats, populations and their trends (except occasional census of a few species of wildlife), ecosystem health indicators, or effectiveness of the management practices in achieving the objectives. This leaves one in the dark as to where the protected areas are heading towards, whether biodiversity in and around these is increasing or decreasing, and whether ecosystems are degrading or improving. Monitoring on a continuous basis is a must for determining trends, detecting imminent threats to extinction or loss of ecosystem health or degradation of habitats, as well as for determining the effectiveness of the management activities. Monitoring is a key activity in the adaptive management cycle.

Activities. Design of a comprehensive monitoring programme which includes the broad level indicators as well as specific data about the status of biodiversity in the protected areas, their physical and human environment, trends and changes occurring in habitats, ecosystems and genetic diversity. Implementation of monitoring programme at each of the protected areas, including determining status of ecosystems and effectiveness of management activities. A comprehensive set of guidelines is to be brought out for setting state wide standards of monitoring process.

Lead agency. The Forest Department through the office of the Chief Wildlife Warden, in association with the State Council for Biodiversity Conservation.

Collaborators. Scientific community, academia, interested individuals and experts; local communities, media and NGOs.

Expected results. At the end of the action, a mechanism will be in place for regular monitoring of the effectiveness of functioning of protected area programme. A baseline document containing benchmark data about each of the protected area will be available.

Indicators. Quality of data collected; comprehensiveness and soundness of monitoring mechanism; quality of scientific inputs and access to information to general public will ensure quality of data.

Risks and uncertainties. The action may not be implemented for want of adequate financial support. Transparency of monitoring process and dissemination of results, as well as implementation of new programmes indicated by results of monitoring may not be coming forth.

Related actions. Action 3, 5.

Theme: Domesticated Biodiversity

Domesticated biological diversity in the state includes all components of biological diversity of relevance to food and agriculture, including genetic resources of harvested crop varieties, livestock breeds, fish species and non-domesticated resources within fields, farms and pastures. Biological diversity that provides ecological services such as nutrient cycling, pest and disease regulation, pollination, maintenance of local wildlife, watershed protection, erosion control, climate regulation and carbon sequestration is also of critical importance.

The diversity of crop species and their varieties has traditionally given resilience to the agricultural ecosystems. Most of the modern technological advances can be traced back to some wild relatives or locally cultivated varieties. In many cases local species of crops, animals, fruits and vegetables can be seen to be superior to the developed varieties but because of lack of their promotion these have been ignored. The state's resources in terms of domesticated species of crops and livestock are considerable. The unique agroclimatic zone of the western arid part of the state is home to many uniquely important species of domesticated flora and fauna. Through generations of innovation and experiment the farmers have nurtured diversity of plants and animals suited to the harsh climate and accumulated rich knowledge of the managed biodiversity.

However, with the advent of the new industrial model of agriculture the state's endemic biodiversity has been pushed in the background. Many of these species are no more marketed, some have been even displaced from subsistence use. The agricultural support system (of soils, micro-organisms, water quality, organic matter) is being imperilled. The concern for conservation of the traditional and local varieties of plants and animals that have been used for economic benefits is valid and an immediate one.

Objective:

Identify, document and inventorise the domesticated biodiversity of the state and recognise its unique value.

The exact status of the managed biodiversity resources of the state is not even known. The departments of agriculture, fisheries, animal husbandry (including the one of sheep and wool), horticulture, and related agencies work in isolation of each other and in pursuit of very narrowly focused programmes. Since there has been no state level mechanism to view the resources in terms of their overall diversity and their mutual ecological interactions, the holistic picture and even data concerning biodiversity is lacking. Apart from this, there is no agency involved with the documentation of the agricultural practices and local knowledge of the farmers which is intricately linked with what will survive and what will not. The strategies to conserve the resources will emerge from the social, technological and environmental context in which the domesticated biodiversity is being managed.

Action 11. Prepare inventory of domesticated and agrobiodiversity resources of the state including all the components of such biodiversity.

Basis for action. Data and information about the agro-ecosystems of the state are lacking. This information is crucial to planning any programme for conservation of agrobiodiversity as well as the diversity of fishery and horticultural resources. The species and genetic variety as also their ecological links among each other and with other wild biodiversity must be identified, recorded and studied.

Activities. Conducting surveys to identify the species and genetic varieties of plants and animals in ponds, farms, fields, orchards, and pastures; identifying the unique soil biodiversity in agro-ecosystems, and identifying the roles of species as pollinators, pest control, weeds, fungal associations and the like; preparing report on the state of each of these components such as significance, extent, conservation status, trends and threats, conservation strategies and actions; dissemination of this knowledge among the policy makers, professionals, agriculturists, scientists and the media.

Lead agency. The State Council for Biodiversity Conservation, in association with the Departments of Agriculture.

Collaborators. Departments with land-based activities such as Forest, Soil Conservation, Fisheries, Animal Husbandry, etc; farmers and local knowledge holders, community leaders, local political leaders; NGOs and ecological experts should all be involved in evolving strategies as well as in gathering data.

Expected results. Databases, maps, reports and other scientific documents containing information about the domesticated biodiversity resources of the state.

Indicators. Comprehensiveness of the databases and status reports; quality of participation gone into evolving the inventories.

Risks and uncertainties. Lack of support from policy makers especially the finance and planning department.

Related actions. Action 17.

Diversity of Fruits in the Aravallis

Biodiversity in the state is directly linked to health and food security of the people. Not only is health of people safeguarded by the rich repertoire of native medicinal plants coupled with local knowldege about their use, nutritional security of a vast number of populations is dependent upon availability of diverse food from native vegetation in form of local fruits. The number of people who access cultivated fruits from markets is far smaller than the number of people who meet their nutritional need from fruits from the wild or fruits grown in their own fields. Some of the important fruits of the region are:

- *Mango*: Occurs naturally in the southwestern hills of the Aravallis.
- *Jamun:* Two species of *Syzygium* namely *S. heyneanum* and *S. jambos* occur naturally in riverine parts in the southern Aravallis.
- *Khajur (Phoenix sylvestris):* It occurs almost throughout the Aravallis but it is concentrated mostly in southern Aravallis where its fruit is collected during summer season. The *Phoenix* fruit (Khajur) is dried and stored. The cultivators use it as nutritive sweet fruit while doing agricultural works in their maize crop during monsoon.
- *Karonda:* Two species of *Carissa* are found in the region. *C. spinarum* is the wild variety that grows in southern Aravalli whereas the variety C. *congesta* is cultivated throughout the eco-region for its fruit.
- *Sitaphal (Custard apple)-Annona squamosa:* Sitaphal occurs naturally in the southern region of Aravallis. In some degraded areas near habitations it occurs as a gregarious species.
- *Ber (Ziziphus mauritiana):* Ber occurs naturally throughout Aravalli region. It is also cultivated as a fruit crop. A number of varieties have been developed for commercial purposes. These include gola, sev, choumu, mudia, umrain, etc.
- *Aonwla (Emblica officinalis):* Aonwla is an important fruit plant of Aravalli especially of central and southern parts. Although the size of wild variety is small, yet the quantity of fruit produced is very large.
- *Kair (Capparis decidua):* This is very widely distributed throughout Aravallis. The shrub *Capparis decidua* is named after its fruit kair. The fruit is a small berry and is used for preparing pickles. The dry fruits are preserved and used as a vegetable to be cooked later. The nutritional and medicinal values associated with this fruit are high.

Other important fruits occurring naturally / cultivated in the region along with their present availability trends are Amrood – *Psidium guajava,* Gonda – *Cordia dichotoma,* Gondi – *Cordia gharaf,* Timru – *Diospyros melanoxylon,* Tamarind – *Tamarindus indica,* Mahuwa – *Madhuca indica,* Piloo – *Salvadora persica,* Gangeran – *Grewia tenax,* Kaith – *Feronia limonia,* Bel – *Aegle marmelos,* Sangri – *Prosopis cineraria,* Dansan – *Rhus mysurensis,* Banana – *Musa paradisiaca,* Wild Banana – *Ensete superbum,* Kakar – *Flacourtia indica,* Papaya – *Carica papaya,* Falsa – *Grewia asiatica,* Bad – *Ficus benghalensis,* Anjir – *Ficus carica,* Goolar – *Ficus glomerata*, Nimbu – *Citrus lemon,* Maha nimbu – *C. grandis.*

Source: V D Sharma: BSAP for Aravallis

Action 12. Identify, delineate, map and study the principal agro-ecological zones of the state and the current and potential changes under way in their status, health and their environment, including measures to contain these changes.

Basis for action. Agro-ecosystems are as important as wild ones, though these are simpler in terms of number of constituent species. These are impacted deeply by human actions and manipulation and therefore close monitoring of changes in their resilience and health is necessary to ensure their uninterrupted productivity. Degrading soils by way of salinization or by decrease in soil micro-organisms could imperil an agricultural ecosystem even if the higher species are intact. Atmospheric pollution could affect the native vegetation as well the soil structure. Changes in groundwater table could trigger off a chain reaction of processes leading to changes in the vegetation and to the overall productivity or security of the ecosystem. It is therefore necessary to understand the various agricultural ecosystems of the state and the trends of change under way. Bioregional planning could be facilitated only when such a knowledge is complete and comprehensive. At present this knowledge is lacking in the state.

Activities. Survey and map the agroclimatic zones and agro-ecosystems of the state with respect to the landraces of crops; prepare scientific reports on the ecosystem processes and impacts of agricultural activities on them; suggest strategies for ensuring continued health and vitality of these ecosystems.

Lead agency. The State Council for Biodiversity Conservation in association with the Agriculture Department..

Collaborators. Ecologists, academia, agriculturists, farmers and local knowledge holders should participate in the process.

Expected results. A deeper understanding of the agro-ecological zones of the state; a strategy for effective measures to conserve domesticated biodiversity at ecosystem level.

Indicators. Quality and accuracy of scientific work done and of reports prepared.

Risks and uncertainties. Lack of support from policy makers especially the finance and planning department.

Related actions. Action 16.

Action 13. Research and document the prevalent traditional practices and knowledge of local farming methods in the state and how these contribute to conservation of domesticated biodiversity.

Basis for action. Looking to the pace of changes towards the intensive 'industrial' model of agriculture the traditional knowledge and traditional practices may soon be lost for ever. This knowledge represents hundreds of years of experience, and is likely to provide clues to solving many problems arising out of indiscriminate application of new methods and technologies. Application of local knowledge in integrated pest management (IPM) is a case in illustration. So is the specific knowledge of farmers about the drought resistant varieties of local crops. Systematic study and documentation of this knowledge is lacking in the state.

Activities. Conducting surveys and researching existing literature; setting up networks of local knowledge holders and researchers; documenting local knowledge and farming practices; establishing incentives for sharing this knowledge in public domain and other promotional schemes that would bring the hidden knowledge of local practitioners to the public domain.

Lead agency. The State Council for Biodiversity Conservation in association with the Agriculture Department and Agriculture Universities.

Collaborators. Ecologists, academia, agriculturists, farmers, school teachers, and local knowledge holders should participate in the process.

Expected results. Documentation of traditional knowledge about agricultural practices, ecosystems and their products and services and their uses.

Indicators. Completeness of the document and of the participatory process; broad-based stakeholders participation.

Risks and uncertainties. Lack of financial support.

Related actions. Action 40.

Objective:

Develop policies and practises to ensure long term conservation of species and genetic diversity of domesticated species, and the supporting ecosystem components.

Conservation of crop and livestock genetic resources as well of support systems (physical and human) is necessary for continued existence of managed ecosystems. Diversity of biological resources is critical not only in maintaining production capacity of the ecosystems but also for functions such as mitigation of pests and diseases, pollination and maintaining soil formation and its rejuvenation. Diversity at landscape levels as well of the wild species existing in agricultural fields as weeds, pests or other forms should also be conserved. Along with the physical resources, the knowledge of managing these species and their unique uses has evolved over thousands of years of experience and experimentation. This knowledge must also be conserved. None of these objectives can be achieved without participation of farmers, indigenous and local communities.

Action 14. Launch an awareness raising campaign focused on the value and importance of domesticated biodiversity and managed ecosystems, especially among the practitioners and policy makers.

Basis for action. The level of awareness about the importance of biodiversity and integrated health of managed ecosystems is decreasing among the practitioners, that is, farmers, herders, and cattle breeders; and this understanding is totally lacking among the policy makers in the state. This leads to lower level of support and valuation for biodiversity vis-à-vis modern methods of intensive agriculture. An ecologically inaccurate perception about resources leads to degradation of resource base through uninformed decision making. It also hampers success of conservation programmes. It is a crucial element of the overall conservation strategy to raise the awareness level of the key actors in these programmes.

Activities. Preparation of brochures, booklets and posters, and audiovisual resources on the significance, status and the value of biodiversity in the managed ecosystems of the state; dissemination of these publicity materials; mass media campaigns through radio, television, and the press; setting up networks of local knowledge holders and practitioners and policy makers at large, bringing out newsletters and exchanging knowledge and views on issues of conservation.

Lead agency. The State Council for Biodiversity Conservation in association with the Agriculture Department.

Animal Genetic Resources

Animal genetic resources (AnGR) and their management is an important issue in conservation. This global concern is central in management of domesticated biodiversity and is viewed as one of the most important economic issues linked to genetic diversity. Domestic animals make a major contribution to the economy of the state. Pastoralist communities like *gujars* and *rebaris* depend critically upon livestock rearing and have accumulated extensive breeding knowledge and experience. The state is known for its local breeds of livestock which have over the centuries adapted to the specific climatic conditions. Although state can benefit from a breeding programme based upon selective improvement of indigenous genetic resource, excessive reliance upon introduced breeds such as Holsteins and Jerseys can lead to similar ecological fallout as in the case of industrial model of agriculture.

Important **breeds of cows** in the state are: **Mewati,** found in northern Aravallis, valued as dual-purpose cattle and for heavy plough and carting; **Gir** from central Aravallis, also dual-purpose but mostly preferred for dairying with average yield of 5.5 kg. to 9 kg. per day; **Kankrej,** found in parts of central / southern Aravallis; **Malvi** in southern Aravallis, a hardy and strong animal, very useful for pulling heavy weight and for cultivation in strong soils; **Nagori,** found in central Aravallis, a draught breed, bullocks being regarded as the best is the whole of India; **Rathi** and **Tharparkar** are important breeds from the western region of the state.

Breeds of buffalos found in the Aravallis are: **Murrah,** considered the best milk yielding variety in India; average milk yield being about 11-14 kg per day; **Surti and Mehsana** buffaloes are of medium size, although the milk yield of these animals is not high but they are reared in southern Aravallis in Udaipur, Dungarpur, Banaskantha, and Sabarkantha districts having adapted well to the agro-geo climatic conditions of the region.

Goats in the state are reared for milk, meat, and hides, some of the goat breeds giving high yield of milk. The important breeds of goats found in Aravalli eco-region are: **Jakharana**, a breed is found in northern Aravallis near the village Jakharana in Alwar district, milk yield of this goat is very high and goes up to 8 kg per day; **Marwari,** found in central Aravallis, a breed for mutton; **Sirohi,** from Sirohi district of the state, it is mainly a goat for milk

Sheep rearing is an important occupation of the pastoralist communities in the state. The important breeds found in the region are: **Chokla,** light or medium in weight, characterised by dark brown or black patches and a brown face, producing good quality carpet wool, it is distributed in northern Aravallis; **Marwari,** with a black face and stocky built the breed is hardy, thrifty, and disease resistant; **Nali,** a brown-faced animal with medium to long leafy ears, having a big sized body with short legs and yellow hooves; **Sonadi,** a sheep with long well-built body with white or light brown faces, colour often extending to neck and limbs, distributed in southern Aravallis; **Malpura,** a breed having long well built body with white or light brown faces, the wool produced being coarse and hence suitable for manufacture of small carpets, distributed in northern and central Aravallis.

Source: V D Sharma: BSAP For Aravallis

Collaborators. The academia, educational institutions, schools, media, NGOs and the major land-based departments of the state government.

Expected results. Better availability of accessible documents and publicity materials on the status and importance of the state's managed ecosystems; raised level of awareness in the target groups and public in general; creation of effective networks of enthusiasts, advocacy , and other support groups.

Indicators. Quality of material brought out under the campaign, effectiveness of dissemination strategy, number of people actively associated with the movement; change in level of public support for conservation of domesticated biodiversity.

Risks and uncertainties. The required financial support may be difficult to obtain.

Action 15. Develop programme of incentives encouraging cultivation of local species and varieties of crops, livestock, fish, fruits and vegetables, especially those that are being forgotten or abandoned.

Basis for action. In the current shift towards the marketable crops and hybrid varieties, traditional crop varieties and knowledge of their cultivation is being lost. This may lead to permanent loss of these crop varieties and related knowledge many of which may prove to be very valuable in future. Existing market mechanisms encourage abandoning traditional practices and the subsistence crops are being viewed as less valuable. This trend must be reversed. However, this cannot happen unless the incentives for marketable crops be abolished and incentive for the local varieties be established.

Activities. Survey and find out the extent, status and trends in cultivation of subsistence crops especially of local seeds, rearing of local breeds of livestock, poultry, fish etc; launch programmes of economic incentives by correcting market perversities in case of species that are in danger of disappearing; assess true value of these local species and varieties in strengthening the ecosystem resilience and other services; support consumer movements for products from organically diverse faming with local species; including these local varieties in public distribution system.

Lead agency. The State Council for Biodiversity Conservation in association with the Agriculture Department.

Collaborators. Government sectors and departments concerned with farming practices, that is, horticulture, fishery, animal husbandry; public distribution system and food and supplies department; local political leadership, community leaders, representatives of farmers, cattle breeders; NGOs, ecologists, environmental scientists and media.

Expected results. Better support among consumers and producers for local species and varieties, greater areas cultivated for these crops; increased public support for local varieties.

Indicators. Number of incentive programme implemented and their effectiveness in terms of coverage and final outcome; shift in preference levels of consumers and producers; quality of participation in development of the programme.

Risks and uncertainties.

Related actions. Actions 14, 16.

Voices for Local Livestock Breeds

In an international workshop organised at Sadri, Udaipur, in November 2001, a group of livestock breeders and NGOs thrashed out the priorities for conservation of the local breeds and their contribution to sustainable rural development. The text of the "Sadri Declaration" is reproduced below.

"SADRI DECLARATION",
Being recommendations passed by the participants of the
International Conference and Workshop on
Local Livestock Breeds for Sustainable Rural Livelihoods
Towards community-based approaches for animal genetic resourceconservation
UdaipurandSadri,1-4November,2000

Acknowledging the diverse roles of indigenous animal breeds for sustainable rural livelihoods in India (for food security, soil fertility, draught power, as social and cultural asset, source of income and saving etc), esp. in marginal areas,
being conscious of the threat to domestic animal diversity, (due to government policies, economic pressures, increasing poverty, cultural erosion etc., and
concerned about the lack of awareness in all spheres of stakeholders,
we recommend:

1. Policy changes concerning
- access to resources (grazing, water ...)
- changes in emphasis in the curriculum for veterinary + animal husbandry scientists, extension workers, etc. (more emphasis on bio-diversity, conservation of indigenous breeds)
- breeding policy reviews through consultative processes involving all stakeholders.
- formulation of land use plans that guarantee land use/rights for indigenous breeds and indigenous livestock keepers

2. Concerted actions by NGOs, CBOs and communities, including
- networking, documentation, awareness raising and dissemination of information about the situation and advantages of indigenous breeds
- improvement of marketing (niches) for the products of indigenous breeds
- developing of local institutions + breeding organizations

3. Changing/expanding research towards the needs of poor livestock keepers towards achieving:
- improved economic situation of livestock keepers
- legal recognition of indigenous breeds as national assets
- maintenance of Indian Domestic Animal Diversity (DAD) for the benefit of future generations

Source: Internet

Action 16. Change the sectoral policies in order to make biodiversity-rich farming practices profitable and productive vis-à-vis intensive monoculture.

Basis for action. Globally there has been a growing consciousness towards the value of biodiversity-rich farming practices and towards the ecological risks of the intensive industrial model of agriculture. In the state of Rajasthan, however, the movement towards the true value of organically diverse farming needs to be strengthened. State agencies play a vital role in guiding the path of development in agriculture sector. The vast network of extension workers in the state has been advocating change towards the new improved hybrid varieties, fertilisers and irrigation methods. There is now a need for taking a new look at these policies and making necessary changes to incorporate the value of diversity of crops and livestock, especially local varieties, in view of their sustainability and resilience.

Activities. Reform practices of subsidies and incentives that encourage loss of local species and varieties of crops and livestock; launch organic farming movement among the farming community and also the consumers of agricultural produce; correct market imperfections and distortions that contribute to loss of biodiversity; set up demonstration plots to prove the productivity levels of organic farming.

Lead agency. The State Council for Biodiversity Conservation in association with the Agriculture Department.

Collaborators. State Agricultural Universities, departments of horticulture, fisheries, and animal husbandry; finance and planning departments; NGOs, local leadership and farming communities.

Expected results. Better acceptability of organic farming methods, better market demand for organically produced food; removal of perverse subsidies and indirect support to intensive monoculture.

Indicators. Extent of reversal of monoculture support policies; level of awareness among producers and consumers of importance of organically produced food.

Risks and uncertainties.

Related actions. Action 15.

Forest Biodiversity

The state's forests are a major source of biodiversity at all the three levels of genetic, species, and ecosystem components. The pressures on the forest resources are mounting and the threats of degradation and eventual loss of species and ecosystems is approaching fast. The programme of protected area network only partially covers these forest lands. Though there are graded regimes of management defined by the legal classification of reserved, protected and unclassed forests, this aspect relates only to access to resources and the type of activities (other than management actions) therein. In spite of regulation of working of forests since promulgation of the Forest (Conservation) Act 1980, the slow and invisible processes of degradation of forest vegetation is a real threat. The present multiple-use management of forests leaves scope for extractive activities such as grazing, gathering of fuelwood and other non-timber forest produce. Forest fragmentation by diverting forest land for other developmental activities; lack of knowledge about key habitats, keystone species and the forest environment in general; and spread of exotics and weeds are some of the concerns that must be addressed immediately. In view of this, an explicitly defined strategy for ensuring protection of forest biodiversity is imperative.

Economics of Diversity

The intensive input agriculture model with its monoculture of crops is not only bad for its ecological fallouts, it also conceals many economic weaknesses within its subsidy driven false economic promise. On the other hand, traditional cultivation of diverse range of locally grown cereal and non-cereal crops have shown comparable or even better economic returns without the attednednt problems of ecological degradation. Some examples of such diverse production systems are indicated below.

I. Jatropha curcas (*Ratanjot*) Plantations @ 2500 plants/ha at 2 x 2 m spacing with 15 year cycle gives a net surplus of Rs. 38,400/-
II. Ailantus excelsa (Ardu) Plantations (in areas of sand deposits and stabilised sands in Sawaimadhopur, Bharatpur and Dholpur) : The expected cash flow from unit 400 plants over a periods of 15 years gives a net surplus of Rs. 54,000.
III. Chlorophytum tuberosum (*Safed Musli*) Plantations (Banswara, Dungarpur, Chittorgarh) - 15 x 30 cms in ridges. The average yield of root tuber is expected to be 1000 kg/ha of green tubes of 250 kg of dry tuber.
IV. Dendrocalamus strictus (Bamboo) Plantation (Chittorgarh, Jhalawar , Bundi) at 6 x 6 m spacing. At 80% survival rate the expected cash flow at the end of 15 year is Rs. 36,156.
V. Cassia angustifolia (*Sonamukhi*) Cultivation: The plant is cultivated on sandy to sandy loam soils at 30 x 30 cm spacing for its medicinal value of its leaves which is obtained from four cutting annually i.e. 1000 kg/annum which is sold @ Rs. 15/kg. The cash flow at the end of 5th year is Rs. 62,700. In addition the seeds can be sold Rs. @ 50/kg. These crops are being raised in Jodhpur, Pali Districts
VI. Commiphora mukul (*Guggal*) Plantation on stony and rocky gravelly site in Vindhyan region.
VII. Plantago ovata (*Isabgol)* cultivation for husk (as done in Jalore, Jodhpur, Pali Districts).
VIII. Lowsonia inermis (*Mehndi*) cultivation as a cottage scale industry as is being raised in Nagaur and Pali Districts..
IX. Slip plantation of Saccharum munja (*Munj*) on sandy wastelands and ravineland for cottage scale industry.
X. Slip plantation of Saccharum munja (*Munj*) on sandy wastelands and ravineland for cottage scale industry.

Source: S K Verma: BSAP For The Vindhyan Region, 2001.

Objective:

Improve knowledge and understanding of biodiversity at all levels in the natural forests of the state.

Action 17. Launch a programme of identifying and inventorying the species and genetic diversity of flora and fauna found in the forests of the state.

Basis for action. The extent, distribution and status of the forest resources at species level has not been surveyed or inventoried, though identification of species has largely been done by the BSI (though, again, not with reference to notified forest estate of the state). Most of the forests have been studied in the course of preparation of working plans (plans of extraction) but these plans do not take into account the *ecological* conditions of forests. Species of trees, shrubs, grasses and herbs are listed in working plans with a view to their direct economic use. Status of forest crops is recorded along with crop composition, density, age, and regeneration of important species. Checklists of species found in each compartment is also prepared. The working plans may provide a baseline data and maps on which to build more complete databases of species, but a considerable amount of work still needs to be done to determine components of biodiversity at all levels. An ecological perspective would need to take into account the rarity or certain species, the role of keystone (and dominant) species, the conditions and changes in the soils, microbes, and the microenvironment of forests. This would require changes taking place in relative abundance of different components of diversity of communities such as grasses, shrubs, climbers and the trees and their dependent hosts, insects, pests, preys, symbiotic organisms etc..

Activities. Survey, researching of existing data, and mapping of species, provenances (genetic diversity), plant communities, associations and landscape level ecosystems across the forests of the state; information on uses of various species (locally as well in the trade), their harvesting patterns.

Lead agency. The Forest Department in association with the State Council for Biodiversity Conservation.

Collaborators. Ecologists, taxonomists, economists; local knowledge holders, forest dwellers and indigenous people should be associated.

Expected results. Detailed databases on species level biodiversity components of the forest estate of the state.

Indicators. Completeness of data and its amenity to practical use; quality of mapping and its utility in planning; quality of participation of local populations in the process.

Risks and uncertainties. The required amount of financial resources may be difficult to obtain.

Related actions. Action 18.

Action 18. Identify and map the plant community ecosystems across all forest lands and classify these according to prevalent scientific system to understand their status, trends and changes under way.

Basis for action. Just as with species, the knowledge and data at the level of ecological communities and larger scale ecosystems in forest reserves is inadequate in the state. Ecological units at the level of watersheds, associations, alliances, and landscapes must be known to understand the mosaic dynamics of ecosystem interaction. This will also include data on the abiotic support environment constituents such as soils, water, air and landforms. A detailed knowledge of these ecosystems is necessary for planning a sound conservation strategy.

Activities. Survey, research and mapping of ecological communities and ecosystems at different levels and scales; identifying present status and trends and changes under way and potential threats and required management interventions.

Indian Bedellium (Guggul)

Promising Medicinal Plant For Wastelands Of Dry Areas

Indian bedellium popularly known as guggul (*Commiphora wightii* Engl. Syn. *Commiphora mukul* Arnott) is a medicinal plant. The gum obtained from this plant is highly valued in pharamaceutical industry. It is known as *guggulu* in Ayurveda and *guggal* in Unani. In view of the growing domestic demand, bright export prospects and dwindling supply bases, Indian bedellium has assumed considerable commercial significance, of late. The plant grows under extreme dry or arid climatic conditions and even in poor and rocky soils. Hence its commercial cultivation could be promoted in the waste lands of dry areas.

Indian myrrh (gum guggul) is a proven remedy for anteriosterosis, diabetes, internal inflammation, arthritis and obesity. It lowers the cholesterol level of blood. Pharmacological investigations have brought out the anti-inflammatory, anti-rheumatic, anti-plasmatic, anti-arthoslerotic and hypacholestroemic/hypolipidaemic properties of Indian myrrh. In ayurveda, it is used as expectorant, aphrodisiac, carminative, diaphoretic, ecbolic, emmernagogue and demulscent. Indian myrrh is a component of large number of patented drug formulations in Ayurveda. Maha yograj Guggul and Rasandi Guggul are popular guggulu preparations. An oral pill known as gugulpid which is already in the market since 1987 is one of such drugs. Unani medicines like Hab Mugil, Zimad Bavabir and Marham ushaq contain guggul. In addition to the pharmaceutical applications of the oleo-gum resin mentioned above, the gum obtained from the plant is used as and incense and fixative in perfumery industry.

Indian myrrh (gum guggul) has demand both in domestic and International market. According to an estimate, the domestic demand of gum guggul is to the tune of 300 tonnes. To meet the domestic demand presently India is importing substantial quantities of guggul. In Gujarat, which is a major supplier and consumer of Indian myrrh (gum guggul) in our country, the present production/ collection is not sufficient to meet the annual demand of 100 tonnes from the pharmacies in the state. This may be viewed from the background that about 25 years back, the production/ collection of guggul in the state was to the tune of 500 tonnes.

Though the existence of this plant or its related species has been reported from Arabia, Ethiopia, Suddan, India and Pakistan, the major supply used to come from Somalia. Presently, the supply of myrrh has been considerably reduced due to the unrest in Somalia. This situation points out the need for stepping up the production of this medicinal plant to achieve the twin objectives of meeting domestic demand and earning foreign exchange through export.

Commercial cultivation of guggul could be taken up on farm basis. It could also be grown in the periphery of farm as a hedge. The unit size of the farm considered is one acre. However, in view of the yielding pattern of the crop i.e. once in two years it would be advisable to divide the unit into two equal parts and plan its harvesting in two phases spaced at one year's gap, in order to ensure sustained returns.

Source: NABARD, New Delhi

Lead agency. The Forest Department in association with the State Council for Biodiversity Conservation.

Collaborators. Academia, ecologists, environmental scientists, NGOs, local knowledge holders, and representatives of local communities should be associated with this activity.

Expected results. Detailed data and analysis of the forested ecosystems in the state.

Indicators. Quality and completeness of data and reports produced; quality of participation of different experts and stakeholders.

Risks and uncertainties. Financial support is uncertain.

Related actions. Action 22.

Objective:

Evolve forest management policies and practices to take into account the role of forests in conservation of biodiversity.

The essential components of forest management at present include protection against encroachment and wood cutting, regeneration or replanting certain degraded lands, extraction of non-timber forest produce and some regulation of grazing in open forests. There is no explicit management mandate or activity addressing the concern for the type of species that grow in the forest so far as the green cover of the forest is good. The management approach needs to change from a macro area-based one to micro composition-based and ecosystem-based one.

Action 19. Recognise and address the concern of biodiversity conservation as integral part of forest management by amending policies and legislation.

Basis for action. Biodiversity in a forest ecosystem is the underpinning of health of the ecosystem. The productive and protective functions of forests can both be enhanced and maintained only if the diversity at the level of species, communities and the physical environment in which these exist is protected. At present the goals of forest management do not explicitly incorporate commensurate importance of maintaining biodiversity in forest reserves. The official legislation namely the Rajasthan Forest Act 1953 does not address this concern at all. Nor does the state forest policy do so. It is imperative, therefore, that the concern of biodiversity conservation be established as a mainstream concern in forest management in the state. Forest department's agencies and institutions, the curricula for education and training, and the forest service in general need to be sensitised on the issue of biodiversity conservation.

Activities. Review of forest legislation and policy in the state, identifying and incorporating the required changes in these to address the biodiversity concern; incorporation of biodiversity conservation as a core curriculum in training of forestry personnel.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Policy makers in government departments of personnel, education and environment; ecologists and environmentalists in the academia and outside of it; local communities and forest dwelling indigenous populations; representatives of political leadership.

Expected results. A document containing revised forest legislation and new guidelines on forest administration of the state.

Indicators. Quality of consultations; effectiveness of document and changes in policy proposed.

Risks and uncertainties. Adequate political will for change in legislation or policy changes may not be coming forth.

Action 20. Prepare a macro-level forest biodiversity management plan by delineating various types of management areas and assessing complementarities in their management in consultation with forest dwellers and surrounding populations.

Basis for action. The permanent forest estate of the state comprises of wildlife reserves (PAs), protection forests (main watersheds), natural multiple-use forests (community-proximate), and planted production forests (mainly plantations and regeneration closures). Each of these areas has specific objectives of management which are complementary in terms of their alignment with the broad goal of biodiversity conservation. Protection and production forests might constitute corridors linking wildlife reserves, multiple-use forests have greater species diversity than plantation forests, and plantation forests may have good populations of wild animals but no plan for their protection. This interaction of these different management areas needs to be studied, understood and monitored to draw upon the relative strength of each type of area to enhance the conservation value of the other types of areas. It is first of all necessary to delineate, survey and prepare interactive maps of these areas with geographical information system (GIS) technology. A strategy of building complementarities among these different areas and their management functions will then be highly valuable in ensuring conservation and enhancement of forest biodiversity in the state.

Activities. Delineate, survey and map the various type of forest areas in the state; identify the relative strengths of different types of areas and related management functions, draw up a macro-level forest biodiversity management plan.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Ecologists, geographers, and wildlife experts; local knowledge holders, NGOs.

Expected results. Document containing detailed description of forest areas of the state; interactive maps of these areas; site specific strategies for enhancing the biodiversity components in forest areas of the state.

Indicators. Comprehensiveness of data, maps and strategies.

Risks and uncertainties. Availability of funds.

Related actions. Actions 19, 22.

Action 21. Adopt silvicultural practices in particular and sustainable forest management practices in general, to manage and work forests without causing loss of their biodiversity.

Basis for action. Forest management activities include protection, regulation of grazing and removal of fuelwood and non-timber forest produce, rehabilitation and replanting of degraded sites. All human activities can potentially decrease the biodiversity in a forest ecosystem, if due consideration is not given to the objective of conservation. At present forest management activities (as well as the forest working plans) in the state do not explicitly address the concern of biodiversity conservation. Management functions and

activities should be determined from the fact how fragile a particular ecosystem is to disturbance. Commonly accepted practices such as leaving behind snags in harvesting or cleaning operations, ensuring corridors of undisturbed forests between two blocks of forests, leaving the keystone species out of scope for extraction activities, ensuring longer rotation, working in a mosaic pattern of blocks or patches, network of undisturbed virgin reserves within forest estate, locating key areas having higher concentration of biodiversity within forests (such as areas adjacent to PAs, areas with rare & threatened species, areas with unusual landforms or geology, rivers, streams, and wetlands, areas with forest types not found in PAs, areas with biological diversity of social and cultural importance or of medicinal, agricultural, or other economic value; areas that contain habitats of migrating species), knowledge of tree gap dynamics, etc should be incorporated into the management plans of the forests. This should, of course, be set in the larger context of sustainable forest management for which appropriate set of guidelines will need to be developed.

Activities. Review of present forest management practices and identifying required changes; development of sustainable forest management guidelines explicitly incorporating biodiversity conservation as an integral management objective; training and sensitising the forest department personnel in this regard.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Independent experts in the field of sustainable management of tropical forests; conservationists, taxonomists, ecologists, and natural resource management experts in the state.

Expected results. A document in the form of sustainable forest management manual for the state; revised guidelines for implementation of this manual.

Indicators. Comprehensiveness and quality of the manual; degree to which the manual is disseminated to the forest department personnel and received and implemented by them.

Risks and uncertainties. Availability of financial support.

Related actions. Actions 20, 22.

Action 22. Involve local populations, particularly direct stakeholders and user-groups, in management of forests to ensure that they obtain benefits which will motivate them to support conservation of forest resources.

Basis for action. The need for participation of local populations in management of forests is well understood and widely accepted. The state of Rajasthan has made considerable progress in the Joint Forest Management (JFM) movement currently under way in the country. However, the activities under JFM are limited to certain aspects of forest management and do not go deep enough in building lasting partnerships with the communities. There is a need to review the pace, the structure, the approach and the implementation of this movement. Empowerment of communities and financially strengthening the community organisations must be ensured for a long term and meaningful participation. Participation must be based on real and direct benefits accruing to each party. Commitments of government agencies must be clear, equitable and long-term. Often most arrangements at present are *ad hoc*, short term in nature, limited in scope, and tied up with specific plantations or projects. Thus revamping of a broader model of ensuring people's participation and enlisting their support in conservation of forests need to be undertaken.

Activities. Review the scope, extent and nature of stakeholder participation in forest management in the state; make necessary changes in these as agreed by all concerned in consultative and participatory manner; bring out detailed and revised guidelines in the form of a manual; disseminate these documents among the forest dwellers and populations surrounding forest areas.

Lead agency. The Forest Department in association with the State Council for Biodiversity Conservation.

Collaborators. Sociologist, anthropologists, natural resource managers; local political leadership, NGOs, *gram panchayats*, and representatives of forest dwellers and populations surrounding forest areas.

Expected results. A strengthened framework for building partnerships with local communities; a document containing detailed procedures and guidelines.

Indicators. Structural soundness of the new guidelines; quality of consultations and participation gone into its making.

Risks and uncertainties. Willingness on part of the Forest Department for ceding powers to communities may not be coming forth; local political interests may distort power equations.

Related actions. Actions 7, 23.

Objective:

Strengthen the system of forest reserves by expanding its coverage and improving its protection.

Action 23. Demarcate the permanent forest estate of the state and enter it accordingly into all relevant public records to ensure its protection against encroachment and misuse.

Basis for action. One of the major causes of encroachment and illegal occupation of forest lands is lack of clear demarcation of forest boundaries on ground and on paper. This often leads to conflicts and hostilities of forest department personnel with the local populations and compromises the integrity and security of the permanent forest estate of the state. The two major departments dealing with lands in the state are the Land Revenue Department and the Forest Department. Often the records maintained by the two do not coincide. The procedure laid out in the Forest Act of the state for bringing lands under formal forest reserve system prescribes duties and responsibilities of the two authorities. Unfortunately, for lack of co-ordination and for the reasons of power dynamics between the two agencies of government, the desired level of clarity in status of forest lands is not present. It is a task of greatest urgency and of highest priority to settle disputes of boundary demarcation throughout the forest lands of the state and to develop a consistent and integral system of records where clear demarcation, maps, and records are maintained at all levels.

Activities. Develop clear policies, procedures and guidelines in respect of bringing lands under the formal forest reserve system (*e.g.* as things stand a proposal to constitute a particular piece of wasteland into reserved or protected forest might be rejected by one district collector whereas another person in the same office might agree and forward it to government; decision making is thus a matter of personal choice rather than being

based on clear policies); designate a unified authority to deal with this issue (the forest department might propose something, the land revenue department might not agree, and vice versa; someone has to sort things out); survey and demarcate all the boundaries especially in disputed and complicated cases, enter all such lands into records, remove multiplicity of land records in case of forest lands (it is not clear what does it mean to say 'recorded as forest in government record' when a piece of land might be recorded as forest land in the official records of the forest department whereas it might be recorded as pasture land in the records of the land revenue department; courts have tended to recognise the records of the forest department, but the legal implication is not always clear); put clear demarcation of forest boundaries on ground.

Lead agency. The Forest Department, in association with the Land Revenue Department.

Collaborators. Local self-government, communities, land survey engineers (for technology support) and local political leaderships.

Expected results. Clear demarcation of forest boundaries on ground and on paper; interactive maps of forest boundaries; database of forest lands.

Indicators. Clarity of records and maps; extent of local participation in decision making especially in case of disputed lands.

Risks and uncertainties. Political will, financial resources may be difficult to resource.

Related actions. Action 20.

Action 24. Bring additional land under the reserve system especially those lands that are well-forested but do not constitute part of the formal forest reserve system.

Basis for action. A considerable area of well-forested lands in the state lies outside the formal forest reserve system. Most of these lands comprise of hillocks, uplands or ravines that are not suitable for cultivation or have not been easily accessible or are lying away from human settlements (often recorded as *gairmumkin bhakar* or *bilanam sarkar*; for example, in Bundi district alone some 20,000 hectare of such land has been identified). However, as human and livestock population grows, even these are likely to be broken up or deforested. These lands have no management plans and no management activities prescribed are present. The agency responsible for these lands is the Land Revenue Department which is the steward of all lands in the state other than forest lands. For want of protection and management, these forests are likely to be lost in very near future if no measurers are taken either to bring these under the regime of the formal forest reserve system (preferably as *village forests* as defined under the Rajasthan Forest Act 1953) or to put these under some alternative system of management so that the forests and the biodiversity of these lands are protected.

Activities. Identification, survey, demarcation and mapping of well-forested public lands outside the formal forest reserve system; bringing these lands under the formal forest reserve system.

Lead agency. The Forest Department in association with the State Council for Biodiversity Conservation and the Land Revenue Department.

Collaborators. The Land Revenue Department, local communities, NGOs, scientists and local political leaders at each site.

Sacred Groves

A traditional practice of biodiversity protection through community-managed system of *sacred groves* is a feature found throughout the state. Sacred groves are sanctified wilderness areas and a tradition of conservation, of natural resources especially trees and plants. These areas are intermixed with spiritual belief, secular appreciation of values attached to trees and wilderness, cultural ethos and a sense of belonging to nature. Sacred groves are supposed to enjoy popular protection and considered inviolable as no trees could be felled or produce extracted from these areas. The main abiotic setting such as land use and water resource points could not be tampered with. Sacred groves provided various uses since ancient times namely meditation, religious studies and refuge for floral and faunal diversity. Systematic inventory of sacred groves and their contribution in protection of biodiversity is essential in reviving the traditional practices and societal management of these resources under the new set up of local self-rule institutions of p*anchayats*. Sacred groves can offer a range of social and economic initiatives for countering the processes that cause ecological degradation.

Source: S K Verma: BSAP For The Vindhyan Region

Expected results. Increase in the size and representativeness of the forest reserves of the state; better protection and management of forested lands.

Indicators. Completeness of identification of eligible lands, timely and proportionate progress made in survey and demarcation; extent of participatory decision making in the process of selecting lands.

Risks and uncertainties. Lack of political will, unwillingness of Land Revenue Department.

Related actions. Action 20.

Action 25. Encourage private and public land holders to manage the native vegetation by setting up private forest conservation areas.

Basis for action. Considerable land estate is held in the state by public agencies other than the Forest Department. Lands held as pasture by the local self-government bodies, in the catchments of irrigation dams, along public roads, agricultural and animal farms, military cantonments, and other such lands have considerable extent of native vegetation. Private land holders, especially in corporate sector and cooperative farms (e.g. the Central Farm in Suratgarh, Sheep Farms all over the state, military farms, etc) also hold significant areas. The basic objectives of each of these agencies are different, but a degree of awareness and incentives for maintaining native vegetation in preference for exotics and monocultures can contribute significantly to conservation of forests and of biodiversity.

Activities. Identify lands other than forest lands in public and private domain that bear native vegetation; launch programmes of incentives and awareness building for conservation of native vegetation.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. Relevant public agency in charge of the lands; ecologists and conservationists, NGOs and local communities.

Expected results. Database of lands and their holders; changes in the attitude of land holders towards value of native vegetation; better conservation of biodiversity in these lands.

Indicators. Completeness of the database; effectiveness of awareness strategies and incentives.

Risks and uncertainties. Ability of agencies holding lands to appreciate the value of native vegetation may be limited.

Related actions. Action 20, 22, 24.

Action 26. Launch a programme of regenerating native forest vegetation in degraded areas in forest reserves.

Basis for action. Although the forest land in the state constitutes 9% of the total geographical area, the area of well-stocked forests is only 3%. Clearly, a predominant proportion of forest lands are either degraded or barren. These lands suffer from soil erosion, loss of species and loss of soil moisture and organic matter. If the ecological health of these areas is not restored, these may soon be beyond threshold of restoration. A comprehensive forest regeneration programme is therefore urgently called for.

Activities. Identification, survey and mapping of degraded forest areas in different parts of the state; carefully designed regeneration or eco-restoration interventions; prioritisation and phasing of areas with the most fragile ecosystems; implementation of long-term restoration plans through the agency of local communities, civil society organisations, and various government agencies.

Lead agency. The Forest Department in association with the State Council for Biodiversity Conservation.

Collaborators. Local communities, local political leadership; ecologists and taxonomists.

Expected results. Enhanced forest cover and forest biodiversity.

Indicators. Comprehensiveness of survey and mapping; effectiveness of regeneration strategies; quality of local participation in evolving restoration plans and their implementation.

Risks and uncertainties. Lack of financial sources.

Related actions. Action 20, 22.

Objective:

Develop policies and practices to reduce pressures on forest lands and demand for forest produce.

In view of increasing pressures on the forests of the state it is necessary to manage both the demand side and the supply side for forest products. Pressures on forest resources and forest lands are both multifarious and heavy. While it is imperative on the one hand to avoid waste or misuse of forest resources by correction of public polices, it is necessary on the other hand to increase efficiency in use of these resources, to increase overall economic value, especially to the local populations, and to increase supply of forest products from non-forest lands.

Action 27. Evolve a sustainable energy use policy with special focus on bio-fuels in order to reduce pressure of fuelwood gathering from forests.

Basis for action. Energy from bio-fuels constitutes a major fraction of the total energy consumption in the state. In terms of total informal non-commercial energy, this percentage is even higher. Almost all of this comes from fuelwood and other biomass gathered from farms, fields, forests, and other public and private lands. This loss of organic matter is a major cause of loss of productivity of agricultural and other soils. However, collection of fuelwood from forests poses, apart from loss of vegetation and impoverishment of soils and physical environment, the threat of degradation of forest composition and loss of biodiversity. Fuelwood gathering is the second greatest threat to the forests of the state after grazing. In view of this, it is necessary to evolve strategies and actions to mitigate this adverse effect of fuelwood gathering on the forest resources of the state.

Activities. Evolve policies and guidelines to regulate collection of fuelwood from forests, especially in ecologically fragile regions(*e.g.* do away with free fuelwood permits, charge appropriate fees, allow for only subsistence consumption not for sale in nearby towns); promote alternative energy sources among rural populations; develop and enforce regulations to avoid use of wood as source of energy in industries such as textile processing, dying etc.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department and the Department of Non-conventional Energy.

Collaborators. Local communities in and around forests; local political leaders.

Expected results. Reduction in withdrawal of fuelwood from the forests; enhancement of forest environments and forest cover in the state.

Indicators. Comprehensiveness of alternative energy plans; quality of local participation in design and implementation of plans.

Risks and uncertainties. Willingness of political leadership in forcing industries to abandon use of wood fuel may be lacking; lack of financial resources especially for implementation of programmes may be a limitation.

Related actions. Action 7, 17, 25.

Action 28. Develop a programme of reducing grazing pressure on state's forest resources by addressing both the supply-side and demand-side problems.

Basis for action. The state of Rajasthan has the largest population of livestock in the country and one of the lowest percentage forest cover. Grazing is the most serious pressure on the forest resources of the state. Almost every patch of forest in the state, except some parts of protected areas, is affected by overgrazing, that is grazing at an intensity beyond the regenerative (carrying) capacity of the ecosystem. Overgrazing leads to degradation of forest environment and ecosystem in many ways. It reduces diversity of species, blocks vegetation regeneration, compacts soils and depletes their organic content, and compromises the overall productivity of the ecosystem. Grazing also brings in human presence leading to attendant problems of hacking, cutting and damaging trees and other vegetation.

Activities. A state-wide grazing policy needs to be developed. Areas should be closed for grazing by rotation for a few years and then allowed for controlled grazing according to carrying capacity of forests. On supply side, regeneration of grasslands within and outside forests should be taken up. Campaigns for cattle-breed improvement and incentives for

practices such as stall-feeding should be launched. Policy level changes such as charging realistic fees for grazing in forests should be brought in.

Wonder Nutrition

Spirulina, a blue green alga also known as 'magic alga' is the richest known source of protein in the world. Besides protein the presence of carbohydrates, fats, carotenoids, vitamins and minerals make it a "complete food for tomorrow" (WHO). This alga has therapeutic and chemo-preventive applications. Its popular use has been in treatment of anemia, malnutrition, arthritis, and even in obesity. Its recent endeavor has been in arresting AIDS and cancer. With these enormous benefits of *Spirulina*, many production units have come up all over the world. It is being produced in south India also. Because of its sensitivity to temperature, intensity of light, photoperiods, and pH, it is being produced mostly under strictly controlled conditions of poly-houses.

In Rajasthan, Dr. Pushpa Shrivastava, Associate Professor, Rajasthan University Jaipur, separated a local strain of Spirulina from Jamua Ramgarh Lake that is resistant to the climatic extremes. She also developed a technique of cultivating it in open. Since Jaipur falls in semi-arid region of the country and therefore has extremes of climatic conditions, Dr. Shrivastava has developed indigenous methods of controlling the temperature and other conditions. She has also applied for a patent for the technique developed by her.

Dr. Shrivastava has also organized a group of local women called "Manjul Spirulina Samwhardhan Sansthan" in Burthal Village of Bassi Tehsil in Jaipur district. The purpose of this organization is to train women for cultivating *Spirulina* with local technique. So far, about 280 women have been trained for cultivation of *Spirulina* alga.

- Average production of dry Spirulina is between 8 gms to 10 gms/day / Sq. mt.
- Maximum production is 14 gms / day / sq mt (summer)
- Minimum production is 5 gms / day / per sq mt (winter)
- The cost of production of dry *Spirulina* by this technique is Rs. 130/- per kg.
- The market price of *Spirulina* is about Rs. 700/- per kg.
- On an average, a woman can generate an additional income of Rs. 1000/- per month by cultivation of *Spirulina* in her home.

Source: V D Sharma: BSAP For Aravallis

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Department of Animal Husbandry, planning and policy making departments and agencies; local communities especially livestock rearing communities living in and around forests, NGOs, and local political leaders should participate in decision making under this action.

Expected results. Reduced grazing pressure on forests, recovery of vegetation cover in forests; greater productivity of grasslands and rangelands across the state.

Indicators. Comprehensiveness of identification and prioritisation of areas to be developed and managed; effectiveness of strategy; level of participation of local stakeholders in the process.

Risks and uncertainties. Political will for increasing grazing fees and other policy reforms may not be coming forth; lack of financial resources and lack of sustained commitment of government may be a limitation.

Related actions. Action 26.

Action 29. Launch a continuous programme of tree improvement so that tree cultivation becomes a viable economic activity vis-à-vis crop cultivation and the overall production of fuel, fibre, forage, timber and other ligneous products increases to meet demands.

Basis for action. Unsustainable agricultural practices on marginal lands has been a driving force for diminishing forest estate of the state. Whether forest lands are being formally diverted for agriculture (now rarer) or these are being encroached upon, the trend can be stemmed by establishing economic incentives in favour of growing trees on farm and off-farm (that is, on public and private wastelands). Cultivation of trees and other permanent vegetation is viewed as uneconomic, backward, and a last-resort activity, though in reality this need not be so. The productivity of trees needs to be increased several times if the economics of tree cultivation, especially in view of a long rotation period, is to be economically viable. Ecological costs of growing crops after clearing forest vegetation are huge. But lack of knowledge, absence of market mechanisms and faulty policies of government prevent this realisation from dawning upon local populations. It is therefore necessary to launch a long-term programme of tree improvement, especially of the species of economic importance so that tree growing in various forms such as agroforestry, farm forestry and forest farms can establish as a mainstream economic activity. This will reduced pressures on the natural forests of the state and help conserve the forests and their biodiversity.

Activities. Identify the most promising economic tree species suitable for (and native to) the various agroclimatic zones of the state; launch programme of their breed improvement and of cultivation practices; develop a continuous programme of incentives for tree cultivation under agroforestry and farm forestry schemes.

Lead agency. The Forest Department in association with the State Council for Biodiversity Conservation.

Collaborators. Agriculture Department, researchers and scientists in relevant fields, local farmers and local political leadership.

Expected results. A comprehensive strategy and action plan for tree improvement in the state will be available.

Indicators. Soundness of strategies and complete of data on possible species, their economics and demand; level of participation in the process of development of strategy and action plan.

Risks and uncertainties. Tree improvement is a long term process and sustained commitment to of government is difficult to ensure. Some sort of legislative measure may be brought in ensure long term commitment of the state.

Related actions. Action 27, 30.

Action 30. Identify economically important non-timber forest produce and develop these resources and enhance the overall economic value of these products to the local populations.

Basis for action. Non-timber forest produce are now in reality the major economic produce flowing from the forests of the state, since there are no forest felling operations under

way or planned in near future (except in plantation forests). However, data about the exact quantity, value, and the status of sustainability of the present rate of extraction is not known. This is because of the fact that a large number of products are being extracted informally and not being monitored effectively. Produce under this category might be grasses, fodder from tree lops, fruits, flowers, gums and resins, honey and the like. Several other types of forest produce is extracted under formal schemes of the department, such as tendu leaves, bamboo, and the like. In both these cases, the value of the produce accruing to local populations must be enhanced. This will win the commitment of the local people to the cause of conservation of forests. Treating these products as a source of state revenue is neither fair nor justified since it is the people living close to the forest who bear the cost of conservation. They have an economic right and a moral right on the income from these products. The ecological benefits of conservation accrue to every citizen equally whether he lives in cities or in villages. However, since the city-dweller does not sacrifice any right or privilege for the conservation of forests, the local populations must be compensated for their contribution to the cause of conservation.

Activities. Identify the full range of non-timber forest produce, the sustainable production capacity of forest resources for these; develop policies and schemes to ensure flow of all economic benefits from these produce to the local populations; help set up appropriate market mechanisms and economic incentives to enhance the total direct and indirect value of these products (such as value addition, local craft and cottage industry); setting up (or identifying from among existing institutions) an authority for promoting these activities.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Departments of Agriculture, Industry, Ayurvedic Medicine, Finance, and Planning; development economists, natural resource economists; local populations and their political leadership, NGOs, banks and financial institutions, marketing experts.

Expected results. Better understanding and knowledge of the non-timber forest produce extraction, production capacity of the resource base; a comprehensive strategy and action plan to ensure sustainable harvesting of these produce and enhancement of its value to the local populations.

Indicators. Comprehensiveness of data and information; soundness of strategy evolved; quality of participation of local stakeholders in the process of planning and implementation.

Risks and uncertainties. Uncertainty about availability of financial support; willingness of state level political leadership to forego the state revenue in favour of local populations.

Related actions. Action 29, 31.

Action 31. Develop policies and incentives to encourage cultivation of trees in agroforestry systems as a mainstream economic activity.

Basis for action. Agroforestry has a tremendous potential and holds a great reward in the state's economic production in view of the unique agroclimatic conditions in the state. Tree cultivation in arid areas has demonstrated ecological benefits of strengthening the agricultural production base and the supporting physical environment (of soils, moisture, temperature), apart from contributing to direct economic production. At present, however, agroforestry is being practised only at a fraction of its total potential, though it has been practiced traditionally in the state. Some interest in tree growing activity,

especially in planting of exotics such as the eucalypts, has been seen but the true potential of growing native tree species and field crops together for mutual benefit and enhanced economic production is yet to be realised. It is therefore imperative that a sound and well-considered programme of promotion of agroforestry and farm forestry should be launched in the state. This will increase production of ligneous products and reduce pressures on the natural forests, on the one hand and will prove the value of trees vis-à-vis crops in the popular mind.

Activities. Survey and assess the potential for agroforestry programmes in the state's different agroclimatic zones; develop policies of incentives (such as produce support price, subsidy on seedlings, credit, setting up wood processing units for value addition, etc) to promote agroforestry among the farmers of the state.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest and Agriculture departments..

Collaborators. Agronomists, silviculturists, and ecologists in the state; farmers associations and local leaders; banks and financial institutions.

Expected results. Greater acceptability of tree cultivation as a mainstream economic enterprise, increased cultivation of trees on farmlands in the state; reduced pressures on natural forests.

Indicators. Soundness of policies and strategies; trends in areas covered or trees planted on farmland; level of participation of the stakeholders in the process of formulation strategies, plans and schemes.

Risks and uncertainties. Availability of financial resources.

Related actions. Action 30.

Action 32. Develop policies, programmes and incentives for promoting recycling of forest based products and their effective substitution.

Basis for action. Recycling of forest based products is a universally accepted activity for reducing pressure on forests. Substitution of wood by other materials such as plastics and steel may not be that straightforward in terms of environmental sustainability. Amount of energy that goes into making of steel and plastics, for example, may be much more and normally not visible to people in general. Many times however, use of forest based products such as (use of *pattal-dona*, for example) may be more justified rather than their replacement. In spite of that, careful consideration will reveal many cases where wood products and articles can be substituted for by non-wood local or industrial material. The state has at present no policy or programme of encouraging (even monitoring) use of non-wood products and articles in lieu of wood material or of its recycling. A programme of incentives should therefore be launched and monitored on a long term basis.

Activities. Identify potential scope for recycling and substitution of wooden products and articles; develop policies and incentives (*e.g.* higher taxes on wooden products in certain categories, tax rebate or subsidy for industries deflecting use of wood in favour of other materials) for achieving this potential.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Departments of Agriculture, Industry, and Finance; experts in industrial production and product life-cycle analysis; trade associations and merchants.

Expected results. Better utilisation of wood material; reduction in demand for wood products.

Indicators. Comprehensiveness of data and analysis; soundness and effectiveness of strategies; reduction in demand for wood products.

Risks and uncertainties.

Related actions. Action 29.

Action 33. Bring the wastelands outside forest reserves under social forestry programmes to increase their productivity.

Basis for action. The state has a vast amount of wastelands that constitute a substantial proportion of the total geographical area. There is a tremendous potential for enhancing production of wood based products and ecological services by productively employing this resource. This would reduce pressure on the natural forests. The social forestry programmes that have been implemented over the past two decades have contributed considerably to production of wood, fodder and fibre. However, these programmes were rather *ad hoc* and were purely an offshoot of externally aided projects rather than a continuous long-term commitment of the state. As of today, for example, there are no social forestry programmes under way. There is a need to establish a long-term programme of social forestry and also to incorporate in the process the lessons learnt from experience of past programmes.

Activities. Assess the total potential scope for bringing the state's vast wastelands under forestry plantations, survey identify, map and prioritise these lands; develop economic incentive and technological package with forward and backward linkages in place to launch a long-term plan of greening of wastelands.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Land Revenue Department, soils scientists, remote sensing experts; arboriculturists, ecologists, development economists, natural resource economists; local communities and local political leadership.

Expected results. A comprehensive database and interactive GIS maps of wastelands in the state; prioritised list of actions and programmes for different sites, especially places close to forests; strategy and action plan for greening the wastelands.

Indicators. Completeness of identification of scope and prioritisation process; soundness of strategies; level of participation of local populations in planning and implementation of programmes.

Risks and uncertainties. Financial support may be difficult to obtain.

Related actions. Action 27.

Grassland Ecosystems

Grassland ecosystems harbour important elements of biodiversity even while playing a crucial role in economic life and ecological security for people of the state. Grasslands have been seedbeds for ancestors (and wild relatives) of major cereal crops and these still harbour genetic material necessary to breed cultivated varieties resistant to crop diseases. Grasslands also provide habitat for plants and animals which have evolved over a long period for specialised survival in these specialised habitats. These range from microflora and microfauna to large mammals. The state’s grasslands in the drier parts harbour many

large mammals in pockets of concentration, such as the antelopes, as also species of rare and endangered birds, such as godavan, houbara bustard, partridges and quails.

The grassland ecosystems of the state are highly stressed, most of them also being already highly degraded as a result of excessive human pressure, such as habitat destruction and fragmentation (cultivation, mining, pollution, encroachment), overgrazing, and infestation with non-native and invasive species. The result has been loss of species composition, genetic isolation and drifting, impoverishment of soils and soil nutrients, weaker nutrient recycling, and consequent loss of resilience of these ecosystems to stand further environmental changes.

Biological diversity of grassland ecosystems must be maintained and, where possible, restored, for continued existence of these ecosystems and their associated species of animals and plants. Loss of diversity of species in a grassland ecosystem directly affects its biological productivity. It affects adversely nutrient recycling and leads to deterioration of soils and quality of ground water. Simplified grassland ecosystems are less resilient to environmental changes such as pest and weed invasion, drought, flood, and fire hazards. In this sense, diversity of an ecosystem is an insurance against the perils, both natural and externally imposed human activities. Conservation of the biodiversity of these fragile ecosystems is therefore of utmost importance.

Objective:

Survey and identify the important grassland ecosystems in the state, especially those which are still pristine and those not yet beyond the threshold of recovery, and prepare a baseline database of their diversity, functions, structures as well as pressures, threats, and trends of change.

Action 34. Prepare a detailed functional inventory of the major grassland habitats in the state, including catalogue of the biodiversity that they harbour.

Basis for action. No systematic information about the extent, types, and status of grassland areas of the state is available at present. The only studies that can be attributed are those of old geographers (eg Mishra 1967) who have written about these ecosystems based on their general information. The picture on the ground has changed a great deal, with loss of areas, species and vitalities of the grassland ecosystems. The general botanic composition or characterisation of grasslands across of the state (see *Floral Diversity* on page 37) does not provide the correct picture about the integrity, resilience, and heath of these ecosystems. It is necessary therefore to assess the extent, status, and trends of changes under way in the grassland resources of the state as also to assess the role these ecosystems play in the economic well being and ecological security of the state. A detailed resource inventory of these resource is therefore urgently called for.

Activities. Identification, survey, and inventorying of major grasslands areas of the state including their ecological status and present utilisation. Grasslands in desert areas (such as the *sewan* grasslands of Jaisalmer), protected areas (such as Talchhapar in Churu), *birs* or *jors* (such as those of Pali and Jalor and Bhilwara), and other isolated grasslands (such as the one of Shergarh in Baran district), should all be covered under this survey. A GIS enabled database would help in establishing benchmark maps and future monitoring of changes in extent, distribution, and health of these ecosystems. Baseline data about the ecosystems should include detailed data on species, area, food webs, interferences, soils,

nutrient cycling, socioeconomic context, utilisation, uses and abuses, risks and threats, trends and the like.

Lead agency. The lead agency in this action is the State Council for Biodiversity Conservation, in association with the Forest Department.

Collaborators. The land revenue department, which administers non-forest public lands is a key collaborator in this action. Ecologists, botanists, wildlife experts, local populations, especially graziers and others who depend closely on use of grasslands, traditional knowledge holders, women holding special knowledge, media and the NGOs should participate in the process of identification and assessment of ecosystems.

Expected results. At the end of this action, an up-to-date database of the grassland resources of the state, their extent, status, trends of changes under way, and a catalogue of biodiversity supported in these lands will be available in the public domain. This will form a basis for all future plans to conserve the grassland ecosystems in the state.

Indicators. The accuracy and timeliness of data and maps prepared in the course of this exercise; the process of participation of different interested sections of society is also of key importance in determining quality and utility of the data, and subsequent acceptance of future conservation plans.

Risks and uncertainties. Interest groups such as graziers, migratory cattle breeders and associated political groups may try to avoid any control or management of commons that are being used by them at present. Wider public support and winning confidence of these groups will be a necessary part of the solution.

Action 35. Set up a network of preserved or protected grasslands habitats, representative of the diversity of overall grassland resources of the state and mark these out of bound for general development activities, possibly by bringing these under the category of protected areas.

Basis for Action. At present the number and extent of grassland areas under formal management (in form of notified forest lands or protected areas) is not adequate to represent all the types of grassland ecosystems in the state. To preserve the genetic resource base as well as the ecosystem elements unique to each of the major grassland types in the state, it is necessary to have a wider network of protected or specially managed areas. Grasslands that form part of *orans* are managed by the *panchayats* but, in practice, they have neither management plans nor necessary willpower, skills and financial resources for effective management of these areas. Most of the *orans* in the state are in state of degradation, with vegetation cover stripped, degraded, or replaced with weeds. A grassland network in the state could cover various grassland areas under management of different agencies, with a coordinating agency to assist in preparation of management plans and their implementation. A programme for designing a network so that the various areas selected represent complementarities to make a holistic representation of the essential diversity of grassland resources of the state is thus urgently called for.

Activities. Design of a network of grassland ecosystems across state. Areas selected should be valued for species richness, species endemism, unique higher taxa present, unusual ecological or evolutionary phenomena and rarity of habitat type; including ecological characteristics, particularly populations of birds, insects, animals, large herbivores, and their population trends. This should be done after the detailed database of all the grassland resources of the state has been built under the preceding action. The

network should set up arrangements for coordinating exchange and information among them as also by a central agency. An institutional arrangement should be put in place to ensure that these grassland areas are managed on the basis of sound, scientifically prepared, management plans so as not to erode their biological diversity or ecological conditions. The network of areas should be notified by the government in its gazette and an agency appointed for its administration or supervision to ensure that necessary policies and programmes in this regard are implemented and followed up.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest, Land Revenue, Agriculture, and Animal Husbandry departments.

Collaborators. The process should involve ecologists, environmentalists, economists, representatives of local populations, and user groups especially graziers and other local users, NGOs and interested public representatives.

Expected results. At the end of this action, a network of grassland ecosystems representing all the diversity of these ecosystems in the state will be formally constituted. All these areas will have a framework for future management under supervision of a single agency.

Indicators. Representativeness and completeness of the network; quality of participation of stakeholders in the consultations leading to establishment of the network.

Risks and uncertainties. Different agencies controlling the grassland areas in the state as well as the different user groups (such as the migratory and local graziers) will make coordination and consensus a difficult goal to achieve. However, effort should be made to gain confidence of each stakeholder if the initiative is to be a success in the long run.

Related actions.

Objective: Develop policies and programmes for sound management and sustainable utilisation of the grassland resources of the state so as to meet the economic needs of the dependent populations while ensuring ecological integrity of these ecosystems.

Action 36. Put in place clear polices and guidelines regarding human manipulation of grassland ecosystems, esp. by way of utilisation, altering tree density, species composition, and introduction of exotics.

Basis for Action. Grasslands across the state form a resource-base for livelihood of local and migratory populations in the dominantly pastoral economy of the state. As a result, conservation and livelihood should be linked together rather than be treated separately. A policy of management based on livelihood in lead priority will not necessarily be at cross purposes with conservation, if sound scientific planning is resorted to, while ensuring participation of all the major stakeholders. In fact, the ecological and the economic objectives in management of grasslands can be aligned very well, considering the scientific evidence that diversity of species is an important parameter determining productivity of biomass of interest to the user communities. Therefore, it is very important to have a clear and detailed policy for management and utilisation of grasslands in the state. The policy in this regard should encompass all the aspects of management such as utilisation (rotation grazing, restricted grazing), alteration of vegetation composition (tree planting under silvipastoral programmes, change of grass species), introduction of species (in course of planting programmes or incidental

introduction through livestock gazing), etc. Such a policy will help achieve both the goals of livlihood and conservation.

Activities. Organise consultations with interested stakeholders and develop grassland management policy and guidelines common across the state, irrespective of the type of agency controlling or managing the resource. Bring the policy into action after due validation from all the stakeholders and testing for its scientific soundness, in order to ensure sound management of grassland ecosystems in the state. Publish, disseminate, and enforce such policy and guidelines, bringing in new legislation if necessary, and monitor its implementation.

Lead agency. The State Council for Biodiversity Conservation along with the Forest Department.

Collaborators. Scientists, ecologists, local populations including user groups, knowledge holders and women, local public representative, and NGOs.

Expected results. Grassland management policy and guidelines for the state will be available and in a position to be implemented across the state.

Indicators. Soundness of policy and guidelines, and quality of stakeholder participation gone into the process leading up to formulation of such policy and guidelines.

Risks and uncertainties. Lack of participation of certain groups who would stand to gain from non-management rather than from regulation of these resources.

Related actions. Actions above.

Action 37. Launch a programme of eradication of invasive species in major grassland habitats of the state with a carefully designed plan of ecological restoration.

Basis for Action. A large number of formally managed and notified grassland reserves in the state are at present infested with invasive weeds, particularly *Prosopis juliflora*. Many of the *birs* or *jors* classified under category of forest land have been almost lost to this invasive species. Weed infestation not only reduces productivity of useful native grasses, it also sets off processes of long term ecological changes which would be impossible to reverse after certain point of time. Unfortunately, eradication of a recalcitrant invasive species such as the mesquite is an expensive, long-term, and involved operation as a strong seed bank in the soils has already been built up over the years. Biotic agents responsible for dispersal of this seed (e.g. goats, cattle, migratory sheep, donkeys etc) are far too many and have a long unpredictable range. An isolated eradication programme or a work programme in parts (treating pockets at a time) may not succeed as seeds get dispersed around in succeeding seasons. Hence a state level initiative aimed at cleaning the important grasslands in the state needs to be taken up after thorough technical examination of the problem and its solution. The programme needs to be carried out on a sustained basis with precautionary protocols enforced in these areas and their environs for all time to come. For these reasons this action assumes a very important and urgent priority.

Activities. Develop technical sound solution programme of eradication of unwanted invasive aliens particularly the mesquite. Implement the programme of eradication (which may generate its own revenues in initial years and be a net source of revenue in short term) in notified grassland areas under supervision of ecologists at least for five years to ensure that it doesn't return to these areas.

Lead agency. The Forest Department of the state.

Collaborators. Ecologists, plant scientists, economists, local communities, user groups, and local public representatives, department or agency in charge of grassland areas being taken up under weed eradication programme.

Expected results. Important grasslands will be rid of invasive non-native plants and will lead to better conditions for re-mergence of native grass species. Process of ecological restoration will be set in. This will improve the floral biodiversity in these areas, and eventually the faunal diversity also.

Indicators. Technical soundness of the weed control programme; extent of elimination of invasive aliens and reduction of infested areas, ecological restoration as measured through indicators established.

Risks and uncertainties. Mesquite is a highly recalcitrant plant and will stage a come-back soon after the eradication operation if extreme care is not taken about its return. If it returns, the efforts made in this regard may go waste.

Related actions.

Wetland Ecosystems

Wetlands of the state contain a high concentration of biodiversity at all levels ranging from microflora to large vertebrates. The state has (in spite of being predominently an arid state) a rich natural heritage of wetlands set in varied ecological situations such as the salt marshes of desert areas and the freshwater lakes in the southern part. The wetland resources of the state comprise of both natural wetlands and manmade wetlands. Among the former are rivers and streams (all seasonal), freshwater lakes (seasonal and perennial), brackish, saline and alkaline marshlands and *ranns*, freshwater ponds (mostly seasonal but a few permanent). A larger number of wetlands are man-made, including water reservoirs, barrages, hydroelectric dams, small irrigation tanks, village tanks, salt exploitation and mined out areas under seasonal submergence, wastewater ponds including settling ponds, oxidation basins, irrigated lands esp. rice fields, canals, ditches and seasonally flooded arable lands.

Wetlands perform many important natural functions and provide many values to the state's economy. They are a major source of recharging of ground water aquifers. They modify flood flow peaks and store flood waters temporarily. They entrap sediments and other substances, thus enriching soils (hence the practice of *peta kasht* or bed cultivation in wetland areas). They store and release heat, thus moderating the microclimate of their immediate environs. Wetlands absorb carbon dioxide and other pollutants from the atmospheric and from terrestrial sources. They support complex food chains and provide a background in which rich and diverse ecosystems evolve and sustain themselves.

In view of their above functions, wetlands are highly valuable to the state's ecological security and economic productivity, though these value are rerely expressly recognised in public policy or economic planning. Wetlands are a rich repertoire of biodiversity. They are the principal source of irrigation (the only sustainable renewable source, since ground water pumping is neither sustainable nor ecologically secure, being dependent upon the recharge function of the wetlands), and water supply. They directly support economic activities such as fisheries, animal farming, salt extraction, and sand extraction. They are of great scientific and educational value, being complex ecosystems they present themselves as laboratories for study and learning. Scientific issues such as inventorying, classification, evaluation, ecological monitoring, biodegradation of organic matter,

paleoecology, biodiversity, and impact assessment can be illuminated from studies conducted on these ecosystems. Wetlands in the state are also associated with local cultural and religious beliefs, apart from supporting local economic activities such as agriculture, bed cultivation, fishing, and handicraft. They are places of recreation activities such as bird watching, photography, landscape admiring, and water sports. They serve the function of flood control, erosion control, improvement of water quality, and improvement of climate.

Unfortunately, the state's wetland resources are neither fully known nor in a good shape. The threats to these resources and the processes of their degradation, resulting in impairment of their functions and loss of their values, are many. Almost all the natural wetlands in the state are affected by change of their hydrological regime due to construction and agricultural activities in their catchments. Depletion of wetlands is a serious threat, arising from agricultural encroachment, draining, waste dumping, mining, and other human activities. The biodiversity of these ecosystems is being destroyed through illegal hunting (esp. of migratory birds), invasion of non-native species introduced by intent or by accident (such as exotic fish, water hyacinth). Degradation of their water quality is another major threat process which may undermine the very ecological existence of many wetlands. Pollution such as sewage and industrial effluents and dumping of solid wastes into the wetlands or their catchments, agricultural pollution arising from use of pesticides and fertilizers, are among major causes of loss of water quality of wetlands. Loss of wetland areas is caused by agricultural expansion and building activities near urban areas, mining and other activities such a construction of roads, leading to fragmentation of the habitats.

There are many underlying reasons for these threat processes. Lack of appropriate ownership institutions, lack of knowledge (in public domain) of the importance of wetlands and the role they play in the state's economy, and absence of management plans with most agencies responsible for these areas are important reasons. Pubic awareness for wetlands, both at the level of policy makers in government and at the level of managers of these resources, is lacking. There is lack of adequate information about these resources, their characteristics, their status and the trends of change under way in these fragile ecological areas. Absence of knowledge and information leads to poor management and lack of public support for conservation of these vital resources. Lack of institutional capacity and financial support for conservation of wetland resources is another reason for these being in a state of neglect. There exists no central institution body, nor any coordinating mechanism, for management and conservation of the wetlands in the state. The responsibility for management of different areas lies with different sectors who have their own narrow objectives of extracting a particular benefit from these resources. For example, a salt mine manager would be least concerned about the migratory birds that depend upon the salt fields; or an irrigation engineer looking after a reservoir would be normally unaware of the what is happening to the fish in that reservoir or whether waterbirds are being illegally hunted. Such gaps in comprehension of the holistic picture of these ecosystems lead to adverse and improver management (or non-management) of these important resources.

The Ramsar Convention, to which India is a signatory, obligates the contracting parties to prepare comprehensive conservation plans for the wetland resources listed under the convention. This, however, in no way means that the wetlands other than those listed as being of 'international importance' are not to be managed. In fact, all wetland resources are precious and equally valuable and effort should be made to identify maximum number of such wetlands as would find a place in the Convention list. As such, a sound strategy for managing the wetland resources of the state would not only fulfil India's

international obligations under the Convention, it also makes eminent economic and ecological sense for a state so critically dependent upon its renewable water resources. The overall objective of the following actions is conservation and rehabilitation of the wetland reosurces of the state so as to preserve all the functions and values of these ecosystems the integrity of which is indepensible to the state's goal of achieving sustainable development.

Objective:

Identify, survey, and inventory the wetland resources of the state and assess their ecological, economic, scientific, and cultural importance to the people of state.

Action 38. Prepare a detailed inventory of the wetland resources of the state including a GIS enabled database capable of being used in project planning for conservation of these resources.

Basis for Action. At present, the exact number, distribution, features, ecology, and status of the wetland areas of the state is not even known. Fragmentary information is available with different agencies such as the Land Revenue Department (the *Tehsil* offices only record the *khasra* numbers and ownership and nothing more!), the Irrigation Department, the Forest Department, and other agencies. No scientific information about the ecological characteristics or ecological status of these wetlands is available, except in case of a few of the wetlands managed by the Forest Department, in which case fragmentary data may be available. It is of great importance and great urgency, therefore, that a detailed status report and database of the wetland resources of the state is prepared. This will form the basis of all future planning in regard to conservation of these resources.

Activities. Conduct a detailed survey of the wetlands resources of the state using available data and supplementing it with remotely sensed data and other sources of information from field. At each of these sites, carry out detailed survey of the ecological characteristics, including the kind of flora and fauna, the processes of degradation if any under way, and threats perceived if any. Draw up maps of these resources and integrate these with a GIS database for analysis and planning. Assess the role that these resources play in the economic life and ecological security of the people of the state.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department and the Land Revenue Department.

Collaborators. Government departments and agencies concerned, such as fisheries, livestock, irrigation, and groundwater departments; wetland experts and ecologists, scientists, researchers; local populations and local public representatives, NGOs.

Expected results. A detailed up-to-date database of wetland resources in the state will be available. This will form the basis of all future planning for conservation and 'wise use' (as defined under the Ramsar Convention) of these resources.

Indicators. Completeness of the database, structure of the database with a view to its utility in future planning; extent of participation of all interested stakeholders in the process leading up to building up of the database.

Risks and uncertainties. Lack of participation of local populations and lack of incorporation of local knowledge in the database may limit the practical utility of the database in conservation planning.

Related actions.

Ramsar Sites in the State

Out of the six wetlands of India listed as sites of international importance under the Ramsar Convention, two lie in the state. One of these sites, namely, Keoladeo National Park, is a world famous habitat for mirgratory birds and is also listed as a World Heritage site by the UNESCO.

Keoladeo National Park

Located 27*07'-27*12'N, 77*29'-77*33'E, situated in eastern Rajasthan, the park is 2 km south-east of Bharatpur. The park has an area of 2,873 ha. The area was declared a national park on 10 March 1982, and accepted as a World Heritage Site in December 1985. Previously the private duck shooting preserve of the Maharaja of Bharatpur since the 1850s, the area was designated as a bird sanctuary on 13 March 1956.

The site comprises a freshwater swamp which is part of the Indogangetic Great Plains. The area is flooded in the monsoon. From October to January the water level gradually falls, and from February the land begins to dry out. The environment is partly man-made with dykes dividing the area into 10 units, each with a system of sluice gates to control water level. The aquatic vegetation is rich and provides a valuable food source for waterfowl. The site supports some 364 bird species and is considered to be one of the world's best and richest bird areas. It is the major wintering ground of the western population of the endangered Siberian crane *Grus leucogeranus*.

The ban on grazing (November 1982) has caused local resentment, and aquatic plant growth is no longer kept in check. The Ramsar Monitoring Procedure was applied in November 1988 because of concern that the lack of grazing was leading to weed infestation and loss of wetland.

Sambhar Lake

Located 27*00'N, 75*00'E. Situated in the districts of Jaipur and Nagaur. Area 24,000 ha. The wetland has been identified as one of the sites for conservation under the Indian wetland programme and a detailed management plan for its conservation is being prepared. Designated as a Ramsar site on 23 March 1990.

It is a shallow wetland, the depth ranging between 0.5m and 2m. Four main streams feed the lake from a drainage area of about 268,800 ha. The vegetation present in the catchment area is mostly xerophytic.

Sambhar Lake is famous for harbouring large numbers of flamingos, second only to the Rann of Kutch. Waders congregate here in appreciable numbers, as well as migratory birds such as pochard, coot and other aquatic species. The terrestrial fauna confined to the catchment area includes rare/threatened species such as *Uromastix*, saw-scaled viper, desert cat and desert fox. Siltation, soil salinisation and discharge of sewage from towns are some of the major problems confronting the wetland.

Source: Ramsar Bureau

Action 39. Designate a representative network of critically important wetlands of the state and put in place a system of their management.

Basis for Action. Considering that equal level of intensive management is not possible at all the wetlands of the state (for want of resources), it is necessary to devise a comprehensive, adequate, and representative network of the major wetlands in the state and designate an independent agency responsible for coordinating their management. Such an institutional arrangement is necessary for development and implementation of conservation plans for each of these sites.

Activities. Devise a state-wide network of important wetlands in the state. Some of these may be declared protected areas, some may be posed as candidate sites to be listed under the Ramsar Convention, the World Heritage convention, and the like. For each of these sites, an agency such as a government department or and NGO may be designated as the coordinating agency for its management. This will have to be bolstered with some legal or statutory backing, as well as supported with some financial resources. Necessary training and skills may have also to be imparted to those who will be in charge of these sites. The coordinating agency at each site may be selected with a view to its ability in terms of practical and scientific terms for dealing with the threats that the site may be facing.

Lead agency. The State Council for Biodiversity Conservation with collaboration of the Forest Department or the Land Revenue Department.

Collaborators. Scientists, ecologists, local people and their representatives, public representatives, NGOs, and government departments concerned.

Expected results. A permanent institution for long term management of the important wetlands of the state will be in place.

Indicators. Comprehensiveness and representativeness of the network of wetlands to encapsulate all the diversity of ecosystems and species in the state.

Risks and uncertainties. Coordination of the different agencies and stakeholders making use of wetlands is a fragile exercise and prone to political and bureaucratic interference. Choice and empowerment of the coordinating agency or management agency for each of these sites is a crucial factor in this respect.

Related actions.

Objective: Put in place policies, programmes and guidelines for sustainable management of the wetland resources of the state while ensuring that the biodiversity of these resources and their ecological integrity is maintained.

Action 40. Prepare management plans for all the wetland sites in the state and have these management plans implemented over the next few years.

Basis for Action. Management plan of a wetland may be prepared from the point of view of conservation (as in the case of sites forming the designated network or protected areas mentioned above), or with a focus on the principal use to which it is being put to at present but with the concern of conservation built into it at all levels. For example, an irrigation tank may already have a detailed management plan for effectively providing the benefit of irrigation services to the people concerned. However, such a plan may show no concern for the migratory birds that visit it or of the illicit shooting of such birds. In

such a case, the agency responsible for its implementation must be sensitised to the concern of conservation of biodiversity (as part of the larger programme of intersectoral integration, see action 49), and the plan must be revised with concerns of conservation built into it. This is required for all the wetlands whether these are being managed by the *panchayats*, other community originations, or a private enterprise.

Activities. With technical assistance of interested parties management plans of all the wetlands in the state should be reviewed and revised. For sites where no management plans exist, these should be prepared. Or at least guidelines for conservation of biodiversity or ecosystem integrity should be developed, extended and implemented and monitored by some the central agency. Management plans are to be evolved in a participatory manner, taking care of the all the aspects of conservation of the ecosystem in question. The management plans of the designated wetlands of crucial importance forming the network of protected areas should be prepared with conservation as the central theme, and extractive and other utilisation activities as secondary benefits arising from such management.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. Concerned departments and agencies having ownership or responsibility for management of the respective wetland sites; ecologists, wetland experts, local populations, and people's representatives.

Expected results. Each wetland in the state will have a management plan at hand, and will provide a safeguard from further degradation of these sites. A framework for continuous monitoring will be in place.

Indicators. Completeness of coverage of all the wetlands in the state; soundness of the management plans, their dissemination and enforcement.

Risks and uncertainties. Many agencies may be unwilling to sacrifice their central economic interests (such as a fishery official insisting on a high productivity exotic fish species) in favour of conservation; this must be overcome by communicating the real benefits of conservation rather than on the basis of the 'holier values' of biodiversity.

Related actions.

Action 41. Enforce mandatory requirements of Environment Impact Assessment of development projects situated in hydrological basins of wetland areas.

Basis for Action. Development activities in catchments of wetlands cast serious degradation upon these ecosystems. Apart from overexploitation and mismanagement of ecosystems themselves, catchment destruction is the next most important cause of degradation in these ecosystems. In view of this, it is necessary that all development interventions in catchments of wetlands should be strictly evaluated and regulated for minimising their adverse impact upon these ecosystems. Therefore, the requirement of conducting detailed environmental impact assessment (EIA) should be made mandatory in case of all development interventions.

Activities. Bring up environmental legislation or, under existing legislation, frame or strengthen rules and regulations to ensure that EIA is carried out in case of all interventions physically situated within the catchments of the wetlands in the state. Designate a nodal agency, such as an institution or a committee, for supervising implementation of such regulations.

Lead agency. The State Council for Biodiversity Conservation, with the help of the Environment Department.

Collaborators. Legal experts, development administrators, policy makers, politicians, representatives of industries and corporate sector, ecologists, environmentalists, local populations, their representatives, NGOs.

Expected results. A framework for guarding against the dangers of ecological degradation of wetlands arising from human activities in their watershed will be in place. Hence it is expected that the adverse impact of these activities will be reduced avoided or at least minimised.

Indicators. Effectiveness of guidelines, rules and regulations evolved to contain the adverse impact of developmental activities upon wetlands; extent of their implementation; extent of participation of all stakeholders in the process leading up to formulation of such rules and regulations.

Risks and uncertainties. Political will, development lobbies, or interested parties such as contractors and suppliers benefiting from development projects may not be in favour of such regulations. Participation of local stakeholders and their involvement in implementation and enforcement of such regulation may help overcome this limitation.

Related actions.

Action 42. Launch a programme of scientific research on the management of wetlands and dissemination of results among policy makers, and local populations, and the public at large.

Basis for Action. Many areas of wetland matters have not been covered sufficiently under research, such as wetland hydrology, soils, vegetation, wetland-friendly techniques for primary production (fish, medicines, *kamal gatta*, *singhara*), tertiary products (wetland tourism, biodiversity in wetlands), impact from development projects, etc. Monetary valuation of wetland goods and services, management and monitoring of wetlands ecosystems, impact assessment, training of personnel, and capacity building for scientific research, are among other areas requiring further research.

Activities. Design and conduct research projects around issues of greatest importance and relevance to wetlands in the state; involve academia (universities, research institutions), individuals (consultants, experts, scientists, local knowledge holders), and agencies responsible for ownership, control and management of wetland sites, in conducting and getting to sponsor such research; coordinate the various research projects and disseminate emerging knowledge and data in order to strengthen the case for wetland conservation; incorporate, also, the research findings into management plans of wetlands as well as in sectoral development plans.

Lead agency. The State Council for Biodiversity Conservation in association with the Department of Science and Technology.

Collaborators. Individual departments and agencies owning or managing wetlands; universities, colleges, research institutions, external experts, individual experts, consultants; local populations esp. knowledge holders and experts, NGOs interested in the field of conservation.

Expected results. Better knowledge about the functioning of wetland ecosystems and their interaction with human activities in the state; improvement in quality of knowledge, data,

and conservation management, in relation to wetlands; better use of wetland resources, more economic returns from the resource without degrading these.

Indicators. Identification of research issues, the capacity and competence of agencies and individuals conducing such research; level of output and its dissemination for better management of wetlands.

Risks and uncertainties. Lack of financial support and lack of scientific research capacity may be among the limiting factors in this action. These may be overcome by outsourcing both the funds and, to limited extent, expertise from outside the state as well as outside the country.

Related actions.

Action 43. Provide economic incentives for conservation of wetlands esp. in situations where wetlands are closely linked with the livelihoods of local populations.

Basis for Action. Economic incentives are an important factor in winning support from populations in conservation programmes. Restraining these populations from use of these resources or expecting them to voluntarily forego some of such benefits will not work unless some sort of compensation is made for this loss. In many situations, wetlands are closely linked with the livelihood of local communities, esp. vulnerable and poorer sections of such populations. A programme of incentives is therefore necessary if active support and cooperation of local populations is to come forth from these people. This is also necessary from the viewpoint of equity and economic justice to these populations who forgo some of their benefits in the larger interest of common good.

Activities. Investigation and exploitation of all opportunities provided by wetland resources for the implementation of wetland-friendly crop and animal farming methods; market research and support to provide more value from given resources; production of other services such as ecotourism; information and awareness building among local populations about the possibilities in relation to what Ramsar Convention calls 'wise use' of these resources.

Lead agency. The State Council for Biodiversity Conservation in association with the Department of Science and Technology.

Collaborators. Economists, administrators, policy makers, politicians; ecologists, scientists; local communities and their representatives, local political leaders and public representatives; sectoral departments and agencies responsible for management of various wetlands resources.

Expected results. A relationship based on trust and mutual benefit among the immediate stakeholders and the management, reconciliation of the interest of livelihood security and conservation; gaining support of local communities for conservation programme; better sustainability of the programme of biodiversity conservation.

Indicators. The extent of benefits actually flowing to local communities; the extent of participation of all relevant stakeholders in the process leading up to formulation of such incentive schemes.

Risks and uncertainties. The balancing of ecological and economic benefits is a delicate exercise and must be carried out with utmost care. Inappropriately designed programmes may accelerate extraction of economic products without due regard to the conservation needs.

Related actions.

Action 44. Launch a programme of information, environmental education, and awareness (IEEA) about wetlands, their role in the state's ecological security and economic well-being, and the importance of their conservation.

Basis for Action. Public awareness—ranging from the level of the political leaders and policy makers to the layman of a city to the local populations living next to fragile ecosystems—is of great importance in winning public support for the cause of conservation, without which no conservation programme can be sustainable in the long run. At present, wetland education is near absent among most sectors of society in the state. Hence a programme of IEEA is urgently called for.

Activities. Organisation of awareness campaigns for politicians, communities, policy makers, media, corporate sector, and the like; including IEEA programmes in primary and secondary education; training of persons responsible for wetland management; reorientation and reinforcement of the role of environmental awareness centres and environmental NGOs; organisation of conferences, events etc. for specific wetland sites; development of cooperation among various organisations and bodies in IEEA programmes on wetlands.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. Agencies in charge of the wetland areas; government agencies and sectors esp. education department, media, and other related departments; NGOs, ecologists; media experts who can help develop publicity materials.

Expected results. Greater awareness among the various sectors of society about the role and the important of wetlands in the economic and cultural life of the state, and in ecological security of the state; enhanced public support at all levels.

Indicators. The impact that the programme makes on general public awareness about the issue of wetlands; comprehensiveness of the programme; its structured approach to match different target groups.

Risks and uncertainties. Availability of financial support may be a limitation.

Related actions.

Theme: Dryland and desert ecosystems

Dryland and desert ecosystems are unique to the state of Rajasthan not only in the country but also in the world. The desert of Thar spread across India and Pakistan is one of the 200 global Ecoregions identified under the Global 200 programme of WWF and IUCN . Compared to most other deserts of the world, the Thar desert has much greater density and variety of vegetation. The floral and faunal richness of this region is evident from the fact that over 900 plant species and 2000 animal species have already been documented. There might be many more species waiting to be discovered, identified and described. The physical environment in various landscapes in the region is unique and so are many of the landforms such as different types of dunes, inter-dunal valleys and rocky plateaus or *magras*. Areas of wetlands, especially of salt marshes (locally known as *ranns* or *dhands*), are scattered all over the area. Isolated hills punctuate the vast landscape of sandy plains, many of them harbouring scrub forests of significant biodiversity. The level of species endemism is high throughout the region

The desert of Thar is also one of the most densely populated deserts in the world. Growth of human and livestock populations along with state-led development programmes is altering the ecosystems with ever rising pace. Loss of vegetation, soil erosion and salinity, breaking up fragile ecosystem under unplanned mining, industrial pollution, species invasion and depletion of groundwater are trends that seriously undermine the health, resilience and sustainability of ecosystems throughout the Thar desert. Biological resources play unique role in the droughts and critically affect the livelihood and food security of the people. Introduction of canal irrigation under a major national project in the heart of this ecoregion has shaken the very foundation of the ecosystem in a significant proportion of the desert. In view of the unique status and unique problems faced by this region, it is necessary to develop separate strategies for conservation of biodiversity in the region.

Objective:

Improve knowledge and understanding of desert ecosystems and their biodiversity at all levels and set up a mechanism for continued monitoring of changes in ecosystems.

One of the principal reason for loss of biodiversity in the arid area is lack of data about the overall biological resources, their diversity ranging from genetic to ecosystem level, and the driving forces determining the status and trends of these components of biodiversity. Initial assessment of the biodiversity is a major bootstrapping activity on which will base the future monitoring programmes as also the conservation strategies. It is therefore of vital importance that the biodiversity of the area is surveyed, studied and inventoried at different levels of genetic, species and plant-community levels.

Action 45. Conduct surveys and research to build up databases and inventories of the components of biodiversity in the desert area.

Basis for action. It is necessary to inventory the unique genetic and species level biodiversity of the desert region. While significant taxonomic work has been done on the vegetation of this region, such efforts have been at individual level. Regional centres of National institutions such as the Botanical Survey of India, the Zoological Survey of India, Central Arid Zone Research Institute have been working in this field. These studies need to be pooled together, gaps emerging need to be filled by surveys and a monitoring mechanism needs to be set up for watching status of vulnerable species and varieties.

Activities. Surveys of dryland vegetation cover, composition including measures of plant vigour, age, distribution, density, viability, rarity; surveys of fauna, population change trends, wildlife age structure, etc; preparation of database of species and genetic diversity on standard models (such as one provided by ABI); periodic monitoring updating and publication of reports in this respect.

Lead agency. The State Council for Biodiversity Conservation in association with the Botanical Survey of India and Zoological Survey of India.

Collaborators. Ecologists, taxonomists working in the region; local knowledge experts, community leaders, local political leadership (their participation will ensure greater support to conservation activities.

Expected results. Consolidate database of species and genetic diversity of flora and fauna of the desert region will be available. This database will form the basis of future planning for conservation of biodiversity.

Indicators. Comprehensiveness of database, structure of database; timeliness of data and their continued updating.

Risks and uncertainties. Lack of availability of adequate financial resources.

Related actions. Action 35.

Action 46. Identify the unique ecosystems at local level, representative of all habitat types, study their ecology, the external (physical and human) environment and driving forces (natural and anthropogenic) determining the trends and changes in these ecosystems.

Basis for action. Desert is a vast stretch of land spread over 150,000 sq km. It is not possible to study all the areas given that resources are and will always be limited. Certain areas in this vast desert are more vulnerable, fragile, and contain greater density of biodiversity. Such ecosystems need to identified, studied as representative trend-indicators of overall desert[2]. These can constitute the core of monitoring mechanism in the long term. Hence the need for identifying and prioritising locations and ecosystems of especial biodiversity significance where, for example, plants and animals are found in abundance.

Activities. Identification of local ecosystems and areas that are biodiversity rich or are marked by unique land-forms; indicators of ambient physical and human environment such as water, air, soil and resource use patterns and pressures; presence of alien or invasive species and their impact; factors indicating ecosystem processes such as species interaction, species endemism, food chains, energy flow patterns, ecosystem stress assessment. Each identified ecosystem is to be described in greater detail and indicators defined for its continuous monitoring.

Lead agency. The State Council for Biodiversity Conservation in association with a suitable NGO identified for this purpose (or the local university).

Collaborators. Local university and colleges, especially ecology department experts; environmental experts, sociologists, natural resource economists; Forest Department, Land Revenue Department, Agriculture Department; NGOs and local populations and their representatives, local political leaders.

Expected results. A representative network of ecosystems (landscapes or habitats) that is representative microcosm of the biodiversity of the desert region; a basis for monitoring changes in biodiversity will be available for future; a document on interaction between ecosystems, their physical environment and human activities.

Indicators. Representation of the ecosystems (or habitats) identified; completeness and accuracy of their description; level of participation of the collaborators and the local people and leaderships.

Risks and uncertainties. Availability of financial resources.

Related actions. Action 33.

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[2] In one such exercise titled *Biodiversity Conservation Prioritization Project* (BCPP) 23 sites in the desert region of Rajasthan have been identified to be of high conservation priority [WWF 2000]. Similar work may be carried forward to prepare a comprehensive network of such priority sites.

Biodiversity Rich Orans in the Thar Desert

Orans are traditional institutions evolved by communities themselves. These are sacred, secular, ecological, and economic institutions all in one. The word *oran* comes from the Sanskrit word *aranya* meaning *wilderness*. The number of orans in Western part of the state is very large. Although now degraded, barren, and greatly reduced in extent because of encroachment for cultivation, some of these areas still remain rich in biodiversity.

Orans	Tehsil/District	Area in bighas	Habitat Type	*Animals*
Kolu-Pabuji	Phalodi/ Jodhpur	15800	Sandy plane	*Vulpes v.pusilla, Uromastix hardwic*
Veeratra	Choutan/ Barmer	18000	Magara	*Gazella bennetti, Vu7lpes v. pusilla, Black bucks*
Ramdeora	Pokaran/ Jaisalmer	3000	Magara	*Vulpes v. pusilla*
Bhadariyaji	Pokatan/ Jaisalmer	41000	Magara	*Vulpes v. pusilla Ft S. oramat*

Source: S M Mohnot: BCPP

Action 47. Conduct detailed scientific survey and study in the command and transboundary areas of the *Indira Gandhi Nahar Pariyojana* where deep level ecological changes are taking place.

Basis for action. Indira Gandhi Nahar Pariyojana is one of the world's most ambitious projects famed to have brought water to the parched desert sands from the distant Himalayas. Ironically, it could also be one of the greatest ecological disasters ever funded with public money. Although impacts of the water are already being felt in terms of waterlogged soils, wetlands, burgeoning populations of pests like mosquitoes, and changes in the native vegetation composition, the long term impact of this complete metamorphosis of the desert landscape is likely to be of far reaching consequences. It is difficult to predict the future scenario given the geographical scale of the changes taking place. But it is certain that apart from the areas actually irrigated substantial areas will be affected by transboundary effects and edge effects of changing ecosystems. Anything from outbreak of epidemic pests threatening local vegetation and human health to land lost to salinity and water logging, invasion by alien species of flora and fauna, and shift in climatic patterns of rainfall and wind could eventually take place. How this oasis of exotic environment will interact with the larger desert ecosystem surrounding cannot be predicted, but it will certainly bring in some cataclysmic changes in near future. It is imperative, therefore, to take cognisance of these perils and to study the ecological changes of ecosystems and their environments at an early stage. Close monitoring of changes caused by the project will help devise an early warning network and make necessary changes in resource use practices to avert major ecological problems.

Activities. Conduct detailed studies of changes in flora, fauna, their species interaction and ecosystem resilience caused by irrigated fields in the midst of desert landscapes; develop predictive models of anticipated changes in composition of vegetation and the physical environment; develop policies and guidelines to minimize the adverse impacts of the canal system on the desert ecosystem, and human populations.

Lead agency. The State Council for Biodiversity Conservation in association with Agricultural University Bikaner.

Collaborators. Departments of Agriculture, Irrigation and Science & Technology; independent experts in the field of ecology, resource economics and environmental impact assessment; local NGOs, local communities and political leadership.

Expected results. Reliable assessment of the extent of changes taking place will be know which will help in developing a mitigation strategy.

Indicators. Quality of data, research and strategies for mitigation of adverse effects; level of participation of stakeholders in the process of developing these strategies.

Risks and uncertainties. Availability of financial support is uncertain; adequate knowledge and technology may not exist to predict the impacts in long-term future with adequate degree of accuracy.

Objective:

Develop policies, programmes and practices to ensure survival of the unique biodiversity resources of the desert region in view of its special significance.

Despite vulnerability of the arid ecosystems of the state, there are no special policies and guidelines regarding management of these vulnerable ecosystems. Unplanned growth of mining activities, introduction of alien species, and development of irrigation projects based on canals and wells without thoughtful consideration of likely impacts on the ecosystems are but a few examples of how absence of an appropriate policy and guidelines can lead to problems. Despite basic resilience of these ecosystems, once key thresholds are passed recovery will become almost impossible. The fragile ecosystems of this region should be subjected to the intrusion of 'development' with great care.

Action 48. Develop a natural resource management plan for the desert region, with special focus on land use patterns, with a view to reducing the region's vulnerability to unpredicted change upon alteration of its unique habitats.

Basis for action. The economy of the desert region is characterised by high degree of dependence upon natural resources such as pasture lands, scrub forests, woodlands, cultivated fields and scanty rainwater. Unfortunately there is no integrated natural resource management plan in existence since each type of resource is managed by (or is responsibility of) a separate department or sector. Some of the departments have no concrete agenda at all for managing the resource under their control. The vast extent of government wastelands and *panchayat*-held pasture lands, for example, are neither being managed nor have any formal management objectives set for these. These are regulated by archaic rules framed long ago that have gone out of context in modern day socio-economic and ecological environment. It is a task of utmost importance therefore to have an integrated natural resource management plan specially designed for the desert region, probably under the larger framework of a similar plan for the entire state.

Activities. Identify the critical dependence of the region's economy on its natural resources; assess the status and trends of change under way, including sustainability of current resource use patterns; develop a comprehensive natural resource management plan in a participatory manner; implement this plan to halt adverse processes and impacts suffered by the ecosystems.

Lead agency. The State Council for Biodiversity Conservation in association with the Department of Agriculture (or maybe the Central Arid Zone Research Institute, Jodhpur).

Collaborators. Departments of Land Revenue, Agriculture & Animal Husbandry, Soil Conservation & Watershed Development, Rural Development, Irrigation, Groundwater, Mining, Industry, of the state government; research institutions located in the region such as AFRI, CAZRI, BSI, ZSI; independent experts such as natural resource economists, ecologists, environmentalists; NGOs, local communities and local political leadership.

Expected results. A balanced understanding of the importance and status of the natural resources in the desert region and their interaction with the socio-economic processes; an early warning mechanism regarding waste or unsustainable use of natural resources; a sound plan for long-term management of natural resources in the desert region.

Indicators. Comprehensiveness and depth of status analysis and management plan; level of participation gone into the process of consultations during assessment of resources and development of management plan.

Risks and uncertainties. Availability of financial resources is uncertain.

Related actions. Action 38.

Action 49. Create a special regional network of protected areas in the desert region that is comprehensive, representative, and adequate and that includes corridors, buffers and transboundary conservation areas.

Basis for action. The desert region harbours several types of habitats including sand dunes, grassland in plains and rocky uplands, hillocks containing xeric scrub and scrub forests, and wetlands. These are rich in terms of endemic species and genetic diversity and their physical environment including the landforms is unique. Presently there are some protected areas identified by the Forest Department, notably the Desert National Park, but which have not yet formally been brought under the legal framework of PAs. It is necessary to expand this network to meet the CAR criteria and complete the related legal processes of declaring these as part of formal protected area network.

Activities. Completing the legal process of settling rights and determining boundaries of areas presently being managed as PAs, identification of new sites for PAs so as to augment and complete the network of PAs. The network does not have to restrict to forest lands but could also include any public land and supplemented by community managed protected areas such as *orans*, *dev-vans* and similar other areas.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Ecologists, natural resource economist, and local knowledge holders; regional centres of national institutions such as BSI, ZSI, CAZRI and AFRI; local populations and local political leadership.

Expected results. A comprehensive, representative and adequate network of protected areas will be in existence; representative samples of the critical components of biodiversity will be preserved in the long term.

Indicators. Technical soundness of the proposed PA network; quality of participation in the process leading to design of network.

Risks and uncertainties. Financial support as well as political will may not be coming forth.

Related actions. Action 36, 37.

Action 50. Declare a portion of the desert region as biosphere reserve by completing the current process under way.

Basis for action. A portion of desert area comprising of lands in the districts of Barmer and Jaisalmer has been identified by scientists and the Forest Department as a candidate area for being designated a biosphere reserve under the Man and Biosphere (MAB) programme of UNESCO. This process needs to be carried further to its conclusive stage so that conservation benefits flowing from this are realised early. This will draw public attention to the importance of conservation of the areas while also enhancing the chances of getting national international funding.

Activities. Preparation of comprehensive proposals including validation by public scrutiny; forwarding and advocating the cause of setting up the biosphere reserve accordingly with the state and national governments.

Lead agency. The State Council for Biodiversity Conservation in association with the Forest Department.

Collaborators. Ecologists, local knowledge holders; regional centres of national institutions such as BSI, ZSI, CAZRI and AFRI; local populations and local political leadership.

Expected results. Designation of a portion of the Thar desert as a biosphere reserve by the UNESCO; leading to international recognition and support to conservation efforts in the region, more chances of attracting funds for conservation activities in the region.

Indicators. Completeness of the document; level of participation in the consultation processes.

Risks and uncertainties. Financial support as well as political will may not be coming forth.

Related actions. Action 37, 38, 40.

Action 51. Develop policies and guidelines to regulate all sectoral programmes in the region, especially land-based activities, by subjecting these to comprehensive review in view of their environmental impact in general and their impact on biodiversity in particular.

Basis for action. Sectoral development programmes can damage ecosystems considerably if their planning is not informed by environmental concerns in general and biodiversity conservation concerns in particular. At present there is no special provision for assessing the impact of a proposed mining area, road, dam, canal or a scheme of promoting irrigation wells and loans in support of the intensive model of agriculture (which is ill-suited to most parts of the desert). There are several areas of acute concern such as sporadic mining and introduction of alien species that need strict regulation. On the other hand, many land-based sectoral programmes can be modified to achieve the objective of conservation of biodiversity as a co-activity. Integrated rural development programmes involving rangeland or pastureland development and silvipastoral areas, soil conservation programmes, water-use efficiency improvement programmes, energy conservation programmes etc are examples of activities that could be adapted to help achieve the goal of biodiversity conservation rather than impede it.

Activities. Identify the ways in which sectoral development activities could endanger the biodiversity of the region; develop comprehensive mandatory procedures and best practice guidelines to aid sound planning and implementation of the activities of economic development in various sectors.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. The relevant development departments; departments of planning and finance; agency in charge of environment impact assessment in the state; independent

experts in the fields of development economics, natural resource economics; NGOs, representatives of local communities, and local political leadership.

Expected results. More informed decision making and planning in the development programmes of the various sectors of government; mitigation of threats to biodiversity of the region on account of state sponsored activities.

Indicators. Soundness of analysis of activities and processes, effectiveness of guidelines and mitigation strategies; level of participation gone into the process.

Risks and uncertainties. Adequate recognition of the importance of biodiversity and consequent concern for its conservation may not be coming forth with the political leadership.

Related actions. Action 38, 41.

Action 52. Launch a regional programme of building awareness among the populations, both rural and urban, building complementarities with their local knowledge, and integrating biodiversity management with their livelihood and lifestyle.

Basis for action. Nowhere is the livelihood of people more directly linked to biological resources than in desert. Livestock rearing is a major economic activity and is wholly dependent upon the open pastures and wastelands. Cultivation of hybrid seeds is very limited and is sensitive to local ecological and climatic changes. A large majority of cultivators still use local seeds which are better suited to the drought conditions. Fuelwood collection is also a substantial source of livelihood to the people, especially in times of famine, which directly depends upon (and seriously jeopardises) the sparse vegetation in the region. The connection between livelihood and biological resources is thus two-way and by no means optimal. The productive capacity of the resource base is being seriously undermined over the last few decades. It is necessary to understand this link between biodiversity and livelihood and develop policies and practices to build mutually supporting interactions between the resources and the income of the people. Programmes for reduction of impacts on resources and avoiding perverse interaction could also include identifying and promoting alternative livelihood sources especially for populations living in and around fragile areas and protected areas.

Activities. Study the dependence of people's livelihood on natural resources especially biological resources; assess sustainability of existing rate and patterns of resource use; identify ways and means to reconcile livelihood needs with conservation needs; development policies and guidelines to avoid adverse interactions between the twin objectives of livelihood security and conservation; develop programmes and action plans including alternative livelihood options and implement these.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. Departments Agriculture & Animal Husbandry, Soil Conservation & Watershed Development, Rural Development, Mining, Industry; research institutions located in the region such as AFRI, CAZRI; independent experts such as natural resource economists, ecologists, environmentalists; NGOs, local communities and local political leadership.

Expected results. Better interaction between the livelihood and conservation needs in the area; halting of degradation of biodiversity of the region.

Indicators. Soundness of strategies; level of participation of people, especially the vulnerable sections in the process leading up to the formulation of policies and guidelines.

Risks and uncertainties. Availability of financial support and long term commitment of government may not be coming forth as envisaged.

Related actions. Action 39, 40.

Theme: Policy and support

Biodiversity is an extremely important economic asset of the state. Its implicit contribution, however, is not commonly understood by the policy makers. The productive capacity of the entire terrestrial and aquatic resources is dependent upon the ecosystem health. Many of the economic production sectors are critically dependent upon the health of ecosystems. For example, no agriculture would be possible in absence of biological resources; soils would become sterile, unproductive and watersheds will not hold any moisture. Water supply can be critically endangered as a result of loss of vegetation in feeding watersheds. Production of medicines, forage, timber, and fuelwood would be impossible if the biological resources of the state are not husbanded properly. Livestock production, an important pillar of the state's economy, could be threatened by loss of biodiversity. In spite of this close dependence of the state's economy on the biological resources of the state, the issue of biodiversity is hardly recognised by the political leadership and the people in general as important. Part of this is due to lack of awareness about the underlying ecological processes that sustain the productive capacity of the natural resources. The other part of this is due to the fact that the issue has never before been examined publicly. It has not even been raised adequately in scientific circles.

An important strategy therefore is to bring the issue of biodiversity into the mainstream of the state's planning process. This mainstreaming requires two essential processes. One, that there should be a well-considered policy on how the state proposes to conserve the diversity of biological resources and the integrity of the ecosystems. Second, the concern of biodiversity conservation should be integrated into all the other sectors of economic activities, particularly those that erode the natural capital of biological resources and the underlying environmental support system (soils, micro-organisms, water, air) and compromise the sustainability of these very activities. The second issue has been dealt elsewhere in this report. Here a detailed strategy of putting in place policies and institutions for supporting the conservation of biodiversity is outlined.

Objective:

Recognise the true value of biological diversity in the state's economic, social and cultural life and accord commensurate importance and matching commitment to its sustainable management.

The true value of the biological resources in terms of direct and indirect benefits and services provided by these must be understood and recognised explicitly in government's policies and programmes. This should be accompanied by allocating adequate resources and priority to the sectors responsible for conservation of biological resources.

Action 53. Develop and declare official goals, objectives and mission statement to guide the process of conservation of biodiversity in the state.

Basis for action. At present the official position of the state in relation to biodiversity is not clear. In fact, the policy makers in the state are not even aware of the existence of this issue. This is clearly a critical gap in the planning and policy making process. Biodiversity deserves as much attention as other issues such as population, education, health and infrastructure. The overall framework of sustainable development and under this the concern of environmental management is the larger context in which biodiversity conservation is to be set. Nevertheless, the specific issue of conservation of biodiversity is too important to be missing from the state's policy domain. It is necessary to explicitly declare a policy statement on the issue of biodiversity conservation. A clear statement of goals, objectives, and mission will provide an overall guiding mechanism for management of biological diversity.

Activities. Draw up a policy statement or paper including the broad goals and objectives in relation to management of the diversity of biological resources of the state. This could be modelled on the policies relating to management of other natural resources of the state such as land, soils and water. Ultimately the state must embrace the larger framework of sustainable development within which each of the issues can be defined in a proper perspective. Secondly, prepare a mission statement and broad policy guidelines in relation to biodiversity and disseminate the same widely across all sectors of government and in public at large.

Lead agency. Specifically appointed committee for the task. This committee may be constituted by the State Council of Biodiversity Conservation or some similar public authority.

Collaborators. Representatives of scientific community, civil society, rural communities, political leadership and the economic planning sectors of the government should participate in the process.

Expected results. A policy document outlining the state's goals, objectives, policies and approach to conservation of its biological diversity.

Indicators. Quality of the document produced and of the process gone into its making.

Risks and uncertainties. Recognition from the political leadership has to come about for the appropriate level of concern.

Action 54. Create institutional mechanism for overall planning and implementation of the biodiversity conservation programmes in the state.

Basis for action. The only institution or agency that can be said to be concerned with biodiversity in the state is the Forest Department. The Department's mandate is limited to enforcement of the Wildlife (Protection) Act 1972, which is the only legal framework for regulating management of biodiversity in the country. An institution or agency (or a network of agencies) needs to be created with a much wider scope of activities and a larger mandate for planning and implementation of biodiversity conservation programmes. This body would include within its scope the broadest aspects of biodiversity conservation including agriculture, animal husbandry, fisheries, irrigation, mining and other activities that might impact adversely or favourably the diversity of biological resources in the state.

Mining and Biodiversity

Mining is one of the most important economic sectors in the state of Rajasthan. Unfortunately, mining is also one of the most important cause of environmental degradation, particularly loss of biodiversity and disruption of watersheds. Mining quarries are often sited in virgin areas carrying native vegetation, sometimes in the midst of the best forests, where the very nature of this land use leads to total destruction of habitats. Mining quarries scattered around cause fragmentation of habitats, disruption of hydrological cycles, and loss of large areas of productive lands covered with dumps of quarry spoils. It is of utmost urgency that mining and mineral development in the state be carefully reviewed from this angle and sound policies and procedures be put in place to avoid catastrophic loss of natural resources arising out of the activities of this sector. The solution would probably lie within the following general principles and directions of change:

1. ***Mining activities should be planned within the overall framework of land-use plan which would include the all other land-use activities and concerns such as protected areas, fragile ecosystems, and health of watersheds.***
2. Incorporate environmental information in general, and biodiversity information in particular, into site assessment, including prospecting surveys, siting guidelines etc. Including expertise from conservation organisations, public and private, into such planning would ensure quality of such planning.
3. Put in place transparent and accountable procedures, with external monitoring throughout the life cycle of mining sites and products, ensuring participation of all stakeholders including local communities.
4. Make explicit provisions—including financial mechanisms, land tenure arrangements etc—in closure plans of mining sites after operations are over, including rehabilitation of site and restoration of original vegetation.
5. Extend the scope of environmental assessment—and relevant regulatory procedures in place—to full mining cycle of operations including processing of minerals, wastes generated, and their safe disposal. The latter casts particularly serious adverse impact in the state where it is a common sight to find mineral industry wastes dumped along even the best of the highways and in the most sensitive areas.
6. Mining policy and practices in the state must adopt product-life-cycle and mine-site- life-cycle approaches so as to ensure continuity and integrity of responsibility for containing adverse impacts of these activities on the environment.
7. Mining sector should upgrade its capacity in handling conservation issues as an important concern on their own. Such capacity building should include upgrading curricula in mining colleges, making available to mining planners better data on biodiversity resources of the state, and better coordination among the agencies responsible for environmental management and the mining sector.

Source: Intersectoral Workshop, RIPA, Jaipur

Activities. Activities under action include creation of a state level body (the State Council for Biodiversity Conservation, for example) charged with directing the overall programme of biodiversity conservation. Identification of the potential members of this body, design of its structure, functions and procedures rules of working will be important activities. Under this body, several specialist committees, task forces and agencies are to be created each entrusted with specialised functions. An important part of this mechanism will be the biodiversity institute which will be looking after the needs of research, training and state level monitoring of biodiversity resources and processes.

Lead agency. The steering committee constituted under the BSAP process along with the working group constituted under the same process.

Collaborators. The Forest Department of the state, representatives from academia, civil society, political leadership and other independent experts, departments of planning, finance, and HRD in the state government.

Expected results. Creation of a state level mechanism including the apex body, its constituents, and specialised agencies. Clear rules, mandates, objectives, and procedures for functioning of these will be available in document.

Indicators. Completeness and effective design of the mechanism; quality of participation in the process leading to this.

Risks and uncertainties. Adequate support from the government and understanding of the need for this mechanism may not be coming forth from policy makers and political leaders.

Action 55. Incorporate the concerns of environmental conservation in general and biodiversity conservation in particular into development planning in the state at all stages, right through local plans to the district plans to the state level plan.

Basis for action. Local planning and district planning is an important stage in development planning process in the state and is going to be even more important in future in view the general direction of decentralisation of planning process. At present however, the district plans do not reflect adequately the environmental concerns and loss of environmental values and resources in the course of development interventions. Biodiversity conservation is not an issue at all in these plans even though a great majority of these plans depend critically upon natural resources, among which biological resources are the most important. In view of this, it is necessary to evolve guidelines, rules, and procedures and put these into practice in order to ensure that all development planning, right from village level plans to the district level and state level plans, be informed in terms of the environmental impacts of proposed development interventions, esp. upon the biodiversity resources of the district, and methods of containing these impacts. Not only that, the plans must treat conservation of biodiversity as an important developmental intervention in itself, and ensure that adequate resources are allocated for this important component of the plans. Thus, biodiversity conservation needs to be treated in these plans at two levels: first, as a mainstream development activity in itself; and second, as an environmental concern aimed at containing and managing the adverse impacts of other development activities.

Activities. Evolving detailed guidelines for incorporation of biodiversity concerns into local plans and district plans; constitution of distinct planning working groups on biodiversity, for identification and incorporation of specific aspects into plans while using district level data on biodiversity in identifying and prioritising conservation needs; review of sectoral plans at district as well as at village level or *panchayat* level from

Building People's Institutions

The *Arvari Sansad*

At a meeting held at *Hamirpur* village (Alwar distict) in 1998, a collective decision was taken by villagers of the *Arvari catchmen*t to form a *Sansad* (parliament) that could help regulate resource use in the *Arvari catchment*. Elected members from 34 villages of the 72 villages situated in the catchment attended the meeting. These representatives took a decision to form a 90-member parliament that would lay down guidelines concerning *jal, jungle* and *jamin* (water, forest and land). Issues like mining, forest felling, hunting and over-utilization of groundwater were discussed. A 15-member coordinating committee was formed, entrusted with the responsibility of preparing guidelines for resource utilisation in the catchment based on suggestions arising out of the discussions. These guidelines have been ratified by the parliament. According to the members, though there is a strong will among the villagers, forest guards could be of help in enforcing regulations. It is hoped that through a process of dialogue with the Forest Department, a collaborative network for conservation can be built up. The NGO Tarun Bharat Sangh is initially acting as the facilitator but hopes to withdraw once the Sansad has established a working office and is fully functional.

At a Sansad meeting held on 5-6 June 1999 at *Samara* village, the guiding resolutions for the utilisation of natural resources were finalised. Some of them are listed below:

Direct Irrigation from Arvari River

- *No one is allowed to draw water directly from the river for irrigation, after Holi, when the lean season starts then.*
- *Before Holi, in the areas that are directly irrigated by the waters of Arvari river, only mustard and gram may be grown. During the kharif rains, however, apart from sugarcane and rice, any crop may be grown.*

Irrigation from Wells

- *Only crops that require less water should be grown in the areas that are irrigated from the wells near the river.*
- *Vegetables are to be grown only according to local needs.*
- *People should be penalised for growing sugarcane and rice against the advice of the Sansad.*
- *The use of organic manures should be attempted.*

Market Independent Crops Grown (Bazar mukt fasal)

- *Production should be for local needs.*
- *Direct relations between the producers and the buyers should be established.*

Sale of Water banned

- *Water should not be drawn from the river using pumps.*
- *The waters of Arvari should not be used for commercial purposes or for mining operations.*
- *Digging bore wells to draw water should not be allowed in the Arvari catchment.*

(continued)

The *Arvari Sansad* *(continued)*

Save wildlife and Fish

- *Villagers should keep watch over people who hunt.*
- *Areas that are affected by hunting are to be identified.*
- *A tiger protection programme should be identified, as the presence of tigers would act as a deterrent to hunting.*

Identify the Areas Affected by Mining

- *Put an end to all mining activities in the area.*
- *Lands that have suffered due to mining should be regenerated.*

Increase Greenery in the Catchment Area

- *There should be total ban on the cutting of green trees.*
- *Grazing of livestock from outside areas in the Arvari catchment should be prevented.*
- *Cutting of grass etc. should begin only after Deepawali, after the pastures have had a chance to regenerate during the monsoons.*
- *Pastures for livestock should be developed in the villages.*
- *Denuded hill slopes should be afforested.*

Prevent Overuse of water in Arvari

- *Since it is possible that the abundance of water might tempt the villagers and the government to overuse water, care should be taken to check such use.*
- *Continue Construction of Water harvesting Structures to make the Conservation effort Sustainable*

Encourage traditional methods of conservation

- *Revive traditional conservation methods.*
- *These methods should be written down by the educated youth of the region.*

Source: BSAP For The Arvari Basin

perspective of biodiversity and natural resource conservation; incorporation of financial resources in each plan to take care of conservation needs of relevant territories; training and reorientation of district level planning teams in this regard; issuing guidelines and mandatory provisions from state level authority which would ensure that district plans not taking care of environmental concerns are not sanctioned.

Lead agency. The State Council for Biodiversity Conservation in collaboration with the Planning Department.

Collaborators. All the sectoral agencies and departments; district administration representatives; political leadership; local communities, NGOs; local ecologists, economists.

Expected results. Local plans and district plans will reflect due environmental concern for conservation of natural resources in general and for conservation of biodiversity in particular.

Indicators. Comprehensiveness and soundness of the guidelines issued in this regard; amount of financial resources set apart for conservation mainstreaming in district and local plans.

Risks and uncertainties. Political will, and sensitisation of the sectoral agencies and departments is an important ingredient for success of this action.

Objective:

Develop state wide policy and guidelines to conserve biodiversity by avoiding waste or misuse of biodiversity.

Action 56. Develop guidelines and practices across all the sectors of development for taking into account the value of biodiversity and avoid its waste while planning and implementing their sectoral plans.

Basis for action. One of the most important cause of biodiversity loss in the state is the state's pursuit of its 'development agenda'. The various sectors and agencies responsible for planning and implementation of development programmes are neither aware nor motivated enough to take care of the biodiversity resources in their respective sectors. Mining department and mining corporations pursue their sectoral programme of exploiting to the maximum possible the mineral resources of the state. The irrigation and agriculture department strive to break up and bring maximum possible land under cultivation. The public works department pursues single-mindedly its mission of constructing maximum kilometres of roads. And so on and so forth. The idea of 'sustainable development' is lacking, whereas the agencies responsible for management of the state's natural resources are also not fully seized of the importance of diversity of biological resources. It is therefore necessary to develop broad guidelines incorporating concerns of biodiversity conservation across all the sectors of government. These guidelines must be communicated to all the policy makers and executing officers as well as other personnel of the sectors.

Activities. Develop common guidelines for incorporating concern of biodiversity conservation in sectoral planning in a participatory manner; disseminate these guidelines across all the sectors at all levels of decision making; ensure that the guidelines are followed in practice.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. The Forest Department, all the other departments and sectoral agencies with focus on land-based activities, scientists and experts, planning department and the finance department.

Expected results. A document containing detailed guidelines for incorporating biodiversity conservation concerns in planning and implementation of sectoral programmes. A change in development departments approach towards a more prudent, environmentally sound, and sustainable path to development.

Indicators. Relevance, comprehensiveness and soundness of the guidelines; degree of compliance with these guidelines; quality of participatory process gone into development of the guidelines.

Risks and uncertainties. Ability of the sectoral departments to appreciate or recognise the importance of biodiversity conservation may be limited. Biodiversity conservation

concerns may be viewed in a negative perspective as obstruction in the path of development.

Action 57. Reform economic policies that directly or indirectly encourage loss of biodiversity.

Basis for action. Apart from the activities of development sectors, there are other supportive policies and measures that tend to promote private and public initiatives that go against conservation of biodiversity. For example, agricultural subsidies (for inputs, research, energy price, etc) or food price subsidies (as well as price support) promote the 'industrial' model of intensive agriculture vis-à-vis organic farming. Credit policies that favour the 'developed' varieties of crops and marketable produce vis-à-vis local varieties and sustenance produce also tend to promote loss of biodiversity. Grazing in forests and other public lands with reduced fee or no fee at all encourages overgrazing and tends to cast a view as if grasses and forage in forests were of little value. Similar policies in many other sectors tend to strengthen the belief that local or indigenous species of plants and animals are inferior to the 'modern' ones. While addressing the issue of productivity of farms may be a valid concern, doing it with loss of the diversity of the resource base leads to the situation of one step forward and two steps backwards. Free or cheap irrigation encourages farmers to waste this precious resource while degrading the lands and the soils. Advancing cheaper loans for industrial development may increase industrial production while it may also pollute groundwater and streams, and create barren lands (e.g. may deforest far-off areas by creating a market for fuelwood). It is evident therefore that policies supporting economic development of the state must be evaluated in terms of their impact on the natural resources of the state, especially their impact on the biodiversity of the state, and must be reformed in this regard.

Activities. Identify all the policies that directly or indirectly invite waste or misuse of biodiversity; review and reform these policies so as to avoid conflict with the goal of biodiversity conservation.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. Experts in the fields of natural resource economics, public policy, ecological-economists, the Forest Department and other agencies in the state concerned with environmental management and natural resource management; the planning and finance departments, political leadership; civil society organisations, and independent environmentalists.

Expected results. Economic and public policies that are in harmony with the objective of biodiversity conservation. Policy directives contained in a document would have been disseminated across a wide section of society, especially those involved in making public policy and in the media.

Indicators. Relevance, comprehensiveness and soundness of the new policies; degree of implementation of these policies; quality of participatory process gone into development of the new policies.

Risks and uncertainties. Ability of the political leadership to appreciate the importance of biodiversity conservation may be limited. Biodiversity conservation concerns may not be viewed to be of sufficient significance to warrant policy changes.

Action 58. Develop policies and practices to reduce demand for biological resources.

Basis for action. Extraction of resources is clearly one of the most important causes of loss of biodiversity. Fuelwood extraction is degrading forests, overgrazing has all but reduced pastures to wastelands. Extraction of many rare and endemic species for medicinal or other use has pushed these species to the brink of extinction (phog *Calligonum polygonoides* for charcoal making, for example, in the desert region). Even water-harvesting can change the vegetation in watersheds irreversibly (such as the upstream check dams have all but dried up the famous Ramgarh Lake of Jaipur and the Fatehsagar of Udaipur). The current rate of growth of human and livestock population (the largest in the country) keeps on increasing the demand for produce and the pressures on the ecosystems of the state. It clearly calls for stemming this demand if the biological resource base is to be sustainably used. Demand management is thus a key action in aid of conservation of biodiversity of the state.

Activities. Review the use of biological resources in the state, develop a plan of reducing the demand for these resources by adopting measures such as substitution, value-addition, removal of perverse subsidies, ensuring true market value to the local people for their produce, charge realistic economic-ecological costs such as grazing fee, efficient use in saw-mills, improved *chullhas*; ensuring recycling of resources, and so on. New policies and practices encouraging positive trends in this respect should be enforced across the entire spectrum of use of biological resources.

Lead agency. The State Council for Biodiversity Conservation.

Collaborators. Experts in the fields of natural resource economics, public policy, government departments and agencies concerned with natural resource management; the planning and finance departments, political leadership; civil society organisations, industry and corporate sector.

Expected results. Reduced demand for biological resources and less pressure on the ecosystems; a new policy framework for continual improvement in efficiency of resource use in future.

Indicators. Extent to which the new policies and practices are effective in reducing demand for biological resources; quality of participation gone into evolving the new policies, practices and guidelines.

Risks and uncertainties. The task is a large one with a wide scope, so sufficient mobilization of all the stakeholders may be lacking. This may make the subsequent policies ineffective.

Theme: Integration into sectoral programmes

One of the most important causes of biodiversity loss is the lack of concern for the value of biodiversity and ecological services in sectoral plans and programmes of the state. Since these programmes are not informed by the true value of biodiversity, unnecessary and avoidable loss of species, habitats, and degradation of ecosystems results in as a side effect of sectoral activities. A glaring example is that of the mining sector in which public and private players both pursue the goal of mineral extraction and profit making in a single track mode. In absence of a land-use plan in the state, mining and quarry sites are selected in a totally contingent manner driven by the private interests of the lessees. As a result, one commonly comes across mining activities in the midst of streams, in the centre of forested lands, in pastures, along public roads and near (or even in the midst of) habitations. This is result of many factors including failures institutional mechanism already in place (when, for example, a *patwari* issues no-objection certificate for mines in middle of rivers and streams), lack of a central mechanism for managing the state's natural resources, and absence of sectoral guidelines and professional standards in the

relevant sector of government. While policy failure and lack of institutional mechanism have been dealt with elsewhere in this chapter, the following is an attempt to bring out suitable strategies and actions to address this glaring gap in the development programmes of the various sectors of development.

Government departments and agencies managing various sectors of economy are organised on the basis of either a type of resource (forests, mines, tanks and canals, road and building, transport) or for discharging a functional responsibility arising out of a particular piece of legislation (the environment department). In absence of a state level agency coordinating the activities of various sectors (except the finance department which enforces only the narrow function of allocation of budgets), each sector's activities cast negative externalities on the other sectors. Mining sector is damaging resources such as forests, pastures, water bodies, canals, roads and other public lands. Pollution control department casts externalities on the industry sector by either obstructing or escalating costs of this sector through its *post facto* regulations (it rarely is involved in planning of industrial development of state which is a responsibility of the industry department). In this kind of perverse relationships among different sectors of the economy both the economy and the ecological security of the state is jeopardised. Since each sector entails some negative environmental externalities, environmental degradation including loss of biodiversity is the greatest negative impact of this.

It is necessary, *first of all*, to have a central mechanism in the state for coordinating the economic development of the state within which there should be a focus on the environmental soundness and ecological security of the state watched on equal footing as the concern for economic growth. The State Council of Biodiversity Conservation proposed under this report is an example of such a mechanism.

Secondly, it is necessary to review all the sectoral policies and programmes to test for their soundness in respect of environmental costs not exceeding the benefits they generate to the society as a whole. Similarly, under this initiative each sectors key actors, public servants and private entrepreneurs, should be informed and sensitised about the value of environmental service, especially of ecological services and diversity of biological resources.

Thirdly, introduction of bioregional planning in the state (albeit at a later stage) would necessitate changing the basis of planning in each sector. Land use plan should be the most basic need for proceeding planning with other sectoral activities.

Fourth, environmental impact assessment should be made mandatory for all the sectoral activities not just in the narrow sense of local impacts, but in an integrated manner looking to the overall impact on the state's ecological security. EIA procedures in the state are not standardised nor commonly known. This is one of the important sectoral interventions that is of critical importance in conservation of the state's biodiversity (among other components of the environment).

Fifth, the central mechanism of economic (not just financial) planning should include environmental costs into accounting books so as to avoid false sense of growth and well-being despite a decline or stagnation in the overall productivity of the economy. This "green accounting" is already a widely accepted approach globally. The approach is all the more important in the context of the state since a very large part of the GDP of the state is based on the natural resources of the state.

Finally, many of the existing sectoral programmes can be modified or adapted to achieve the objective of biodiversity conservation as a co-objective within the programmes.

Examples can be cited of watershed development programmes, cooperative movement, adult literacy and basic education sectors, and so on.

Sectoral Integration Matrix

The interaction between the various sectoral activities and biodiversity have been laid out in a matrix form in the following pages. There are five broad aspects of interaction delineated: how the activities of a sector cast adverse effects on biodiversity, what is the root (historical) cause of nature of these adverse impacts, strategies and actions for managing these adverse impacts, and indicators of progress made in this direction.

Integration of Biodiversity into Sectoral Programmes Under Biodiversity Strategy & Action Plan

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
1. Agriculture **[Department of Agriculture** **Fisheries Dept** **Command Area Development** **Soil Conservation & Watershed Dept** **Dept of Land Revenue]** • Grain crops. • Vegetable crops. • Land irrigation. • Pastoralism. • Livestock production. • Aquaculture. • Processing of agricultural and animal products; etc.	• Agriculture causes a reduction in soil quality (organic matter and mineral deficiencies, decreased fertility, increases in acidity levels), susceptibility to water and wind erosion, contamination of waterways or groundwater (use of fertilizers, organic matter, pesticides), etc. • Livestock production gives rise to significant pressures due to localized overgrazing, access to water points, etc. • Agriculture and livestock production are often poorly integrated and conflicts frequently exist between their uses of biodiversity. • Uncontrolled growth of livestock may lead to degradation of pastoral lands. • The diversity of races and varieties of livestock adapted to local conditions is decreasing. • Protection of crops and livestock from pests sometimes impacts non-target species. • Introduction of exotic fish displaces indigenous fish species, sometimes dispossesses traditional fisherfolk, and affects wildlife dependent on indigenous fish species	• Promote the adoption of practices that support the sustainable development of livestock production and agriculture. • Reduce the impact of agricultural activities and livestock production on wild species and natural environments. • Effectively integrate the management of pastoralism and agriculture. • Promote the adoption of non-polluting techniques for processing agricultural resources. • Provide economic incentives, social rewards, and other incentives for biologically diverse and organic farming	• Promote organic farming practices. • Work towards the integration of agriculture/livestock/forestry/fisheries production systems e.g. by increasing and improving the use of agricultural by-products in cattle fodder/feed. • Implement a decentralized financing system for the livestock production sector and support breeders' associations. • Develop a management plan for the pastoral land base that supports the preservation of pastoral ecosystems, a better distribution of water points and their management. • Support fish farming development cooperatives, with restocking and enhancement of indigenous fish species, and integrated fish-cum-crop systems. • Develop a network of windbreaks and green corridors in agricultural environments. • Implement a program to protect water sources in agricultural environments. • Link crop diversity and the Public Distribution System, by guaranteeing purchase of diversity of food crops from farmers and diversifying the products available in the PDS shops • Facilitating direct links between organic farmers and consumers, by providing or subsidising transportation, certification or quality checks, and marketing infrastructure	• Percentage of land devoted to agriculture/livestock/forestry. Number of farmers turning to organic, biodiversity agriculture • Animal density on the agricultural land base. • Quantity of pesticides and chemical fertilizers used per unit of cultivated land. Productivity of organic farms for each crop. Extent of in-situ (on farm) use of indigenous seeds and livestock Diversity of foods and other agricultural produce available in PDS shops and other outlets Number of consumer-producer networks

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
2. Energy **[Dept of Energy, Dept of Alternative Energy]** • Energy resources development. • Energy production and transportation. • Energy use, etc.	• Energy resources development, energy production and transportation (construction of powerhouses, transmission lines, etc.) may degrade ecosystems. • The use of fossil fuels is responsible, on a global scale, for climatic warming, and locally for loss of vegetation/animal species, urban smog. • Unplanned harvesting of fuelwood results in deforestation.	• Promote technologies that contribute to energy conservation. • Promote the environmentally sound development of energy resources. • Promote renewable energy resources. • Promote the use of energy forms other than wood in arid zones. Formulate appropriate siting and clearance policies, or strengthen those that already exist.	• Develop a strategy for energy safety and efficiency. • Develop a guide to good practices for energy development, production and transportation. • Implement an energy conservation information campaign. • Develop strategic plans for fuelwood supply. Develop biodiversity indicators and integrate them into EIA, clearance, and siting procedures; ensure public participation in all such procedures.	• Release rate of greenhouse gases per unit of energy. • Change in energy use efficiency, e.g. GNP per joule, and conservation. • Per capita consumption of fuelwood, its geographic redistribution in favourable patterns. • Quantity of fuelwood substituted. Recycling of wastes from energy production systems

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
3. Mining & Minerals **[Dept of Mines & Geology]** • Mining resources extractive activities. • Metallurgical processing of mining resources. • Inorganic chemistry. • Restoration of mining sites; etc.	• Mineral exploitation and mining industry processes result in contamination due to the discharge of extraction waste & the use of toxic chemicals, e.g. roadside dumps of stone slurry. • Mining sites involves extensive destruction of vegetation cover to allow access to resources or to satisfy employee's energy and housing needs. • When extractive activities have been completed, mining sites are not always rehabilitated. • Old metallurgical and steel processes are major pollutants.	• Promote ecologically sustainable mining excavating practices. • Promote the restoration of mining sites upon completion of excavating activities. • Promote the use of ecologically sound mineral processing industries. Formulate norms for mining, specifying that ecologically fragile areas are off-limits to mining.	• Develop environmentally sound guides to good practices for mining development and excavation. • Create reforestation areas around quarries and mines. • Promote the recycling of mining waste. • Introduce incentive measures for the restoration of mining sites upon completion of excavation activities. Strengthen EIA procedures, integrate biodiversity concerns into them, and ensure full public participation at each stage. Promote the restoration of mined sites to as close to original habitat as possible (based on thorough baseline studies before mining takes place). **Build implementation of environmental measures, and restoration, into mining proposal budget**	• Total area of sites restored. • Percentage of mineral substances salvaged and recycled from rejects and waste.

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
4. Industrial Development and Tourism **[Dept of Industries, Dept of Tourism]** • Industrial development by setting up industrial areas, laying down regulation codes, pollution standards. • Tourism.	• Industrial processes use a huge quantity of resources and may contaminate ecosystems through the discharge of wastes or pollutants, e.g. textile dying plants, smelters. • Tourist activities and infrastructures result in the degradation of natural environments of great ecological value. Siting of industries in ecologically fragile areas, causes destruction Extraction of resources for industrial use causes biodiversity loss	• Promote and support research to mitigate the impacts of pollution caused by industrial processes. • Promote ecologically sustainable types of tourism, including ecotourism. Formulate appropriate siting policy, with ecologically fragile areas being off-limits to large-scale industries. Ensure that all extraction of industrial raw material is done with prior EIAs, ensuring that over-exploitation or irreparable biodiversity loss does not take place.	• Implement a research program to mitigate the impacts of a given industrial process, and allocate it the necessary financial support. • Adopt a tourist code that takes the environment into account. Adopt stronger, clearer, legally backed measures for integrating biodiversity into industrial planning and operations. Formulate measures for full public participation at all stages of industrial (including tourism) planning and implementation, in particular of communities affected by industrial siting and operations or by tourism activities. Put into place tax or other fiscal measures to generate revenue from biodiversity-based industries	• Quantity and nature of pollutants discharged by industries from a given sector. • Number of companies certified in conformity with environmental requirements. • Number of tourist agencies/ operators/ companies/ hotels with an environmental code of ethics. Extent of local people's involvement in planning and decision-making. • Level of awareness / concern about biodiversity among industry/corporate sector and govt officials/deptt dealing with industrial policy Extent of revenue generation from industry, for biodiversity purposes

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
5. Urban / Rural Development **[Dept of Urban Development, RD, PWD, PHED]** • Land use planning. • Road building, infrastructure in rural areas, creation of water sources. • Demography : population planning. • Urban development. • Waste management. • Transport; etc.	• Accelerated urbanization has various impacts on urban centres and villages, including reduced access to potable water, poorer air and water quality, lack of management measures for solid waste, wastewater and rainwater, forest loss, draining out of wetlands, over-extraction of resources for urban consumption, land degradation for brick-making etc., and so on. • Expansion of the rural settlements usually has an adverse effect on nearby natural environments. • Demographic growth and migratory movements exert considerable pressures on natural resources, exceeding the environment's carrying capacity. • Modes of transportation, building of roads, etc. **destroy fragile ecosystems**; consume large quantities of fossil fuels and are responsible for the emission of numerous air pollutants, loss of species.	• Adopt an integrated land use planning approach that takes the environment's carrying capacity into account, and **marks** ecologically fragile areas (including areas of importance for wild and domesticated biodiversity) as being off-limits to destructive industrial-urban projects and processes. •: Development policies and programmes should be guided by informed choices and thorough analysis of likely impacts, ensuring that they do not lead to irreversible ecological damage. • Promote the creation of a network of green spaces with diversity in villages and cities. • Prevent the migration of rural populations, by ensuring adequate livelihood and employment options, redirecting investments to rural areas, focusing on regenerating land/water resources and enhancing the productivity of land, and so on.	• Develop and implement integrated regional and subregional land use/development plans. Government notifications requiring all departments to harmonise their plans and schemes, towards the integrated land use plans. Integrate biodiversity concerns into all rural development schemes and policies, including employment and welfare and PDS schemes. Implement rural development schemes for land, water, and forest regeneration, which provide employment, enhance biodiversity, and create food security. • Create an awareness about the importance of biodiversity and its conservation among populations, especially amongst decision-makers and policy-makers... • Improve the refuse collection and treatment system. • Develop and implement ecologically sensitive urban development plans, including creation and protection of green spaces in urban centres and villages, recycling, roof-top water.	• Number of land development plans implemented. Extent of protection of ecologically fragile areas due to implementation of integrated land use/development plans. • Urban population growth rate. • Total area of green spaces in the villages. • Total area of green spaces in the urban environment. Extent of employment created in environmental regeneration and management projects **in** rural development sector. • Rate of sprawl of urban centres. • Waste collection rate. • Wastewater treatment rate.

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
6. Conservation of Wildlife Resources **[Dept of Forests & Wildlife]** **In-situ** • Establishment and development of a network of protected areas that is representative of biological diversity. • Management of protected areas. • Maintenance or recovery of rare, threatened or vulnerable faunal and floral species. • Conservation, outside protected areas, of over-exploited species. ***Ex-situ*** • Establishment, development and management of ex-situ conservation sites (zoos, botanical gardens, arboretums, seed banks, seed	• Networks of protected areas are not representative of the diversity of ecosystems. • The inadequacy of financial, physical and human resources allocated to protected areas leads to gaps in their management, namely, a lack of blueprints and management plans, insufficient monitoring of wild populations of fauna and flora, etc. • Local communities are not aware of the role protected areas play in biodiversity conservation • Lack of awareness combined with poverty in communities may result in encroachment into protected areas for purposes such as agriculture, grazing, logging, poaching, etc. • Faunal or floral species are rare, threatened, vulnerable due to the degradation of natural environments, overexploitation, poaching, etc. • Insufficient data are available on species at risk and their exact status • Degradation, fragmentation or disappearance of wildlife habitats outside protected areas. Negative impact on people's livelihoods and rights, causing hostility, clashes with officials, wildlife-human conflict, erosion of traditional conservation practices and beliefs, and adverse social environment for	• Increase the number of protected areas to improve the representativeness of the network. • Maintain and develop the existing network of protected areas. • Increase **scientific** knowledge regarding the situation of species at risk, incorporating appropriate , traditional/ indigenous knowledge. • Maintain or restore rare or threatened animal and plant species. • Crack down on the illegal trade of threatened species and their products. **Ex-situ** • Protect races and varieties used to supply food and in agriculture by developing collections to conserve genetic material (gene and seed banks). • Promote research and training activities related to *ex-situ* conservation.	• Establish protected areas to fill gaps in the protected areas network. • Develop blueprints and management plans for protected areas. • Implement a program for the inventory and monitoring of biological resources in protected areas. • Develop a transboundary management strategy for protected areas. • Develop a management policy for protected areas with full involvement of local communities. • Undertake projects to reintroduce a given species. • Implement programs to restore wildlife habitats. Facilitate conservation of habitats and species by communities, on community and private lands and government lands. **Ex-situ** • Inventory and categorize the different races and varieties of livestock and crops. • Introduce a legislation to regulate the production, multiplication and	• Number of hectares or percentage of territory devoted to protected areas. • Number of protected areas with a management plan. • Proportion of protected floral or faunal species versus the number of species on the list of species at risk. • Number of recovery plans implemented. • Number of species on the list of threatened species found in protected areas. Shift in attitudes of officials and local people towards one another. Number of community conserved areas or sites with species protection by communities. Enhancement of key biological and physical indicators, including populations of critical species, water flow and

production centres, etc.). **Wildlife** • Knowledge of animal species exploited in their habitats. • Management of wildlife exploited through hunting, trapping, sport- and commercial fishing.	conservation. ***Ex-situ*** • Species used for cultivated farm crops are threatened by drought, changes in flood patterns, poor farming and pastoral practices, the introduction of new varieties of crops, etc. • *Ex-situ* conservation sites are faced with inadequate facilities, insufficient monitoring, and deficiencies in human, financial and physical resources. ***Wildlife*** • Knowledge of numerous animal species and their habitats is incomplete. • Species are poached to such an extent that their survival is threatened.	**Wildlife** • Improve knowledge about the state of animal populations, their demographic trends, habitats and degree of exploitation; use both traditional/indigenous and modern knowledge. . • Determine the current status of each wildlife species exploited and establish measures that support sustainable use. • Step up measures to reduce poaching.	distribution of improved seeds. • Create a seed bank. • Adopt a master plan for the development of botanical gardens and zoos. **Wildlife** • Develop and implement a blueprint for research on wildlife and wildlife habitats. • Create a data bank and atlas on wildlife.	regularity, and others. **Ex-situ** • Number of species in aquariums, zoos or botanical gardens. **Wildlife** • Number of poaching-related offences. • Number of ex-situ conserved / catalogued species.

Sector/Departments & Their Activities	How Its Activities May Degrade Biodiversity	Policy/Goal That May Help Conserve Biodiversity	Actions/Interventions That May Help Achieve Goal	Indicators of Progress Towards Goal
7. Forest Resources **[Forest Dept. Land Rev Dept]** • Logging and other forestry activities. • Forest management and reforestation. • Gathering of leaves, fruits, fungi, medicinal plants /NWFP.	• Knowledge of ligneous species and forest ecosystems is often incomplete. • Logging has many impacts, including pollution of waterways, modification of water regime balance, compaction and decreased fertility of soils, degradation or fragmentation of wildlife habitats, degradation of forests or permanent loss of forest cover. • Excessive harvesting and gathering for commercial purposes endangers certain species of great value (medicinal, nutritional, etc.). • Drought, desertification and bushfires are natural threats to forests.	• Improve knowledge about the state of ligneous and non-ligneous resources and the extent of their/harvest. • Promote measures that support the rational and sustainable exploitation of forest resources. • Improve exchanges of information, expertise and know-how in the field of forest resources management. Formulate ~~EIA~~ procedures for forestry operations, with biodiversity concerns built in. Encourage the use of indigenous/traditional knowledge relating to forests. Integrate biodiversity as a critical factor in all forestry codes/manuals/practices, including working plan guidelines.	• Identify forest resources, determine deforestation and regeneration rates and monitor the state of forest ecosystems. • Develop a national reforestation program and promote the natural regeneration of degraded sites. • Implement forest resources management methods based on annual reforestation and harvesting rates. • Develop forest harvesting methods that do not threaten water and wildlife resources. Involve local communities in all forestry planning and implementation programmes, as key decision-makers, where appropriate. Facilitate and encourage community initiatives in forest regeneration and conservation	• Harvesting rates of the allowable cut. • Reforestation rates. • Quantity of NWFP produced locally and sold on the market. Status ~~Extent~~ of biodiversity in forests where forestry operations are underway; including key biodiversity indicator species. Extent and quality of forest cover. Extent of shift away from timber towards NTFP, as goal for forest use and for livelihoods of local communities, where appropriate. Number of areas where communities are successfully managing forests

Appendix A

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Appendix C

Summary of Objectives and Actions

Protected Areas

Objective: Consolidate the structure and management of the existing protected area network.

Action 1. Complete the legal process of boundary demarcation and settlement of rights in the existing protected areas.

Action 2. Prepare management plans for all the PAs incorporating long term and short actions and get them appraised in a consultative and participatory process.

Action 3. Provide for adequate infrastructure, human and financial resources to strengthen the management of the existing protected areas.

Objective: Prepare a long-term plan of comprehensive, adequate and representative network of protected areas in the state.

Action 4. Assess the adequacy of the present network of protected areas and draw up a long-term plan to make the network CAR, and to enhance their role in biodiversity conservation.

Action 5. Develop policy measures and incentives for establishment of private and community protected areas in the state.

Objective: Develop policies and practices to ensure long-term sustainability of protected areas and their contribution to biodiversity conservation.

Action 6. Broaden community participation in management of the PAs, through actions initiatives such as ecodevelopment plans.

Action 7. Broaden the objectives of management of PAs to include the full range of issues enshrined in the CBD.

Action 8. Create a better physical and human context for managing the protected areas.

Action 9. Enhance the ecological and social value of the protected areas by increasing level of benefits flowing to the people in and around these areas.

Action 10. Set up a mechanism for continuous monitoring of the status, processes, trends, and management needs and practices in the protected areas of the state.

Domesticated Biodiversity

Objective: Identify, document and inventories the domesticated biodiversity of the state and recognise their unique value.

Action 11. Prepare inventory of domesticated and agrobiodiversity resources of the state including all the components of such biodiversity.

Action 12. Identify, delineate, map and study the principal agro-ecological zones of the state and the current and potential changes under way in their status, health and their environment, including measures to contain these changes.

Action 13. Research and document the prevalent traditional practices, knowledge of local farming methods in the state and how these contribute to conservation of domesticated biodiversity.

Objective: Develop policies and practises to ensure long term conservation of species and genetic diversity of domesticated species, and the supporting ecosystem components.

Action 14. Launch an awareness raising campaign focused on the value and importance of domesticated biodiversity and managed ecosystems, esp. among the practitioners and policy makers.

Action 15. Develop programme of incentives encouraging cultivation of local species and varieties of crops, livestock, fish, fruits and vegetables, esp. those that are being forgotten or abandoned.

Action 16. Change the sectoral policies in order to make biodiversity-rich farming practices profitable and productive vis-à-vis intensive monoculture.

Forest Biodiversity

Objective: Improve knowledge and understanding of biodiversity at all levels in the natural forests of the state.

Action 17. Launch a programme of identifying and inventorying the species and genetic diversity of flora and fauna found in the forests of the state.

Action 18. Identify and map the plant community ecosystems across all forest lands and classify these according to prevalent scientific system to understand their status, trends and changes under way.

Objective: Evolve forest management policies and practices to take into account the role of forests in conservation of biodiversity.

Action 19. Recognise and address the concern of biodiversity conservation as integral part of forest management by amending policies and legislation.

Action 20. Prepare a macro-level forest biodiversity management plan by delineating various types of management areas and assessing complementarities in their management in consultation with forest dwellers and surrounding populations.

Action 21. Adopt silvicultural practices in particular and sustainable forest management practices in general, to manage and work forests without causing loss of their biodiversity.

Action 22. Involve local populations in management of forests to ensure that they obtain benefits which will motivate them to support conservation of forest resources.

Objective: Strengthen the system of forest reserves by expanding its coverage and improving its protection.

Action 23. Demarcate the permanent forest estate of the state and enter it accordingly into all relevant public records to ensure its protection against encroachment and misuse.

Action 24. Bring additional land under the reserve system esp. those lands that are well-forested but do not constitute part of the formal forest reserve system.

Action 25. Encourage private and public land holders to manage the native vegetation by setting up private forest conservation areas.

Action 26. Launch a programme regenerating native forest vegetation in degraded areas in forest reserves.

Objective: Develop policies and practices to reduce pressures on forest lands and demand for forest produce.

Action 27. Evolve a sustainable energy use policy with special focus on bio-fuels in order to reduce pressure of fuelwood gathering from forests.

Action 28. Develop a programme of reducing grazing pressure on state's forest resources by addressing both the supply-side and demand-side problems.

Action 29. Launch a continuous programme of tree improvement so that tree cultivation becomes a viable economic activity vis-à-vis crop cultivation and the overall production of fuel, fibre, forage, timber and other ligneous products increases to meet demands.

Action 30. Identify economically important non-timber forest produce and develop these resources and enhance the overall economic value of these products to the local populations.

Action 31. Develop policies and incentives to encourage cultivation of trees in agroforestry systems as a mainstream economic activity.

Action 32. Develop policies, programmes and incentives for promoting recycling of forest based products and their effective substitution.

Action 33. Bring the wastelands outside forest reserves under social forestry programmes to increase their productivity.

Grassland Ecosystems

Objective: Survey and identify the important grassland ecosystems in the state, especially those which are still pristine and those not yet beyond the threshold of recovery, and prepare a baseline database of their diversity, functions, structures as well as pressures, threats, and trends of change.

Action 34. Prepare a detailed functional inventory of the major grassland habitats in the state, including catalogue of the biodiversity that they harbour.

Action 35. Set up a network of preserved or protected grasslands habitats, representative of the diversity of overall grassland resources of the state and mark these out of bound for general development activities, possibly by bringing these under the category of protected areas.

Objective: Develop policies and programmes for sound management and sustainable utilisation of the grassland resources of the state so as to meet the economic needs of the dependent populations while ensuring ecological integrity of these ecosystems.

Action 36. Put in place clear polices and guidelines regarding human manipulation of grassland ecosystems, esp. by way of utilisation, altering tree density, species composition, and introduction of exotics.

Action 37. Launch a programme of eradication of invasive species in major grassland habitats of the state with a carefully designed plan of ecological restoration.

Wetland Ecosystems

Objective: Identify, survey, and inventory the wetland resources of the state and assess their ecological, economic, scientific, and cultural importance to the people of state.

Action 38. Prepare a detailed inventory of the wetland resources of the state including a GIS enabled database capable of being used in project planning for conservation of these resources.

Action 39. Designate a representative network of critically important wetlands of the state and put in place a system of their management.

Objective: Put in place policies, programmes and guidelines for sustainable management of the wetland resources of the state while ensuring that the biodiversity of these resources and their ecological integrity is maintained.

Action 40. Prepare management plans for all the wetland sites in the state and have these management plans implemented over the next few years.

Action 41. Enforce mandatory requirements of Environment Impact Assessment of development projects situated in hydrological basins of wetland areas.

Action 42. Launch a programme of scientific research on the management of wetlands and dissemination of results among policy makers, and local populations, and the public at large.

Action 43. Provide economic incentives for conservation of wetlands esp. in situations where wetlands are closely linked with the livelihoods of local populations.

Action 44. Launch a programme of information, environmental education, and awareness (IEEA) about wetlands, their role in the state's ecological security and economic well-being, and the importance of their conservation.

Dryland and desert ecosystems

Objective: Improve knowledge and understanding of desert ecosystems and their biodiversity at all levels and set up a mechanism for continued monitoring of changes in ecosystems.

Action 45. Conduct surveys and research to build up databases and inventories of the components of biodiversity in the desert area.

Action 46. Identify the unique ecosystems at local level, representative of all habitat types, study their ecology, the external (physical and human) environment and driving forces (natural and anthropogenic) determining the trends and changes in these ecosystems.

Action 47. Conduct detailed scientific survey and study in the command and transboundary areas of Indira Gandhi Nahar Pariyojana where deep level ecological changes are taking place.

Objective: Develop policies, programmes and practices to ensure survival of the unique biodiversity resources of the desert region in view of its special significance.

Action 48. Develop a natural resource management plan for the desert region, with special focus on land use patterns, with a view to reducing the region's vulnerability to unpredicted change upon alteration of its unique habitats.

Action 49. Create a special regional network of protected areas that is comprehensive, representative, and adequate and that includes corridors, buffers and transboundary conservation areas.

Action 50. Declare a portion of the desert region as biosphere reserve by completing the current process under way.

Action 51. Develop policies and guidelines to regulate all sectoral programmes in the region, esp. land-based activities, by subjecting these to comprehensive review in view of their environmental impact in general and their impact on biodiversity in particular.

Action 52. Launch a regional programme of building awareness among the local populations, building complementarities with their local knowledge, and integrating biodiversity management with their livelihood.

Policy and support

Objective: Recognise the true value of biological diversity in the state's economic, social and cultural life and accord commensurate importance and matching commitment to its sustainable management.

Action 53. Develop and declare official goals, objectives and mission statement to guide the process of conservation of biodiversity in the state.

Action 54. Create institutional mechanism for overall planning and implementation of the biodiversity conservation programmes in the state.

Action 55. Incorporate the concerns of environmental conservation in general and biodiversity conservation in particular into development planning in the state at all stages, right through local plans to the district plans to the state level plan.

Objective: Develop state wide policy and guidelines to conserve biodiversity by avoiding waste or misuse of biodiversity.

Action 56. Develop guidelines and practices across all the sectors of development for taking into account the value of biodiversity and avoid its waste while planning and implementing their sectoral plans.

Action 57. Reform economic policies that directly or indirectly encourage loss of biodiversity.

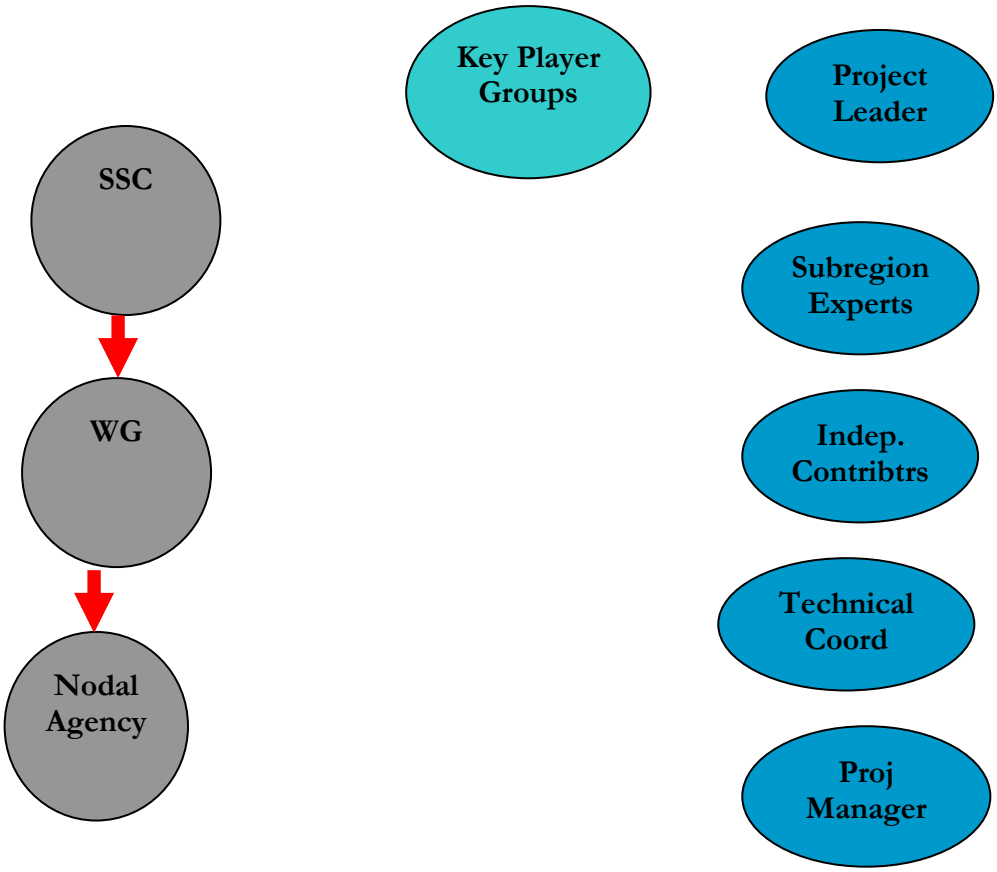
Action 58. Develop policies and practices to reduce demand for biological resources.

Appendix D

Process of evolving the BSAP

Structure

The Rajasthan Biodiversity Strategy & Action Plan has been evolved over the period of last one year invloving participation of a large number of persons, organisations and institutions. The state level institutional structure set up for the process is depicted in Figure 1 below.



The State Steering Committee is the apex body charged with the madate of ensuring tha process of preparation of BSAP in the state is participatory and that the commitment of the state government towards this process is strong. The SSC members (Table 1) include secretaries to the government in different departments that may have adverse impacts on the biological resources of the state.

Table 1: Members of the State Steering Committee for NBSAP Rajasthan

Development Commissioner	Chairman
Director HCM RIPA	Member
Principal Secretary, Environment	Member
Principal Secretary, Agriculture	Member
Principal Secretary, Finance	Member
Secretary, Forests	Member
Secretary, Planning	Member
Secretary, Revenue	Member
Director CAZRI	Member
Principal Chief conservator of Forests	Member
Chief Wildlife Warden	Member
Chief Conservator of Forests (Development)	Member Secretary

A working group was constituted for the state to draw up the strategy and to directly supervise the process of development of the SAP. The working group consistd of experts in the field of conservation, natural resource management and other related subjects. The members of the working group are listed in Table 2 below.

Table 2: Members of the Working Group for NBSAP Rajasthan

1.Shri Samar Singh, P-I, Hauz Khas, New Delhi
2.Prof. Shekhar Singh, Indian Institute of Public Administration, IPEstate, New Delhi
3.Shri Shantanu Kumar, Sirdaus Farm C-Zone Bye Pass, Jaipur
4.Shri H.S. Panwar, M-22, South City, Gurgaon
5.Shri V.D.Sharma C-101, Moti Marg, Bapu Nagar, Jaipur
6.Smt. Madhu Sarin, 48,Sector 4,Chandigarh
7.Dr S M Mohnot, Director Desert School of Sciences , Jodhpur
8.Smt. Neelima Khaitan ,Seva Mandir,Old Fatehpura,Udaipur
9.Shri Rajendra Singh, Tarun Bharat Sangh, Bheekampura, Alwar
10.Shri Devi Lal Vyas, P.E.D.O , V&P-Mada, Dist.Dungarpur
11.Dr.D N Panday IFS, Associate Professor, IIFM, Nehru Nehru Nagar PO Box357, Bhopal
12.Shri Harsh Vardhan, C 158 A, Dayanand Marg, Tilak Nagar, Jaipur
13.Shri D.P.Govil, 4-16, Jawahar Nagar, Jaipur

The state's geographic scope being vast it was decided that the state be divided into three different geographic regions and an expert be entrusted the task of preparing a report on each region. The three regions identified were:

Table 3: List of regions and regional experts

Region	Expert
1. The Thar Desert	Dr S M Mohnot, School of Desert Sciences, Jodhpur
2. The Aravali hills	Mr V D Sharma, President, Prayavaran Prahari, Jaipur
3. The Eastern plains and Hadoti plateau.	Mr S K Verma, Chairman, Green Arc Society, Udaipur.

Consultations

The process involved consultations with the following distinct sections of soceity.

1. Experts and scientists in the field of conservation and related fields.
2. Local communities and community leaders.
3. Local knowledge holders in the field of biodiversity.
4. Panchayats and local leadership
5. Village Forest Protection & Management Committees
6. Policitcal leadership
7. Academia
8. School teachers and students
9. NGOs and voluntary agencies
10. Mediapersons
11. Industry and coporate sector
12. Officers of various governemtnt departments
13. Forest officers esp protected area managers
14. Grassroots level workers in forest, agriculture and related departments
15. Women and vulnerable sections of society

Consultations were organised at different levels. There were several inhouse informal discussions held during the first three months on various thematic aspects. Later Many of the consulations were organised by the regional experts during their own process of formulation of regional plans. The state nodal agency organised those consultations which spanned the entire state.

The state process was also linked with the national process through participation of the nodal agency and regional experts in national consultation events. The state team also participated in the Mid term National Workshop at New Delhi and Western Region workshop in Ahmedabad orgnised under the national process.

Public Participation

In the course of preparation of BSAP for the Aravallis a number of meetings with the villagers and public hearing cum workshops were organized for involving different sections of the village community. Help of Village Forest Protection Committees, Gram Panchayats, NGOs, and Forest Department and other departments, was taken to ensure participation and involvement of all sections of the society. These meetings are summarised in the table below.

SN	Date	Place of meeting	Participants	Subject discussed
1	6.11.2000	Jaipur	Members of EWG, Scientists working on Biodiversity, NGOs & Forest Officers.	Discussions about the NBSAP Project, scope of coverage, and methodology to be adopted for the process.
2.	8.12.2000	Udaipur	Members of EWG, Scientists of Udaipur University working on Biodiversity, NGOs, and Village level organizations and Forest Officers.	Discussions about the formats for the collection of field data and identification of suitable individuals for collection of data in Southern Aravallis.
3.	30.12.200	Ajmer	Members of EWG, Forest Officers, NGOs, and knowledgeable individuals having good contacts with villagers.	Discussions about the NBSAP Program and identification of individuals who could get the information from the villagers for different villages in Central Aravallis.
4.	5.1.2001	Sariska (Alwar)	Members of EWG, Forest Officers, NGOs.	Discussions about the NBSAP Project and identification of individuals for collection of information in the prepared questionnaires from the selected villages.
5.	11.1.2001	Raoli wildlife sanctuary Rajsmand	Members of EWG, Forest Officers, NGOs, and knowledgeable individuals.	Discussions about the NBSAP process, and identification of individuals for collection of information from the villagers of Raoli Wildlife sanctuary.
6.	5.2.2001	Udaipur	Working Group members, Forest Officers, NGOs, Scientists, village organizations.	Co-coordinator reviewed the information collected by various individuals. Some additional villages were also selected for collection of biodiversity information.
7.	6.2.2001	Palyakhera	Villagers, members of VFPMCs, local leaders, various stakeholders, members of EWG, subject matter specialists, NGOs, and Forest Officers.	Exchange of views on the status of biodiversity of the area, people's perception, and methods for sustainable utilization of indigenous biodiversity. Information about ethnic medicines and folk knowledge etc. etc.
8.	7.2.2001	Kewda (Udaipur)	Villagers, elected members of Panchayat, members of VFPMC, school teachers, members of Eco Working Group, Forest Officers, NGOs etc.	Obtained people's perception of sustainable utilization of biodiversity, collected information about ethno-botany, ethno-zoology, and ethno-forestry, information collected by Shri Damodar Tulsia was cross checked in the meeting and was found to be correct.
9.	8.2.2001	Mt. Abu (Sirohi)	Working Group members, Forest Officers, Local NGOs, Press people and knowledgeable local people.	Coordinator talked about the NBSAP Project, its objectives and the process, identified villages from where information was to be collected in the questionnaires and identified the persons who will do the job.

Public Participation (Continued)

S N	Date	Place of meeting	Participants	Subject discussed
10.	11.2.2001	Sadri (Pali)	Forest Officers, members of Eco Working Group and knowledgeable local people.	Discussed the NBSAP Project – objectives and methodology for collection of information in the questionnaires, identified people and villages for collection of information and mass contact.
11.	16.4.2001	Gandhi Nagar (Gujrat)	Working Group members and Forest Officers of Gujrat State.	Exchange of views about the NBSAP Project, people's participation and collection of data from Aravalli areas of Gujrat State.
12.	20.4.2001	Jaipur.	Eco Working Group members, University scientists, NGOs, and knowledgeable individuals.	Discussed the methodology adopted for mass contact and compilation of information relating to NBSAP Project. The draft Action Plan is likely to take at least three more months in finalization.
13	10.5.2001	Bujarail, Raoli Rajsamand	Members of EWG, Villagers, Elected members of Panchayat, & Forest Officers	Collected information about the status of forests, agriculture and people's aspirations about restoring the biodiversity of the area.
14	23.5.2001	Raghunathpura (Alwar)	Members of EWG Aravalli, Aravari Sansad, villagers,	Collected information about the status of the existing Biodiversity in natural forests and in agricultural fields, problems of mining etc.
15	25.5.2001	Bagheri & Chandela villages.	Members of EWG, Filming team NBSAP, Sarpanch, villagers, & Forest officers	Information about the bio-diversity, people's suggestions for restoring the biodiversity and its uses.
16	26.5.2001	Hetemji village. (Mt. Abu)	Members of EWG, Filming unit of NBSAP Villagers, forest officers	Information about the loss of indigenous flora & fauna, people's aspirations for rehabilitation.
17	26.5.2001	Arna illage (Mt. Abu)	Same as above	Same as above
18	26.6.2001	Gurgaon Haryana	Members of Haryana Nodal agency, Villagers of Haryana, members of *Mahila Mandals* of Haryana, Officials of Agriculture, Animal husbandry, Forest Department,	Discussed the present status of biodiversity of Aravallis in Haryana, the agricultural diversity, the status of wild and domesticated animals, legal help in preservation of the forests that have been regenerated in Haryana Aravallis.
19	28.8.2001	Bharev & Sihad villages Dhariawad	Members of EWG, Villagers, Members of Village Forest Protection and Management Committees	Information about the status of biodiversity of the forests, and agriculture. Working of the Village Forest Protection Committees.
20	13.10.2001	Bhanpur Kalan (Jaipur)	Members of EWG, Villagers, Members of VFPMC, Forest officers	Talked to the villagers and collected information about the Biodiversity related subjects. Forest plantations raised by VFPMC have started giving revenue.

Meetings

Meetings of the SSC and the Working group were organised from time to time to review the progress made and to guide the process of development of strategy. The following meetings were held in Jaipur in this regard.

Table 4: Meetings of SSC and the Working Group under NBSAP Rajasthan

Meeting	Date
State Working Group	2 May 2001
State Steering Committee	7 June 2001
Working Group Review Meeting	7 August 2001
Mid-term Workshop New Delhi	13 - 15 June 2001
Working Group Review Meeting	15 Dec 2001
Intersectoral Integration Workshop	4 Sep 2001
Western Region Workshop Ahmedabad	8 - 10 Nov 2001
Worskhop on Desert Biodiversity	18 Feb 2002
State Steering Committee	19 Feb 2002
State Task Force on Sustainable Development	14 March 2002

Consultations through invitation

A series of consultations took place via written communication. The Call for Participation prepared by the national NBSAP team and other documents were disseminated among professionals, scientists, government officers, political leaders, media persons and and NGOs. Posters and literature on the NBSAP process was circulated to all the collectors of the 32 districts with invitation to participate in the process. Many collectors responded and gave valuable suggestions.

Literature on project was also distributed to 98 identified experts in the state. These experts incuded independent consultants, academicians, scientists working in research institutions, and other experts. A large number of interested persons personally visited the biodiversity cell in CMS-RIPA and they contributed to the process through personal discussions. Invitation to participate in the process were also sent to all the MLAs and the pradhans in the state to seek their inputs. Many of them responded with interesting ideas that enriched the process of evolution of the state's strategy.

Appendix E

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Appendix F

List of Rare and Threatened Plants of Rajasthan

Species	Type	Distribution
Abutilon bidentatum Hochst. var. *major* (Blatt. & Hallb.) Bhandari, Fl. Indian Desert 60. 1978 Vern. Name: Imarti (Malvaceae).	India: Rajasthan, Amarsagar, Jaisalmer, Blatter & Hallberg 5644 (BLAT)	Endemic to W. Rajasthan in Barmer, Jaisalmer and Jodhpur districts.
A. fruticoum Guill & Perr. var. *chrysocarpa* Blatt. & Hallb. In Journ. Bombay Nat. Hist. Soc. 26:277, 1918 (Malvaceae).	India: Rajasthan, Vinjorai, on rocks Jaisalmer dt., Blatter & Hallberg 5660 (BLAT)	Endemic to W. Rajasthan in Jaisalmer District.
Alysicarpus monilifer (L.) DC.var. *venosa* Blatt. & Hallb. In Journ. Bombay Nat. Hist. Soc. 26: 240. 1918. (Fabaceae).	India: Rajasthan, Bada Bag, Jaisalmer, Blatter & Hallberg 7226 (Lectotype), 7225 (BLAT)	Endemic to W.Rajasthan in Jaisalmer district
Ammania desertorum Blatt. & Hallb. In Journ. Bombay Nat. Hist. Soc. 25: 213. 1918 & 26; 527.1919 Vern-name: Moto-Jal-Bhangro(Lythraceae).	India: Rajasthan, Devikot, Jaisalmer Dt., Blatter & Hallberg 3341; near Devukit, Jaisalmer dt., Blatter & Hallbert 3342, 3343; Vinjorai, Jaisalmer dt., Blatter & Hallberg 3344; Kotda near Seu, Jodhpur dt., Blatter & Hallberg 3345; near Badka on wet ground, Blatter & Hallberg 3346, 3347 (BLAT).	Pakistan, India (Rajasthan, Gujarat).
Anogeissus sericea Branids var *nummularia* King ex Duthie, Fl. Upper Gang. Pl. 1:340. 1903; Scott in Kew Bull. 33:559. 1979 (Combretaceae).	India: Rajasthan, Duthie, 4663, (K, BM, both Isotypes).	W. Rajasthan, Punjab and Gujarat. A very rare species.
Anticharis glandulosa Asch. var. *caerulea* Blatt. & Hallb. (in Journ. Bombay Nat. Hist. Soc. 26: 549. 1919 nom. nud.) ex Santapau in Journ. Bombay Nat. Hist. Soc. 56: 280. 1959: Bhandari, Fl. Indian Desert 279. f. 103 1978 (Scrophulariaceae).	India : Rajasthan, Jaisalmer, on rocks, Blatter & Hallberg 10284 (Lectotype); Bada Bag, Jaisalmer, Blatter & Hallberg 10282; Jaisalmer rocky plateau, Blatter & Hallberg 10283; Vinjorai, Jaisalmer dt., Blatter & Hallberg 10285 (BLAT)	Endemic to W. Rajasthan in Jaisalmer district.
Aristida royleana Trin. & Tupr. Sp. Gram. Stip. 160. 1842 & in Mem. Acad. Petersb. Ser. 6.7: 160. 1843 (Poaceae)		Pakistan (Baluchistan, Sind, NWFP), N.W. India. A very rare species.
Barleria prionitis L. var. *diacantha* Blatt. & Hallb. in Journ. Bombay Nat. Hist. Soc. 26: 811. 1919 (non *B. diacantha* Nees 1847): Bhandari, Fl. Indian Desert 299. 1978(Acanthaceae).	India: Rajasthan, Barmer, on rocky hill side, Blatter & Hallberg 9165 This specimen is no longer available in Blatter Herbarium and is presumably lost or destroyed.	Endemic to W. Rajasthan in Barmer and Jodhpur disticts.
Bonnaya baracteoides Blatt. & Hallb. in Journ. Bombay Nat. Hist. Soc. 25: 416. 1918: Bole & Almeida in Journ. Bombay Nat. Hist. 74 : 617. 1979	India : Rajasthan, Mt. Abu, Sirohi Dt., Blatter & Hallberg 1514, Lectotype (BLAT), 1515, 1516	Endemic to Rajasthan in Mt. Abu.

(Scrophulariaceae).		
Caralluma edulis (Edgew.) Benth. & Hook. F. Gen. Pl. 2:782. 1876; Bhandari in Journ. Bombay Nat. Hist. Soc. 68: 296. 1971 & Fl. Indian Desert 220, f. 70. 1978. *Boucerosia edulis* Edgew in Journ. Linn. Soc 6: 205 Pl 1. f. 1-8. 1962. Vern. Name: Pimpa (Asclepiadaceae).		Pakistan, India (W. Rajasthan in Jaisalmer district). Very rare in W. Rajasthan.
Cenchrus prieurii (Kunth) Maire var *scabra* Bhandari, Fl. Indian Desert 395. 1978 (Poaceae).	India: Rajasthan Vinjorai, Jaisalmer dt., Blatter & Hallbert 6675 (BLAT)	Not collected after the types collection, endemic.
Melhania futteyporensis Munro var. *major* (Blatt. & Hallb.) Santapau in Journ. Bombay Nat. Hist. Soc. 56: 278. 1959 (Sterculiaceae).	India: Rajasthan, Barmer, rocks, Blatter & Hallberg 7286 (Lectotype), 7259, 7296 (BLAT)	Barmer, Chittourgarh, Jodhpur and Kota districts, Rajasthan.
M. magnifolia Blatt. & Hallb. in Journ. Bombay Nat. Hist. Soc. 26: 228. 1918. (Sterculiaceae).	India: Rajasthan, Kailana, Jodhpur, Blatter & Hallberg 7285 (Lecto-type), 7279; Osian, Jodhpur dt., Blatter & Hallberg 7280 (BLAT)	Barmer, Jodhpur, Kota and Jhalawar districts, Rajasthan,
Monsonia heliotropioides (Cav.) Boiss. Pl. Orient. 1: 879. 1867. Vern. Mame: Mayur-shikha (geraniaceae).		Egypt, Pakistan (SindP, India (W.Rajasthan in Bikaner District). Very rare specie
Pavonia arabica Hochst. ex Steud. var *glutinosa* Blatt. & Hallb. In Journ. Bombay Nat. Hist. Soc. 26: 227. 1918 (Malvaceae).	India: Rajasthan, Kailana, Jodhpur, Blatter & Hallberg 5669 (Lecto-type), 5668; Bada Bag, Jaisalmer, Blatter & Hallberg 4667; Barmer, on rocks, Blatter & Hallberg 5685 (BLAT).	Endemic to W. Rajasthan in Barmer, Jaisalmer and Jodhpur Districts.
P. arabica Hochst. Ex Steud. var. *massuriensis* Bhandari, Fl. Indian Desert 69. 1978 (Malvaceae).	India: Rajasthan, common on rocky plateau of Massuria, Jodhpur, Bhandari 4A (JAC).	Known only from the type locality, endemic.
Psoralea odorata Blatt. & Hallb. in Journ. Bombay Nat. Hist. Soc. 26: 238. Vern. Name : Jhil (Fabaceae).	India: Rajasthan, Barmer sand, Blatter & Hallberg 7005 (Lectotype); near Kotda, Blatter & Hallberg 7003; Devikot, Jaisalmer dt., Blatter & Hallberg 7004; near Bap, Jodhpur dt., Blatter &Hallberg 7002 (BLAT).	Pakistan, India (W. Rajasthan).
Pulicaria rajputanae Blatt. & Hallb. in Journ. Bombay Nat. Hist. Soc. 26: 535. 1919. Vern. Name: Bhola-ligru(Asteraceae).	India: Rajasthan, Balsamand, Jodhpur, Blatter & Hallberg 10039 (Lectotype); Kailana, Jodhpur	

Appendix G

List of medicinal plants of Rajasthan

	Name of Species	Family
1.	*Abelmoschus moschatus*	Malvaceae
2.	*Abelmoschus esculentus*	Malvaceae
3.	*Abrus precatorius*	Fabaceae
4.	*Abutilon indicum*	Malvaceae
5.	*Acacia nilotica*	Minosaceae
6.	*Acacia catechu*	Mimosaceae
7.	*Acacia farnesiana*	Mimosaceae
8.	*Acacia leucophloea*	Mimosaceae
9.	*Acacia pennata*	Mimosaceae
10.	*Acacia Senegal*	Mimosaceae
11.	*Acalypha indica*	Euphorbiaceae
12.	*Achyranthes aspera*	Amaranthaceae
13.	*Actiniopteris radiata*	Actiniopteridaceae
14.	*Adhatoda zeylanica*	Acanthaceae
15.	*Adiantum incisum*	Adiantaceae
16.	*Adiantum lunulatum*	Adiantaceae
17.	*Adiantum capills-veneris*	Adiantaceae
18.	*Adlantum caudatum*	Adiantaceae
19.	*Aegle marmelos*	Rutaceae
20.	*Aerva lanata*	Amaranthaceae
21.	*Agava americana*	Agavaceae
22.	*Ageratum conyzolers*	Asteraceae
23.	*Ailanthus excelsa*	Simaroubaceae
24.	*Albizia lebbeck*	Mimosaceae
25.	*Alhagi maurorum*	Febaceae
26.	*Allium cepa*	Liliaceae
27.	*Allium sativum*	Liliaceae
28.	*Aloe vera*	Liliaceae
29.	*Alysicarpus vaginalis*	Fabaceae
30.	*Amaranthus caudatus*	Amaranthaceae
31.	*Amaranthus spinosus*	Amaranthaceae
32.	*Ammannia*	Lythraceae
33.	*Ampelocissus*	Vitaceae
34.	*Anogeissus latifolia*	Combretaceae
35.	*Alangium salvifollum*	Alangiaceae
36.	*Anisomeles indica*	Lamiaceae
37.	*Annona squamosa*	Annonaceae
38.	*Argemone mexicana*	Papaveraceae
39.	*Argyreia nervosa*	Convolvulaceae

40.	*Argyreia strigosa*	Convolvulaceae
41.	*Arisaema tortuosum*	Araceae
42.	*Aristolochia bracteolata*	Aristolochiaceae
43.	*Aristolochla indica*	Aristolochiaceae
44.	*Asparagus racemosus*	Liliaceae
45.	*Asparagus scandena*	Liliaceae
46.	*Azadiracta Indica*	Maliaceae
47.	*Bacopa monnieri*	Scrophulariaceae
48.	*Balanites aegytiaca*	Balanitaceae
49.	*Barleria acanthoides*	Acanthaceae
50.	*Barlerla prionitis*	Acanthaceae
51.	*Bauhinia racemosa*	Caesalpiniaceae
52.	*Bauhinia variegata*	Caesalpiniaceae
53.	*Bergia suffruticosa*	Elatinaceae
54.	*Blepharis linariaefolia*	Acanthaceae
55.	*Blumea lacera*	Asteraceae
56.	*Boerhavia diffusa*	Nyctaginaceae
57.	*Bombax celiba*	Bombacaceae
58.	*Boswellia serrata*	Burseraceae
59.	*Brachiaria ramosa*	Poaceae
60.	*Bridelia retusa*	Euphorbiaceae
61.	*Bridelia squamosa*	Euphorbiaceae
62.	*Bryonopsis laciniosa*	Cucurbitaceae
63.	*Butea monosperma*	Fabaceae
64.	*Cadaba fruticosa*	Capparaceae
65.	*Calligonum polygonoides*	Polygonaceae
66.	*Calotopis procera*	Asclepiadaceae
67.	*Calotropis gigantea*	Asclepiadaceae
68.	*Capparis decidua*	Capparaceae
69.	*Capparis grandis*	Capparaceae
70.	*Capparis sepiaria*	Capparaceae
71.	*Capsicum annuum*	Solanaceae
72.	*Carica papaya*	Caricaceae
73.	*Carissa congesta*	Apocynaceae
74.	*Casearia elliptica*	Flacourtiaceae
75.	*Cassia absus*	Caesalpiniaceae
76.	*Cassia auriculata*	Caesalpiniaceae
77.	*Cassia fistula*	Caesalpiniaceae
78.	*Cassia obtusifolia*	Caesalpiniaceae
79.	*Cassia occidentalis*	Caesalpiniaceae
80.	*Cassia sena*	Caesalpiniaceae
81.	*Cassia sophera*	Caesalpiniaceae
82.	*Cassia tora*	Caesalpiniaceae
83.	*Cassisa mimosoides*	Caesalpiniaceae

84.	*Cayratia triafolia*	Vitaceae
85.	*Celastrus paniculatus*	Celastraceae
86.	*Centratherum antheiminticum*	Asteraceae
87.	*Centella asiatica*	Apiaeae
88.	*Ceropegia bulbosa*	Asclepiadaceae
89.	*Chenopodium album*	Chenopodiaceae
90.	*Chlorophytum tuberosum*	Liliaceae
91.	*Chrozophora rotteri*	Euphorbiaceae
92.	*Cicer arietinum*	Fabaceae
93.	*Cissampelos pareira*	Menispermaceae
94.	*Cissus quadrangularis*	Vitaceae
95.	*Cistanche tubulosa*	Orobanchaceae
96.	*Citrullus colocynthis*	Cucurbitaceae
97.	*Citrullus lanatus*	Cucurbitaceae
98.	*Citrus limon*	Rutaceae
99.	*Citrus maxima*	Rutaceae
100.	*Cleome brachycarpa*	Cleomaceae
101.	*Cleome gynandra*	Cleomaceae
102.	*Cleome viscosa*	Cleomaceae
103.	*Clerodendrum phlomoidis*	Verbenaceae
104.	*Clitoria ternatea*	Fabaceae
105.	*Cocculus hirsutus*	Menispermaceae
106.	*Cocculus pendulus*	Menispermaceae
107.	*Coix lacryma-jobi*	Poaceae
108.	*Commelina benghalensis*	Commelinaceae
109.	*Commiphora wightii*	Burseraceae
110.	*Convolvulus auricomus*	Convolvulaceae
111.	*Convolvulus prostratus*	Convolvulaceae
112.	*Corbichonia decumbens*	Molluginaceaae
113.	*Corchorus fascicularis*	Tiliaceae
114.	*Corhours depressus*	Tiliaceae
115.	*Cordia dichotoma*	Ehretiaceae
116.	*Cordia gharaf*	Ehretiaceae
117.	*Costus speciosus*	Zingiberaceae
118.	*Crateva nurvala*	Capparaceae
119.	*Cressa cretica*	Convolvulaceae
120.	*Crotalaria burhia*	Fabaceae
121.	*Croton bonplandianum*	Euphorbiaceae
122.	*Cucumis melo*	Cucurbitaceae
123.	*Cucumis prophetarum*	Cucurbitaceae
124.	*Cucurbita moschata*	Cucurbitaceae
125.	*Cuminum cyminum*	Apiaceae
126.	*Curculigo orchioides*	Hypoxidaceae
127.	*Curcuma amada*	Zingiberaceae

128.	*Curcuma longa*	Zingiberaceae
129.	*Cuscuta hyalina*	Cuscutaceae
130.	*Cuscuta reflexa*	Cuscutaceae
131.	*Cyamopsis tetragonoloba*	Fabaceae
132.	*Cynodon dactylon*	Poaceae
133.	*Cyperus rotundus*	Cyeraceae
134.	*Dactyloctenium aegyptium*	Poaceae
135.	*Dalbergia sissoo*	Fabaceae
136.	*Datura innoxia*	Solanaceae
137.	*Daucas carota*	Apiaceae
138.	*Delonix elata*	Caesalpiniaceae
139.	*Dermodium velutinum*	Fabaceae
140.	*Dendrocalamus strictus*	Poaceae
141.	*Dendrophthoe falcata*	Loranthaceae
142.	*Diospyros cordifolia*	Ebenaceae
143.	*Dichanthium huegallii*	Mimosaceae
144.	*Dichrostachys cinerea*	Mimosaceae
145.	*Dicoma tomentosa*	Asteraceae
146.	*Digera muricata*	Amaranthaceae
147.	*Diplocyclos palmata*	Cucurbitaceae
148.	*Echinops echinatus*	Asteraceae
149.	*Eclipta alba*	Asteraceae
150.	*Ehretia laevis*	Ehretiaceae
151.	*Elytraria acaulis*	Acanthaceae
152.	*Enicostema axillare*	Gentianaceae
153.	*Ensete superbum*	Musaceae
154.	*Euphobia hirta*	Euphorbiaceae
155.	*Euphorbia caducifolia*	Euphorbiaceae
156.	*Euphorbia heyneana*	Euphorbiaceae
157.	*Euphorbia indica*	Euphorbiaceae
158.	*Euphorbia neriifolia*	Euphorbiaceae
159.	*Euphorbia tiucalli*	Euphorbiaceae
160.	*Evolvulus alsinoides*	Convolvulaceae
161.	*Fagonia indica*	Zygophyllaceae
162.	*Fagonia schweinfurthil*	Zygophyllaceae
163.	*Feronia limonia*	Rutaceae
164.	*Ferula asafoetida*	Apiaceae
165.	*Ficus benghalensis*	Moraceae
166.	*Ficus hispida*	Moraceae
167.	*Ficus racemosa*	Moraceae
168.	*Ficus religiosa*	Moraceae
169.	*Ficus virens*	Moraceae
170.	*Gardenia turgida*	Rubiaceae
171.	*Gisekia pharanacioides*	Mulluginaceae

172.	*Glinus lotoides*	Mulluginaceae
173.	*Globba marantina*	Zingiberaceae
174.	*Gloriosa superba*	Liliaceae
175.	*Gmelina arborea*	Verbenaceae
176.	*Grewia flavescens*	Tiliaceae
177.	*Grewia hirsuta*	Tiliaceae
178.	*Grewia orientalis*	Tiliaceae
179.	*Grewia Subinaequalis*	Tiliaceae
180.	*Grewia tenax*	Tiliaceae
181.	*Gymnema sylvestre*	Aseepiadaceae
182.	*Haldina cordifolia*	Rubiaceae
183.	*Halicteris isora*	Sterculiaceae
184.	*Haloxylon recurveum*	Chenopodiaceae
185.	*Heliotropium europaeum*	Boraginaceae
186.	*Hemiadelphis polyspermus*	Acanthaceae
187.	*Hemidesmus indicus*	Periplocaceae
188.	*Heteropogon contortus*	Poaceae
189.	*Hibiscus rosa- sinensis*	Malvaceae
190.	*Holarrhena pubescens*	Apocynaceae
191.	*Holoptelea integrifolia*	Ulmaceae
192.	*Hygrophila auriculata*	Acanthaceae
193.	*Hymenodictyon excelsum*	Rubiaceae
194.	*Hypodematium crenatum*	Aspidiaceae
195.	*Ichnocarpus frutescens*	Apocynaceae
196.	*Indigofea tinctoria*	Fabaceae
197.	*Indigofera argentea*	Fabaceae
198.	*Indigofera cordifolia*	Fabaceae
199.	*Indigofera linifolia*	Fabaceae
200.	*Indigofera linnaei*	Fabaceae
201.	*Indigofera oblongifolia*	Fabaceae
202.	*Ipomoea nil*	Convolvulaceae
203.	*Ipomoea obscura*	Convolvulaceae
204.	*Ipomoea pes-tigridis*	Convolvulaceae
205.	*Jasminum grandiflorum*	Oleaceae
206.	*Jatropha curcas*	Euphorbiaceae
207.	*Kirganelia reticulata*	Euphorbiaceae
208.	*Lannea coromandelica*	Anacardiaceae
209.	*Lantana camara*	Verbenaceae
210.	*Launaea procumbens*	Asteraceae
211.	*Launaea resedifolia*	Asteraceae
212.	*Lawsonia inermis*	Lythraceae
213.	*Leeea macrophylla*	Leeaceae
214.	*Leonotis nepetiifolia*	Lamiaceae
215.	*Lepidagathis cristata*	Acanthaceae

216.	*Lepidagathis trinervis*	Acanthaceae
217.	*Leptadenia pyrotechnica*	Asclepiadaceae
218.	*Leptadenia reticulata*	Asclepadaceae
219.	*Leucas aspera*	Lamiaceae
220.	*Leucas cephalotes*	Lamiaceae
221.	*Leucas urticaefolla*	Lamiaceae
222.	*Limnophila indica*	Scrophulariaceae
223.	*Luffa echinata*	Cucurbiaceae
224.	*Lycium barbarum*	Solanaceae
225.	*Madhuca indica*	Sapotacaeae
226.	*Mallotus philippensis*	Euphorbiaceae
227.	*Malva parviflora*	Malvaceae
228.	*Mangifera indica*	Ancardiaceae
229.	*Marsdenia tenaclssima*	Asclepiadaceae
230.	*Martynila annua*	Martyniaceae
231.	*Maytenus emarginatus*	Celastraceae
232.	*Melia azedarach*	Meliaceae
233.	*Mentha spicata*	Lamiaceae
234.	*Miliusa tomentosa*	Annonaceae
235.	*Mimosa hamata*	Mimosaceae
236.	*Mimusops elengi*	Sapotaceae
237.	*Mollugo cerviana*	Molluginaceae
238.	*Momordica charantia*	Cucurbitaceae
239.	*Monochoria vaginalis*	Pontederiaceae
240.	*Moringa oleifera*	Moringaceae
241.	*Mucuna pruriens*	Febaceae
242.	*Musa paradisiaca*	Musaceae
243.	*Nelumbo nucifera*	Nelumbonaceae
244.	*Nerium oleander*	Apocynaceae
245.	*Nicotiana tabacum*	Solanaceae
246.	*Nymphaea nauchali*	Nymphaeaceae
247.	*Nymphoides hydrophylla*	Menyanthaceae
248.	*Nymphoides indica*	Menyanthaceae
249.	*Ochthochloa compressa*	Poaceae
250.	*Ocimum canum*	Lamiaceae
251.	*Oligochaeta ramosa*	Asteraceae
252.	*Opuntia elatior*	Cactaceae
253.	*Oroxylum indicum*	Bignoniaceae
254.	*Oxalis corniculata*	Oxalidaceae
255.	*Panicum antidotale*	Poaceae
256.	*Papaver somnifera*	Papaveraceae
257.	*Pedalium murex*	Pedaliaceae
258.	*Pegolettia senegalensis*	Asteraceae
259.	*Pentanema indicum*	Asteraceae

260.	*Pergularia daemia*	Asclepiadaceae
261.	*Peristrophe paniculata*	Acanthaceae
262.	*Phoenix sylvestris*	Arecaceae
263.	*Physalls minima*	Solanaceae
264.	*Phyllanthus emblica*	Euphorbiaceae
265.	*Phyllanthus fratrnus*	Euphorbiaceae
266.	*Piper betle*	Piperaceae
267.	*Piper nigrum*	Piperaceae
268.	*Pistia stratiotes*	Araceae
269.	*Plantago ovata*	Plantaginaceae
270.	*Plumbago zeylanica*	Plumbaginaceae
271.	*Polyathia longifolia*	Annonaceae
272.	*Polygonum plebeium*	Polygonaceae
273.	*Pongamia pinnata*	Febaceae
274.	*Prosopis cineraria*	Mimosaceae
275.	*Psoralea crylifolia*	Febaceae
276.	*Pterocarpus marsupium*	Febaceae
277.	*Pueraria tuberosa*	Febaceae
278.	*Pulicaria crispa*	Asteraceae
279.	*Punica granulata*	Punicacaeae
280.	*Raphanus sativus*	Brassicaceae
281.	*Rhinacanthus nasutus*	Acanthaceae
282.	*Rhynchosia minima*	Fabaceae
283.	*Ricinus communis*	Euphorbiaceae
284.	*Rungia repens*	Acanthaceae
285.	*Saccharum officinarum*	Poaceae
286.	*Sagittaria sagittifolia*	Alismataceae
287.	*Salvadora oleoides*	Saivadoraceae
288.	*Salvadora persica*	Salvadoraceae
289.	*Salvia santolinaefolia*	Lamiaceae
290.	*Santalum album*	Santalaceae
291.	*Sapindus emarginatus*	Sapindaceae
292.	*Sarcostemma viminale*	Asclepiadaceae
293.	*Schrebera swietenioides*	Oleaceae
294.	*Schweinfurthia papilionacea*	Scrophulariaceae
295.	*Sesamum indicum*	Pedaliaceae
296.	*Sesbania bispinosa*	Fabaceae
297.	*Setaria glauca*	Poaceae
298.	*Sida cordata*	Malvaceae
299.	*Sida cordifolia*	Malvaceae
300.	*Sida ovata*	Malvaceae
301.	*Sida rhombifolia*	Malvaceae
302.	*Sida spinosa*	Malvaceae
303.	*Sisymbrium irio*	Brassicaceae

304.	*Solanum albicaule*	Solanaceae
305.	*Solanum anguivi*	Solanaceae
306.	*Solanum nigrum*	Solanaceae
307.	*Solanum virginianum*	Solanaceae
308.	*Sonchus asper*	Asteraceae
309.	*Sonchus oleraceus*	Asteraceae
310.	*Soymida febrifuga*	Meliaceae
311.	*Spermadictyon suaveolens*	Rvbiaceae
312.	*Sphaeranthus indicus*	Asteraceae
313.	*Spilanthes calva*	Asteraceae
314.	*Spilanthes paniculata*	Asteraceae
315.	*Sporobolus helvolus*	Poaceae
316.	*Sterculia urens*	Sterculiaceae
317.	*Suaeda fruticosa*	Chenopodiaceae
318.	*Syzygium cumini*	Myrtaceae
319.	*Tactaria macrodonta*	Asclepiadaceae
320.	*Tagetes erecta*	Asteraceae
321.	*Tamarix aphylla*	Tamaricaceae
322.	*Tecomella undulata*	Bignoniaceae
323.	*Tectona grandis*	Verbenaceae
324.	*Tephrosia purpurea*	Fabaceae
325.	*Terminalia arjuna*	Combretaceae
326.	*Terminalia bellirica*	Combretaceae
327.	*Thespeslia populnea*	Malvaceae
328.	*Tinospora cordifolla*	Menispermaceae
329.	*Trachyspermum ammi*	Apiaceae
330.	*Trapa natans* var. *bispinosa*	Trapaceae
331.	*Trianthema portulacastrum*	Aizoaceae
332.	*Tribulus terrestris*	Zygophyllaceae
333.	*Trichodesma indica*	Boraginaceae
334.	*Trichosanthes bracteata*	Cucurbitaceae
335.	*Tridax procumbens*	Asteraceae
336.	*Trigonella foenum-graecum*	Fabaceae
337.	*Triticum aestivum*	Poaceae
338.	*Tamarindus indica*	Caesalpiniaceae
339.	*Tylophora hirsuta*	Asclepiadaceae
340.	*Typha angustata*	Trapaceae
341.	*Urginea indica*	Liliaceae
342.	*Vanda tessellata*	Orchibaceae
343.	*Vernonia cinerea*	Asteraceae
344.	*Vigna triobata*	Fabaceae
345.	*Viscum articulatum*	Loranthaceae
346.	*Vitex negundo*	Verbenaceae
347.	*Vitis vitiginea*	Vitaceae

348.	*Waltheria indica*	Stercluiaceae
349.	*Withania somnifera*	Solanaceae
350.	*Woodfordia fruticosa*	Lythraceae
351.	*Wrightia tincotoria*	Apocynaceae
352.	*Xanthium strumarium*	Asteraceae
353.	*Zaleya decandra*	A zoaceae
354.	*Zea mays*	Poaceae
355.	*Zingiber officinale*	Zingiberaceae
356.	*Ziziphus mauritiana*	Rhamnaceae
357.	*Ziziphus nummularia*	Rhamnaceae
358.	*Zygophyllum simplex*	Zygophyllaceae

Appendix H

Plant Genetic Resources of Rajasthan

Introduction

The mane task assigned to this station is to carry out plant genetic resources (PGR) activities and it's sustainable availability for the users in the development of this region in general and in their crop improvement programmes for the development of agriculture in arid and semi-arid regions in particular.

Objectives

The station is entrusted with the responsibility to carry out PGR activities in Rajasthan mainly and its adjoining areas of Gujarat and Haryana with the following objectives:

- Build-up of PGR through crop/region-specific/multicrop explorations independently or in collaboration with other organisation and introduction of germplasm from isoclimatic regions of the world suited to arid/semi-arid environments.
- Characterisation, preliminary evaluation, identification of accessions for specific/desired traits and maintenance of germaplasm of indigenous and exotic agri-horticultural crops and economic plants.
- Conservation of germplasm of this region for long-term in National Gene Bank (NGB)at NBPGR, New Delhi
- Documentation and cataloguing of germplasm for dissemination of information among users (plant breeders/ researchers).
- Supply of germplasm to researchers/ farmers and other indentors for its utilization

Crop responsibilities

Major crops assigned to this station are as follows:

Agricultural Crops:

Pearl Millet (Pennisetum glaucum), Cowpea (Vigna unguiculata), Guar (Cyamopsis tetragonaloda), Moth (Vigna aconitifolia), Mung (Vigna rediata), Castor (Ricinus cimmunis) and Til (Sesamum indicum).

Horticultural Crops:

Bael (Aegle marmelos), Ber (Zizyphus spp.), Karonda (Carissa spp.) Lasora (Cordia myxa), Phalsa (Grewia asiatica), Pomegranate (Punica granatum) and miscellaneous.

Economic Plants:

Acacia spp., Agave spp., Atriplex spp., Cassia spp., Jatropha spp., Jojoba (Simmondsia chinensis), Ker (Capparis spp.,) Khejri (Prosopis cineraria), Tumba (Citrullus colocynthus) and miscellaneous.

This satation also serves as one of the sites for mulitlocation evaluation of world collection of pearl millet and groundnut germplasm under NBPGR/ ICRISAT joint evaluation programme.

Build-up of germplasam

Germplasm of agri-horticultural crops and economic plants has been built at this station mainly through exploration and collection activity. Besides this, germplasm of a large number of species with desirable traits has also been introduced from isoclimatic regions of the world. In westem arid/semi-arid regions of Gujarat and Rajasthan states, rich diversity occurs in pearl millet, sorghum, black gram, cowpea, green gram, guar moth Brassicae, sesame, cucurbits, forage grasses and legumes. Many of the important major food/ commercial crops though not native to this region exhibit rich variability due to their cultivation over centuries and have now become naturalized in this region Many of them possess

germplasm with desirable traits mainly for drought hardiness, short duration, pest/ disease resistance, salt tolerance, etc. due to their age old cultivation in harsh arid environments.

Exploration and collection

The station has (as of March 19990 conducted 56 major and 13 short explorations in parts of Gujarat, Haryana and Rajasthan mainly and in areas of adjacent states of these 22 major explorations have been conducted jointly in collaboration with ICAR institutes/ PD/ AICRP/ NRC/ SAU and ICRISAT. In all, 12316 collection comprising of cultivated (11977) and wild (339) were made as per the details given here below:

Creals and millets	1667
Pulses and legumes	5442
Oilseeds	1753
Vegetables	1355
Fruits and minor fruits	877
Fibres	312
Medicinal and aromatic plants	50
Spices and condiments	167
Forage and fodder plants	153
Halophytes	22
Wild relatives/ weedy forms	339
Others	179

Maintenance of germplasm

Germplasm of working collections and promising accessions of agri-horticultural crops and economic plants being maintained at this station is as follows:

Agricultural Crops (13911)

Pearl millet (249), Cowpea (396), Guar (4865), Moth (1980), Mung (1247), Castor (370), and Til (4804).

Horticultural Crops (277)

Aonla *(phyllanthus emblica)*-1 Bael *(Aegle marmelos)*-2, Ber *(Zizyphus mauritiana)*- 27, wild Ber *(Zizyphus* spp.*)*-199, Carissa spp.-12, Cordia spp.-59, Date palm *(Phoenix dactylifera)*-1, Kankoda *(Momordica diocea)*-1, Ker (Capparis spp.)-36, Kinnow *(Citrus deliciosa)*-1, Phalsa *(Grewia asiatica)*- 5, Pomegranate *(Punica granatum)*-11and West Indian cherry *(Malphigia punicifolia)-2*.

Economic Plants (980)

Acacia spp. (47), Agave spp. (3), Atriples spp. (123), Asparagus spp. (2), Calliandra calothyrsus (1), Cassia spp. (3) Ceratonia siliqua (1), Copernicia cerfera (1), Euphorbia spp. (6), Hibiscus elatus (1), Indigofera hirsta (1), Jatropha spp. (22), Jojoba (Simmondsia chinensis)- 103, Khejri (Prosopis cineraria)-404, Lesquerella fendleria(1), Leucaena leucocephala (24), Linaloe (1), Macroptilium lathyroides (1), Medicago arborea (1), Phaseolus acutifolius (24), Prosopis tamarugo (1), Salvia hispanica (1), Santalum acuminatum (1), Sesbania sp. (9), Simarouba glauca (1) and Tumba (Citrullus colocynthis)-197.

Documentation of germplasm

Data generated through explorations, characterization and preliminary evaluation are compiled in the form of Annual Reports, Research Highlights, Newsletters, etc. Research papers/ Research Reports including Popular Articles and Crop Catalogues (9) have been published for dissemination of information to users.

Conservation of germplasm

2470 accessions comprising of pearl millet (249), cowpea (219), guar (609), moth (666), mung (532) and til (195) have been deposited in National Gene Bank at NBPGR, New Delhi for long term conservation.

[from *PGR Activities at Regional Station at Jodhpur*. NBPGR 2000]

Appendix I

Forest Types of Rajasthan

The forest vegetation varies with the climate and soil variations and is also to a great extent modified by biotic influences. Broadly speaking, nine forest sub-types have been recognised in the State, viz. (i) *Anogeissus pendula* forests corresponding to Champion's edaphic climax of tropical dry decodipis fprests -- 5/ E1, (ii) *Acacia catechu* forests corresponding to Champion's edaphic climax of tropical dry deciduous forests -- 5/E2, (iii) *Boswellia serrata* forests corresponding to Champion's edaphic climax of torpical dry deciduous forests --5/E5, (iv) *Butea monosperma* forests corresponding to Champion's edaphic climax of tropical dry deciduous forests -- 5/E9, (v) *Dendrocalamus strictus* forests corresponding to Champion's edaphic climax of tropical dry deciduous forests -- 5/E9 (dry bambbo brakes), (vi) *Tectona grandis* forests corresponding to Champion's edaphic climax of tropical dry deciduous forests -- 5a/C1a (very dry teak forests), (vii) *Mixed Miscellaneous* forests corresponding to Champion's northern dry mixed deciduous -- 5B/C2, (viii) *Subtropicla ever green* forests corresponding to Champion's central Indian sub-tropical hill forest -- 8AC3 and (ix) *Thorn forests* corresponding to Champion's desert thorn forests -- 6B/C1.

(i) *Anogeissus pendula* (duhuk) forests: This is the principal type of forest covering about 60% of the forest area (10,200 sq miles). The dominant species is *Anogeissus pendula* which often forms pure stands. *Acacia catechu, Butea monosperma, Bauhini recemosa, Wrightia tomentosa, Acaci leucophloea, Lannea coromandelica* and *Diospyros melanoxylon* form the common associates. The undergrowth consists chiefly of *Grewia flavescens, Nyctanthes arbortristis, Zizyphus nummalaria* and *Balanites aegyptica.* The average height of the crop is about 8 m and the crop density varies from 0.6 to 0.8. These forests are important from the protective point ov view as these provide a useful vegetative cover on the water-sheds. *Anogeissus pendula* is also used for small timber, fuel and charcoal.

(ii) *Acacia catechu* forests: This species which is economically important for the production of *katha,* occurs almost pure in patches and sometimes mixed with other species and occupied about 3% of the forest area. It is commonly found in the south-eastern region of the State. The species occurring in association with Khair are *Zizyphus xylopyra, Z. glaverrima, Anogeissus pendula, Dichrostachys marmelos* and *Acacia leucophloea.*

(iii) *Boswellia serrata* forests: *Boswellia serrata* is found in the upper ridges of Aravali hills in shallow soils and covers about 1000sq miles, forming 5% of the total area. The trees commonly attain a height of 12-13 meters and a girth of 20-25 cm. *Boswellia serrata* is a good packing case timber for which there is increasing demand. Transport costs involved extracting it from remote areas is a major factor. This species occurs either in pure patches or in mixeture. The species occurring as associates are *Sterculia urens* and *Lannea coromandelica.* It is sometimes also mixed with *Embilica officinalis, Anogeissus latifolia* and *Acacia catechu* or with *Zizyphus* spp. In rocky areas there is practically no grass cover but in deeper so8ls *Apluda, Eragrostis, Themeda quadrivalvis* and *Heteropogon contortus* form the main undergrowth.

(iv) *Buyea monosperma* (dhak) forests: This species is characteristic of badly drained clyey soil and occurs chiefly along foothills and depressions. The total area covered is about 565 ha (1.5% of forest area). Dhak usually occurs in pure patches, but where mixed *Dichrostachys cinerea, Acaica leucophloea* and *Zizyphus* form the common associates. The canopy is not more than 8m high and average crop density 0.6.

(v) *Dendrocalamus strictus* forests: Bamboo covers about 2.5% of the area (940 ha) mostly in parts of Chittorgarh, Udaipur, Kota and Abu hills, It generally forms pure patches in depressions and also in mixture with species like *Anogeissus pendula, Mitragyna parviflora, Cassia fistula, Schrebra swietenoides, Diospyrus melanoxylon, Lannea coromandelica* and *Ougenia oojinensis.* It also occurs in teak forests. The clumps are aof varying size with 10 to 30 culms and 5 to 9 m in height. The bamboo forests have, however, deteriorated a great deal due to unsystematic working and congestion in clumps.

(vi) *Tectona grandis* (teak) forests: Teak forest of the dry type occupy over 2635 ha and represent the northern limit of the natural zone of teak in India. Teak occurs commonly in southern and south-eastern parts of the State at elevation of 250 to 650 m in more or less pure stands in Banswara, and elsewhere in mixture with several species. In northern aspects and better protected areas, the forests are well stocked while in otherareas heavy biotic interferences have rendered the teak crop to various stages of degradation. The common associates of teak area *Diospyros melanoxylon, Anogeissus latifolia, Aegle marmelos, Terminalia tomentosa, Dalbergia paniculata, Sterculia urens, Bauhinia racemosa, Soymida febrifuga, Acacia catechu,* etc. On ridges and sloping ground *Boswellia serrata, Cochlospermum gossipyum* and *Wrightia tomentosa* also occur in

mixture with the teak crop. The under-growth is spares and usually consists of *Nyctanthes arbortristis, Helictres isora, Holarrhena antidysenterica,* etc.

The teak forests are potentially valuable forests but having been degraded by indiscriminate hacking, are now being rehabilitated by tending and artificial regeneration. Recent trials with coppicing the malformed growth have shown very good prospects of converting this inferior crop into well-grown stands.

(vii) *Mixed miscellaneous forests:* In the south-eastern region which receives more rainfall, mixed miscellaneous types of forests occurforming about 20% of the total forests area. The dominant species of this type is *Anogeissus latifolia,* associated with *Disopyros melanoxylon, Aeglemarmelos, Madhuca indica, Buchanania lanza, Albizzia odoaristissima, Dalbergia latifolia, Schrebra swietinioides, Mitragyna parvifolia, Terminalia belerica, Cassia fistula, Pterocarpus marsupium,Holoptelia integrifolia, Butea monosperma, Mallotus phillipensis,* etc. The undergrowth consists mainly of *Hoarrhena antidysenterica, Grewia flavescens, Helictres isora, Zizyphus* spp., etc. The grass cover is luxuriant.

(viii) *Sub-tropical evergreen forests:* The sub-tropical evergreen forests occur over limited extent in bout 20 sq miles round Mt. Abu at elevation of 1000 to 1300 m where the rainfall is 1500 mm or more annually. The main species are *Flacourtia indica, Bauhinia purpurea, Erythrina suberosa, Anogeissus sericea, Crataeva religiosa,* etc. *Mangifera indica* and *Syzygium cuminii* occur on the slpes of Mt. Abu. The introduced species are *Pinus roxburghii, Grevillea robusta, Salix* spp. and *Eucalyptus* spp.

(ix) *Thron forests:* These are found mainly in the arid aeas of north-west, ravines and sandy tracts and occupy 1882 ha of area. In the hill tracts, the species occurring are *Acacia Senegal, Grewia tenex, Zizyphus jujuba, Mimosa hameta, Euphorbia caducifolia,* etc., while the unstable sand dunes hardly support any tree growth except some small scrub. The sand dunes are initially colonised by species like *Cyperus arenarinus, Indigofera* spp., *Citrius colocynthis* and annual grass shrubs like *Leptadenia, Crotolaria, Calotropis, Areua javanica, Zizyphus rotundifolia,* etc., come up below. Other species, particularly tree species, come up only when the dunes are stabilised and these consist of *Prosopis cineraria (Prosopics spicegera), Acacia senegal, Salvadora oleoides, Gymnsporia spinosa, Tecomella undulata, Grewia tenex* etc.

In the pronounced saline areas, such as near Sambhar lake, *Salvadora oleoides* with *S. persica, Tamarix dioca, T. aphylla, Azadirachtaindica, Calotropis procera, Suaeda fruticosa* and *Salsolia foetida* are found. Ravine are along Chambal, Banas and other rivers are heavily grazed and contain an open crop of *Prosopis spicegera, Salvadora oleoides, Balanites aegyptica, Acacia catechu,* etc.

Tree Savannahs : Scattered grasslands occur over a wide area, though forming a small percentage of the forest area. These are important reserves of fodder for the cattle.

The naturally occurring grass type in the State are: *Lasiurus indicus- Cenchrus* and *Lasirus-Cymbopogon* type in arid tracts, *Schima-Dicanthium* and *Cymbopogon* types in semi-arid tracts, *Dicanthium-Cenchrus* type in transition zones of arid and semi-arid, and *Themeda-Pseudanthistiria* and *Themeda-Pennisetum hohenackeri* types in sub-humid zones. From the point of view of fodder, *Lasiurus indicus, Sehima pervosum, Dicanthium annulatum, Cenchrus ciliaris, Cenchrus setigerus* and *Pannicum antidotale* from the most important grasses.

The tree vegetation in grasslands is sparse consisting of *Acacia leucophloea, Balanites aegyptica, Dictrostachys cinerea, Capparis decidua, Zizyphus xylopora* and *Prosopis spicigera.* The undergrowth consists of shrub and grass cover.

[from T N Srivastava: *Forest Resources of Rajasthan* in *The Natural Resources of Rajasthan* by M L Roonwal (ed)]

Appendix J

National parks and wildlife sanctuaries in Rajasthan

S.No.	Name	Area(Sq.Km.)	District	Year
National Parks				
1.	Keolaeo Ghana	28.73	Bharatpur	1981
2.	Ranthambhor	392.50	Sawaimadhopur	1980
Sanctuaries				
1.	Bandh Baretha	199.5	Bharatpur	1985
2.	Bassi	138.69	Chittorgarh	1988
3.	Bhainsrodgarh	229.14	Chittorgarh	1983
4.	Darrah	274.41	Kota	1955
5.	Desert National Park	3162.00	Jaisalmer, Barmer	1981
6.	Fulwari Ki Nal	492.68	Udaipur	1983
7.	Jaisamand	52.34	Udaipur	1955
8.	Jamwa Ramgarh	300.00	Jaipur	1982
9.	Jawahr Sagar	153.41	Kota, Bundi, Chittorgarh	1975
10.	Kailadevi	676.40	Karauli, Sawaimadhopur	1983
11.	Kumbhalgarh	608.57	Pali/ Udaipur, Rajsamand	1971
12.	Mount Abu	112.98	Sirohi	1960
13.	Nahargarh	50.00	Jaipur	1980
14.	National Chambal Sanctuary	280.00	Kota, Sawaimadhopur, Bundi, Dholpur, Karauli	1979
15.	Ramgarh Vishdhari	252.79	Bundi	1982
16.	Sajjangarh	5.19	Udaipur	1987
17.	Sariska	557.50	Alwar	1955
18.	Sitamata	422.94	Chittorgarh, Udaipur	1979
19.	Sawai Mansingh	127.76	Sawaimadhopur	1984
20.	Shergarh	98.70	Baran	1981
21.	Tal Chhaper	7.19	Churu	1971
22.	Totgarh Raoli	463.03	Ajmer, Pali, Rajsamand	1983
23.	Van Vihar	25.60	Dholpur	1955
24.	Ramsagar	34.40	Dholpur	1955
25.	Kesarbagh	14.76	Dholpur	1955
Total		9161.21		

[source: Office of the Chief Wildlife Warden, Rajasthan, Jaipur]

Appendix K

Closed areas

S.No	Name of Closed areas	District	Area Sq. Km.	Date of notification
1.	Guda Bishnoi	Jodhpur	424.58	03.12.1980
2.	Doli	Jodhpur	424.76	28.06.1976
3.	Lohavat	Jodhpur	1242.31	25.06.1981
4.	Sathin	Jodhpur	242.86	25.06.1981
5.	Jambleswarji	Jodhpur	870.24	06.09.1983
6.	Dechu	Jodhpur	661.18	01.08.1984
7.	Sonkhlia	Ajmer	526.81	17.01.1980
8.	Gagwana	Ajmer	225.00	06.09.1983
9.	Tilora	Ajmer	1.42	13.09.1984
10.	Mukam	Bikaner	168.82	17.05.1980
11.	Diyatra	Bikaner	50.19	10.05.1983
12.	Deshnok	Bikaner	25.17	10.051983
13.	Jodhvir	Bikaner	75.85	10.05.1983
14.	Bajju	Bikaner	210.00	03.08.1983
15.	Sanvatsar Kotsar	Churu	70.91	03.04.1986
16.	Bardod	Alwar	2.36	17.05.1980
17.	Jodiya	Alwar	30.00	13.09.1984
18.	Sainthal Sagar	Jaipur	3.00	04.07.1981
19.	Mehla	Jaipur	150.00	04.07.1981
20.	Dhorimanna	Barmer	680.17	27.08.1982
21.	Jaroda	Nagaur	30.00	08.11.1982
22.	Rotu	Nagaur	586.20	05.02.1983
23.	Jawaibandh	Pali	5.00	08.05.1983
24.	Kaualiji	SMadhopur	37.80	06.09.1983
25.	Sorsan	Kota	100.00	09.01.1984
26.	Ujala	Jaisalmer	3000.00	17.01.1984
27.	Ramdevra	Jaisalmer	3000.00	17.01.1984
28.	Ranipura	Tonk	87.77	14.02.1984
29.	Menal	Chittor	107.97	31.05.1984
30.	Kanak Sagar	Bundi	8.00	19.02.1985
31.	Sanchor	Jalore	1813.12	28.09.1985
32.	Bagdarah	Udaipur	3.42	27.08.1982
	TOTAL		**14864.91**	

Appendix L

Wetlands in the State

S.	Distric	Topo	Type	Village	Latitude		Area
1.	Ajmer	45j	Reservoir	Untra	263400	744600	390.00
2.	Ajmer	45j	Reservoir	Ramsar	261700	745200	546.00
3.	Alwar	54a	Lake/Pond	Umran	272900	763500	897.00
4.	Alwar	54a	Reservoir	Tehla	271400	762500	507.00
5.	Banswara	46i	Reservoir	Bansyara	235300	743300	9204.00
6.	Barmer	40o	Playas	Barmer	255800	711715	585.00
7.	Bhratpur	54f	Reservoir	Baretha	265400	772200	1600.00
8.	Bhilwara	45k	Reservoir	Purani-Arwar	254900	744800	468.00
9.	Bhilwara	45k	Reservoir	Jharoli	252600	745500	390.00
10.	Bhilwara	45o	Reservoir	Mandalgarh	251000	750400	429.00
11.	Bhilwara	45k	Reservoir	Chaterpur	255600	742100	351.00
12.	Bikaner	44d,39p	Reservoir	Ramra	282000	724600	556.00
13.	Bundi	45o	Reservoir	Narva	252900	752700	3900.00
14.	Chitaurgarh	45p	Reservoir	Rawatbhata	245500	753500	18062.00
15.	Churu	45i	Playas	Chhaper	274700	742400	741.00
16.	Dausa	54b	Reservoir	Ghumana	265100	763800	546.00
17.	Dausa	54b	Reservoir	Baragaon	264800	762000	585.00
18.	Dholpur	54f	Reservoir	Nibi	263900	774500	468.00
19.	Dholpur	54f	Reservoir	Angai	263700	772700	2300.00
20.	Dungarpur	46e	Reservoir	Bodamali	233400	735600	234.00
21.	Jaipur	45n	Playas	Daber	265100	750300	1811.00
22.	Jaipur	45n	Reservoir	Khejruas	265800	752900	702.00
23.	Jaipur	54a	Reservoir	J Ramgarh	270300	760200	663.00
24.	Jaisalmer	39l,40i	Playas	Baramsar	270315	705000	3510.00
25.	Jaisalmer	40n	Playas	Pokaran	264900	715100	2769.00
26.	Jalore	40p,L	Playas	Bhakhasar	244145	711830	29192.00
27.	Jalore	40p,L	Playas	Motisani	253800	724500	1092.00
28.	Jalore	45c	Playas	Mohiwara	253500	725500	2886.00
29.	Jhalawar	54d,H	Reservoir	Asnawar	242900	762000	936.00
30.	Jodhpur	45b	Playas	Dediya	265000	720700	858.00
31.	Jodhpur	45f	Playas	Melav	263200	731015	1053.00
32.	Jodhpur	45f	Playas	Kaparda	261700	732700	3237.00
33.	Jodhpur	45a	Playas	Bap	272030	722400	1209.00

34.	Kota	45o	Reservoir	Ummedgan	250600	755600	351.00
35.	Nagaur	45i	Playas	Sujangarh	274000	742800	897.00
36.	Nagaur	45j	Reservoir	Gonarda	264600	741900	858.00
37.	Nagaur	45n	Playas	Jabodinager	265700	750300	5562.00
38.	Pali	45g	Reservoir	Pali	255100	731500	1365.00
39.	Pali	45g	Reservoir	Pali	254500	732200	2457.00
40.	Pali	45g	Reservoir	Suherpur	251300	730300	429.00
41.	Pali	45g	Reservoir	Suherpur	250400	731000	3891.00
42.	Pali	45f	Reservoir	Flabroo	260215	732300	1326.00
43.	Rajsamand	45h	Reservoir	Nathdwara	245500	734600	468.00
44.	Rajsamand	45g	Reservoir	Kelwa	250500	735300	819.00
45.	Sawaimadhopur	54f	Reservoir	Hindaun	264300	770600	1053.00
46.	Sawaimadhopur	54b	Reservoir	Sapotia	261700	764900	819.00
47.	Sawaimadhopur	54b	Reservoir	Ranthabhor	260415	761900	897.00
48.	Sikar	45m	Playas	Sikar	272830	751400	635.00
49.	Sirohi	45c	Reservoir	Ora	250300	724900	624.00
50.	Sirohi	45d	Reservoir	Dhahah	244100	725600	702.00
51.	Ganganagar	44k	Waterlogge	Thakarwali	292100	741000	2652.00
52.	Ganganagar	44g,C	Waterlogge	Kishanpura	291800	735815	312.00
53.	Tonk	45n	Reservoir	Mejru	261200	752300	1404.00
54.	Tonk	54c	Reservoir	Unara	255300	760000	1014.00
55.	Udaipur	45h	Reservoir	Virpura	241500	735800	2523.00

Appendix M

Glossary of terms

This glossary, intended to facilitate understanding of the report by readers not having background in biosciences, is an abridged version of the glossary of biodiversity terms adapted by the Convention on Biological Diversity. Scientific terms relating to biodiversity and biotechnology only have been given.

abiotic
: non-living; devoid of life.

accession
: a sample of a crop variety collected at a specific location and time; may be of any size.

accident (accidental)
: any incident involving a significant and unintended release of genetically modified microorganisms in the course of their contained use which could present an immediate or delayed hazard to human heath and the environment.

accidental release
: the unintentional discharge of a microbiological agent (i.e., microorganism or virus) or eukaryotic cell due to a failure in the containment system.

adaptation
: a genetically determined characteristic that enhances the ability of an organism to cope with its environment.

adaptation traits
: complex of traits related to reproduction and survival of the individual in a particular production environment. Adaptation traits contribute to individual fitness and to the evolution of animal genetic resources. By definition, these traits are also important to the ability of the animal genetic resource to be sustained in the production environment.

adaptive radiation
: evolutionary diversification of species derived from a common ancestor into a variety of ecological roles.

adaptive zone
: a particular type of environment requiring unique adaptations then allowing adaptive radiation to occur.

advanced informed agreement
: advanced informed agreement refers to the principle that international exchange of transgenic plants and microorganisms that could adversely affect plants should not proceed without the informed agreement of, or contrary to the decision of, the competent authority in the recipient country. (*See also* prior informed consent.)

agrobiodiversity or **agricultural biological diversity**
: that component of biodiversity that contributes to food and agriculture production. The term agrobiodiversity encompasses within-species, species and ecosystem diversity.

agrobiotechnology
: the research on and development of agricultural products such as crop varieties and crop protection products by modifying genes to confer desirable properties such as pest resistance or improved nutritional profiles.

agroecology
: the use of ecological concepts and principles to study, design, and manage agricultural systems. Agroecology seeks to evaluate the full effect of system inputs and outputs by integrating cultural and environmental factors into the analysis of food production systems and to use this knowledge to improve these systems, taking into account the needs of both the ecosystem as a whole and the people within it.

agroforestry
: a collective name for land-use systems and technologies where woody perennials (tree, shrubs, palms, bamboos, etc.) are deliberately used on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence.

algal symbiont

see zooxanthellae.

alien species
a species that has been transported by human activities, intentional or accidental, into a region where it does not naturally occur. (Also known as an exotic, introduced, nonindigenous, or nonnative species.)

allele
one of two or more forms of a gene arising by mutation and occupying the same relative position (locus) on homologous chromosomes.

allopatric
occupying different geographical ranges. (*Opp.*: sympatric.)

allopatric speciation
speciation through geographically separated populations.

anadromous
the annual migratory behavior of adult fish -such as salmon and lamprey- from the ocean into freshwater rivers and lakes in order to spawn.

animal genetic resources databank
a databank that contains inventories of farm animal genetic resources and their immediate wild relatives, including any information that helps to characterize these resources.

animal genome (gene) bank
a planned and managed repository containing animal genetic resources. Repositories include the environment in which the genetic resource has developed, or is now normally found (*in situ*) or facilities elsewhere (*ex situ - in vivo* or *in vitro*). For *in vitro, ex situ* genome bank facilities, germplasm is stored in the form of one or more of the following: semen, ova, embryos and tissue samples.

anoxia
the absence of oxygen in water and sediments.

antibiotic
an antimicrobial compound produced by living micro-organisms, used therapeutically or sometimes prophylactically in the control of infectious diseases. Over 4,000 antibiotics have been isolated, but only about 50 have achieved wide use.

aquaculture
breeding and rearing fish, shellfish, etc., or growing plants for food in special ponds.

aromatherapy
the therapeutic use of pure essential oils and other substances obtained from flowers, plants, and aromatic shrubs, through inhalation and application to the skin. Generally based on traditional practices from around the world.

artificial insemination
a breeding technique, most commonly used in domestic animals and sometimes in captive breeding of wild animals, in which semen is introduced into the female reproductive tract by artificial means.

artificial selection
selective breeding, carried out by humans, to produce a desired evolutionary response.

asexual reproduction
reproduction of a plant or animal without fusion of male and female gametes. It includes vegetative propagation, cell and tissue culture.

assay
a technique that measures a biological response; the determination of the activity or concentration of a chemical. (*See also* bioassay.)

Ayurveda
a philosophy and healing system developed over thousands of years in India, in which patients are characterized by the elements of earth, water, fire, air, and ether. Employs botanical preparations, usually combinations of a number of herbs.

***Bacillus thuringiensis* (Bt)**
a natural enemy of insects which was isolated from dead silk worms. This bacterium kills insects with the help of a protein, the so-called Bt-toxin. More than 50 Bt-toxins have been detected, each with its own characteristics.

backcross
the cross of a hybrid with either of its parents (or a genetically equivalent individual).

bacteria
members of a group of diverse single-celled organisms; organisms lacking a nucleus.

bacteriophages
a group of viruses whose hosts are specifically bacteria.

baseline data
fundamental units of basic inventory information that are crucial for biodiversity conservation planning and management. These are both biotic and abiotic and usually include: (1) the presence and/or abundance of species and other units; (2) other dependent biotic data (e.g. plant cover for macroarthropods); (3) the appropriate influential abiotic variables, and (4) human variables.

benthic
living on or in the bottom (in contrast to pelagic).

benthos
organisms living on or in the bottom of oceans, seas, rivers, lakes and other water bodies.
Depending on the size of the organisms, benthos is regarded as macrobenthos (organisms > 1000 μm), meiobenthos (organisms between 42 μm and 1000 μm) and nanobenthos or microbenthos (organisms < 42 μm). Depending on the depth distribution, benthos is regarded as epibenthos (living between low water line and 200 m depth), mesobenthos (living at depths between 200 and 1000 m), hypobenthos (living between 1000 and 2000 m) and abyssal benthos (living below 2000 m).

bequest value
value, defined by willingness to pay, to ensure that peoples' offspring or future generations inherit a particular environmental asset.

bioassay
the determination of the activity or concentration of a chemical by its effect on the growth of an organism under experimental conditions.

bioavailability
the degree of availability to biodegradation of pollutants in contaminated soil or land.

biocatalyst
an enzyme, used to catalyze a chemical reaction.

biochemical
a product produced by chemical reactions in living organisms.

biocoenosis
varied community of organisms living in the same small area, e.g. in the bark of a tree, on a wall, in a pond.

bioconversion
the conversion of a compound from one form to another by the actions of organisms or enzymes; synonym: biotransformation.

biodegradation
the microbially mediated process of chemical breakdown of a substance to smaller products caused by micro-organisms or their enzymes.

biodiversity
is a synonym of **biological diversity**, see below. The contracted form 'biodiversity' was apparently coined by W.G. Rosen (1985) for the first planning meeting of the 'National Forum on Biodiversity' held in Washington DC (September 1986), the proceedings of which (E.O. Wilson and F.M. Peter, 1988) brought the notion of biodiversity to the attention of a wide field of scientists and others.

bioenergy
energy made available by the combustion of materials derived from biological sources.

bioerosion
the erosion of material such as coral rock and shells, that results from the direct action of living organisms such as boring sponges, fungi, worms, molluscs, or sea urchins.

biogeography
the scientific study of the geographic distribution of organisms.

bioinformatics
a scientific discipline that comprises all aspects of the gathering, storing, handling, analysing, interpreting and spreading of biological information. Involves powerful computers and innovative programmes which handle vast amounts of coding information on genes and proteins from genomics programmes. Comprises the development and application of computational algorithms for the purpose of analysis, interpretation, and prediction of data for the design of experiments in the biosciences.

biolistics
in molecular biology, a method developed to inject DNA into cells by mixing the DNA with small metal particles and then firing the particles into the host cell at very high speeds.

biological control
pest control strategy making use of living natural enemies, antagonists or competitors and other self-replicating biotic entities.

biological control agent
a natural enemy, antagonist or competitor, and other self-replicating biotic entity used for pest control.

biological diversity
- 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. (*Syn.*: biodiversity)

biological pesticide (biopesticide)
a generic term, not specifically definable, but generally applied to a biological control agent, usually a pathogen, formulated and applied in a manner similar to a chemical pesticide, and normally used for the rapid reduction of a pest population for short term pest control.

biological resources
includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with direct, indirect or potential use or value for humanity. (*Syn.*: biotic resources)

biologics
vaccines, therapeutic serums, toxoids, antitoxins and analogous biological products used to induce immunity to infectious diseases or harmful substances of biological origin.

biomass
all organic matter that derives from the photosynthetic conversion of solar energy.

biome
a major portion of the living environment of a particular region (such as a coniferous forest or grassland), characterized by its distinctive vegetation and maintained by local climatic conditions.

biopesticide
naturally occurring biological agents used to kill pests by causing specific biological effects rather than by inducing chemical poisoning. The idea is based on mimicking processes that arise naturally (e.g. protecting the coffee bean by its caffeine content), and is argued to be favorable to conventional chemical pesticides as it is more easily biodegradable and more target specific. A biopesticide's mechanism of action is based on specific biological effects and not on chemical poisons.

biopharmaceutical
recombinant protein drugs, recombinant vaccines and monoclonal antibodies (for therapeutic roles). Biopharmaceuticals are still only a small part of the pharmaceutical industry, but of increasing importance. (*See* biologics.)

biopiracy
bioprospecting regarded as the perpetuation of the colonial habit of plundering other countries' biological resources without fair and equitable compensation, resulting in environmental, economic and social detriment.

bioprocess
any process that uses complete living cells or their components (e.g. enzymes, chloroplasts) to effect desired physical or chemical changes.

bioprospecting
entails the search for economically valuable genetic and biochemical resources from nature

bioreactor
a contained vessel or other structure in which chemical reactions are carried out (usually on an industrial scale), mediated by a biological system, enzymes or cells. A bioreactor can range in size from a small container to an entire building.

bioregion
a territory defined by a combination of biological, social, and geographic criteria, rather than geopolitical considerations; generally, a system of related, interconnected ecosystems.

bioremedation
the use of biological agents to reclaim soils and waters polluted by substances hazardous to human health and/or the environment; it is an extension of biological treatment processes that

have been used traditionally to treat wastes in which micro-organisms typically are used to biodegrade environmental pollutants.

biosafety

safety aspects related to the application of biotechnologies and to the release into the environment of transgenic plants and other organisms particularly microorganisms that could negatively affect plant genetic resources, plant, animal or human health, or the environment.

biosphere reserve

established under UNESCO's Man and the Biosphere (MAB) Programme, biosphere reserves are a series of protected areas linked through a global network, intended to demonstrate the relationship between conservation and development.

biosynthesis

the synthesis of molecules by living organisms or their components.

biota

all of the organisms, including animals, plants, fungi, and microorganisms, found in a given area.

biotechnology

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

biotic

pertaining to any aspect of life, especially to characteristics of entire populations or ecosystems.

biotic resources

see: biological resources

biotope

small area with uniform biological conditions (climate, soil, altitude, etc.).

biotransformation

the conversion of a compound from one form to another by the actions of organisms or enzymes; synonym: bioconversion.

biotype

group of genetically identical individuals.

bloom

a sharp increase in density of phytoplankton or benthic algae in a given area.

botanical

a substance derived from plants; a vegetable drug, especially in its crude state.

botanical medicine

a medicine of plant origin, in crude or processed form; used to represent herbal, or plant-based, medicines that are not consumed as isolated compounds (as are pharmaceuticals); includes single herb, herb combination, and herb combined with non-herbal ingredient products; delivery formats include capsules, tablets, herbal teas, extracts, tinctures, and bulk herbs.

breed

either a sub specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species or a group for which geographical or cultural separation from phenotypically similar groups has led to acceptance of its separate identity.

breed at risk

any breed that may become extinct if the factors causing its decline in numbers are not eliminated or mitigated. Breeds may be in danger of becoming extinct for a variety of reasons. Risk of extinction may result from, *inter alia*, low population size; direct and indirect impacts of policy at the farm, country or international levels; lack of proper breed organization; or lack of adaptation to market demands. Breeds are categorized as to their risk status on the basis of, *inter alia*, the actual numbers of male and female breeding individuals and the percentage of pure-bred females. FAO has established categories of risk status: critical, endangered, critical-maintained, endangered-maintained, and not at risk.

breed not at risk

a breed where the total number of breeding females and males is greater than 1,000 and 20 respectively; or the population size approaches 1,000 and the percentage of pure-bred females is close to 100 percent, and the overall population size is increasing.

broad spectrum

a pesticide which is active towards a wide variety of weeds or other pests; often used to describe an antibiotic that is effective against a wide range of micro-organisms.

brown bag sales
sales by farmers to other farmers of seed they have saved.

buffer zone
a transition zone between areas managed for different objectives.

bycatch
incidental take; also called non-target species.

captive breeding
the propagation or preservation of animals outside their natural habitat (see ex-situ conservation), involving control by humans of the animals chosen to constitute a population and of mating choices within that population.

carrying capacity
the maximum number of people, or individuals of species, that a particular environment can sustain without environmental damage.

cell fusion
a technique of fusing two cells from different species to create one hybrid cell for the purpose of combining some of the genetic characteristics of each original.

centers of origin and diversity
places in the world where crops have the greatest genetic diversity in the form of traditional crop and varieties and wild relatives. Centers of diversity are typically, but not always, the same locations as the centers of origin or oldest cultivation of the crop.

center of diversity
an area with a high number of species, which might be recognized on a global, regional or local scale.

characterization of animal genetic resources (AnGR)
all activities associated with the description of AnGR aimed at better knowledge of these resources and their state. Characterization by a country of its AnGR will incorporate development of necessary descriptors for use, identification of the country's sovereign AnGR; baseline and advanced surveying of these populations including their enumeration and visual description, their comparative genetic description in one or more production environments, their valuation, and ongoing monitoring of those AnGR at risk.

chemicalization
accumulation of unnatural concentrations of certain chemical compounds.

clade
set of species from a common ancestral species.

clear-cutting
the removal of the entire standing crop of trees. In practice, may refer to exploitation that leaves much unsaleable material standing (e.g. a commercial clear-cutting).

clone
a genetic replica of another organism obtained through a non-sexual (no fertilization) reproduction process. Cloning by nucleus transfer involves the transfer of a donor nucleus from (cultured) cells of embryonic, fetal or adult origin into the recipient cytoplasm of an enucleated oocyte or zygote, and the subsequent development of embryos and animals. These clones usually have different mitochondrial genomes.

co-adaptation
evolution of characteristics of two or more species to their mutual advantage.

co-evolution
evolution in two or more interacting species in which the evolutionary changes of each species influence the evolution of the other species.

co-management
the sharing of authority, responsibility, and benefits between government and local communities in the management of natural resources.

coastal waters
marine benthic and pelagic ecosystems having substantial influence from the land.

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.

community
an integrated group of species inhabiting a given area; the organisms within a community influence one another's distribution, abundance and evolution. (A Human Community is a social group of any size whose members reside in a specific locality.)

competition
use or defense of a resource by one individual that reduces the availability of the resource to other individuals.

competitive exclusion
the extinction of one species by another species in the same area through competition.

conservation
the management of human use of the biosphere so that many yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations: Thus conservation in positive, embracing preservations, maintenance, sustainable utilization, restoration, *and* enhancement of the natural environment.

conservation biology
the science of conserving biological diversity.

conservation of biodiversity
the management of human interactions with genes, species, and ecosystems so as to provide the maximum benefit to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity.

conservation of farm animal genetic resources
refers to all human activities including strategies, plans, policies and actions undertaken to ensure that the diversity of farm animal genetic resources is being maintained to contribute to food and agricultural production and productivity, now and in the future.

conservation values
the value to society of conserving environmental resources.

contained use
any operation in which microorganisms are genetically modified or in which such genetically modified microorganisms are cultured, stored, used, transported, destroyed or disposed of and for which physical barriers, or a combination of physical barriers together with chemical or biological barriers are used to limit their contact with the general population and the environment.

containment
application of phytosanitary or other measures in and around an infested area to prevent spread of a pest or a disease.

continental shelf
the edges of continental landmasses, now covered with seawater; generally the most productive parts of the ocean.

coral bleaching
a phenomenon occurring when corals under stress expel their mutualistic microscopic algae, called zooxanthellae. This results in a severe decrease or even total loss of photosynthetic pigments. Since most reef building corals have white calcium carbonate skeletons, the latter show through the corals' tissue, and the coral reef appears bleached.

critical breed
a breed where the total number of breeding females is less than 100 or the total number of breeding males is less than or equal to five; or the overall population size is close to, but slightly above 100 and decreasing, and the percentage of pure-bred females is below 80 percent.

critical-maintained breed and **endangered-maintained breed**
categories where critical or endangered breeds are being maintained by an active public conservation programme or within a commercial or research facility.

cross-breeding
the breeding of distinct and genotypic types or forms in plants. This may entail the transfer of pollen from one individual to the stigma of another of different genotype.

cross-pollination
the transfer of pollen from the stamen of a flower to the stigma of a flower of different genotype, but usually of the same species.

cryogenic storage
: the preservation of seeds, semen, embryos, or micro-organisms at extremely low temperatures, below -130 °C; at these temperatures, water is absent, molecular kinetic energy is low, diffusion is virtually nil, and storage potential is expected to be extremely long.

cryopreservation
: the storage of plant material at very low temperatures (-196°C) in liquid nitrogen.

cultivar
: distinct form or variety of domesticated plant derived through breeding and selection and maintained through cultivation.

cultural diversity
: variety or multiformity of human social structures, belief systems, and strategies for adapting to situations in different parts of the world..

debt-for-nature swaps
: a conservation agency buys up some of a developing country's international debt ("secondary" debt) on the world's money market. The agency then promises to dispose of the debt in return for a promise from the indebted country that it will look after a conservation area.

deconvolution
: isolating the active compound out of a natural product mixture.

demography
: the study of birth rates, death rates, age distributions, and size of populations. It is a fundamental discipline within the larger field of population biology and ecology.

deoxyribonucleic acid (DNA)
: the molecule that generally encodes all genetic information. It consists of two strands or chains of sub-units, known as nucleotides.

detritus
: a major food-source in a variety of ecosystems, consisting of organic remains of plants and animals, often heavily colonised by bacteria.

development values
: the value to society of converting environmental resources to development uses.

dinoflagellate
: a protozoan, characterised by having two lash-like structures (flagella) used for locomotion, often abundant in the open ocean. Many produce light and are one of the primary contributors to bioluminescence (green or red) in the ocean. Some dinoflagellates, known as zooxanthellae, are symbiotic in the tissues of corals and some other tropical invertebrates.

diploid
: having a pair of homologous chromosomes with the exception of the sex chromosome, the total number of chromosomes being twice that of a gamete.

direct use value
: economic values derived from direct use or interaction with a biological resource or resource system.

directional selection
: selection leading to a consistent directional change in any character of a population through time, for example selection for larger eggs.

disruptive selection
: selection favouring individuals that deviate in either direction from the population average. Selection favours individuals that are larger or smaller than average.

DNA (deoxyribonucleic acid)
: the long chain of molecules in most cells that carries the genetic message and controls all cellular functions in most forms of life.

DNA bank
: storage of DNA, which may or may not be the complete genome, but should always be accompanied by inventory information. (*Note*: at the present time, animals cannot be reestablished from DNA alone.)

do-no-harm principle
: *see*: precautionary principle.

domestic animal diversity (DAD)
: the spectrum of genetic differences within each breed, and across all breeds within each domestic animal species, together with the species differences; all of which are available for the sustainable intensification of food and agriculture production.

domestic biodiversity
: the genetic variation existing among the species, breeds, cultivars and individuals of animal, plant and microbial species that have been domesticated, often including their immediate wild relatives.

domesticated species
: species in which the evolutionary process has been influenced by humans to meet their needs (syn.: cultivated species).

domesticates
: organisms that have undergone domestication.

domestication
: the process by which plants, animals or microbes selected from the wild adapt to a special habitat created for them by humans.

downwelling
: a process by which surface waters increase in density and sink. Strong downwelling occurs mainly off Greenland and Antarctica.

driftnet
: a gill net suspended vertically from floats at a specific depth and left to drift freely.

ecological economics
: a branch of economics that takes account of ecological principles and examines economic values of non-market ecological products and services.

ecological or ecosystem resilience
: ecological resilience can be defined in two ways. The first is a measure of the magnitude of disturbance that can be absorbed before the (eco)system changes its structure by changing the variables and processes that control behaviour. The second, a more traditional meaning, is as a measure of resistance to disturbance and the speed of return to the equilibrium state of an ecosystem.

ecological or ecosystem services
: ecological or ecosystem processes or functions which have value to individuals or to society.

ecology
: the scientific study of the interactions of living organisms and their environment.

ecosystem
: a dynamic complex of plant, animal, fungal, and micro-organism communities and their associated non-living environment interacting as a functional unit; the organisms living in a given environment, such as a tropical forest, a coral reef or a lake, and the physical part of the environment that impinges on them.

ecosystem diversity
: the diversity among biological communities and their physical settings, characterised by differences in species composition, physical structure, and function. It is the highest level of biological diversity.

ecosystem rehabilitation
: the recovery of specific ecosystem services in a degraded ecosystem or habitat.

ecosystem restoration
: the return of an ecosystem to its original community structure, natural complement of species, and natural functions.

ecotourism
: travel undertaken to witness sites or regions of unique natural or ecologic quality, or the provision of services to facilitate such travel.

edge effect
: processes that characterize habitat fragmentation and the concomitant creation of edges.

elite
: advanced germplasm in a breeding or crop improvement programme.

endangered breed
: a breed where the total number of breeding females is between 100 and 1,000 or the total number of breeding males is less than or equal to 20 and greater than five; or the overall population size is close to, but slightly above 100 and increasing and the percentage of pure-bred females is above 80 percent; or the overall population size is close to, but slightly above 1,000 and decreasing and the percentage of pure-bred females is below 80 percent.

endangered-maintained breed
: categories where critical or endangered breeds are being maintained by an active public conservation programme or within a commercial or research facility.

endemic
native to and restricted to a specific geographic area.

environmental impact assessment (EIA)
process by which the consequences of proposed projects or programs are evaluated as an integral part of planning the project, alternatives are analysed, and the general public has ample opportunity to comment.

enzyme
a protein which catalyses the conversion of a substrate to a product. Other than a few well-established enzymes such as papein and trypsin, most enzyme names can be recognised by the suffix -ase, e.g. cellulase, protease, etc.

epipelagic
referring to the top 200 meters of the ocean, seas and lakes.

equilibrium theory
theory that suggests that under natural circumstances, species addition and loss are balanced, and furthermore, that displacement from the equilibrium value results in changes in speciation or extinction rate that tend to restore the system to its equilibrium state.

eradication
application of phytosanitary and other measures to eliminate a pest from an area.

establishment
perpetuation, for the foreseeable future of a pest, or a biological agent, within an area after entry.

estuary
an ecosystem in which a river or stream meets ocean waters; characterised by intermediate or variable salinity levels and often by high productivity.

ethical values
statements of ethical principle that inform the private and social valuation of biological resources.

ethnobiology
study of the way plants, animals and micro-organisms are used by humans.

eukaryote
an organism whose DNA is enclosed in nuclear membranes. The vast majority of species (plants, animals, protista,...) are eukaryotic. (*Opp.*: prokaryote.)

eutrophication
process by which a lake, a river, part of a sea, etc. is enriched with nitrates, phosphates and other nutrients (often from human sources such as agriculture, sewage, and urban runoff) which favour the growth of algae and often kill other organisms by lack of oxygen.

evaluation
measurement of the characteristics that are important for production and adaptation, either of individual animals or of populations, most commonly in the context of comparative evaluation of the traits of animals or of populations.

ex-situ
out of the original location. In conservation, often in a laboratory, collection, botanical garden, zoo, or aquarium. (Opposite: *in-situ*)

***ex-situ* conservation**
the conservation of components of biological diversity outside their natural habitats.

***ex situ* conservation of farm animal genetic diversity**
all conservation of genetic material *in vivo*, but out of the environment in which it developed, and *in vitro* including, *inter alia*, the cryoconservation of semen, oocytes, embryos, cells or tissues. Note that *ex situ* conservation and *ex situ* preservation are considered here to be synonymous.

exclusive economic zone
that part of the marine realm seaward of territorial waters within which nations have exclusive fishing rights.

existence value
the value of knowing that a particular species, habitat or ecosystem does and will continue to exist. It is independent of any use that the valuer may make of the resource.

exotic
not native to a given area; either intentionally transplanted from another region or introduced accidentally.

exotic species
see: alien species.

extant
still living at the present time. (*Opposite*: extinct)

external costs/externalities
external costs/benefits exist when an activity by one person causes a gain/loss of welfare to another person that is uncompensated within the market.

extinct
no longer surviving. (*Opposite*: extant)

extinct breed
a breed where it is no longer possible to recreate the breed population. Extinction is absolute when there are no breeding males (semen), breeding females (oocytes), nor embryos remaining.

extinction
the death of any lineages of organisms. Extinction can be local, (when it is known as extirpation) in which one population of a given species vanishes while others survive elsewhere, or total, in which all its populations vanish.

extractive reserve
forest area for which use rights are granted by governments to residents whose livelihoods customarily depend on extracting forest products from the specified area.

extreme environments
environments characterised by extremes in growth conditions, including temperature, salinity, pH, and water availability, among others.

extremophile
a micro-organism whose optimum growth is under extreme conditions of temperature, etc.

fallow
the period during which land is left to recover its productivity (reduced by cropping) mainly through accumulation of water, nutrients, attrition of pathogens, or a combination of all three. During this period, the land may be bare or covered by natural or planted vegetation. The term may be applied to the land itself or to the crop growing on it.

familiarity
having enough information to be able to judge the safety or risks of an LMO. It can be used to indicate ways of handling risks. It is not synonymous with safety. Relatively low degree of familiarity may be compensated for by appropriate management practices. Familiarity can be increased as a result of a trial or experiment. This increased familiarity can then form a basis for future risk assessment.

farm animal genetic resources (AnGR)
those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them. These populations within each species can be classified as wild and feral populations, landraces and primary populations, standardized breeds, selected lines, and any conserved genetic material.

farmers' rights
rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant or animal genetic resources, particularly those in centres of origin.

fauna
all of the animals found in a given area.

Fauna
a book listing, with descriptions and illustrations, all animals that live in a given area.

fecundity
rate at which females produce offspring.

fitness
the expected contribution of an allele, genotype, or phenotype to future generations. The fitness of genes and organisms is always relative to the other genes and organisms that are present in the same population. Usually it is measured as the average number of offspring produced by individuals with a certain genotype, relative to the number produced by other genotypes.

flagship species
popular, charismatic species that serve as symbols and rallying points to stimulate conservation awareness and action.

flora
all of the plants found in a given area.

Flora
a book listing, with descriptions and illustrations, all plants that grow in a given area.

food web
an abstract representation of the feeding relationships of organisms within a community or an ecosystem.

fouling communities
benthic organisms attached to submerged objects of economic importance, such as pilings or boat-bottoms.

founder effect
the loss of genetic diversity when a new colony is formed (e.g. on an oceanic island) by a very small number of individuals from a larger population elsewhere.

fragmentation
the breaking up of extensive landscape features into disjunct, isolated, or semi-isolated patches as a result of land-use changes.

functional foods
foods that are considered to have a positive beneficial effect on health, by the addition of active ingredients, or by making bioavailable existing ingredients. Includes 'functional' modified or fortified soft drinks and other beverages, bread, dairy products, cereals, and snacks.

gamete
specialised haploid cell (sometimes called a sex cell) whose nucleus and often cytoplasm fuses with that of another gamete in the process of fertilisation.

gene
the units of heredity transmitted from generation to generation. Each gene is a segment of nucleic acid carried in the DNA encoded for a specific protein. More generally, the term 'gene' may be used in relation to the transmission and inheritance of particular identifiable traits. The basic unit of heredity, a gene is an ordered sequence of nucleotide bases comprising a segment of DNA. A gene contains the sequence of DNA which encodes one polypeptide chain. The sum of an organism's genes is known as its genome. The variant forms of each gene are termed **alleles.**

gene-bank
a storage facility where germplasm is stored in the form of seeds, pollen, embryos, semen, pollen, or in vitro culture, or in cryogenic storage, or, in the case of a field gene bank, as plants growing in the field.

gene flow
exchange of genetic traits between populations by movement of individuals, gametes or spores.

gene mapping
determination of the relative positions of genes on a DNA molecule (chromosome or plasmid) and of the distance, in linkage units or physical units, between them.

gene pool
the total amount of genetic material within a freely interbreeding population at a given time.

generics
copies of well-known drugs for which patent protection has expired. Companies specialising in generics invest little on research, or only on research in manufacturing procedures. The average price of a generic is 30 per cent below that for patented products.

genetic distance
a measure of the genetic similarity between any pair of populations. Such distance may be based on phenotypic traits, allele frequencies or DNA sequences. For example, genetic distance between two populations having the same allele frequencies at a particular locus, and based solely on that locus, is zero. The distance for one locus is maximum when the two populations are fixed for different alleles. When allele frequencies are estimated for many loci, the genetic distance is obtained by averaging over these loci.

genetic distancing
the collection of the data on phenotypic traits, marker allele frequencies or DNA sequences for two or more populations, and estimation of the genetic distances between each pair of populations. From these distances, the best representation of the relationships among all the populations may be obtained.

genetic diversity
the diversity of genes within and among populations of a species. This is the lowest level of biological diversity.

genetic drift
random gene frequency changes in a small population due to chance alone.

genetic engineering
: the identification of genes coding for useful traits and their introduction into other species of plants and animals ('transgenic species'). Genetic engineering offers the possibility of correcting genetic defects at source, or introducing new, desirable genetic characteristics that will stay with the subject and may be passed on to its successors.

genetic erosion
: loss of genetic diversity between and within populations of the same species over time; or reduction of the genetic basis of a species due to human intervention, environmental changes, etc.

genetic marker
: a gene with a clear, unambiguous phenotype used in genetic analysis to identify individuals that carry it or other linked genes. May act as a probe to mark a nucleus, chromosome or locus.

genetic material
: any material of plant, animal, microbial or other origin containing functional units of heredity.

genetic resources
: genetic material of plants, animals or micro-organisms, including modern cultivars and breeds, primitive varieties and breeds, landraces and wild/weedy relatives of crop plants or domesticated animals, of value as a resource for future generations of humanity.

genetically modified organism (GMO)
: the modification of the genetic characteristics of a micro-organism, plant or animal by inserting a modified gene or a gene from another variety or species. GMOs may be micro-organisms designed for use as biopesticides or seeds that have been altered genetically to give a plant better disease resistance or growth.

genome
: the complete set of genes and non-coding sequences present in each cell of an organism, or the genes in a complete haploid set of chromosomes of a particular organism. It is the genetic endowment of an organism. When expressed, this will result in the observable characteristics or phenotype.

genomics
: the study of genomes including genome mapping, gene sequencing and gene function. The use of this information in the development of therapeutics.

genotype
: the entire genetic constitution of an organism, or the genetic composition at a specific gene locus or set of loci.

germ cell
: a small organic structure or cell from which a new organism may develop.

germplasm
: the genetic material which forms the physical basis ofheredity and which is transmitted from one generation to the next by means of germ cells.

green petroleum
: bioprospecting seen as the means to a new 'green petroleum', capable of bringing wealth to the gene-rich but financially poor countries of the South.

greenhouse gases (GHGs)
: gases, such as carbon dioxide and methane, that tend to trap heat radiating from the Earth's surface, thus causing warming in the lower atmosphere. The major GHGs causing climate change are carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). The Kyoto Protocol also addresses hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), ans sulphur hexafluoride (SF6).

guild
: a group of species found in the same place that share the same food resource. Example: the lizard species of a sand dune that feed on insects.

GURTs
: Genetic Use Restriction Technologies; see **Terminator technology** and **Traitor technology**

habitat
: the place or type of site where an organism or population naturally occurs.

habitat restoration
: the return of a habitat to its original community structure, natural complement of species and natural functions.

haploid
: having the number of chromosomes present in the normal germ cell equal to half the number in the normal somatic cell.

herbs
plants or plant parts valued for medicinal, savoury, cosmetic, flavouring, or aromatic qualities.

heterozygosity
genetic variability among individuals within populations and variability among populations.

homologous chromosomes
contain identical linear sequences of genes and pair during meiosis.

homozygote or **homozygous**
individual having two identical alleles of a particular gene or genes, and so breeding true for the corresponding characteristics.

horticulture
the cultivation of ornamental and vegetable plants in gardens or smallholdings (market gardens).

hotspot
an area particularly rich in total numbers of species.

hybrid
individual organism resulting from a cross between parents of differing genotypes. Hybrids may be fertile or sterile, depending on qualitative and/or quantitative differences in the genomes of the two parents. Hybrids are most commonly formed by sexual cross-fertilization between compatible organisms, but techniques for the production of hybrids from widely differing organisms are being developed by cell fusion and tissue culture.

hybrid zone
region of reproduction among individuals of different species.

hybridization
the act of crossing two different individual organisms of differing genetic constitution from different populations or different species.

hypoxia
a state of low oxygen concentration in water and sediments, relative to the needs of most aerobic species.

impact assessment
an evaluation of the likely impact on biological diversity of proposed programmes, policies, or projects.

in-bred
a cross between parents of similar genetic constitution which could be from the same blood line (shared ancestry).

in-bred line
in plants, a line produced by repeated selfing and selection. Results in truebreeding and a fixed genotype.

inbreeding
mating of close relatives, which reduces genetic diversity, often leading to expression of deleterious recessive characteristics and reduction of fitness in the offspring.

inbreeding depression
a reduction in fitness and vigour of individuals as a result of increased homozygosity through inbreeding in a normally outbreeding population.

indicator species
a species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem. They reflect the quality and changes in environmental conditions as well as aspects of community composition.

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.

in-situ
in the original location. (Opposite: *ex-situ*)

***in-situ* conditions**
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 of farm animal genetic diversity**
: all measures to maintain live animal breeding populations, including those involved in active breeding programmes in the agro-ecosystem where they either developed or are now normally found, together with husbandry activities that are undertaken to ensure the continued contribution of these resources to sustainable food and agricultural production, now and in the future.

***in-situ* gene banks**
: protected areas designated specifically to protect genetic variability of particular species.

insurance value
: the value of biodiversity in maintaining ecosystem functions over a range of environmental conditions.

integrated area management (IAM)
: management approach whereby a specific area is zoned and regulated for a variety of uses, including research, species protection, tourism, harvesting, cutting down trees, hunting, or fishing, that is compatible with the management goals for the area.

integrated pest management
: an ecologically based strategy that relies on natural mortality factors, such as natural enemies, weather, and crop management, and seeks to control tactics that disrupt these factors as little as possible while enhancing their effectiveness.

intellectual property right
: a right enabling an inventor to exclude imitators from the market for a limited time.

intergenerational equity
: proposition that future generations have a right to an inheritance (capital bequest) sufficient to allow them to generate a level of well-being no less than that of the current generation. Fairness in the treatment of different members of the same generation.

intertidal zone
: the zone of overlap between land and sea that is submerged at high tide and exposed at low tide.

introduced species
: *see* alien species.

introduction
: the entry of a pest or species resulting in its establishment.

introduction of a biological control agent
: the release of a biological control agent into an ecosystem or an area where it did not exist previously.

inundative release
: the release of overwhelming numbers of a mass-produced biological control agent in the expectation of achieving a rapid reduction of a pest population without necessarily achieving continuing impact.

introgression
: incorporation of genes of one species into a gene pool of another species.

invasive species
: an introduced species which invades natural habitats.

inventorying
: the surveying, sorting, cataloguing, quantifying and mapping of entities such as genes, individuals, populations, species, habitats, ecosystems and landscapes or their components, and the synthesis of the resulting information for the analysis of process.

invertebrate
: any animal without backbone or spinal column.

in vitro
: storage of living materials as tissue culture, and may include cryopreservation (storage at low temperature, usually in liquid nitrogen).

***in vitro* culture**
: *see* tissue culture.

in vivo
: taking place in a living organism.

joint products
: commodities which are produced in such a way that a change in the output of one of them necessarily involves a change in the output of the other.

karyotype
characteristic chromosomes of a species.

keystone species
a species that influences the ecological composition, structure, or functioning of its community far more than its abundance would suggest.

land tenure
the right to exclusively occupy and use a specified area of land. Tenure may also be limited to certain resources ("resource tenure") such as timber but not to all resources in a given area. Tenure may be held by individuals, communities, government, or corporations.

landrace
a crop cultivar or animal breed that evolved with and has been genetically improved by traditional agriculturalists, but has not been influenced by modern breeding practices.

life sciences companies
companies which combine businesses in pharmaceutical, agricultural chemicals and products, and food and nutrition.

line
a homozygous, pure breeding group of individuals phenotypically distinct from other members of the same species. Broader than strain.

littoral
the ocean shore, including the rocky intertidal, sandy beaches, and salt marshes.

living modified organisms (LMOs)
genetically modified organisms (GMOs) whose genetic material does not occur naturally by mating or natural recombination.

locus
the site on a chromosome occupied by a specific gene.

macroevolution
large-scale evolution, entailing major changes in biological traits.

managed forest
productive forest where harvesting regulations are enforced, silvicultural treatments are carried out, and trees are protected from fires and diseases.

management of farm animal genetic resources
the sum total of technical, policy, and logistical operations involved in understanding (characterization), using and developing (utilization), maintaining (conservation), accessing, and sharing the benefits of animal genetic resources.

mangrove forest
a community of salt-tolerant trees, with associated shrubs or vines and other organisms, that grows in a zone roughly coinciding with the intertidal zone along protected tropical and subtropical coasts.

marginal values
the change in the value of a resource that is due to an incremental change in its quantity.

mariculture
breeding and rearing marine fish, shellfish, plants etc. for food in special areas.

marine ecosystems
regions of ocean space encompassing coastal areas from river basins to estuaries to the seaward boundary of continental shelves and seaward margins of coastal current systems. They are relatively large regions, characterized by distinct bathymetry, hydrography, productivity and trophically linked populations.

marker assisted selection
the use of molecular markers to follow the inheritance of genes, particularly those genes which cannot be readily identified. Selection of a marker flanking a gene of interest allows selection for the presence (or absence) of a gene in a new progeny.

market failure
this occurs when market prices are not equal to the social opportunity cost of resources. External effects or externalities are evidence of market failure.

market prices
prices generated through a market mechanism. When all costs and benefits (societal) have not been taken into account, this may be less than the social cost.

mass selection
breeding method whereby seed from a number of individuals is selected to form the next generation. Selection criteria are relaxed until later generations and crosses are performed at random.

maximum sustainable yield
the largest yield that can be obtained which does not deplete or damage natural resources irreparably and which leaves the environment in good order for future generations.

mechanism-based screening
a receptor- or enzyme-based screen against which a range of materials can be run, including natural products such as plants, marine organisms, fungi, and micro-organisms, but also synthetic compounds.

medicinal and aromatic plant material
whole plants and plant parts (including seeds and fruits) used primarily in perfumery and pharmacy. Includes fresh, dried, uncut, cut, crushed, and powdered material.

meiosis
the process of division of sexual cells in which the number of chromosomes in each nucleus is reduced to half the normal number found in normal somatic cells. When two sexual cells fuse, each contributes its half of the chromosomes. The resulting embryo contains the full chromosome complement. Cells with half the chromosomes are called haploids: those with the normal chromosomal complement, diploids.

meristem
the tip of a growing plant shoot or root.

meristem tip culture
a cell culture developed from a small portion of the meristem tissue of a plant.

mesopelagic
referring to depths between 200 to 1,000 meters in the ocean, seas and lakes.

metabolites
chemical products of metabolism; the biological synthesis or breakdown carried out by cells or their components.

metapopulation
a set of partially isolated populations belonging to the same species. The different populations are able to exchange individuals and recolonize sites in which the species has recently become extinct.

microbe
synonymous with micro-organism.

microevolution
evolutionary changes on the small scale, such as changes in gene frequencies within a population.

micro-organisms
groups of microscopic organisms, some of which cannot be detected without the aid of a light or electron microscope, including the viruses, the prokaryotes (bacteria and archaea), and eukaryotic life forms, such as protozoa, filamentous fungi, yeasts and micro-algae.

micropropagation
the use of biotechnological methods to grow large numbers of plants from very small pieces of plants, often from single cells using tissue culture methods.

minimum viable population
the smallest isolated population having 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 percent and 1000 years, respectively.)

molecular marker
a molecular selection technique of DNA signposts which allows the identification of differences in the nucleotide sequences of the DNA in different individuals. In agriculture, a tool which allows crop geneticists and breeders to locate on a plant chromosome the genes for a trait of interest. It is considered more efficient than conventional breeding as it has the potential to greatly reduce development times and substitutes laboratory selection for much of the fieldwork.

monophyletic group
set of species containing a common ancestor and all its descendants.

mutagen
agent that induces a mutation within an organism, such as X-rays, gamma rays, neutrons, and certain chemicals such as carcinogens. KP is an agent capable of inducing a mutation (a change

that alters the sequence or chemistry of bases in the DNA molecule) in the genetic material of an organism.

mutation

any change in the genotype of an organism occurring at the gene, chromosome or genome level.

mutualism

- interspecific relationship in which both organisms benefit. Example: flower pollination by insects.
- a kind of symbiotic relationship, such as the one between sea-anemones and clown-fishes, or corals and zooxanthellae, in which both species benefit; the relationship can be obligate or facultative for one or both partners.

native peoples

see indigenous peoples.

native species

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

natural enemy

an organism which lives at the expense of another organism and which may help to limit the population of its host. This includes parasitoids, parasites, predators and pathogens.

natural forest

see primary forest.

natural forest management system

controlled and regulated harvesting of forest trees, combined with silvicultural and protective measures, to sustain and increase the commercial value of subsequent stands; relies on natural regeneration of native species.

natural selection

process by which the genotypes in a population that are best adapted to the environment increase in frequency relative to less well-adapted genotypes over a number of generations.

nekton

swimming organisms that are able to move independently of water currents (opp. plankton). These include most fish, mammals, turtles, sea snakes, and aquatic birds.

nematode

roundworms, often internal parasites of animals and plants. The latter are significant economic pests on foodcrops as few crops are immune to attacks of these creatures which inhabit the soil about the roots of plants. The development of nematode-resistant varieties of crop plants is important to food growth economics.

neoendemics

clusters of closely related species and subspecies that have evolved relatively recently.

niche

the place occupied by a species in its ecosystem and its role: where it lives, what it feeds on and when it performs all its activities.

nitrogen fixation

biological assimilation of atmospheric nitrogen to form organic nitrogen-containing compounds.

non-consumptive value

the value of resources which are not diminished by their use. Values that do not require access to or active use of a biological resource by the valuer. Passive use value may imply that the resource is used by other humans whose welfare matters to the valuer. It therefore includes vicarious use value, bequest value and existence value.

non-equilibrium theory

suggests that the number of species increases or decreases depending on how the environment influences species production, exchange and extinction at any particular time.

non-exclusive goods

public goods to which it is impossible, or excessively costly, to operate any mechanism.

non-governmental organization (NGO)

a non-profit group or association organized outside of institutionalized political structures to realize particular social objectives (such as environmental protection) or serve particular constituencies (such as indigenous peoples). NGO activities range from research, information distribution, training, local organization, and community service to legal advocacy, lobbying for legislative change, and civil disobedience. NGO's range in size from small groups within a particular community to huge membership groups with a national or international scope.

non-use value
see non-consumptive value.

normalizing selection
see stabilizing selection.

nucleotide
unit building block of DNA. It consists of a sugar and phosphate backbone with a base attached.

oligotrophic
low in nutrients and in primary production.

ontogeny
life cycle of a single organism; biological development of the individual.

opportunity cost
the value of the best alternative use of a resource. This consists of the maximum value of other outputs we could and would have produced had we not used the resource to produce the item in question.

option value
the potential value of the resource for future (direct or indirect) use.

orthodox seed
seed that can be dried and stored for long periods at reduced temperatures and under low humidity.

over-expression host
an organism that produces more of the desired enzyme or compound than normal.

parapatric speciation
speciation in which the new species forms from a population contiguous with the ancestral species' geographic range.

parasite
an organism that consumes part of the tissues of its host, usually without killing the host.

parasitoid
an insect parasitic only in its immature stages, killing its host in the process of its development, and free living as an adult.

parataxonomist
field-trained biodiversity collection and inventory specialist recruited from local areas.

passive use value
see non-consumptive value.

patent
a government grant of temporary monopoly rights on innovative processes or products.

pathogen
a disease-causing micro-organism; a bacterium, fungus or virus.

pathway
a sequence of reactions undergone in a living organism; any means that allows the entry or spread of a pest.

pelagic
free-swimming (nektonic) or floating (planktonic) organisms that live exclusively in the water column, not on the bottom. (*Opposite*: benthic)

pest
any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or other organisms and/or their products.

phenotype
the characteristics of an organism that result from the interaction of its genetic constitution with the environment.

pheromone
- a volatile hormone or behaviour-modifying agent. Normally used to describe sex attractants -for example bombesin for the moth *Bombyx*- but includes volatile aggression-stimulating agents (*e.g.* isoamyl acetate in honey bees).

photosynthesis
chemical reactions in plants and plant-like organisms whereby the sun's energy is absorbed by the green pigment chlorophyll, permitting carbon dioxide and water to be synthesized into carbohydrates accompanied by the release of water and oxygen.

phyletic evolution
genetic changes that occur within an evolutionary line.

phylogeny
history or evolutionary development of any plant or animal species.

phylogenetic
pertaining to the evolutionary history of a particular group of organisms.

phylum
in taxonomy and systematics, the highest level of classification below the kingdom. For instance, Mollusca (slugs, snails, clams, squids, etc.) constitute a phylum.

phytomedicine
medicinal products based on standardised active ingredients within a herbal base. This term is sometimes used more broadly to include all plant-based medicines.

phytonutrients
naturally-occurring compounds found in fruits and vegetables, such as beta carotene, capsaicin, and flavonoids.

picoplankton
planktonic organisms ranging in size from 0.2 to 2.0 micrometers.

plankton
floating and drifting organisms that have limited swimming abilities and that are carried largely passively with water currents (opp. nekton). These include bacteria (bacterioplankton), plants and plant-like organisms (phytoplankton) and the animals (zooplankton) that eat them.

plant functional attributes
readily observable features of vegetation that are considered significant for growth, physiology and survival (for example pollination mechanisms, seed dispersal mechanisms, rooting systems.)

Pleistocene
the span of geological time preceding the Recent epochs, during which the human species evolved. It began 2.5 million years ago and ceased with the end of the last Ice Age 10,000 years ago.

pleuston
organisms that float on the sea surface.

pollen culture
a culture of plant cells derived from pollen in a synthetic medium: the progeny generated will have a single set of chromosomes.

pollination
the transfer of pollen from an anther to the stigma in angiosperms, or from the microsporangium to the micropyle in gymnosperms. Pollination can be caused by pollinators such as butterflies, bees, birds, bats but also by the wind or the water.

pollinator
a pollinator is an agent, generally an animal (insect, bird, bat, etc.) that carries pollen to the female part of a flower.

polyploid
organism containing two or more sets of genes or chromosomes.

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.

population viability analysis
a comprehensive analysis of the many environmental and demographic factors that affect survival of a population, usually small.

post-emergent
a herbicide which acts after the seed has germinated.

pre-breeding
the development of germplasm to a state where it is viable for breeder's use. Primarily involves the evaluation of traits from exotic material and their introduction into more cultivated backgrounds.

precautionary principle
if the costs of current activities are uncertain, but are potentially both high and irreversible, the precautionary principle holds that society should take action before the uncertainty is resolved. (*Opposite*: wait-and-see principle)

pre-clinical studies
the various tests conducted in whole animals and other test systems, such as cell cultures, to determine the relative toxicity of a compound to living systems. These are referred to as pre-

clinical studies - tests conducted and evaluated prior to the first administration of the compound to humans. Also included in this category are two-year carcinogenicity assays which typically overlap with the chemical testing phase. Pre-clinical tests include: **toxicity** (how poisonous it is and what side effects might be expected); **bioavailability** (how effectively it is taken up into the body and delivered to the tissue where it is needed); **pharmacokinetics** (how it is metabolised, and therefore how long it stays in the body); and whether it has the desired physiological effect.

predator

a natural enemy that preys and feeds on other animal organisms, mor than one of which are killed during its lifetime.

primary forest

a forest largely undisturbed by human activities. (*Also* natural forest; *opp*. secondary forest.)

primary metabolites

compounds ubiquitous in living organisms and essential for life, such as carbohydrates, the essential amino acids and polymers derived from them.

primary production

amount of organic material synthesised by organisms from inorganic substrata in a given area in a given period.

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.

primary value

the value of the system characteristics upon which all ecosystem functions depend.

primitive cultivar

crop forms developed from landraces. Improvement through selection restricted to a few specific characteristics and often more uniform in nature than a landrace.

prior informed consent (PIC)

the principle that international shipment of a pesticide that is banned or severely restricted in order to protect human health or the environment should not proceed without agreement, where such agreement exists, or contrary to the decision of the designated national authority in the participating importing country.

private opportunity cost

the opportunity cost faced by an individual agent of using a resource (not including any externalities.)

private value

the value to the private agent of using or refraining from using a resource.

prochlorophyte

bacteria that are the smallest photosynthetic cells (less than one micrometers; see picoplankton) in the open ocean; nearly ubiquitous in the sea.

production environment

all input-output relationships, over time, at a particular location. The relationships will include biological, climatic, economic, social, cultural and political factors, which combine to determine the productive potential of a particular livestock enterprise. A **high-input production environment** is one where all rate-limiting inputs to animal production can be managed to ensure high levels of survival, reproduction and output. Output and production risks are constrained primarily by managerial decisions. A **medium-input production environment** is one where management of the available resources has the scope to overcome the negative effects of the environment on animal production, although it is common for one or more factors to limit output, survival or reproduction in a serious fashion. A **low-input production environment** is one where one or more rate-limiting inputs impose continuous or variable severe pressure on livestock, resulting in low survival, reproductive rate or output. Output and production risks are exposed to major influences which may go beyond human management capacity.

production function

this describes the outputs that may be obtained from combining different quantities of inputs.

production traits

characteristics of animals, such as the quantity or quality of the milk, meat, fiber, eggs, draught, etc. they (or their progeny) produce, which contribute directly to the value of the animals for the farmer, and that are identifiable or measurable at the individual level. Production traits of farm

animals are generally quantitatively inherited, i.e. they are influenced by many genes whose expression in a particular animal also reflects environmental influences.

progeny testing

procedure to establish the genotype of a parent by recording the genetic status of offspring/progeny.

prokaryote

an organism having a cell without a distinct nucleus. Bacteria and blue-green algae are prokaryotes. (*Opposite:* eukaryote.)

propagule

a dispersal stage of a plant or animal, such as fertilized eggs, larvae, or seeds.

protected area

a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

protein

any of a class of nitrogenous compounds forming an essential part of living organisms and having large molecules consisting of one or more chains of amino acids linked together.

protein engineering

the generation of proteins (specifically enzymes) with subtly modified structures, thus conferring new properties such as changed catalytic specificity or thermal stability.

protoplast

a plant cell from which the cell wall has been removed by mechanical or enzymatic means. Protoplasts can be prepared from primary tissues of most plant organs as well as from cultured plant cells.

public good

a good which, once provided to one user, must be provided in the same amount to all users due to its non-rival and non-excludable nature.

quarantine

official confinement of regulated articles for observation and research or for further inspection, testing or treatment.

quarantine pest

a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being offically controlled.

quasi-option value

the value of the future information made available through the preservation of a resource.

Quaternary period

the second and last period of the Cenozoic era extending from 2.5 million years ago to the present.

recalcitrant

a term applied to pollutants which are not biodegradable or are only biodegradable with difficulty.

recalcitrant seed

seed that cannot withstand either drying or temperatures of less than 10° C and cannot therefore be stored for long periods as orthodox seeds can.

reciprocal externality

these are externalities where all parties using some resource impose external costs on all others.

recombinant DNA (r-DNA)

a strand of DNA synthesised in the laboratory by splicing together selected parts of DNA strands from different organic species, or by adding a selected part to an existing DNA strand.

recombinant DNA technology

the process of excising segments of DNA from one species of organism and inserting them into the DNA of another species.

recurrent selection

a breeding method aimed at increasing the frequency of favourable genes through repeated cycles of selection and selected crossing of individuals.

red tide

reddish-brown discoloring of surface water from blooming populations of dinoflagellate phytoplankton; since long associated with nutrient pollution.

reef ball
: a designed artificial reef used to restore ailing coral reefs and to create new fishing and scuba diving sites.

restoration
: the return of an ecosystem or habitat to its original community structure, natural complement of species, and natural functions.

rights
: entitlements assured by custom, law or property.

risk
: the outcome of an action is said to involve risk where: the set of all possible outcomes of that action is known, and where the probability distribution of all possible outcomes is also known.

risk assessment
: the use of scientific data to identify and characterize the nature and magnitude of hazards, if any, and the likelihood of hazards being realized.

risk management
: the implementation of the most appropriate measures to minimize the identified risks and mitigate their effects while achieving the anticipated results.

RNA
: a molecule with similar structure to DNA that is involved in a number of cell activities, especially protein synthesis. Some viruses have RNA as their genetic material.

safe or **safety**
: the conditions determined with reasonable certainty to have acceptable or negligible risk to human health or to managed or natural ecosystems.

safe minimum standard
: a restriction (taboo, prohibition, harvesting season) which limits the use of resources to levels that are thought to be safe, e.g. conservation of a sufficient area of habitat to ensure the continued provision of ecological functions and services, at the ecosystem level.

secondary forest
: natural forest growth after some major disturbance (e.g. logging, serious fire, or insect attack). (*Opp.*: primary forest.)

secondary value
: the value of ecosystem functions.

seed bank
: a facility designed for the *ex-situ* conservation of individual plant samples 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.

self-pollinated
: see **in-bred**.

sessile
: fixed or attached; unable to move.

sibling species
: species so similar to each other as to be difficult to distinguish by human observers.

silviculture
: the science of cultivating forest crops (usually timber), based on a knowledge of forest tree characteristics.

sinks
: growing vegetation tends to absorb carbon dioxide (CO2) from the atmosphere. Calculating the effect of sinks (by land-use change and forestry) is methodologically complex and still needs to be clarified.

social opportunity cost
: the opportunities forgone by society, including externalities, in using a resource in some way. For biological resources this may be different from the market price of that resource.

somatic cell
: any cell other than a germ cell.

source country
country providing genetic resources.

spawn
the eggs of certain aquatic organisms or the act of producing such eggs or egg masses.

speciality biotechnology products
include enzymes, fine chemicals, speciality food products and food ingredients. Non-medical diagnostics for detection of pesticides in the environment and contaminants in food.

speciation
separation of one population into two or more reproductively isolated, independent evolutionary units.

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

species diversity
the number and variety of species found in a given area in a region.

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.)

species selection
the differential multiplication and extinction of species as a result of differences in certain traits possessed by the organisms belonging to the various species, and causing a spread of the favouring traits through the fauna or flora as a whole.

spread
expansion of the geographical distribution of a pest or other organism within an area.

stability
the ability of a given assemblage of organisms to withstand disturbance without a major change in the number of species or individuals.

stabilizing selection
selection favouring individuals in the middle of the distribution of phenotypes in a population and disfavouring the extremes. Also called normalizing selection.

stochastic
referring to patterns or processes resulting from random factors.

stock
a specific population or group of populations.

straddling stock
a population of organisms that travels between the exclusive economic zones of two or more countries, or between them and the high seas.

strain
a population of cells all descended from a single cell; also called a clone. A group of organisms within a species or variety distinguished by one or more minor characteristics; a variety of bacterium or fungus used for culturing. The term is mostly associated with cells, bacteria, fungi and viruses, but is sometimes applied to plants.

strong sustainable development principle
proposition that the opportunity set for future generations can only be assured if the level of biodiversity they inherit is no less than that available to present generations.

subsidies
government grants to suppliers of goods or services.

subspecies
groupings or populations within a species that are distinguishable by morphological characteristics or, sometimes, by physiological or behavioural traits.

surrogate markets
markets used in place of the missing markets for environmental resources. Surrogate markets are at least existing markets for resources with some of the properties of the non-marketed resource being valued.

sustainable development
development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

sustainable intensification of animal production systems
: the manipulation of inputs to, and outputs from, livestock production systems aimed at increasing production, productivity, and product quality, while maintaining the long-term integrity of the systems and their surrounding environment, so as to meet the needs of both present and future human generations. Sustainable agricultural intensification respects the needs and aspirations of local and indigenous people, takes into account the roles and values of their locally adapted genetic resources, and considers the need to achieve long-term environmental sustainability within and beyond the agro-ecosystem.

sustainable use
: 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.

symbiosis
: the close relationship of two organisms in proximity, with one benefiting and the other either benefiting (mutualism), not being significantly affected (commensalism), or being harmed (parasitism).

sympatric
: occurring in the same place. (*Opp.*: allopatric.)

sympatric speciation
: speciation via populations with overlapping geographic ranges.

systematics
: the study of the historical evolutionary and genetic relationships among organisms and of their phenotypic similarities and differences.

target species
: the intended catch of a fishery. (*Opp.*: bycatch)

taxon (pl. taxa)
: the named classification unit (*e.g. Panthera tigris*, *Panthera*, Felidae, Carnivora or Mammalia) to which individuals, or sets of species, are assigned. *Lower taxa* are those at subspecies and species level (*e.g. Panthera tigris sumatrae*). *Higher taxa* are those above the species level (at genus, family, order, class, *etc.* level; *e.g. Panthera*, Felidae, Carnivora, Mammalia).

taxonomy
: the naming and assignment of organisms to taxa.

technology transfer
: the transfer of knowledge or equipment to enable the manufacture of a product, the application of a process, or the rendering of a service.

terminator technology
: the genetic engineering of plants to produce sterile seeds. It is considered the most morally offensive application of agricultural biotechnology, because over 1.4 billion people depend on farm-saved seeds. *See also* traitor technology.

Tertiary period
: the first period of the Cenozoic era, beginning 65 million years ago and closing with the start of the Pleistocene, 2.5 million years ago.

theory of local existence
: suggests that the number of species increases or decreases depending on how the environment influences species production, exchange and extinction at any particular time.

threatened species
: species that are, often genetically impoverished, of low fecundity, dependent on patchy or unpredictable resources, extremely variable in population density, persecuted or otherwise prone to extinction in human-dominated landscapes.

tissue culture
: a technique in which portions of a plant or animal are grown on an artificial culture medium. (Also: *in vitro* culture.)

total economic value
: the sum of use and non-use values with due consideration of any trade-offs or mutually exclusive uses or functions of the resource or habitat in question.

total environmental value
: it is a function of primary value and total economic value.

total extracts
contain the whole spectrum of ingredients present in the original herb, plus any new active compounds formed during processing.

traditional Chinese medicine (TCM)
the primary healthcare for 20% of the world's population, the system of medicine developed over thousands of years in China, which treats the patient holistically, and includes herbal preparations - usually combinations of between five and ten species.

traditional knowledge
the knowledge, innovations and practices of local and indigenous communities. As used in the CBD, those elements of traditional knowledge that are relevant to the conservation and sustainable use of biodiversity.

traditional resource rights
the term TRR encompasses intellectual property rights, but denotes broader 'bundles of rights' including for example, human rights, land rights, religious rights, and cultural property.

traitor technology
also known as genetic use restriction technology (GURT), refers to the use of an external chemical to switch on or off a plant's genetic traits.

transformation
uptake of naked DNA by a competent recipient strain.

transgenic
organisms into which DNA from another genotype are introduced by, for example, micro-injection or retroviral infection.

translocation
switching of a segment of a chromosome to another chromosome.

tribal peoples
see indigenous peoples.

trophic
referring to the nutrients available to and used within a population, community, or ecosystem.

trophic level
feeding level in food chain or pyramid; for example, herbivores (organisms that eat plants) constitute one trophic level.

umbrella species
species whose occupancy area (plants) or home range (animals) are large enough and whose habitat requirements are wide enough that, if they are given a sufficiently large area for their protection, will bring other species under that protection.

unadapted
material lacking the characteristics or agronomic performance for cropping in a specific area.

unidirectional externality
these are externalities in which the external costs or benefits of the resource use are "one way".

unintended release
any release of GMOs which is not a deliberate release

upwelling
a process by which water rises from lower depths into the shallows, usually the result of divergence or offshore currents.

use value
values obtained through the use of a resource. This includes direct and indirect use values and instrumental values. Preservation in this sense is as much a use as development.

utility function
a description of the way in which the well-being of individuals depends on different combinations of goods and services consumed.

utilization of farm animal genetic resources
the use and development of animal genetic resources for the production of food and agriculture. The use in production systems of AnGRs that already possess high levels of adaptive fitness to the environments concerned, and the deployment of sound genetic principles, will facilitate sustainable development of the AnGRs and the sustainable intensification of the production systems themselves. The wise use of AnGRs is possible without depleting domestic animal diversity. Development of AnGRs includes a broad mix of ongoing activities that must be well planned and executed for success, and compounded over time, hence with high value. It requires

careful definition of breeding objectives, and the planning, establishment and maintenance of effective and efficient animal recording and breeding strategies.

valuation

the attachment of monetary value to an object through a consideration of both internalised and externalised costs.

variance

a statistical measure of the dispersion of a set of values about its mean.

variety

a taxonomic rank below subspecies in zoology and botany, varieties are often the result of selective breeding and diverge from the parent species or subspecies in distinct but relatively minor ways. Usage varies in different countries.

vector

'a carrier'. In genetic manipulation the vehicle by which DNA is transferred from one cell to another. An agent of transmission; for example, a DNA vector is a self-replicating segment of DNA that transmits genetic information from one cell or organism to another.

vicariant patterns

when several taxa are subdivided by the same tectonically and climatically produced barriers to dispersal.

virus

the smallest known type of organism. A non cellular entity that consists minimally of protein and nucleic acid, and that can replicate only after entry into specific types of living cells, and then only by usurping the cell's own systems.

voucher specimens

collections of organisms that are maintained to provide permanent, physical documentation of species identifications and associated data resulting from inventories.

wait-and-see principle

a reactive method of dealing with the environment that places the burden of proof on those who would conserve. (*Opposite*: the precautionary principle)

welfare

an index of well-being.

wide crossing

in plant breeding this refers to the process of undertaking a cross where one parent is from outside the immediate genepool of the other, *i.e.* landrace or primitive line crossed with a modern cultivar.

wild relative

plant or animal species that are taxonomically related to crop or livestock species and serve as potential sources for genes in breeding of new varieties of those crops or livestock.

willingness to pay

is the amount an individual is willing to pay to acquire some good or service. This may be elicited from stated or revealed preference approaches.

willingness to accept

is the amount of compensation an individual is willing to take in exchange for giving up some good or service. This may be elicited from stated or revealed preference approaches.

zooxanthellae

microscopic dinoflagellate algae that live mutualistically in the tissues of certain marine invertebrates, including reef-building corals and giant clams.

zygote

fertilised ovum of animal or plant formed from the fusion of male and female gametes.