Contents

AN OVER-VIEW ON BIOLOGICAL DIVERSITY ACT – 2002*

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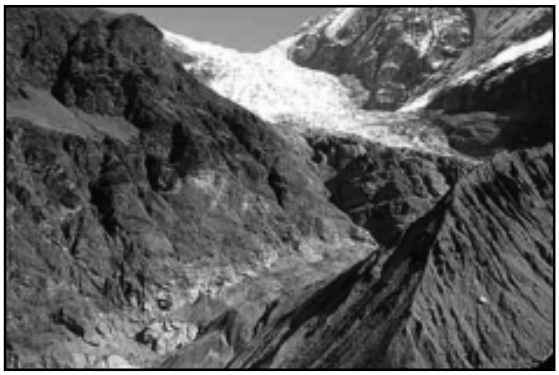

"Biological diversity means the variability among living organisms from all sources including interalia, terrestrial, marine and other aquatic eco system and the ecological complexes of which they are part and this includes diversity within species, between species and of eco-system."

Introduction

Biodiversity encompasses the variety of all life on earth. India is one of the 17-mega diverse countries of the world. With only 2.5% of the land area, India already accounts for 7.8% of the global recorded species. India is also rich in traditional and indigenous knowledge, both coded and informal.

India is a Party to the Convention on Biological Diversity (CBD) (1992). Recognizing the sovereign rights of States to use their own biological resources, the Convention expects the Parties to facilitate access to genetic resources by other Parties subject to national legislation and on mutually agreed upon terms (Article 3 and 15 of CBD). Article 8 (j) of the Convention on Biological Diversity recognizes contributions of local and indigenous communities to the conservation and sustainable utilization of biological resources through traditional

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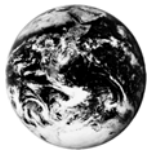


knowledge, practices and innovations and provides for equitable sharing of benefits with such people arising from the utilization of their knowledge, practices and innovations.

Biological diversity is fundamental to agriculture and food production. From the millions of genes that serve as building blocks to the thousands of plants and animals that inhabitant the earth, almost limitless combinations of organisms that make up natural ecosystems. Under the contextual reference of modern intensive agriculture demanding many farmers to adopt high yielding varieties of plants and animals, Biodiversity makes an essential contribution for feeding the millions of population of the world. When farming communities abandon diversity, varieties and breeds of animals extinct and the specialized useful traits may be lost. Agricultural diversity forms an important component for tackling unforeseen effects of climate change and is one of the essential key component for developing varieties and animal species with standing temperature extreme floods, droughts, outbreak of diseases reducing the crop productivity and directly causing untold hardship to farming community.

Biodiversity is a multi-disciplinary subject involving diverse activities and actions. The stakeholders in biological diversity include the Central Government, State Governments, institutions of local self-governmental organizations, industry, etc. One of the major challenges before India lies in adopting an instrument, which helps to realise the objectives of equitable sharing of benefits enshrined in the Convention on Biological Diversity.

Salient Features of the Biological Diversity Act - 2002

- After an extensive and intensive consultation process involving the stakeholders, the Govt. of India has brought Biological Diversity Act, 2002.
- To regulate access to biological resources of the country equitable share in benefits arising out of the use of biological resources.
- To conserve and sustainable use of biological diversity.
- Setting up of National Biodiversity Authority (NBA), State Biodiversity Board (SBB) and Biodiversity Management Committee's. (BMC's).
- NBA and SBB are required to consult BMCs in decisions relating to bioresource / related knowledge within their Jurisdiction.
- To respect and protect knowledge of local communities traditional knowledge related to biodiversity.
- To secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources.
- All foreign nationals / organizations require prior approval of NBA for obtaining biological resources and / or associated knowledge for use.
- Indian scientists / individuals require approval of NBA for transferring results of research to foreign nationals / organizations.
- Conservation and development of areas of importance from the standpoint of biological diversity by declaring them as biological diversity heritage sites.
- Protection and rehabilitation of threatened species.
- Involvement of institutions of State Government in the broad scheme of the implementation of the Biological Diversity Act through constitution of committees.
- Protect India's rich bioiversity and associated knowledge against their use by foreign individuals and organizations without sharing benefits arising out of such use and check Biopiracy.
- Indian Industry needs prior intimation to SBB to obtain bioresource. SBB has right to restrict if found to violate conservation and sustainable use and benefit sharing.
- Provisions for notifying heritage sites by State Government in consultation with local body.

- Creation of National, State and Local Biodiversity Fund and its use for conservation of biodiversity.
- Prior approval is needed from NBA for IPRs in any invention in India or outside India on Bioresource.

Biodiversity

Biological Diversity means the variability among living organisms from all sources, including interalia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and this includes diversity within species, between species and of ecosystems. Biodiversity is defined as the variety and variability among living organisms and the ecological complexes in which they occur is measured at three levels *viz*., genes, species and ecosystem.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is a landmark in the environment and development field, as it takes for the first time a comprehensive rather than a sectoral approach to the conservation of Earth's biodiversity and sustainable use of biological resources. It was in the year 1984 that the needs to have in place a global convention on biological diversity started gaining momentum. In response, the United Nations Environment Programme (UNEP) in the year (1987) recognized the need to streamline international efforts to protect biodiversity. It therefore established an ad hoc working group to investigate "the desirability and possible form of an umbrella convention to rationalize current activities in the field. This group by 1988 concluded that a) the existing treaties were inadequate to address the issue of conservation and sustainable use and b) a new global treaty on biological diversity was urgently needed. Organisations such as the World Conservation Union (IUCN) and the Food and Agricultural Organisation (FAO) contributed draft articles in addition to specific studies commissioned by the UNEP. The UNEP Secretariat prepared the first draft and the formal negotiating process was started in 1991. The Inter-governmental Negotiating Committee for a Convention on Biological Diversity (INC) was given the task of ensuring the adoption of the Convention. On May 22, 1992 the nations of the world adopted the CBD in Nairobi and on June 5, 1992 the CBD was tabled at the UN Conference on Environment and Development in Rio de Janeiro where a record 150 countries signed the Convention.

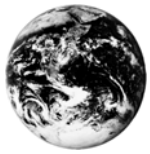
The Convention on Biological Diversity (CBD) was negotiated and signed by nations at the UNCED Earth Summit at Rio-de-Janeiro in Brazil in June 1992. The Convention came into force on December 29, 1993. India became a Party to the Convention in 1994. At present, there are 175 Parties to this Convention.

The main objectives of the Convention are:

- Conservation of biological diversity;
- Sustainable use of the components of biodiversity;
- Fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

Re-affirming the sovereign rights of Parties over their own biodiversity, the Convention balances conservation with sustainable utilisation and access to and use of biological resources and associated knowledge with equitable sharing of benefits arising out of such use. The CBD offers opportunities to India to realise benefits from its rich biological resources and associated traditional knowledge.

The CBD stipulates that the parties, even though having sovereign rights over their biological resources, would facilitate access to the genetic resources by other parties subject to national legislation and on mutually agreed terms. The CBD also provides for equitable sharing of benefits arising from the utilisation of traditional knowledge and practices, with holders of such knowledge. This has made it necessary for a legislation to be put in place, which lays down the framework for providing access, for determining the term of such access and for ensuring the equitable sharing of benefits.



SUMMARY OF BIOLOGICAL DIVERSITY ACT, 2002

- 12 Chapters
- 65 Sections and many subsections
- Notified Notifications and Rules
- Chapter – I : Preliminary –Terminologies and Definitions
- Chapter – II : Regulations of access to Biological Diversity (3)
  - ◆ Certain persons not to undertake Biodiversity related activities without the approval of NBA (3)
  - ◆ Results of research not to be transferred to certain persons without the approval of NBA (4)
  - ◆ Section 3 and 4 not to apply to certain Collaborative Projects (5)
  - ◆ Application for IPR rights not to be made without approval of NBA (6)
  - ◆ Prior intimation to State Biodiversity Board for obtaining biological resource for by Indian citizen or a body corporate for the utilization of bioresources for commercial purpose (7)
- Chapter – III : Establishment of National Biodiversity Authority
- Chapter – IV : Functions and Powers of National Biodiversity Authority
- Chapter – V : Approval by the National Biodiversity Authority for understanding certain activities ie **Transfer of biological resource or associated knowledge.**
- Chapter – VI : Establishment of State Biodiversity Board
- Chapter – VII : Finance, Accounts and Audit of National Biodiversity Authority
- Chapter – VIII : Finance, Accounts and Audit of State Biodiversity Authority
- Chapter – IX : Duties of the Central and State Governments
  - ◆ Central Govt to develop strategic plan for conservation and sustainable use of biodiversity and bioresources (36)
  - ◆ Declaration of Biodiversity heritage sites by the State Government to protect the unique Biodiversity areas. (37)
  - ◆ Power of Central Government to notify threatened/endangered species. (38)
  - ◆ Power of Central Government to designate repositories (39)
  - ◆ Power of Central Government to exempt Normally Traded Commodities (40)
- Chapter – X : Constitution of State

Biodiversity Management Committees

- Chapter – XI : Local Biodiversity Fund
- Chapter – XII : Miscellaneous
  - National Biodiversity Authority to be bound by policy directions as the Central Government may give in writing to it from time to time (48).
  - Power of State Government to give policy directions to the State Biodiversity Boards. (49)
  - Settlement of dispute between National Biodiversity Authority and State Biodiversity Boards (50)
  - Penalities (55)
  - Whoever contravenes or attempts to contravene the provisions of section 3 or section 4 or section (6) shall be punishable with imprisonment for a term which may **EXTENDS TO FIVE YEARS** or with fine which may extend to ten lakh rupees and where the damage caused exceeds **TEN LAKH RUPEES** such **FINE MAY COMMENSURATE WITH THE DAMAGE CAUSED OR WITH BOTH** [55(1)]
  - Whoever contravenes or attempts to contravene the provisions of section 7 or any order made under subsection (2) of section 24 shall be punishable with imprisonment for a term which **MAY EXTEND TO THREE YEARS** or **WITH FINE WHICH MAY EXTEND TO FIVE LAKH RUPEES OR WITH BOTH**

Management structure of Biodiversity Act

A three tiered structure at the national, state and local level is envisaged.

National Biodiversity Authority (NBA)

All matters relating to requests for access by foreign individuals, institutions or companies, and all matters relating to transfer of results of research to any foreigner will be dealt with by the National Biodiversity Authority.

State Biodiversity Boards (SBB)

All matters relating to access by Indians for commercial purposes will be under the purview of the State Biodiversity Boards (SBB). The Indian industry will be required to provide prior intimation to the concerned SBB about the use of biological resource. The State Board will have the power to restrict any such activity, which violates the objectives of conservation, sustainable use and equitable sharing of benefits.

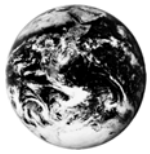
Biodiversity Management Committess (BMCs)

Institutions of local state government will be required to set up biodiversity management Committees in their respective areas for conservation, sustainable use, documentation of biodiversity and chronicling of knowledge relating to biodiversity.

NBA and SBBs are required to consult the concerned BMCs on matters related to use of biological resources and associated knowledge within their jurisdiction.

People's Biodiversity Register (PBR)

- The main function of the BMC is to prepare Peoples Biodiversity Register in consultation with local people.
- The Register shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them.
- Many of our local people or ecosystem people possess valuable knowledge of uses of biodiversity such as herbal remedies and vegetable dyes, much of the knowledge of the status and dynamics of biodiversity also resides with the people at grassroots.



- The tremendous valuation from place to place in the distribution and uses of biodiversity, the documentation has to be highly location specific and time specific.
- The PBR is a complex process involving a series of activities linked to each other in many different ways.
- All local bodies have the responsibility of documentation of local biological resources
- Comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them.
- Data about the local *Vaids* and practitioners using the biological resources.
- Details of the access to biological resources and traditional knowledge grated, details of collection fee imposed and details of the benefits derived and mode of their sharing.
- People's knowledge is of two kinds.
- Knowledge of uses that might find commercial application and that might need to be guarded with respect to IPR.
- Knowledge pertinent to prudent management of natural resources that might be widely shared with benefit to all concerned without any unfair commercial profits accruing to any party.
- The NBA and the SBB shall provide guidance and technical support to the BMC for preparing Peoples Biodiversity Registers (BDR.22,9)
- The Peoples Biodiversity Registers shall be maintained and validated by the BMC

Biodiversity Heritage Sites (BHS)

Biodiversity heritage sites (BHS) should includes both wild and domesticated biodiversity and human cultural relations with such biodiversity. The question will arise, how biodiversity. Heritage sites are different from the concept of "Protected areas"? Protected areas is covered in The Wild Life Act. It is important to focuss while declaring Biodiversity Heritage sites on some aspects like.

- Local communities would be central to such a process including in identifying and deciding on potentials of BHS.
- Both Traditional knowledge and modern scientific knowledge could be used for process of management of BHS
- Involvement of marginalized sections of communities including women should be ensured their involvement in BHS
- Government Institutions, NGO's, Teachers should facilitate local communities for capacity building for managing BHS
- Institutional linkages between and among the existing institutions like panchayats, gram sabhas, village/tribal council, urban wards should be planned for managing the BHS
- Without prejudice to any other law for the time being in force, the State Government may, from time to time in consultation with the local bodies, notify in the Official Gazette, areas of biodiversity importance as biodiversity heritage sites under this Act.
- The State Government, in consultation with the Central Government, may frame rules for the management and conservation of all the heritage sites.
- The State Government shall frame schemes for compensating or rehabilitating any person or section of people economically affected by such notification.

Without prejudice to any other law for the time being in force, the State government may, from time to time in consultation with the local bodies, notify in the Official Gazette, areas of biodiversity importance as biodiversity heritage sites under this Act. [37 (1)]

The State Government, in consultation with the Central Government, may frame rules for the management and conservation of all the heritage sites. [37(2)] The State Government shall frame

schemes for compensating or rehabilitating any person or section of people economically affected by such notification. [37(2)]

The National Biodiversity formed an Expert Committee to prepare the guidelines on establishment of Biodiversity Heritage site. The EC will decide on the type of ecosystems, landscapes and land and water uses and guidelines developed will be notified soon.

As per section 21(1) The National Biodiversity Authority shall while granting approvals under section 19 or section 20 ensure that the terms and conditions subject to which approval is granted secures equitable sharing of benefits arising out of the use of accessed biological resources, their by-products, innovations and practices associated with their use and applications and knowledge relating thereto in accordance with mutually agreed terms and conditions between the person applying for such approval, local bodies concerned and the benefit claimer.

The National Biodiversity Authority Constituted an Expert Committee to develop guidelines for benefit sharing for the access of biological resource occurring in India or associated knowledge there to for research or for commercial utilization or for biosurvey and bioutilization. The Authority while granting approval to any person for access or for transfer of results of research or applying for patent and IPR or for third party transfer of the accessed biological resource and associated knowledge may impose terms and conditions for ensuring equitable sharing of the benefits arising out of the use of accessed biological material and associated knowledge. No person who has been granted approval under section 19 shall transfer any biological resource or knowledge associated there which is the subject matter of the said approval except with the permission of the National Biodiversity Authority 20 (1).

Any person who intends to transfer any biological resource or knowledge associated thereto referred to in subsection (1) shall make an application from and in such manner as may be prescribed by the National Biodiversity Authority. 20(2)

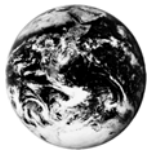
The guidelines shall provide for monetary and other benefits such as royalty; joint ventures; technology transfer; product development; education and awareness raising activities institutional capacity building and venture capital fund. The formula for benefit sharing shall be determined on case-by-case basis. The Authority will soon notify guidelines. The are few examples of benefit sharing in place in some countries.

National Biodiversity Authority (NBA)

- Establishment of NBA.
- The head office of the NBA is established at Chennai.
- NBA consists of the following members.

Members of NBA

- A Chairperson who shall be an eminent person having adequate knowledge on conservation and sustainable use of biological diversity.
- Three ex-officio members appointed by the Central Government. One representing the Ministry dealing with Tribal affairs.Two representing the Ministry dealing with Environment and Forests of whom one shall be the Additional Director General of Forests.
- Seven ex-officio members appointed by the Central Government to represent respectively the Ministries of the Central Government dealing with
  - Agricultural Research and Education
  - Biotechnology
  - Ocean Development
  - Agriculture and Cooperation
  - Indian Systems of Medicine and Homeopathy
  - Science and Technology
  - Scientific and Industrial Research
- Five non-official members appointed amongst specialists and scientists, representatives of industry, conservers, creators and knowledge holders of biological resources



Functions and Powers of NBA

- Regulate activities, approve and advice the government of India on research, commercial, bio-survey and bio-utilization.
- Grant approval to Section 3,4 and 6.
- Certain persons not to undertake Biodiversity related activities without approval of National Biodiversity Authority (Section 3).
- Results of research not to be transferred to certain persons without approval of National Biodiversity Authority (Section 4).
- Application for IPR rights not to be made without approval of National Biodiversity Authority (Section 6).
- Perform such other functions as may be necessary to carry out the provisions of this act.

Approvals by NBA

- Any person who intends to access or apply for a patent or any other form of IPR protection whether in India or outside India referred to sub-section (1) of Section 6 may make an application prescribed by NBA.
- Any person who intends to transfer any biological resource or knowledge associated thereto referred to sub-section (1) of Section 3 shall make an application in such form and in such manner as may be prescribed to the National Biodiversity Authority.
- Determination of equitable benefit sharing by National Biodiversity Authority.

State Biodiversity Board (SBB)

- Establishment of State Biodiversity Board in every State.
- State Government may by notification in the Gazette can establish the SBB in their State name e.g Tamil Nadu Biodiversity Board.
- No State Biodiversity Board shall be constituted for a Union Territory and in relation to Union Territory, the National Biodiversity Authority shall exercise the powers and perform the functions of a SBB for the Union territory.

Collaborative Research

Collaborative research projects involving transfer or exchange of biological resources between government sponsored institutions and similar institutions in other countries will be exempted from this regulation.

Intellectual Property Rights

Intellectual Property Rights relating to biological resources must be defined in order to ensure that the benefits derived from their use are equitably shared. Section 6 of the Act underlines this principle. In case of persons intending to apply for any form of Intellectual Property Right in or outside India for any invention based on any research or information on a biological resource found in India, prior permission of the NBA is required. The NBA may impose benefit sharing fee or royalty or conditions on the financial benefits arising out of commercial utilization of such right while granting permission. Section 21 provides for the determination of "equitable benefit sharing" which is also one of the objectives of the Act. NBA in consultation with local bodies can impose terms and conditions for securing equitable sharing of benefits.

National Biodiversity Fund

A National Biodiversity Fund is being constituted for this purpose. The NBA will ensure that equitable benefit sharing is made during the utilization of biological resources and the knowledge relating to them. The amount of benefit sharing will be deposited in the National Biodiversity Fund and the amount shall be paid directly to such individuals or groups of individuals or organizations in accordance with the terms of any agreement in such manner as decided by the NBA. On behalf of the Central government, the NBA will take all measures to oppose Intellectual Property Rights granted outside India on any biological resource or associated knowledge originating from India.

Enforcement

The section dealt with under chapter XII provides

for enforcement in general and deals with penalty, cognizance of offences, offences by companies, appeal etc in particular. Section 58 provides that the offences under the Act shall be cognizable and non-bailable.

Any person, aggrieved by any determination of benefit sharing or order of the Authority under this Act may file an appeal to the High Court. The time allowed to prefer an appeal is 30 days from the date of communication to the aggrieved person of the Order of the Authority.

If any person contravenes any direction given or order made by the Central Government, the State Government, the National Biodiversity Authority or the State Biodiversity Board for which no punishment has been separately provided under the Act the person shall be punished with a fine which may extend to one lakh rupees and in case of a subsequent offence the fine may extend to two lakh rupees and in case of continuous contravention with additional fine which may extend to two lakh rupees everyday which the default continues.

Biopiracy

To check biopiracy, the proposed legislation provides that access to biological resources and associated knowledge is subject to terms and conditions, which secure equitable sharing of benefits. Further, it would be required to obtain the approval of the National Biodiversity Authority before seeking and IPR based on biological material and associated knowledge obtained from India.

Exemptions provided in the Act

The Biological Act, 2002 provides for the following exemptions:

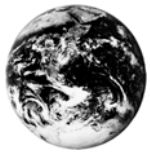
- Exemption to local people and community of the area for free access to use biological resources within India.
- Exemption to growers and cultivators of biodiversity and to *Vaids* and *Hakims* to use biological resources.
- Exemption through notification of normally traded commodities from the purview of the Act.
- Exemption for collaborative research through government sponsored or government approved institutions subject to overall policy guidelines and approval of the Central Government.

Regulation of Access to Biological Diversity

- No person referred to in such-section (2) shall without previous approval of the NBA obtain any biological resource occurring in India or knowledge associated thereto for research or for commercial utilization or for bio survey and bio utilization (3(1))
- The persons who shall be required to take the approval of NBA under sub-section (3(1)).
  - A person who is not a citizen of India 3(2a)
  - A citizen of India, who is a non-resident as defined in clause (30) of section (2) of the Income tax act, 1961 (3(2b))
  - A body corporate, association or organization (3(2c))
    - Not incorporated or registered in India (3(2c I) or
    - Incorporated or registered in India under any law for the time being in force which has any non-Indian partici pation in its share capital or management. (3(2cII))

Results of research not to be transferred to certain persons without the approval of NBA

- No person shall without the previous approval of the NBA transfer the results of any research relating to any biological resources occurring in or obtained from India for monetary consideration or otherwise to any person who is not a citizen of India or citizen of India who is non-resident as defined in clause (30) of



section 2 of the Income-tax Act, 1961 or a body corporate or organization which is not registered or incorporated in India or which has any non-Indian participation in its share capital or management. For the purposes of this section transfer does not include publication of research papers or dissemination of knowledge in any seminar or workshop if such publication is as per the guidelines issued by the Central Government (4).

Collaborative research projects:

- The provisions of section 3 and 4 shall not apply to collaborative research projects involving transfer or exchange of biological resources or information relating thereto between institutions including Government sponsored institutions of India and such Institutions in other countries if such collaborative research projects satisfy the conditions specified in sub-section (5(3)).
- Collaborative research projects shall conform to the policy guidelines issued by the Central Government in this behalf (5(a)).
- Should be approved by the Central Government. (5(b)).

Application for Intellectual Property rights not to be made without the approval of NBA

- No person shall apply for any Intellectual Property Right, by whatever name called in or outside India for any invention based on any research or information on a biological resource obtained from India without obtaining the previous approval of the NBA before making such application. (6(1)).
- NBA while granting the approval under this section, impose benefit sharing fee or royalty or both or impose conditions including the sharing of financial benefits arising out of the commercial utilization of such rights. (6(2)).
- The provisions of this section shall not apply to any person making an application for any right under any law relating to protection of plant varieties enacted by parliament. (6(3)).
- Where any right is granted under law referred to in sub-section (3), the concerned authority granting such right shall endorse a copy of such document granting the right to the NBA. (6(4)).

Permission of commercial utilization of Bioresources

No persons who is a citizen of India or a body corporate or association or organization which is registered in India shall obtain any biological resource for commercial utilization or bio-survey and bio-utilization for commercial utilization except after giving prior intimation to the State Biodiversity Board concerned (7).

- Provided that the provisions of this section shall not apply to the local people and communities of the area including growers and cultivators of biodiversity and vaids and hakims, who have been practicing in digenous medicine. (7)

Determination of equitable benefit sharing by NBA

- NBA shall while granting approvals under section 19 or section 20 ensures that the terms and conditions subject to which approval is granted secures equitable sharing of benefit arising out of the use of accessed biological resources, their by-products, innovations and practices associated with their use and applications and knowledge relating thereto in accordance with mutually agreed terms and conditions between the person applying for such approval, local bodies concerned and the benefit claimers

Conclusion

The intrinsic value of Biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values and its components are to be taken care

properly for the better management of biological resources and biodiversity for the welfare of human beings for better, and healthier as well as peaceful living on earth. The conservation of biological diversity is a serious and common concern of human beings for better living. It should be recognized that the women in rural setup play a vital role in the conservation and sustainable use of biological diversity and affirming the need for the full participation of women at all levels of policy making and implementation for biological diversity conservation. Biodiversity is an important component for economic and social development and poverty eradication and overriding priorities of most of the developing countries in the world.

The conservation and sustainable use of biological diversity is critical importance of meeting of food, fodder, fiber, health, water and other needs of growing world population for which purpose, access to and sharing of both genetic resources and technologies are essential. It should be determined to conserve and sustainable use of biological diversity for the benefit of present and future generations.

Besides law enforcing forces and regulations of the Governments, it is always better to involve the people in a "Participatory Mode" including Tribal people, farmers, ecologists, illiterate villagers, for the conservation and protection of Biodiversity wealth of our great Nation. Awareness creation among people, school children, students and teachers in the colleges, Universities is very important to conserve the biodiversity wealth. Participatory mode of involvement of the people at ground level to acquire more knowledge about the biodiversity conservation will help to maintain and sustain the bioresources and biodiversity. The involvement of local people and their willing participation alone could save the national wealth of biodiversity.

It is difficult to solve and manage and conserve the biological diversity by the State Government or Central Government alone but the people of our great nation have to be aware of our natural biodiversity wealth of our country and they should take all measures to conserve and protect our rich biodiversity not only for better living of our present generation but also for our future generations.

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BIOLOGICAL DIVERSITY AND TRADITIONAL KNOWLEDGE*

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"Heritage includes traditional knowledge which is the creative production of human thought and craftsmanship, language, cultural expressions which are created, acquired and inspired such as songs, dances, stories, ceremonies, symbols and designs, pottery, artworks, scientific, agricultural, technical and ecological knowledge "

At the outset I would like to congratulate the organizers for organising a National level conference on a topic in which India has got high stakes: the natural heritage aspect of heritage. Often the natural or biological aspect of heritage is neglected even though India is rich in natural heritage compared to cultural heritage. I also consider that this Conference is important in that it is the first ever Conference in the world to be organised specifically on natural heritage and museums as a follow up of the decisions taken during general conference of the International Council of Museum (ICOM) in Seoul in 2004. It is also important in the light of ratification by India of the 2003 UNESCO Convention for the Safeguarding of Intangible Heritage.

Regarding biological or natural heritage, the beginning of the modem attempts at management of these resources started with the UN Conference on Human Environment held at Stockholm in 1972.

Intangible Heritage

UNESCO has been involved in the normative processes

* *Inaugural address delivered in the National Conference on Intagible Natural Heritage and Museums during 18 – 20th April, 2007 at Calicut, Kerala.*

related to Intangible heritage. The museum field especially the International Council of Museum (ICOM) also has been increasingly recognizing the importance of Intangible Heritage (IH) and has recently modified its definition of Museums to include both tangible and intangible aspects of collections as the foundations of all Museum..

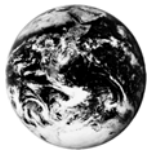
The early efforts in this regard include Shanghai Charter (2001) and Seoul Declaration (2004). "Intangible heritage concerns both natural and cultural resources There are many ICOM members who work in science and natural history museums dealing with the cultural dimension and knowledge-base of the collections and programmer, Documentation on traditional knowledge about bio-diversity is an invaluable intangible element of natural heritage. The National Museum of Natural History in New Delhi and the Lawrence Durrell Zoo in Belize both integrate local knowledge and perceptions of science and the environment into their core activities. It is fair to indicate that the main emphasis of most museums over the centuries has been on the tangible or material heritage, primarily through collecting, recording, researching, interpreting and displaying physical evidence of the past, and of contemporary culture and environment. However, this arguably artificial distinction is by no means universal. More widely, from very early times some museums have also been closely involved in preserving and presenting not just the physical evidence of the past, but also evidence of the immaterial or intangible culture, history or values as well. But a much wider range of museums, archives, libraries and related institutions have also been very concerned with recording, preserving and communicating many other aspects of the intangible heritage as well for many years. I am happy to know that there is a proposal by the Government of India to launch a National Mission on India's Intangible Heritage in a similar line as that of the National Mission on Manuscripts.

Heritage and Traditional Knowledge

Heritage is everything that defines our distinct identities of our people. This is bestowed on us by our ancestors and endowed to us by nature. It includes our social, political, cultural and economic systems and institutions as well as our belief systems, ethics and moral values and our customary laws and norms. Heritage includes traditional knowledge which is the creative production of human thought and craftsmanship, language, cultural expressions which are created, acquired and inspired such as songs, dances, stories, ceremonies, symbols and designs, pottery, artworks, scientific, agricultural, technical and ecological knowledge and skills required to implement this knowledge and technologies. Heritage also includes human genetic material and ancestral human remains. It includes what we inherited from nature such as the natural features in our territories and landscapes, biodiversity which consists of plants and animals and microorganisms and the various diverse ecosystem which we have nurtured and sustained. Heritage also includes our sacred sites, sites of historical significance and burial sites. It also includes all documentation of us on film, photographs, videotapes and audiotapes, scientific and ethnographic research reports, books and papers.

Erosion and Loss of Heritage

The erosion and loss of our heritage, traditional knowledge, cultures and biodiversity has been mainly caused by colonization of Western Groups where Western economic, cultural and political systems were super-imposed over our traditional systems. Even after colonization degradation of our ancestral territories as well as discrimination and lack of respect for cultural rights which has led to the erosion of our cultures. The incursion of development projects such as big dams, mining, oil and gas



extraction, logging of protected areas, chemical based intensive large scale agriculture which have led to the destruction of our ecosystems.

Traditional Knowledge and Communities

Biological resources and related traditional knowledge are often of great commercial value to business corporations in developing commercial products. Corporations often want to acquire IPRs related to biological resources and traditional knowledge as a way of maximizing their income generation.

Traditional communities is a broad term that refers to communities whose way of life is largely shaped by generations of their ancestors. They are distinct from urban or fast-changing societies and lifestyles, maintaining a shared body of cultural, environmental, economic and family customs that are based on traditional occupations, knowledge, values and social hierarchies. Traditional community livelihoods are usually based on natural resources. Traditional communities could include farming or fishing communities, forest-dwelling communities, indigenous people, nomadic communities, etc.

Importance of Traditional Knowledge

Traditional knowledge plays an important role in the conservation of biodiversity and its traditional uses:

- Indian Systems of Medicine (Ayurveda, Siddha, Unani) are part of the official healthcare system in India, and depend on a diversity of biological resources and traditional knowledge.
- Farmers and livestock keepers have improved and nurtured diverse varieties of crops and domesticated animals over generations. This has been invaluable for food security and in providing clothing, healthcare and shelter.
- All over India local communities have independently conserved wild areas, including natural ecosystems, sometimes deemed to be sacred e.g. 'sacred groves', some thousands of years old, dedicated to a local deity.

Traditional knowledge is therefore very valuable in a range of sectors. Industries have often freely used traditional knowledge for developing commercial products, usually without the consent of, or without acknowledging, the original holders of the knowledge. The conflict arises when such knowledge is commercially used without consent, or when IPRs and exclusive rights are claimed over such resources / knowledge.

CBD and Traditional Knowledge

The convention on Biological Diversity (CBD) is the principal international instruments which explicitly acknowledges the role of traditional knowledge, innovations and practices of indigenous and local communities tangible and visible traditional life styles in biodiversity conservation and its sustainable development. The scope of the traditional knowledge covered by the convention, however, is confined to genetic materials, It is a framework convention, setting out general principles that the parties agree to be guided by the work towards in a long term process.

According to Article 8(j) of the convention, each contracting party subject to its national legislation is required to respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities tangible or visible lifestyles relevant for conservation and sustainable use of Biological resources and promote the wider application of such knowledge, innovations and practices with the approval and involvement of their holders and also encourage the equitable sharing of benefits arising from the utilization of such knowledge, innovations and practices.

Biopiracy

Biopiracy is a violation of the rights of traditional communities over their biological resources and related knowledge. The implications of biopiracy are economic as well as ethical: Obtaining IPRs usually patents or Plant Breeders Rights to gain monopoly control over biological resources, related traditional knowledge, or commercial products based on these resources or knowledge, without the consent of, or any benefits going to, the original holders of the resources/knowledge.

The original holders of biological resources and related traditional knowledge do not get any share in the profits made from commercializing the products based on their resources/ knowledge. They also do not get any recognition for nurturing and developing the resources/ knowledge in the first place. Once an IPR is acquired by the biopirate, the original holders of a biological resource or related traditional knowledge are barred from making any commercial use of the IPR-protected knowledge or resource. This could lead to a situation where, for example, a community is not allowed to sell an indigenous product that is covered by an IPR. The IPR-holder dictates the terms of use of the IPR-protected resource/ knowledge, which could mean that traditional communities who are the original holder could lose access to, or control over, their resource/knowledge.

The investigation of biological resources for new commercial uses has been an inherent part of global economic and social development. The problem arises when bioprospecting leads to biopiracy or environmentally unsustainable practices such as collecting huge quantities of samples from an area.

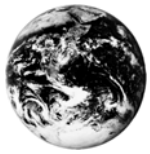
The term 'bioprospecting' has acquired strong negative connotations and is often used in a sense that implies that bioprospecting necessarily leads to biopiracy. Some traditional communities may also find bioprospecting offensive because it seeks to commercially exploit biological resources and related traditional knowledge which are sacred, or which support their livelihoods.

Traditional Communities and Vulnerability to Biopiracy

Traditional communities are especially vulnerable to biopiracy because Traditional communities do not consider their seed, crop and livestock varieties forest and marine resources and related knowledge as private property, but as communal property, God-given, or passed down by generations of their ancestors who have nurtured and developed the natural resources and related knowledge. For most traditional communities the concept of private ownership of a resource like a seed variety is completely alien, thus hindering a full appreciation of the threats and implications of an IPR regime. Traditional communities are vulnerable because of social hierarchies and low levels of awareness and literacy. There is an ignorance of the law and existing IPR-regime and even if the law is known, traditional community members are usually powerless to demand its enforcement to prevent biopiracy or get some form of benefit-sharing agreement, due to factors such as illiteracy, low social status and lack of financial resources. The norms and principles of international IPR regimes have developed in a way that has enhanced the vulnerability of traditional communities to biopiracy.

Traditional Knowledge and Agriculture

Traditional knowledge transforms Biodiversity into Bioresources. Biodiversity and associated traditional knowledge are an integral strength of today's developing countries particularly in the areas of agriculture and Horticulture. It holds great potential all over the world that is increasingly being sensitized to Traditional knowledge. Indigenous men and women over generations have bred races of several food, cash crops and Horticultural crops out of wild plants of the forests called landraces or local or indigenous varieties and these



are the basic foundations of modern plant breeding and global food security. Indigenous farming communities have also identified and managed a series of genes through selection and cross breeding. These genes have potential traits of pest(s) and disease(s) resistance, drought tolerance, high salt tolerance, cold tolerance, tolerance to waterlogging etc.

To develop a crop that can withstand global warming and climate changes across agricultural zones, International scientists visit tropical regions for crop varieties that are drought tolerant / resistance and for this purpose they depend largely on traditional knowledge and local farmers. Breeding and selection process with local varieties, they will be able to develop a potential and high yielding crop variety with combinations traits for tolerance to drought or salinity or resistance to pest(s) and disease(s).

Traditional Knowledge and Health Care

Traditional knowledge is a valuable system continuously developed over generations by tribal and rural communities in different parts of the world and transmitted from one generation to the next generation in oral form. The knowledge covers primarily on human and animal health besides the traditional knowledge pertains to building of houses, food and agriculture, textiles, handicrafts, soil conservation, moisture conservation and other natural resources management.

In India a well developed system using plants for health flourished in the vedic period around 3000 BC. Due to its strong cultural roots the Indian systems of medicine is still vibrant and dynamic and Central core for providing the health, security and livelihood needs of the bulk of India's people particularly the rural and tribal communities.

Accordingly to World Health Organization (WHO) estimated around 80% of the world's population have used indigenous systems of healthcare at one time or the other. In recent years herbal or alternative medicines based on Traditional Knowledge have gained acceptance across the world.

Indian systems of Medicine are the traditional systems of health care practiced in India for over several centuries and are still a viable living tradition of our people. **Ayurveda, Unani, Siddha, Yoga, Naturopathy** are the main traditional systems but it will not be surprising to find the roots of other alternative therapies like Aroma, music, photo, leech etc in traditional health care systems practiced in India.

International Trade of Medicinal Plants

- Annual International trade in Medicinal and aromatic plant material is 400,000 to valued at 1.1 to 1.3 billion US dollars in 1997. This figure is an increase of one third compared to 1995. Now this would have up consideredly.
- China is the leading country with an export of botanical drugs aroung 140,000 t/ year.
- India ranks second in export in terms of volume around 35,700 t/year but only in sixth position in terms of value of around 5,16,110,000 US dollars.

International Market for Herbal Medicines

Annual global sales of medicinal products derived from the genetic resources is around 700 billion US dollars the global market for herbal medicine alone has reached 43 billion US dollars with an annual growth rate between 5 and 15%. It is expected to reach 5 trillion US dollars by 2020. China, the leader in the field generated an income of about 5 billion US dollars in 1999 from the International market and the global exports are around 10 billion US which means China could snatch 50% global exports. Accordingly to WHO estimates, the European market in 1999 was calculated to be 11.9 billion US dollars in which Germany accounts for 38%, France for 21% and UK for 12%. The world wide Fund for Nature statistics

have shown that the European Union imported over 100,000 tonnes of plant material in 1990, of which 12% were from India.

Biodiversity and Bioprospecting

Bioprospecting is the exploration of biodiversity for commercially valuable biological and genetic resources. The term specifically refers to the investigation of biological resources for new commercial uses.

A range of commercial sectors base their activities on bioprospecting, such as the pharmaceutical, biotechnology, seed and crop, horticulture, cosmetics and food sectors. Bioprospectors source their material in two ways:

In addition to biological resources, related traditional knowledge can also be commercially lucrative: In a major global study in 1985, a total of 122 plant-derived pure compounds were identified as being in use as drugs around the world. The medical use of 80% of these compounds correlated with traditional medical use. It was also discovered that these compounds were derived from only 94 species of plants. Given that approximately 250,000 higher plant species exist, it is likely that there are many more medical uses of plants remaining to be discovered. It is believed by many scientists that the most effective way to do so would be to screen plants on the basis of traditional medical use. (However this remains a subject of debate, and it is also argued that a random approach to plant screening and drug discovery is as effective as an approach based on traditional knowledge).

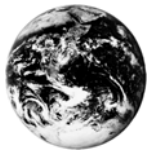
Traditional knowledge is used in different ways by different commercial sectors -it can be used to guide initial discovery and identify new leads, or to guide subsequent research after a useful compound has been identified. Traditional knowledge is usually acquired through published academic research or other secondary sources, rather than directly through field studies.

Protection of Traditional Knowledge

The protection of traditional knowledge innovations and practices of indigenous and local communities has received increasing international attention since the adoption of the CBD in 1992. It is now a well-documented fact that TK plays an important role in the global economy and is valuable not only to those who depend on it in their daily lives but also to modern industry and agriculture. Most traditional societies depend on this knowledge for their food and healthcare needs. There are no reliable estimates of the total contributions of TK associated with traditional crop varieties (landraces) to the global economy, but the contributions of TK in the development and growth of pharmaceuticals and biotechnology-based industries are widely reported. A recent study by the Organization for Economic Co-operation and Development (OECD) has outlined the relative importance of biotechnology patent activity by concluding that the absolute number of biotechnology patents issued by the United States Patent Office and the European Patent Office has grown substantially in comparison with the total number of patents.

Traditional knowledge associated with a biological resource is an intangible component of the resource itself. TK has the potential of being translated into commercial benefits by providing valuable leads for the development of useful products and processes. The valuable leads provided by TK save time, money and investment of modern biotech firms into any research and product development. It is estimated that a hit-rate of 80 percent or more can be achieved in developing medical drugs where the screening of plants is limited to species used by indigenous communities.

The issue of protection and preservation of TK at the international level has been brought to the fore at the instance of developing countries because of different concerns and perspectives. A large number of countries rich in genetic resources and TK and



folklore believe that the traditional communities have been deprived of the benefits from the use of their knowledge, innovations and practices which have been monopolized and used by others, mainly by major companies, without their authorization and without acknowledging or rewarding them for their knowledge. Consequently, there is a perceivable asymmetry between the benefits obtained by the companies that commercial exploitation of this knowledge and the lack of benefits for its true holders. Developed countries have a moral obligation to ensure that indigenous/local peoples receive a fair and equitable share of benefits arising out of the use of their TK and the commercialization of genetic resources. Moreover, if the knowledge assets of developed countries are to be protected by means of an international agreement such as the TRIPs Agreement, it is only fair and equitable that the knowledge assets of developing countries also be similarly protected in a similar way. It is indeed the responsibility of the international community to create an egalitarian system for the availability, acquisition, maintenance and enforcement of intellectual property rights. An international regime would give holders of TK control over the use of their knowledge assets and the capacity to ensure that they are not exploited commercially.

There has been an increasing number of reported cases of misappropriation and commercial exploitation of this knowledge under patents and other IPRs. In many of these cases, claims in the patents on plants and their genetic resources are not fundamentally different from the practices applied by the traditional communities in the utilization of these plants as food, cosmetics or traditional medicines. Some of these cases have been successfully challenged, such as in the cases of neem and turmeric. This raises an important issue of the legal protection of our TK.

The protection of TK is important for the conservation and sustainable development of the environment, as much of the world's crop diversity has been conserved and preserved by indigenous/local peoples, which has helped in the protection and conservation of biodiversity. Their knowledge is central to the conservation and preservation of GRs and other bio-resources. Most of these communities live in areas where the vast majority of the world's plant genetic resources (PGRs) are found. There is also the danger that the biological resources increasingly subjected to IPRs and patents are likely to be plucked to extinction, which raises concerns over their exhaustibility and loss of habitat besides the loss of lifestyles and livelihoods to indigenous communities that have nurtured and used these resources for generations. This may also ultimately would affect food security. International recognition and protection of TK would help in the protection / conservation of the environment and in the management of biodiversity.

The movement of traditional communities from their natural habitat and their increasing attraction with modern society has also raised concerns about the protection of TK, which will lead to its extinction as well will affect biodiversity.

Lack of motivation in the younger generation to learn the traditions is another reason for the protection of TK. There is a fear that TK will suffer extinction with the death of the elders of the community. TK is generally viewed as being inferior, since it does not conform to the accepted scientific methods of learning in the context of the modern approach of science. Only by concerted efforts to protect it and accord it due respect can this trend be stopped. There is also a need to enable these communities to harness TK for their economic uplift and growth.

Traditional Knowledge Digital Library (TKDL)

TKDL is a collaborative project between National Institute of Science Communication and

Information Resources (NISCAIR), Council of Scientific and Industrial Research, Ministry of Science & Technology and Department of AYUSH, Ministry of Health and Family Welfare, which is being implemented at NISCAIR. An inter-disciplinary team of Traditional Medicine (Ayurveda, Unani, Siddha, Yoga) experts, patent examiners, IT experts, scientists and technical officers are involved in creation of TKDL for Indian Systems of Medicine.

The Project TKDL involves documentation of the knowledge available in public domain on traditional knowledge from the existing literature related to Ayurveda, Unani and Siddha, in digitized format in five international languages which are English, German, French, Japanese and Spanish. Traditional knowledge Resource Classification (TKRC), an innovative structured classification system for the purpose of systematic arrangement, dissemination and retrieval has been evolved for about 10,500 sub-groups against one group in International Patent Classification (IPC), i.e. AK61 K35/78 related to medicinal plants.

TKDL integrates widely scattered and distributed references on the Traditional knowledge systems in Ayurveda of India in a retrievable form. TKDL acts as a bridge between the traditional and modern knowledge systems, a bridge between the knowledge contained in an old **Sanskrit Sloka** and the computer screen of a patent examiner, thus breaks the language and format barrier of the prior art available in authorative text books of Ayurveda in **Hindi** and **Sanskrit.** TKDL is not a prior art.

Indian Systems of Medicine, Ayurveda

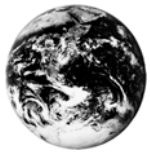
There are 36,000 formulations that are transcribed from 14 Ayurvedic texts and presented in the digital library are based on well-tested Ayurvedic principles. In fact, **Ayurveda** and other Indian Systems of Medicine are formal systems of traditional knowledge. There are 3,67,528 registered practioners in **Ayurveda**, 41,221 in **Unani**, 12,915 in **Siddha** and 388 in **Naturopathy** and annually there are 7,070 graduates and 645 post-graduates in **Ayurveda,** 1280 graduates and 35 post-graduates in **Unani,** 150 graduates and 70 post-graduates in **Siddha** were trained professionally to take up the practice.

Conclusion

The intrinsic value of Biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values and its components are to be taken care properly for the better management of biological resources and biodiversity for the welfare of human beings for better, and healthier as well as peaceful living on earth.

Besides law enforcing forces and regulations of the Governments, it is always better to involve the people in a "Participatory Mode" including Tribal people, farmers, ecologists, illiterate villagers, for the conservation and protection of Biodiversity wealth of our great Nation. Awareness creation among people, school children, students and teachers in the colleges, Universities is very important to conserve the biodiversity wealth. Participatory mode of involvement of the people at ground level to acquire more knowledge about the biodiversity conservation will help to maintain and sustain the bioresources and biodiversity. The involvement of local people and their willing participation alone could save the national wealth of biodiversity.

It is difficult to solve and manage and conserve the biological diversity by the State Government or Central Government alone but the people of our great nation have to be aware of our natural biodiversity wealth of our country and they should take all measures to conserve and protect our rich biodiversity not only for better living of our present generation but also for our future generations.



BIODIVERSITY AND CLIMATIC CHANGE

A. N. Chaturvedi I.F.S.(RETD)

"Bio-diversity compasses all life. Microorganisms, plants and animals all work together to create a living landscape that occupies every zone on the planet, from the heights of the tallest canopy to the depths of the deepest stream."

Bio-diversity refers to the vast array of life forms that make up ecological communities, from the minutest fig wasp to the largest fig tree. Bio-diversity compasses all life. Microorganisms, plants and animals all work together to create a living landscape that occupies every zone on the planet, from the heights of the tallest canopy to the depths of the deepest stream, but this biological diversity is not evenly distributed across earth. Conservation biologists have identified 34 global 'hotspots', that feature remarkable biological niches- most of them in the tropics. Although these hotspots occupy barely 2.3% of earth's land area, they provide the exclusive homes to over 50% of all vascular plants and 42% of terrestrial vertebrates. This small portion of land is so vital that it also holds refuge to nearly 75% of the earth's most threatened mammals, birds and amphibians.

Two criteria are used to distinguish bio-diversity hotspots. The first- a high percentage of endemic plant species found nowhere else, and second- a region that has lost over 70% of its original habitat.

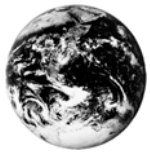
Having the label of a 'Bio-diversity Hotspot' not only underscores a region's unique biological wealth of global interest and local pride, but also bespeaks a grave responsibility, for it reflects severe habitat loss and degradation. Global hotspots of bio-diversity have lost 70-90% of their natural habitat, mostly during the last 150 years. If this trend is not reversed and if this small portion

of land is not conserved then we are effectively destroying some of the world's most complex ecosystems and their unique and exquisite plant and animals.

India includes broad bio-geographic zones, incorporating a wide range of bio-diversity in 25 distinct biotic provinces. Indian flora comprises around 15000 flowering plants, an estimated 33% of which are endemic and represent 6% of world's total. As many as 3000 to 4000 are endangered. Areas rich in plant endemism are the north-eastern and the western ghats and the north-western and eastern Himalayas. The total mammal fauna comprises 341 species out of which 23 are endangered. India's 1178 bird species represent 14% of the world total out of which more than 70 are endangered. The reptile and amphibian fauna include 400 and 165 species respectively, The World Conservation Monitoring Centre has identified five locations in India in their list of World Centres of Plant Diversity. There are today about 480 national parks and sanctuaries covering nearly 4% of the country's land area. Most of these are however neither adequately protected nor properly managed. Outside the protected areas, there is too little recognition of the need or explicit guidelines to maximize environmental benefits, bio-diversity as well as marketable produce. The human and livestock pressures on protected areas are very strong and the future of such areas is very uncertain and cannot be guaranteed.

Ecological Succession: when a site, such as a newly formed river island start being naturally rehabilitated, one or two species are seen. In north India plains usually *Jhao ,Shisham, Khair* are the first colonizer species. As the succession progresses newer species start appearing. The process goes on and the number of species, keep increasing. If there is no biotic interference, and no fires take place, the site conditions keep changing. The soil changes from sandy to loam and then to clay. At this stage the number of species starts reducing. As the succession approaches the climax stage, very few species are left. The fallen wood and rotting trees however provide favorable conditions for increase in the population of insects and fungi. The overall bio- diversity may increase though the species of plants may decline. From a forester's point of view the forest may no longer be economically viable. Most foresters may have visited the Preservation plot in Song Block of Dehradun Forest Division near Lachhiwala. This Preservation plot is more than a century old. The file shows that at the time of formation it was primarily a *Sal* forest but today very few *Sal* trees can be seen. It is mostly a forest of Jamun , *Gutel*, *Bischofia javanica* and other moisture loving species. There are large number of creepers and other evergreen ground flora. Foresters have often used controlled fires as a Sivicultural tool to retard the progress of ecological succession and to maintain the dominant position of the main commercial species like Teak and *Sal*.

Bio-diversity with in Species: Like Homo-sapiens every tree is different in some respect or the other even with in the same species. The colours of the *Semal* flowers in a forest vary from yellow to orange and to scarlet red with numerous hues in between. Several times while traveling from Palia to Dudhawa, I have been fascinated by the abundance of this coloration of *semal* . *Dhak* shows a similar phenomenon. A scientist in Pantnagar University once requested me for samples of seeds of about 20 different *sal* trees for some studies on its oil. I collected the seeds and supplied to him. After some time he told me that the whole system of gradation of trees by species seems to be faulty as he found the seeds of different trees of *Sal* to be chemically different. In tree species that cross- pollinate such differences should be expected. After all the classification of natural vegetation into families, genera and species, is artificial.New trees keep forming due to cross-pollination, mutation and several other natural processes. When Eucalyptus genus was discovered only about 37 species were



identified. To-day, more that 600 species and numerous races, varieties and hybrids are recognized. As the climate changes the species that are not able to adjust to the changed temperatures and moisture regimes fail to germinate and survive. There are 4 old *sal* trees growing in the Botanical garden at Lucknow. From the physical appearance of bark and crown, these appear to be more than 300 years old. These are apparently healthy. I tried to grow *Sal*, around Lucknow, several times. These trees could not survive in the summer months. As we cannot control the climate, we cannot maintain a set bio-diversity mix at any place.

Climatic Change and Bio-Diversity: In thinking about the effects of climatic change on natural communities, it is important to realize that the effects do not suddenly begin at some arbitrary threshold, such as the commonly used benchmark of doubled carbon-di -oxide concentration. Rather, ecological responses will begin with small amounts of warming and will increase as the warming does. Thus a species like deodar which grows at an elevation of up to 2000 m will stop regenerating below 2200m. At least as important as temperature rise itself in effecting the distribution of species and the stability of biological communities, will be the widespread change in precipitation it causes. The species tend to track their climatic optima, retracting their ranges where conditions become unsuitable while expanding them where conditions improve. A general observation is that during past warming trends, species have shifted both, towards higher latitudes and higher elevations. If the entire range occupied by a species becomes unsuitable because of climatic change, the species must either colonize a new, more suitable habitat or become extinct. The species with narrow distribution will suffer more than the species with wider distribution. Even within the last fifty years we have seen the disappearance of Calamus tenuis (canes) from several forest areas. The species with wider distribution will have a better chance to survive in the changed climatic conditions than the one with a narrow distribution.

What needs to be done: There is an immediate need, to intensify field research to find out the suitable species and provenance to tolerate higher temperature and lower rainfall. We should also look for more efficient irrigation systems. In my research trials I found that deep drip irrigation system consumed less water and prevented the upward movement of salts. A task force should be set up to examine the present status of field research and to identify suitable and dedicated research workers who can remain on research jobs for long periods. The multi location species trials must examine both the local species and exotics. A review of past working plans and comparison with the present situation may help to assess the degree of change that may have already taken place in the flora.

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CLIMATE CHANGE AND BIODIVERSITY

R. Hemant Kumar, I.F.S.
Conservator of Forests,
Director, Kanpur Zoological Park

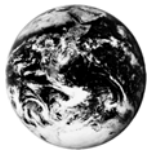
"Climate change affects vegetation in a major way, for example with tree-line shifts towards higher elevation as a response to increased temperature. In that process, least-adapted vegetation and animal species will be the most adversely affected ones, and eventually disappear."

Introduction

The climate of the earth is changing. The climate has always been variable, but what is making us alarming is that the unprecedented magnitude of changes in the climate that too because of increased anthropogenic activities like land use changes (brings about change in physical & biological properties), Industrialization, Population change, Change in energy usage patterns etc

Any change in climate would lead to destabilization of environmental and social conditions all around the globe. These disturbances could jeopardize the conservation of natural ecosystems. Climate change is adversely affecting the natural heritage. Heritage is an irreplaceable source of life and inspiration, it is humankind's legacy from the past, with which we live in the present and pass on to future generations.

Our planet is kept warm due to the so-called greenhouse effect. This effect consists of trapping the energy – radiated by the earth into the atmosphere – instead of allowing it to escape into outer space. The green house gases (CO_2, Methane, Nitrous oxide, Ozone, HFC's, PFC and SF6 and water vapour), involved in this regulatory mechanism are usually found in the atmosphere at very low concentrations.



Carbon dioxide (CO_2) molecules are never found at concentrations higher than a few hundred parts per million (ppm) of air parcels. Nevertheless they play a critical role in the climatic equilibrium of the planet. Prior to the Industrial Revolution, CO_2 concentration was 280 ± 10 ppm. But the present atmospheric CO_2 concentration is above 368 ppm and is expected to go up by 540 to 970 ppm by 2010, which will definitely have an adverse effect on the ecosystem. Because of these GHG's the atmospheric temperature is continuously increasing.

Ramifications of Climate Change

The climate changes are adversely affecting the natural ecosystems in the following manner

- Glaciers are melting worldwide
- Changing Sea-temperatures, and increased level of carbon dioxide dissolved in the ocean are adversely affecting Corals, with bleaching in them has become a more common feature leading to their death.
- Climate changes are forcing some plant and animal species to migrate, as they are unable to adapt to their changing environments, which poses a problem for the conservation of biodiversity hotspots.

Climate Change - its effect on mountainous biodiversity

The melting of glaciers leads to the formation of glacial lakes. The banks of such lakes are made of moraines (accumulated earth and stones deposited by the glacier) that may collapse when the lakes fill up – leading to sudden flooding in the downstream valleys. Any flash flood of this sort can have disastrous consequences for the population and biodiversity of the entire region downstream of the lakes.

Half of the freshwater used by humankind originates from mountain glaciers. If glacier melting continues at its current pace, the winter snowfall will not be sufficient to replenish the amount of snow and ice lost through melting, leading to a deficit in water storage in the form of snow and ice. This could cause many rivers to run dry, inducing shortages of water for drinking, agricultural irrigation, and affecting fisheries and wildlife.

Changes in the atmospheric temperature and in the rate of rainfall will affect the equilibrium between the amount of precipitation stored in winter and the melt away during summer. The melting season of snow coincides with the rainy season in the Himalayas. Consequently, any intensification of rainfall is likely to contribute to the rapid disappearance of snow and ice. It may result in that the Himalayan region will gradually lose its ability to serve as water reservoir for billions of people living downstream.

Besides these geological and hydrological impacts, mountainous ecosystems are also threatened with plant and animal species shifting ranges in order to adapt to the changing environment

Climate change affects vegetation in a major way, for example with tree-line shifts towards higher elevation as a response to increased temperature. In that process, least-adapted vegetation and animal species will be the most adversely affected ones, and eventually disappear.

Consequently, **forest communities** may not move upslope intact because some species will adapt and expand, while others will perish as different species of the same forest community behave differently.

Changes in temperature will definitely increase the threat of forest fires. Also, increased temperature will affect the incidence of invasive species, including pests and diseases. The warming may bring the reverse effect Population growth; settlement expansion and encroachment are likely to become a major management

challenge, which ultimately affect the biodiversity of the mountains

Climate change and biodiversity of oceans

Global warming will affect the oceans through changes in sea-surface temperature, sea level, sea-ice cover, salinity, alkalinity, ocean circulation, and large-scale climate oscillations.

The role of oceans as climate regulators, especially through the circulation of water redistributing heat and salinity through the ocean currents could be dramatically modified. But these changes would also have adverse consequences for biogeochemical cycles as well as for the sequestration of greenhouse gases such as carbon dioxide.

The main features of observed and projected changes are:

- An increase of the global ocean heat content since the late 1950s.
- A global average sea-level rise between 0.1 m and 0.2 m during the twentieth century due to the thermal expansion of ocean waters and the loss of mass from glaciers and ice caps. This rise is projected to reach 0.09 m to 0.88 m between 1990 and 2100.
- A decrease of the extent of sea ice in the Northern Hemisphere of more than 10% since the 1950s in spring and summer, and a likely decrease of 40% in recent decades of sea-ice thickness in late summer to early autumn.
- An increase in the frequency and intensity of warm water currents like El Nino etc since the mid-1970s, compared with the previous 100 years.
- A weakening of the thermohaline circulation system. Coastal ecosystems are sensitive to these physical and chemical changes resulting in their squeezing out
- Loss of coastal wetlands and mangroves, and seawater intrusion into freshwater sources adversely affecting the coastal biodiversity.
- The increase in incidences and severity of cyclones leading to shore erosion, because of sea level rise and loss of corals and mangroves.

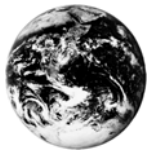
The increased amounts of atmospheric CO_2 absorbed by the oceans will adversely affect the delicate equilibrium of the acidity of ocean waters. Increasing carbonate under-saturation and acidity in the oceans will have a widespread effect on marine animals with calcareous shells or structures, like zooplanktons and on corals, molluscs etc, by impairing their growth and dissolving their skeletons.

It is predicted that these effects, combined with the rise of sea water temperatures, will disrupt the marine food webs with devastating effects on open water and seabed communities throughout the oceans, from the deep seas to shallow waters. The predicted changes in ocean chemistry are expected to affect around 70% of the world's deep-sea corals by 2100.

Coral reefs have a crucial role in shaping ecosystems. They are the primary habitat for hundreds of thousands of species of fish and other organisms and the source of primary production in otherwise typically nutrient poor tropical oceans. That's the reason why corals are called evergreen forests of the oceans

Reef-building corals provide most of the primary productivity of coral reefs and an important shelter for the coral reef organisms. Reduction of abundance and diversity of reef building corals is thus very likely to have a major influence on the surrounding biodiversity.

Let us examine impact of climate change on our own Sundarbans. The Sundarbans mangrove forests are well known for their biodiversity, it houses about 260 bird species, Indian otters, spotted deer, wild boar, fiddler crabs, mud crabs, three marine lizard species, and five marine turtle species. But they also host threatened species such as the estuarine crocodile, Indian python and the Royal Bengal tiger.



The sea-level rise, increased evapotranspiration, and lower freshwater flow in winter due to climate changes will result in increased salinity in the area threatening the conservation of the Sundarbans mangroves. It is expected that with a mere 45 cm rise in global sea level, it will destroy 75 % of the Sundarbans, and apart from it the role of mangroves as natural buffers against cyclones will also get diminished.

Climate change and Terrestrial diversity

Rising atmospheric temperatures, increasing atmospheric CO_2 concentrations, changes in pattern and amount of rainfall, Changes in seasons, hydrological cycles (ground water recharge) and extremities in temperatures are adversely affecting the terrestrial biodiversity.

These changes are expected to have the following impact on the terrestrial ecosystems

Impacts- at species level

- Distribution pattern of the species/ individuals
- Causes changes in physiology
- Migration of species in latitudinal and longitudinal directions
- Extinction of species—at local, regional and global levels (due to range expansions, contractions and eliminations)
- Increase in unwanted species like invasive alien species, parasites, pathogens.

Impacts - at Ecosystem level

- Changes in phenology of the plants
- Availability of fresh water
- Availability of nutrients
- On a host of relations like—prey-predator, parasite-host, plant-pollinator, plant-seed disburser etc
- Pest control
- Negative impact on sylvicultural yields etc

Impact on - distributive regime

- Changes in intensity, frequency and seasonality of extreme events like wild fires, cyclones, floods, droughts severely affect the distribution of fauna and flora, which in turn adversely affect biodiversity and regeneration.
- With the threatened fauna and flora human race also gets threatened.

Epilogue

Going beyond such arguments that biodiversity which includes forests, wildlife and their habitats provide us with tangible benefits. The forests that clothe the habitats of our wildlife like tigers, elephants, hornbills, and king cobras are also the watersheds of major river systems. The forests regulate the flow of water after the seasonal rains and protect the soil underneath from erosion. The survival of these forests is, therefore, critical to the welfare of millions of farmers who depend on these rivers. When we protect forests and wildlife from human destruction *we are not indulging in a luxury that we cannot afford in a poverty-stricken, overpopulated country as argued by some.* We are, ***in fact, protecting the soil-water resources that sustain millions of people.***

Our forests are also treasure troves of biological diversity. They harbor millions of species of plants, insects, amphibians, reptiles, birds and mammals. These life forms took millions of years to evolve; we have only just begun to document their extraordinary variety and diversity. Consequently, we barely understand the complex ecological linkages among these plants and animals: certainly not enough to predict how the elimination of one species may affect the fate of others.

Often, extermination of species can disrupt links between predators and prey, flowers and pollinators, fruits and the dispersers of their seeds. Wild plants and animals have to be primarily saved wherever they are occurring in the living

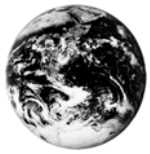
landscapes around us.

The diversity of plant and animal life needs to be preserved also because of the immense current benefits and future gains that it can bring to us. Most of our crop plants and domestic animals are bred from wild relatives and can potentially greatly benefit from the vast, barely tapped wild gene pools. Many of our current drugs, as well as sources of energy, fibers and structural materials, come from a few exploited species that we have discovered. As biotechnology becomes an increasingly important weapon in our fight against hunger; homelessness, poverty and diseases, the role of those as yet undiscovered life forms would become even more central to our welfare. Yet the natural habitats that harbor potentially useful life forms are being lost everyday in a massive extinction spasm that we inflict on nature with such metronomic regularity. Sometimes *we humans seem determined to burn this unique insurance policy that nature has generously provisioned for our future.* **Albert Einstein** once fittingly predicted "if bees were to disappear, man would follow only a few years later" This explains intricacies/ interdepence of different constituents of the ecosystem.

The forests are wonderful laboratories of nature, an irreplaceable library of life. In these we can study nature at work and benefit from the knowledge we gain. Moreover, the wild landscapes that now harbor our wildlife comprise less than 3 percent of our country's landscape of which only 1 percent is inviolate for wildlife. Apart from such practical reasons, there are also ethical and aesthetic reasons for saving wildlife. Forests that sustain animal and plant communities are products of millions of years of natural evolution. Don't they have a right to survive and evolve as nature intended them to, at least in some parts of the once-green earth that we have so drastically modified?

We need to view our protected areas very differently. *If the Taj Mahal, for instance, is dynamited and broken up into pieces and the stones used to build a housing colony in Agra, we would all undoubtedly call that stupid. Even then, the Taj Mahal can be rebuilt, if we have its design and plan. But once we destroy these intricate ecological webs there is no bringing them back!*

Let us come forward and join hands in protecting our biodiversity for the sake of our future generations by vowing to produce less of green house gases



Biodiversity Conservation and Calamitous or Climatic Change

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"Climate change causes extinction by altering the type and availability of ecological niches (potential homes for animals and plants), resulting in conditions that are unsuitable for previously thriving species."

Nature & humankind are an inseparable part of the life support system since the beginning of the time. Today the humankind dominates nature, shapes the environment to suit itself & ones every thing around it with scant regards for the natural scheme of interdependent ecological regions. Due to this anthropological interference, the quality of natural resource & their balance is being disturbed. It should always be remembered that earth's genes, species & ecological systems are the product of about 3000 million years evolution.

The earth receives short wave radiation from the sun, one third of which is absorbed by the atmosphere, oceans, ice, land and living organisms. The energy absorbed from solar radiation is balanced, outgoing radiation from the earth. But long-wave emitted by the warm surface of the earth is partially absorbed by trace gases in the

atmosphere called green house gases (GHGs). The main GHGs are water vapour, carbon dioxide (CO_2) and methane (CH_4). In the absence of these gases, the earth would have been 33 °C lower in temperature than today. In the late 1980s, scientists began to say hat the earth's energy flux was no longer in balance. Earth was getting warmer and affecting the climate. That the climate was changing.

The dire consequences are already apparent. Polar ice caps and glaciers are melting down, leading to a rise in the sea level, which in turn will submerge coastal areas and islands forever. Even our ecosystems are changing, as the delicate balance between different species is disrupted, and the dreadful list goes on. The outcome will be simply apocalyptic for every living creature in this planet. The rate of climate change is the greatest determinant of the impact on biological diversity. Numerous studies have shown how seasonal growth patterns of plants and animals are altering with rising temperatures. A change in climate can also speed up the course of evolution, proving Darwin's theory of 'Survival of fittest'.

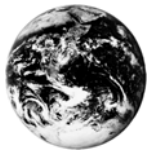
Climate change triggers extinction as well as speciation. Animals have three mechanisms for coping with it: they can either use physiological flexibility or evolve new adaptations or migrate to better sites. Climate change causes extinction by altering the type and availability of ecological niches (potential homes for animals and plants), resulting in conditions that are unsuitable for previously thriving species. When animals can't move to habitats that provide favourable climate, climate change leads to evolutionary changes or extinction.

Detoriation of Environment is mainly due to indiscriminate development, population explosion, unplanned urbanization, increased Industrialization, Fast increasing Agriculture and pasture land. This has resulted into Global warming associated with ozone puncture, 'Green house effect, 'acid rain, receding glacier, rising sea levels, dying plants and animals or threatened our biodiversity and Forest (depletion), posing danger to food security, associated with intense rain and Flood large scale increase of disease epidemics and emergence of mysterious diseases due to ecological degradation. There are various threats that has been observed by us day to day. This climatic change is all human made because 20 years back environmentalist warned and continuously alarmed the world about Global warming. Earth temperature is increasing and atmosphere becoming warmer due to mainly burning of fossil fuel indiscriminately, aviation generated pollution, industrial effluents, oil slicks, release of methane and aerosols into atmosphere. These all activities has increased GHG gases like CO_2, NO_2 and SO_2 in atmosphere. These gases are mainly responsible for global warming. CO_2 in increasing in atmosphere at the rate of 2% every year. It has been doubled in last 30 years. Amount of SO_2 is tripled in last 15 years, disastrous effect of 'green house gases' has led atmosphere temperature to increase by 0.8°C from 1950 to 2007. It was 13.8°C (Global average temperature) in 1950 and in 2007 in recorded 14.6°C. America is biggest polluter of atmosphere. It contributes 2% in population globally and G.H.G. emission share is 25% - it is calculated that:

1 US citizen's emission
= 19 Indians
= 49 Sri Lankans
= 107 Bangladeshis
= 134 Bhutanese
= 269 Nepalese.

It is estimated that till 2100, Global average temperature will rise upto 2 to 4°C. Upto year 2030, there will be rise of 0.5-1°C approximately. It is also observed that temp. rise or warming is more in later half of the century (after 1950) than before 1950.

Fast decreasing forest land has created desertification, &



lowered water table. Every year in World 14 million hectare land is lost and hundreds of species become extinct. Only 3.6 billion hectare land of earth is covered by forest. Why this is going on? It is due to fast increasing urbanization, population explosion and due to increasing Agricultural and pasture land in response :

- Upto 1972 urban population share was 1/3 but it is estimated that upto 2007, it will go upto half of population in the world.
- 1200 million people are living more in year 2007 in comparison to 1975. (Urban population)
- In next 30 years another 2000 million people will be added to urban population in developing nations.

Climatic change posing threat to our biodiversity, Forest and Environment

- Since the year 1500, 245 species from four Taxonomic groups - mammals, birds, reptiles & Amphibians have become extinct But now we have risk of loosing 3 times as many species in there groups.
- To Some extent extinction is a natural process, the study says that current human caused, rates of species loss are 100 - 1000 times more than natural rates.
- Corel reefs - ecosystem appear to be directly threatened globally by increasing atmospheric CO2 and increased temperature of ocean water.
- Global warming is directly declining mangrove forests.
- Almost 24% of mammals are threatened with extinction.
- Increase in frequency of dry spell to local drought may decreased population of wild species.
- Forest depletion also dampens the existence of biodiversity.
- Vulture population is greatly affected by climatic change.
- Globally 62.5 crore people are victim of poisonous gases.
- 300 Animal and bird species are endangered and 167 threatened in India.
- Globally 622 Animal and birds species facing extinction. 1130 - mammalian, 1183 - bird species and 5611 - plant species are endangered. With this disastrous trend, we will loose 50% biodiversity in another 50 years due to global warming and deforestation globally.
- We have lost 50% Forest globally. 11 countries have lost forest almost and 28 countries where forest is threatened.
- There is increase of 150% of natural calamities in between year 1975 - 2007.
- Over exploitation of Fish & marine life.
- Degradation of Sea bed and fish populations due to dodging.
- Degradation of Mangroves due to surge in demand of fish & prawns.
- Effluent from aquaculture farms pollutes the surrounding marine environment.

Effect of Climatic change on Himalayan Glaciers

Large areas of Glaciers about 85% are melting at the average rate of 1.8 meter/year and releasing 96 cusec meter water in Ocean and finally rising seat level. Glaciers like Bhagirathi, Gangotri, Pandari, Rishi, Nanda Devi, Dokriani Barak of Uttaranchal and Chota Shigri of Himanchal are affected. Sea level rise will affected the existence of low lying countries and Islands.

- About 2000 Indian wild asses could loose their only habitat in India.
- In West Bengal, Sunderbans mangrove Swamps are

affected due to sea level rise.

- Goa stands to loose 4.32% of its total area due to sea level rise.
- One meter sea level rise may displace approximately 7.1 million people in India.
- Annual sea level rise in recent years - 3.1mm in 1993-2003 has been higher than previous years - 1.8 mm in 1961-1993.
- The entire population of Lakshadweep is at risk due to sea level rise.

Threat of Flood

India receives an annual rainfall - 400 million hectares meters of which 75% received in four months. Flood generally brings devastation. As death toll mounts, damage reaches unimaginable scales :

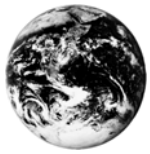
- In the last 4 decades country has lost about Rs. 9720 million in damages to crop, public utilities and houses. Nearby 40 million hectare land is vulnerable to floods, with about 8 million hectare is flooded annually. Ecological degradation caused by humans adds to the problems resulting from erosion, poor natural damage among other things.
- Much of the problem of floods are due to drainage congestion.

- On occasions, floods are caused by mismanagement of water reservoirs.
- Despite 157 flood forecasting stations in India, the country still looses hundred of lives and crore worth of property.

Climatic Change Posing Danger of Food Security

Degradation of soil and water resources is one of the major challenges for global agriculture. Climate change will further alter agriculture systems with substantial consequences of food production. The risk of reduction in food yields is greatest in developing countries, where 790 million people are estimated to be under nourished at present.

- 2°C rise in temperature along with 7% increase in rain fall will reduce net agricultural revenues by 12.3% for whole country.
- Increase in winter temperature by 5°C will result in 10% reduction in wheat yield. Increase in minimum temperature by 1°C will result in decrease of rice yield by. 71 tonnes per hectare.
- Climatic change will cause significant increase in pest population, since moist and warmer conditions are conducive for growth.
- Change in Forest will alter the configuration and productivity of forest ecosystem, It will effect Biodiversity, Agriculture productivity, soil and water resource.
- Rainfall in water may decline by 5-25% lending to



drought in dry summer months.

- Agriculture in coastal regions of Maharashtra, Gujarat & Karnataka will be most negatively affected.

Global warming Associated with Disease Epidemics

- Deadly virus that is decimating vultures population in India.
- More than 10,000 crows killed by the West Nile virus.
- Only 400 Ethiopian wolf left in Africa, the rest killed by a dog disease.
- Nearly 20 species of frogs have been killed by a fungal disease.
- 75% of Antelope, Kundu, wild beats are killed in Africa by Rinderpest virus.
- Global warming results in increase cases of epidemics like malaria, Zoonotic diseases like bird flu, Ebola virus outbreak, salmonellas & recently SARS.
- Malaria affected 500 million people globally, one million people killed per year and 2 person per minute in world.
- WHO reports ascribes 85 of the 102 major disease categories to Environmental Factors.
- 25% of all death in developing countries are due to Environmental Factors.

Poor environment conditions are perfect breeding ground for these contagions. For example, clearance of tropical forest cover cause rain water to accumulate and this is an ideal habitat for mosquitoes. Magnitude or frequency or malarial epidemics are closely associated with short term climate variance. Researcher found that there is strong link between malaria transmission and monthly maximum temperature variance. Increased temperature may have extended transmission season.

Fight Against Global Warming

UN Alternative Suggestions on Climatic Change

- Reduction of CO_2 in Industries.

  1) Subsidy, Tax benefit 2) encouragement for effluent trade

- Focus on Fossil Fuel

  1) Cut in Subsidy 2) Implementation of carbon tax 3) Carbon storage 4) Promotion of under ground storage.

- Construction of Green Buildings

  1-Save energy 2- Strict construction measures & for better use of energy 3- Latest technique like panel, Smart meter & application of intelligence control.

- Reduce transport pollution

  1) Strict standards for CO_2 emission in transport.

  2) More investment in public transport.

  3) High tax on Car & Fuel.

- Agriculture, Forest Waste

  1) Financial Support to better land management.

  2) Control on CO_2 & CH_4 emission.

  3) Security & Management of Forest.

- Encouragement of Renewable energy

  Increase in efficiency of Air, Solar energy, Land heat energy & other clean energy by promoting subsidy, purchase, trade tax etc.

Result

We have to get serious about global warming or climate change. It is not going to be a warmer world, but a more 'sick world'.

Global warming is bleaching and dying of coral reefs world wide. Warming ocean is disrupting reefs delicate but vital ecosystems. 27% of total world coral reef are destroyed or

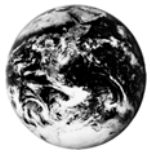
damaged and rest is endangered.

Vast tracts of land around the world are turning into wasteland because of human activity. So rising sea level, dying coral reef and desertification are only some of the major perils of global warming.

Conclusion & Suggestions

1. There should be enforcement of laws & rules on local level because primarily environmental problems are on local issues.
2. Planning should be long lasting & stepwise, first It should be directed towards most polluted area & then on downward trends.
3. There should be maximum development target policy in association with minimum or least environmental loss.
4. Environmental awareness Education on the top of agenda & environment should be taken as a confirmative way of production.
5. Every community should prepare a net natural product, a measure of net changes in the environmental resources base.
6. Special training courses for environmental management techniques & conservation.
7. More funds should be given to Biodiversity assessment & management, considering one of the prime needs of the nation.
8. Concept of Economic development should be given upper hand than economic growth. Economic plan should have environment consideration, It means economy must be ecology oriented.
9. Conservation of forest, biodiversity in association with step to minimize 'Green House gases emission' must be taken as one point program.
10. There is immediate need to set up a high level climatic change (Global Warming) committee to monitor effect of it and to advise effective measures to be taken to control its hazardous effect.
11. For the sake of protection from Global Warming our economy should be ecology oriented. Economic development in the nation's policy is required to save our Biodiversity, not the economic growth.

It is hoped that Biodiversity conservation becoming a people's movement. India is now a party to convention on Biodiversity in the year 1993. It is now great challenge to environment management. It is thus imperative that Biologists, Agriculturists, Veterinarians, Foresters & Common Public should learn more about importance of Biodiversity and its role in the ecosystem functions. Only an international collaborative effort supported by adequate resources & can accomplish the goals of the sustainable use of biological resources for maximising the net long-term benefits to the man kind.



Climate Change and Microbial Biodiversity

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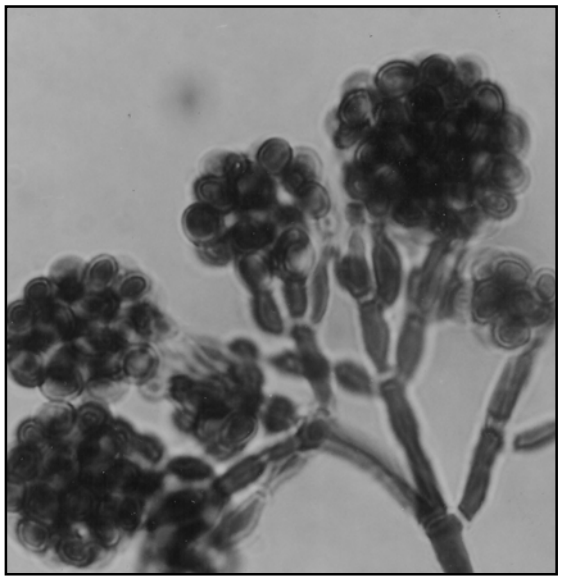


"Any substantial change in amount or pattern of agroclimatic conditions including precipitation and temperature is likely to affect the soil structure, function and microbial and plant composition."

Microbial diversity encompasses a vast spectrum of microscopic organisms including bacteria, fungi, algae, nematodes and protozoans etc. An estimated 50 percent of all living protoplasm on Earth is microbial. There may exist 1.5 million species of fungi on the earth of which only 5% are described; existence of as many as one million species of bacteria has been estimated, of which about 5,000 have been described in the last century. According to new estimates by the Center for Microbial Ecology at Michigan State University (USA) a gram of typical soil contains about 1 billion bacteria, but only 1 percent can be successfully grown (cultured) in the laboratory. Fewer than 5% of all microbial species have been discovered and named - and even less is known about the biodiversity within those species. So little is known about most of the microbial world that no one has ever documented the extinction of a bacterium.

Microbial biodiversity is a vast frontier and a potential goldmine for the biotechnology industry today because it offers countless new genes and biochemical pathways to probe for enzymes, antibiotics and other useful molecules. Worldwide, the economic value of microbes is estimated to be "at least many tens of billions of US dollars". Pharmaceuticals of microbial origin alone account for approximately $35-50 billion per annum in

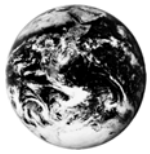
the North. It is the invisible world of microbes that has given us more than 3,222 antibiotics, and to a greater surprise, many of them are derived from soil samples. Besides, the commercial value of microbials extends beyond pharmaceuticals. The total world market for industrial enzymes, all produced by microorganisms, is $1,300 million. Because the process is biological, they are biodegradable and can be used instead of synthetic chemicals. For example, industrial enzymes are used to enhance detergents, as biological pesticides, to clean up toxic wastes, to replace chemicals in paper and pulp processing, and for oil extraction.

Over and above, soil biodiversity influences a huge range of ecological processes that mainly contribute to the sustainability of the life on the earth. For example, these organisms maintain critical processes such as carbon storage, nutrient cycling and plant species diversity. Biodiversity of these organisms in the soil plays a vital role in soil fertility, soil erosion, nutrient uptake by plants, formation of soil organic matter, nitrogen fixation, the biodegradation of dead plant and animal material, reducing hazardous wastes, production of organic acids that weather rocks, and control the population of plant pathogen and insect-pests through natural biological control mechanisms. Soil biota enhance crop productivity because they recycle the basic nutrients required for all ecosystems, including nitrogen, phosphorous, potassium and calcium. They enhance the productivity of the soils by increasing water infiltration, thereby reducing surface water runoff and decreasing soil erosion. Termites, earthworms and other burrow-building soil organisms enhance soil productivity by churning and mixing the upper soil, which redistributes nutrients, aerates the soil and increases surface water infiltration. Earthworms and other invertebrates can bring to the surface approx. 10 to 500 tonnes/per hectare/per year of nutrient rich soil, and thus play a critical role in the formation of fertile top soil. It is estimated that the value of soil biota in terms of soil formation on agricultural land worldwide is US$ 50,000 million per annum.

In the present age of chemicalization and industrialization of agriculture, soil organisms are as vulnerable to climatic changes as higher plants and animals. Any substantial change in amount or pattern of agroclimatic conditions including precipitation and temperature is likely to affect the soil structure, function and microbial and plant composition. A decrease in precipitation may restrict movements of soil organisms, impair metabolism through nutrient deficiencies, prevent growth, and result in death if the water stress is severe. Increasing precipitation may cause changes in soil O_2 tension, creating additional anaerobic microsities in otherwise aerobic soils. Changes in duration, intensity, or seasonality of precipitation may lead to significant wind or water erosion. Since the bulk of soil microbial community exists within the upper 15-20 cm in many soil systems, erosion represents a significant threat to belowground microbial biodiversity.

Microflora and fauna are more sensitive to changes in the water potential of soils than they are to the changes in temperature. Many soil organisms survive low (freezing) as well as high temperatures (up to 40°C) and possibly even higher. Variations in temperature between 0°C and 40°C may affect metabolic rates but not the survival or feeding relationships. However, in seasonally dry or variably dry environments, the functional relationships among the soil biota change markedly. These changes in functional relationships are not due to changes in species composition, because the soil biota has essentially the same community structure following prolonged hot and dry periods. Instead, they are caused by changes in the functioning and abundance of particular species.

Many soil organisms, both microflora and microfauna, have a variety of adaptations that allow them to survive conditions of extreme heat, cold, and dryness. Although a variety of terms have been used to denote such adaptations, they all represent "a physiological state



called anhydrobiosis, in which organism contains no free water and has no measurable metabolism". Organisms in this state may be called spores, cysts, anhydrobiotes, or cryptobiotes, but all are alive but physiologically inactive. They quickly return to an active physiological state when water is again available. Since greenhouse gases affect not only atmospheric temperature but also distribution patterns of rainfall, the potential long-term consequences of water or drier soil conditions on the functional relationships of the soil biota will be affected by the abilities of species of soil organisms to enter an anhydrobiotic state.

Based on the scientific databases, some of the most important short-term consequences of impact of the climatic changes on soil biota and biological activities in the soil are as follows-

1) It is highly unlikely that projected climate changes will result in extinctions of species of soil organisms.

2) Most components of soil biotic community have wide ranges of tolerance to temperature and moisture fluctuations in their environment.

3) The short life cycle of these organisms may permit genetic adaptation to shifts in the soil microclimate. However, climate change may, cause shifts in relative abundance of species and in consequence may reduce the functional role of these organisms in nutrients process and cycling in the soil. This may have a direct impact on our global environment.

4) Because the climatic changes may affect the vegetation cover and species structure either by eliminating or reducing vegetation on the earth, this may have an indirect impact on soil biotic communities where the plants' association fails to survive.

Though the impact of climatic changes can not be quantified, there is some good news in this regard. It has been found from extensive researches globally that a large number of microorganisms that are beneficial to plant health as biofertilizers, growth promoters and biopesticides have not diminished in soil in terms of their colony forming units. That is the reason that scientists have been able to isolate these organisms from soil and develop biological products viz. biopesticides & biofertilizers for commercialization which are being used on large scale all over the world. There is also variety and variability in these microorganisms with ample population meaning thereby that the climate changes have no adverse effect on these microbes and will help in development of more commercially viable alternatives for next generation.

Soil-borne microorganisms are considered to be the greatest source of biodiversity on earth. Plants drive the dynamics of soil-borne microbial communities via their input of various carbon sources into the system. Global climate change comprises changes in temperature, moisture (rainfall) and increased levels of greenhouse gasses, especially CO_2 and the major impact of global climate change on terrestrial ecosystems is expected to occur through its direct effect on plants. Changes in general microbial processes have been observed in response to plant-driven effects of elevated CO_2. However, our knowledge is limited to net process information and knowledge of community diversity and at the same time composition or critical interactions is still lacking. Further research and developmental activities on the aspects of; 1) the effect of enhanced CO_2 concentrations on the composition of the fungal and bacterial community in the rhizosphere 2) impact of the enhanced CO_2 concentrations on the population density of pathogens and antagonists; and 3) impact of enhanced CO_2 concentrations on the sensitivity of plants to soil-borne pathogens are needed at global level to answer the short as well as long-term impacts of global climate changes on the soil microbial biodiversity and sustainable agro-ecosystems.

Vegetation Dynamics, Climate Change and Human Habitation in the Central Ganga Plain During the last 10,000 Years

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"The lake turned smaller in size and also assumed the present ephemeral status. However, the agricultural practices continued with more or less same intensity as before."

Introduction

The Ganga Plain, one of the largest alluvial plains of the country, extends from the Aravalli-Delhi ridge in the west to the Rajmahal hills in the east, Himalayan foot hills in the north to the Bundelkhand-Vindhyan Plateau-Hazaribag Plateau in the south between 770-880 Long. & 240-300 Lat. This region abounds with a large number of potential extinct and extant lakes of varying dimensions (Singh, 1996; 2002), which serve as natural archives to understand vegetation dynamics and various climatic episodes this region experienced in the past, based on the pollen and other proxy records. Further, the pollen evidence gleaned from the well radiocarbon dated lake sediments at different depths also provides very significant insights related to the incipient agriculture practice as well as its subsequent course in this most fertile alluvial tract in response to monsoon fluctuations in a time-frame during the past. However, no sincere efforts were put forward to resolve these issues, barring some pollen-based sketchy information available hitherto from some lakes viz., Basaha Jheel in Unnao District

(Chauhan et al., 2004), Kathauta Tal in Lucknow District (Chauhan et al., 1991), Sanai Tal in Raebareli District (Sharma et al., 2001; 2004) and the Meander Lake in Pratapgarh District (Gupta, 1978), Uttar Pradesh.

Pollen Based Ineferences on Vegetation and Climate

In the present communication an endeavor has been made to decipher some intriguing facts on the changing vegetation scenario and contemporary climatic events in the Central Ganga Plain since prior to 10,000 years (Holocene), derived through the pollen analytical investigations of a 2.8m deep sediment trench profile dug out on the dried bed of Lahuradewa Lake, situated close to a Neolithic-Chalcolithic (about 9000 to 3200 yr BP) site in Sant Kabir Nagar District and another 1.4m deep profile from Misa tal, District Lucknow, Uttar Pradesh (Fig.1). The pollen sequence from Lahuradewa Lake has revealed that between 10600 and 9200 yr BP (Before Present), open vegetation mainly consisting grasses, Chenopodiaceae/Amaranthaceae, Artemisia, sedges, etc. together with intersperse of trees of Aegle marmelos, Holoptelea, Terminalia and thickets of Fabaceae (Legumes) occurred in the region under cool and dry climatic regime (Figs.2). The lake

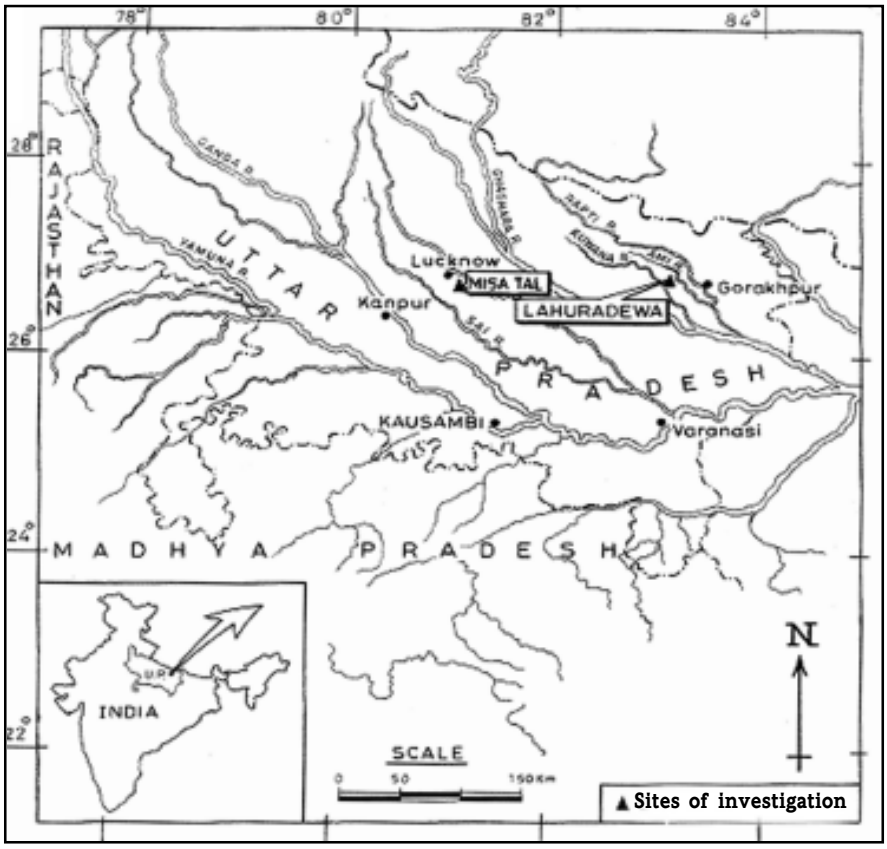


Fig. 1 : *Map showing the sites of study in Ganga Plain*

did exist during this early part of Holocene as clearly indicated by the retrieval of pollen of aquatic plants such as Potamogeton, Typha and freshwater algae-Botyrococcus in the lake sediments. Between 9200 and 6400 yr BP, due to amelioration of climate a few more trees of *Bombax, Emblica officinalis, Syzygium, Lagerstroemia,* etc. also invaded the open grass land vegetation, though sporadically. The progressing profusion of Botryococcus and other aquatic plants demonstrates that the lake turned wider in expanse owing to increased monsoon rainfall. Interestingly, the first appearance of characteristic Cerealia pollen at the levels dated to 7000 yr BP demonstrates the inception of early activities of man associated with some sort of cereal-based agricultural practice. During the time interval between 6400 and 4050 yr BP, the much increase in Bombax followed by the better representation of *Holoptelea, Terminalia,* etc. and advent *Madhuca indica* with shrubby elements of *Melastoma* and *Trewia* suggest the establishment of forest groves in the region as

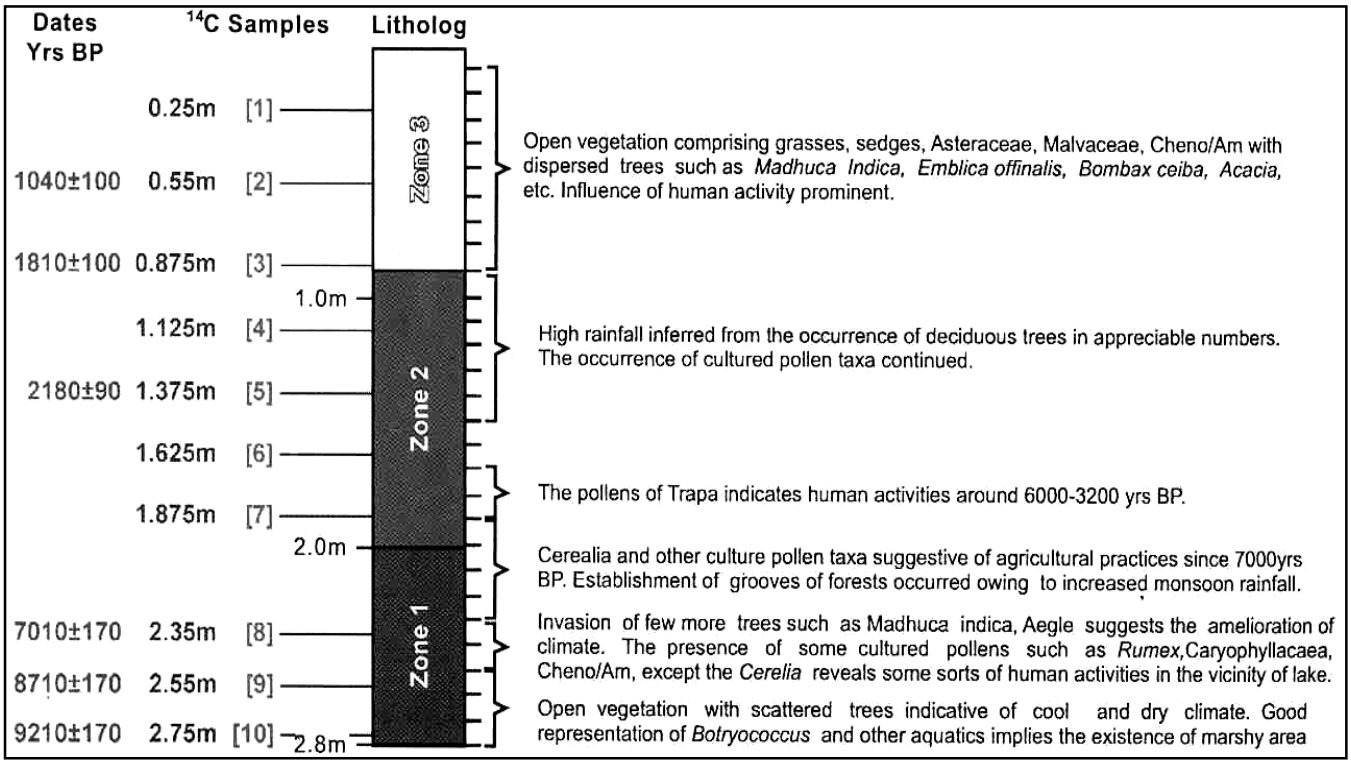
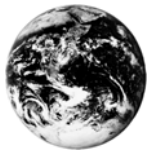


Fig. 2 : *Pollen sequence from Lahuradewa Lake (after Tewari et al., 2006)*

a consequence of increased monsoon precipitation. Owing to the onset of such a favourable climatic condition in the Ganga Valley, the expansion of agricultural practices also took place as reflected by the steady presence of Cerealia along with other culture pollen taxa. In addition, the record of pollen of *Trapa* (Shinghara) in an appreciable numbers at the level dated to 5800 to 2900 yr BP suggests that the ancient settlers would have consumed the Shinghara fruits in their subsistence. Furthermore, the presence of Trapa pollen in this dried lake-bed, located about 100m away from the present lake margin, also suggests that the lake had a bigger dimension and it was perpetually extending even in the close proximity of human settlement at the excavation site. Chronologically, this event of expanded status of the lake falls within the time limit of Period of Climatic Optimum, which is also well known between 7000 to 4000 yr BP (Benrade, 1996) in the global perspectives. Between 4050 and 1300 yr BP, increase in *Madhuca indica* together with *Holoptelea, Syzygium,* Sapotaceae and swampy element of *Barringtonia* and simultaneous decline in grasses implies that the area sustained the localized dense and diversified forest groves under the impact to further enhancement in monsoon rainfall. By this time, the transformation of lake into swamp commenced with the increase in sediment influx of in the lake. This is well manifested by the expansion of sedges and other marshy elements such as Polygonum sp., etc. and simultaneous reduction on grasses. Further acceleration in agricultural practice is witnessed by the more frequent presence of Cerealia and other culture pollen taxa during this phase. This could have occurred to cope with subsistence of the escalating human population in the Ganga Valley during this period. Since 1300 yr BP onwards, the arboreals (trees &



shrubs) happened to be scanty in the forest groves with the commencement of dry climatic conditions as a result of reduction in monsoon rainfall. The lake turned smaller in size and also assumed the present ephemeral status. However, the agricultural practices continued with more or less same intensity as before.

Similar studies conducted on a 1.4m deep trench profile the Misa Tal located about 15km east-southeast of Lucknow and 6km south of Gomti River between 80o Long. & 26o 60' Lat. have generated some dependable information on the vegetation scenarios, pace of crop economy and climate change in the cultural perspectives at shorter-intervals during the two millennia i.e. since the beginning of Christian Era (Wasson et al., In Press). The pollen evidence obtained from the lake sediments has portrayed the presence of open vegetation dominated by grasses, members of Chenopodiaceae/Amaranthaceae, Asteraceae, etc. together with stray of trees of Bombax and shrubs in the vicinity of the lake around 2000 to1850 yr BP (0-150 AD), signifying thereby prevalence of drier climatic condition than that which followed. The sporadic presence of Cerealia and other culture pollen implies the small-scale agricultural practice in the area, which is most likely attributed to low rainfall. In historical perspectives the ruling of Kushana dynasty marks this period.

Subsequently, between 1850 and 300 yr BP (150 and 1700 AD), the open vegetation continued to flourish with scanty trees, however, ground cover became more luxuriant as evidenced by the increased frequencies of grasses, Asteraceae, Chenopodiaceae/Amaranthaceae, Caryophyllaceae, etc. The improvement in aquatic taxa viz., Potamogeton, Lemna and the fresh-water alga, Botryococcus as well as a simultaneous decline in marshy elements namely sedges, Polygonum plebeium and Polygonum sp. reveal that the lake turned wider than before. The change in the overall vegetation assemblage implies the increase in monsoon rainfall. The prosperity in agricultural practices is also reflected by the better representation of Cerealia and other culture pollen taxa. According to the available historical account, during this period the region was under the successive rulings of Gupta, Turkic and Mughal dynasties most probably for exploitation of its economy. Following British period (1700-to 2000 AD) faced the reduction in rainfall and agricultural prosperity, until the independence of the country.

Conclusions

The Ganga Plain with a large number of potential extinct and extant lakes has ample scope to execute the palaeoclimatic studies in order to reconstruct the changing vegetation scenarios and contemporary climatic oscillations in a chronological order during the past. Hence, a comprehensive pollen analytical investigation of series of lake sediment cores/ profiles from different sectors of this alluvial plain is imperative to evolve the common pollen sequence, depicting climatic variability at broader and shorter intervals. Such attempts will also help in simulation of models for the understanding of the future course of climate in a definite time-frame. The approach is also expected to bring out the impact of anthropogenic activities on the natural vegetation, as well as extinction and migration of some important plant species as a consequence of their increasing over exploitation, climatic shifts and natural catastrophe. This information will also enable us to suggest the appropriate measures for the conservation of the natural resource.

In addition, on correlation of data to be generated with already available vegetation and climatic sequences from different parts of the country attempt will be made to work out the various global events such as Glacial and Interglacial phases, Last Glacial Maximum, Period of Climatic Optimum, Medieval Warm Period and Little Ice Age, not yet known precisely from the Indian subcontinent.

Global Climatic Changes and Biodiversity Conservation- Causes and Concerns

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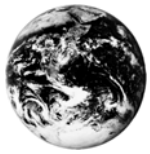
"The current rate of biodiversity depletion is estimated to be hundred fold higher than the recent past may because of the large-scale habitat destruction."

Global climatic changes continue to be the challenging issues among the scientific and societal communities, whether they are the consequences of ozone depletion or environmental degradation or water pollution or land desertification. Some of the predicted deleterious climatic changes expected by the end of twenty-first century are

- ❑ Rise in the global mean temperature (1-3.5° C)
- ❑ Rise in the global mean sea level (approx. 50 cms)
- ❑ Impropriated changes in the day and night durations
- ❑ Unpredicted floods or drought
- ❑ Frequent incidence of cyclones or hurricanes or tsunamis

All these climatic changes have an intrinsic adverse effect on the prevailing biodiversity in general and on agro-biodiversity in particular. Instability in the local climate of a region greatly affects the agro-ecosystems and thereby influencing the genetic and species diversity. The utmost concern of the present day situation is to develop



strategies to minimize the after effects of these climatic changes in short and long run through policy and technological options.

The current rate of biodiversity depletion is estimated to be hundred fold higher than the recent past may because of the large-scale habitat destruction. Recent attack of tsunami in the coastal areas of Thailand, Indonesia region is the eyewitness to the destruction of natural populations and is still continuing. There have been increasing efforts to stockpile and conserve wild medicinal plants in particular in the centralized seed banks. Gene banks are the most convenient facility to conserve the germplasm in safest mode. The National Bureau of Plant Genetic Resources (NBPGR) has been entrusted the responsibility for collection, characterization and conservation of the biodiversity available in the Indian subcontinent. The Bureau operates with a network of 11 regional stations/base centers spread in different phyto-geographical zones of the country. It also maintains a link with 52 National Active Germplasm Sites (NAGS) and 131 other co-operaters through which the Indian National Plant Genetic Resources system (IN-PGRS) operates. The National Gene bank, established to conserve this biodiversity includes seed gene bank, in vitro gene bank and cryo-bank. Of these the seed genebanks are most effective and economic form of the ex situ conservation for the plant species that produce orthodox type of seed i.e., seeds which do not loose their viability even if dried to low moisture content of 5-7 percent. They, by virtue of small size, occupy less space and represent wide genetic variability as each seed has a unique genetic information. The national seed gene bank conserves more than three lakh germplasm accessions representing more than five hundred species collected from all over the country. The seeds are stored at low moisture content (5-7%mc) and at low temperature of –18 to –20^{o}c in specially designed modules. The seed gene banks as a tool to conserve the wild germplasm has many advantages as i) they provide immediate access to plant species allowing researchers and conservationists to evaluate them for properties such as now sources of medicine, nutrition and genes for wild traits, ii) to generate information that could provide helpful information for conserving the remaining population in the nature iii) germplasm stored away from the natural calamities can be used to reinstate the species into the suitable habitats if the need arises. The National Genebank at NBPGR has an extensive conservation programme to facilitate the safe storage of these plants under the Seed Genebank, In Vitro or Tissue Genebank and Cryo-Genebank. The success of this strategy depends on the careful monitoring and the testing of viability. The collections at National Seed Genebank are maintained in three different forms as

a) *Base Collections* where fresh viable pure seeds after drying to 3-7 percent moisture are kept in hermatically sealed tri-layered aluminium foil pouches at – 20^{o}C in long term modules. The base collections are not routinely disturbed except for monitoring the seed viability and to replenish the active collections, in case they are lost.

b) *Active Collections* where the seeds are stored in modules at 5^{o}C and the relative humidity of 35-40 percent in various containers such as cloth-bags, metal cans or glass jars. These collections are maintained at different National Active Germplasm Sites (NAGS) for distribution and regular use.

c) *Working Collections* where seeds stored for two or three seasons at ambient temperature of 20-25^{o}C and relative humidity of approximately 35-40 percent. The breeder's seeds are best stored under these conditions.

VARIOUS THREATS TO BIODIVERSITY AND IMPACT OF CLIMATE CHANGE

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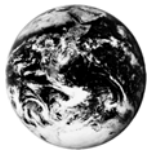
"A repeated forest fire in an area may lead to extinction of a particular species because it does not allow any adaptation period for them. "

Introduction

India is a land of many rivers and mountains. It has a geographical area of 328.726 Million Ha. and is covered by the large number of small and big rivers. Over 70% of the India population is still rural and agriculturalist by occupation for whom this river ecosystems are the major source of their livelihood and prosperity. These small and big rivers also play a major role in keeping the bio-diversity of this country intact and flourishing. India is one of the 12 mega diversity nations with wide variety of flora and fauna, constituting about 7% of world diversity. It supports 16 major vegetation types varying from alpine pastures in the Himalayas to temperate, sub tropical, tropical forests, and mangroves in the coastal areas. The area under forest is estimated to be about 67 Million Ha. (SFR). Roughly about 200 Million people depend directly or indirectly on the forest for their lively hood. The forest eco- system which is very rich in biodiversity provides numerous goods and services and maintains life support system to biotic components. The forest has more than 5150 species of plants, 16,214 species of insects, 44 mammals, 42 birds, 164 reptiles, 121 amphibians and 435 species of fish are endemic to this country. The biotic pressure on the forest eco system has made it very vulnerable and fragile. The recurrent fire in the forest has further compounded the problem of biodiversity conservation.

Definition of Biodiversity

The United Nations convention on biological diversity (UNCBD) defines biodiversity as "The variability among living organisms from all sources including, *inter alia*,



terrestrial, marine and other aquatic eco system and the ecological complexes of which they are part; this includes diversity within species, between species, and of eco system". Inter governmental panel on climate change (IPCC) also recognizes three levels i.e. genetic, species, and eco-system.

Today, the entire biodiversity is under tremendous stress and all the forces, both external as well as internal, are operating in such a complex way that it seems almost difficult to understand that which force ultimately leads to extinction of a species or a genus. Forest meets nearly 40% of the country's energy needs and about 30% of the fodder needs. It is estimated that 270 metric ton of fuel wood, 280 metric ton of fodder and over 12 million cubic meter of timber and several non timber forest products (NTFPs) are removed annually from forest. This alone suggests that how the forest ecosystem or entire biodiversity is subjected to external forces and ultimately it alters the composition of species in biodiversity. Some of the factors which influence the composition of the biodiversity or a forest ecosystem have been discussed in following paragraphs.

External Presure on Biodiversity

In the course of the human quest to conquer nature the society at large has unleashed the forces that today it has become difficult to control them. This is more so because of the swiftness and the irrevocability of the effect on fragile eco system. The triggering global ecological crisis has raised nagging question regarding developmental paths the mankind has hitherto followed and also man's role as the sole arbiter for destiny of all the species of the eco system. The developmental process has led to some permanent changes in the eco system such as loss of forest land, deforestation, repeated recurrence of forest fire, loss of some important component in food chain, unsustainable management of forest and climate change. A brief account of the impact of these forces is given as below.

1. Loss of Forest Land

A forest eco system can try to recover it self if it is left to scientific management and proper care. Ex-situ and In-situ conservation measures may help eco system in gaining its lost ground to some extent until and unless it is too late. With all damages to the ecosystem still there remains an outside chance that its lost ground could be made up but if the forest land is lost then nothing can save an eco system to be lost for ever. There are many "unknowns" which go away with the loss of forest lands. The loss of theses "unknowns" are irreparable. The major species of the lost forest land could be known, there phenology could be traced, their behavior pattern could be understood and possibly their ex-situ conservation may help them grow else where but it does not apply to the group of "unknowns". These "unknowns" are those minor species which have not been fully studied and explored. Their role in the evolution of the eco system is very important and once they have been lost they are lost for ever. The table 1 shows how much of the forest land we have lost until 2003.

There may be some forest land in the above table which can be degraded but when a pristine forest area is diverted for development activities then it become an impossibility to grow the same biodiversity composition on the equivalent land or double the land given in place of the diverted pristine forest area.

Like wise the forest land under encroachment can also be considered very safely as the land lost. The following table gives a comparative statement of the state of affairs under the encroachment segment.

YEAR	Area in hectares
2000-01	1041992.44
2001-02	987603.64

(Source –Forestry Statistics MOEF)

2. Forest Fire

Forest Fire is also very important factor to alter the composition of biodiversity, both within the species and between the species. A repeated forest fire in an area may lead to extinction of a particular species because it does not allow any adaptation period for them. Adaptability is a

Table 1

Name of States	No. of Cases Approved for Diversion of Forest Land	Forest Area in Hact.
1	2	3
Andhra Pradesh	209	21644
Arunachal Pradesh	81	3419
Assam	113	5281
Bihar	102	5979
Chatisgarh	176	15929
Goa	54	410
Gujrat	751	54392
Hariyana	312	1582
Himachal Pradesh	356	4905
J & K	8	1286
Karnataka	306	34138
Kerala	134	30993
Madhya Pradesh	518	228019
Maharashtra	1193	75873
Manipur	9	247
Meghalaya	61	356
Mizoram	42	8528
Orissa	306	27409
Punjab	517	2621
Rajasthan	272	12711
Sikkim	48	623
Tamilnadu	253	4127
Tripura	123	2563
Uttar Pradesh	228	7948
Uttranchal	2341	26873
West Bengal	80	9359
A & N Island	54	2227
D & Nagar Haveli	87	168
TOTAL	**8716**	**589610**

(SOURCE- SFR, MoEF)

complex phenomenon and it requires a very long time to complete its evolutionary process. In a geographical time scale of evolution it varies from thousands of years to millions of years. The following table shows the occurrences of forest fire during 2000 -2001 and 2001-02.

YEAR	Area in hectares
2000-01	198101
2001-02	118148

(Source-Forestry Statistics)

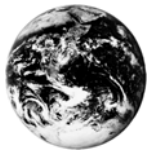
It would be proper to mention here the above figure may be on a very conservative side. There are many fragile species in the forest eco system which can not withstand repeated fire. A forest fire stops pollination process, flowering process and their seeding thus resulting into total non productive biological regime.

3. Loss of Food Chain

A food chain has to be a pyramid in an ideal forest eco system but on account of over indulgence of human greed and killing wildlife for a structured domestic as well as international market, this pyramid structure has shrunk in shape and got blunted at top. The following table illustrates how the population of tiger has gone down since 1984.

Year	Population of tiger
1984	4005
1989	4334
1993	3750
1997	3508
2001-02	3004

(Source-Tiger Census MoEF)



The census process of the tiger population is very primitive in character and has been questioned at different fora in the recent past by experts in this area. A national controversy has been around very recently over the death of tigers in Ranthambhore National Park and Sariska National Park. The killings of tigers have multi pronged linkages and the issue was so serious that prime minister of India had to intervene. Like wise, there are many reported deaths of tigers in other national parks and sanctuaries which have not drawn much attention of ours.

Death of tigers or the topmost members of food chain may look simple but its impact on the eco system is devastating. Absence of the top carnivores at the top may lead to the proliferation of herbivores at down below which feed upon the vegetation and ultimately obliterating the area. The above table shows the loss of tigers only in number but this has a wider manifestation in term of ecosystem and more importantly, this trend is almost every where. The vultures are also on the verge of extinction.

Sustinable Forest Management (SFM)

SFM is a very old terminology in forest history and has a wider connotation. The Fraser Basin Council defines sustainability as "living and managing activities in a way that balances social, economic, environmental and institutional considerations to meet our needs and those of future generations". The concept envisions a scenario of equilibrium amongst its environmental, economic and societal components and that there be continued improvement of human life. This phenomenon reiterates that modifications and improvements in management system should be in accordance with the developmental needs and with no disinvestment in the resource capital such that the needs of present as well as future generations are met.

Though the concept is well defined but all the parameters in the forest eco system are showing something else. The rate of deforestation is alarmingly high in India. It is estimated to be around 0.87% in hill area where as in the planes it is some where 1.7%.With this rate of deforestation an eco system does not get any time to recover. It is so much so that number of seed bearer trees in Sal forest of Uttranchal and U.P. has gone down substantially. If the same pace of deforestation goes then probably there would be no mother trees left in Sal forests of these two states. The same scenario may be observed in other forest types were the dominant species is commercially important. SFM also encompasses Silvicultural treatment to the forest which is also wanting. No financial allocation are being made to these basic areas of the forestry sector.

Climate Change (C C)

Now, climate change (CC) is a real entity and primarily an environmental concern for the scientific community and for the society at the large. A large majority of scientists internationally predicted that if no actions were taken to contain green house gases (GHG) emission, temperature would rise in the range of 2.0-5.0 degree Celsius by the year 2100. Climate change is not only a concern to a developed country but to developing country like India also. Climate change is likely to threaten our food security system water resources, sea level rise and other national calamities. A climate change may also trigger chain of epidemics. The issue was so serious that it was dealt with substantial detail under KYOTO PROTOCOL. Article 2 of the UNFCCC refers to the dangerous human influences on climate, in terms of whether they would allow eco systems to adapt, ensure that food production is not threatened and chart a path of sustainable economic development.

Climate Change Impact on Natural Eco Systems

The large geographical area, varied topography and climatic regimes, long coast line and possession of oceanic island have endowed India with diversity of natural biomes from

deserts to alpine meadows, from tropical rain forest to temperate pine forest, from mangroves to coral reefs and from marshy lands to high altitude lakes. The following assessments of the impacts of projected climate change on natural eco systems is not based on modeling or field studies but on current vulnerability and global level projections of impacts from various studies and literatures.

(a) Wet Lands

The natural wet land eco systems of India include the marine systems such as coral reefs, mangroves, in- land fresh water eco systems.

Marine Eco System : The Indian coast line is over 7500 Km. and it includes the islands of Lakshadweep and Andaman and Nicobars. As many as 3959 coastal wet land site, classified fewer than 13 major wet land types and covering an area of 40230 Sqr. Km. have been mapped by the space application centre across 9 states and 4 union territories. Of these 426 sites are man made wet lands. The wet lands play an important role in the economy of this region through fishery sector. There is about 5.6 metric ton of fish catch per annum through this wet land of which half of it is fresh water. There are many marine as well as fresh water fishes that require a differential temperature in their egg laying and hatching process therefore, a rise in temperature may alter the production of the fish in these areas and ultimately the economy may be ruined.

Mangroves : Mangroves are mainly distributed along the east coast of the country and a very few on the western coast. The Sunderbans, covering an area of about 10,000 Sq.Km. along the Gangage –Brahamputra delta and constitute the worlds largest mangroves wet land of this, about 40% found in West Bengal and rest in Bangladesh. Other important mangroves are

1. Mahanadi in Orissa
2. Godawari & Krishna in Andhara Pradesh
3. Pichavaram & Muthupet in Tamilnadu
4. Gulf of Kutchh in Gujrat
5. Mangroves in Andaman & Nicobar Island

Rise in temperature may lead to melting of polar ice caps resulting into the rise in sea level. A sea level rise can inundate mangroves and the flora and fauna of the area may be lost for ever. Sub mergence of these mangroves with sea water may also result into increase in salinity of the local land mass which may also alter the crop pattern. Likewise increased snow melting in the western Himalayas could bring larger quantities of fresh water into the Gangetic delta. This would have significant consequences in the composition of the biodiversity in Sunderban mangroves.

Coral Reefs : Coral reefs are distributed in 6 major regions along the Indian coast line in Gujarat, the Malwa coast in Maharastra the Lakshadweep islands, Gulf of Mannar in Tamil Nadu, and Andaman and Nicobar Islands.

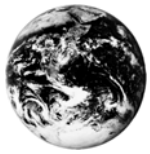
The biodiversity of the coral reef is very rich. Andaman & Nicobar Islands have the highest recorded diversity with 203 coral species 120 algal species 70 sponges and about 1200 species in fish. It is well known the increased sea surface temperature (SST) result in bleaching in coral and a prolonged SST result in death in the coral.

Inland Or Fresh Water Wet Lands : This includes a large number of natural lakes, swamps or marshes as well as men made reservoirs and tanks. There are about 23,444 in-land wet land units covering an area of 35,589 Sq.Km. in total. A study by the wildlife institute of India (WII) showed that 70 to 80 percent of fresh water marshes and the lakes in gangetic flood plains have been lost over the last 5 decades. Climate change impacts would be a complex phenomenon and it may result into a drying up of inland wetlands, swamps and ultimately a permanent loss in flora and fauna would occur.

b. Grass Land Eco System

There are five major grass land types recognized in India, on the basis of species association, geographical and other climatic factors. They are:

1. Alpine grass lands of the Himalayas
2. Moist fluvial grass land of



the Himalayan foot hills

3. Arid grass lands of north western India
4. Semi arid grass lands of central and peninsular India
5. Montane grass lands of western ghats

While considering the likely impact of climate change various factors are taken to consideration. It is well known that C3 and C-4 plants respond differently in photosynthetic process. The C-3 pants normally include cool, temperate grasses and practically all woody dicots while the C-4 plants include the warm, tropical grasses and some dicots. C-4 plants thrive well under conditions of lower atmospheric CO_2 concentration, higher temperature, and lower soil moisture where as C-3 plants show the opposite traits. The climate change model (HADCM2) for India indicate an increase in precipitation by 30% in north eastern reason in addition to a relatively moderate increase in temperature of about 2 degree celsius by the period 2041-2060 this could increase flooding in Brahamputra basin. The HADCM2 projection for the rest of country show steep increase in temperature of 3-4 degree celsius in south and North West part of the country and a decrease of precipitation by 30% in North West. This climatic change may bring in devastation in flora and fauna composition of grass land in the country.

c. Forest Eco System

The forest eco system is very fragile and climate change would not only alter the composition of forest eco system but it will also change the basic physiological changes in the species and between the two species also. The climate change have already started affecting timing of reproduction in plants as well as animals, shifting of plant species, migration of animals, flowering time of the species, pollination etc. These all process will have far reaching consequences in the eco system. IPCC also emphasizes that climate change directly affects the functions of individual organisms (e.g growth and behavior), modifies populations (e.g ,size and age structure) and affects ecosystem structure and functions(e.g, decomposition, nutrient cycling, water flows , species composition, species inter action) and distribution of ecosystem within landscape. Climate change has a wider repercussion on the forest ecosystem. Precipitation has very likely increased during the 20^{th} century by 5 to 10 % over most of the mid and high latitudes of northern hemisphere continents but in contrast rain fall has decreased by 3% on an average over much of the subtropical land area. Rainy days have gone down substantially but ratio of cloud-bursts have gone up and ultimately this has resulted into much more run-off water, washing away productive top soil which is very difficult to come back as soil formation takes a very long time in geographical time scale. According to an estimate by the Planning Commission, India about 60 million tons of top soil gets wa -shed away every year in our country. This is phenomenal. There have been observed changes in some extreme weather and climatic events (IPCC Technical paper -5, 2002). It is more likely that there have been higher maximum temperature, more hot days, less winter and never the less, much lesser cold days in that winter, more hot waves, droughts etc. The immediate climatic change impacts on the plants have been observed are:

1. Poleward shifting and elevation of plants.
2. Growing season has lengthened by about 1 to 4 days per decade in northern hemisphere, especially in higher altitudes.
3. Physiologically, earlier plant flowering has been found.

If the entire process of climate change is studied in totality then it would be fairly safe to assume that climate change (CC) has already started impacting our forests. Some of the changes are quite visible for example, lack of pre monsoon rain is also one of the reasons as to why Sal (shorea robusta) regeneration is not coming profusely in areas of Doon valley and Jharkand. Similarily, hot days/weathers make forest fire recur very often and it leads to elimination of many species which are very valuable from evolution of species point of view.

SUSTAINABLE UTILIZATION AND CONSERVATION OF PLANT DIVERSITY IN INDIA

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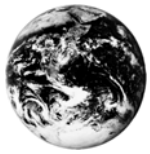
"Rate of forest loss in tropics is currently increasing by 4% to 9% annually. An extremely alarming aspect of this situation is that if all anthropogenic activities were to be stopped immediately, species extinction due to impacts that have already taken place would continue for decades."

A great variety of climatic and altitudinal variations along with varied ecological habitats have contributed immensely to the rich vegetational wealth of India. There are almost rainless areas to the highest rainfall areas. The climate ranges from temperate to arctic in the Himalayas, to tropical and subtropical in its Indo –gangetic plains and the peninsular region. Though the land mass of India is only 2% of the world, it represents 11% of the known world flora. As far as the diversity of major groups of plants and microorganisms is concerned it is estimated that in India there are 850 species of the Virus and Bacteria, 6500 species of Algae, 14,500 species of Fungi, 2021 species of Lichens, 2850 species of Bryophytes, 1200 species of Pteridophytes, 48 species of Gymnosperms and 17,500 species of Angiosperms.

Biodiversity or its physical manifestation-the biological resources are the basis of life on earth.The phytodiversity already supports human needs in many ways such as for food, clothing and shelter and one of the most



fundamental contribution of the plant diversity for human survival is in the supply of World's food. Out of the estimated 2,50, 000 species of flowering plants in the world, nearly 3,000 are regularly exploited for food in some way. Wild species have also provided many of the medicines. WHO has listed over 21,000 plants of medicinal use around the world. Besides, direct benefits phytodiversity also provides the essential ecological benefits of maintaining atmosphere, creating and maintaining soils, sustaining hydrological cycles and controlling climate patterns. These important, most valuable and renewable natural resources are also repository of terrestrial biological diversity. This resource is in imminent danger due to adverse abiotic and biotic stresses resulting from urban expansion, infrastructural development, agriculture and global warming.

Rate of forest loss in tropics is currently increasing by 4% to 9% annually. An extremely alarming aspect of this situation is that if all anthropogenic activities were to be stopped immediately, species extinction due to impacts that have already taken place would continue for decades. In fact there is no exact estimation that how many taxa we have already lost. We always mention about a few conspicuous ones but there must be thousand of species, which have gone forever unrecorded.

India is a part of International Convention on Biological Diversity (CBD) which came into force from 29 December, 1993, which has three main objectives – the conservation of biological diversity, the sustainable use of its components and fair and equitable sharing of benefits arising out of utilization of genetic resources. After the convention the main tasks ahead are Protection and restoration of ecosystem, legal measures for sustainable use and protection, capacity building for biodiversity management and monitoring of biodiversity loss and alteration due to changing climatic conditions.

According to recent International commitments and strategies all member countries have to undertake identification and monitoring of the components of biological diversity important for its conservation and sustainable use. The National Botanical Research Institute (NBRI) is a multidisciplinary plant research institute of international repute has significant role in conservation of plant diversity of India, which is extensively involved in R&D programmes in several strategically important areas of plant sciences, including plant systematics and biodiversity, conservation biology, environmental biology, bioinformatics and plant diversity databases, horticulture and crop improvement, floriculture, plant biotechnology and genetic engineering, and bioprospecting plant and microbial resources for health, environment and industry-related products and technologies. The institute has a wholesome expertise in biodiversity, biotechnology, bioinformatics and is known for its outstanding contributions to enriching the knowledge base on India's plant diversity, particularly in developing globally competent biotech and transgenic technologies, herbal products and digitalized databases.

The institute is recognized as a leading referral center by different Ministries/Departments of Government of India and the United Nations in the matters related to CBD, Traditional Knowledge and Intellectual Property Rights.

A well-designed Botanic Garden in the institute spreads over 25 hectares with documented collections of about 5,000 indigenous and exotic plant species and varieties, a Herbarium with 2,53,103 reference collection of flowering and non-flowering plants of India and two field research stations at Banthra..

The Botanic Garden is known for its immense contributions to conservation and sustainable utilization of important plant resources of economic, ornamental, horticultural, biological, ecological, educational and recreational values. The garden

has an excellent collection of 250 cultivars of roses; 105 cultivars of *Gladiolus*; 250 cultivars of *Chrysanthemum*; 185 cultivars of *Bougainvillea*; 35 races of *Nelumbo nucifera* (lotus); 35 taxa of Cycads; a fern house with 60 species of ferns and fern allies; a special conservatory for tropical and subtropical plants with 350 species/cultivars; Cactus cum Succulent house with 300 species/varieties; Palm house with 50 species; Arboretum with 200 species of trees and shrubs.

Plant resources of rare and endemic taxa are being maintained (*ex-situ*) and constantly enriched in the Botanic Garden. Some of the important taxa worth mention are: *Erythrina resupinata, Phoenix rupicola, Eremostachys superba, Sophora mollis, Adhatoda beddomei, Ginkgo biloba, Cycas beddomei, C. pectinata, Isonandra villosa, Hoya wightii, Frera indica, Rauvolfia serpentina, Tecomella undulata, Vanilla walkeriae, V. wightiana, Curcuma pseudomonatana & Tylophora dalzellii etc.*

Besides, the germplasm collection of the orchids, nearly 25 accessions of *Vanilla planifolia* is also being consistently built-for the development of novel cultivars for high yielding varieties of vanillin by using the molecular techniques.

The plant diversity and conservation biology activities at the institute are focused on seven major programmes such as (1) taxonomy and systematics of angiosperms, pteridophytes, bryophytes, algae and lichens (2) palynology (3) seed biology (4) conservation biology (5) ethnobotany (6) molecular taxonomy and (7) herbarium services.

NBRI is one of the Premier Institute of India, which has nurtured and promoted with a multidisciplinary perspective. The studies are being carried out on different aspects of specialized group of plants (Algae, Lichens, Bryophytes, Pteridophytes) besides flowering plants since last five decades. The thrust areas of research include: assessment and documention of the vast diversity of plants in different phytogeographic zones of India; undertaking creative monographic/revisionary studies, preparation of taxonomic and floristic databases through traditional and modern approaches; conservation of threatened taxa, and bioprospecting for evaluating the biological and economic potentials of the under-explored and un-exploited resources of plant diversity of the country. Most of the phytogeographic regions of India for floristic inventories including protected areas and other ecologically interesting habitats have been explored. The sustained research efforts have resulted in systematic enumeration and documentation of various taxa, including discovery of several new taxa and new distributional records for India.

Recently studies have been promoted on effect of climate change on plant diversity of selected Biosphere Reserves with the view to save the plants from extinction.

HARNESSING PLANT BIODIVERSITY OF FORESTS OF VINDHYAN REGION OF UTTAR PARDESH FOR MEDICINAL USE

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"The diversity of plant life is an essential part of most terrestrial ecosystems in India. India is rich in medicinal plant wealth, having about 3,000 plant species of known medicinal value. India is thus endowed with one of the world's riches biodiversity and cultural traditions in respect of medicinal plants."

Abstract

The present communication throws light on 136 species of flowering plants (Angiosperms) found in Vindhyan Range which are used by the tribal community and other forest dwelling people. The Botanical names, Local/ Trade/Vernacular names, Habit, parts used, and medicinal uses etc are provided in this paper. The prominent families to which the majority of the medicinal plants of the Vindhyan Range include: Fabaceae, Asclepiadaceae, Malvaceae, Acanthaceae, Amaranthaceae, Convolvulaceae and Lamiaceae Some commercially used plants viz. *Tinospora cordifolia, Anogeissus latifolia, Sida acuta, Pterospermum acerifolium, Cassia alata, Cocculus hirstus* etc are found in large population.

Introduction

Ever since the beginning of human civilization, the relation between man and plants is well known. Throughout the Indian sub-continent, thousands of species of higher plants, and lower plants are currently

used by human beings for a number of purposes such as herbal medicines, food, fodder, oil, fuel, fiber etc. Forests are of immense aesthetic, educative and recreational value. There is hardly any part of earth where people do not appreciate the beauty and tranquility of forests. Forests are nature's laboratories which have immensely contributed to the study of various branches of fundamental and applied sciences. Ethno-botanical studies are also of interest to conservationists and other NGOs because such studies have much to offer about the sustainable use of natural ecosystems. As pointed out by many botanists, it is the indigenous people of the world who have learned to live in balance with their natural surroundings. Some of extensive studies on the ethno-botanical aspects of wild plants in the study area have shown that Vindhyan Range contain a considerable number of economically important species. Some researchers have pointed out that the study area and the neighboring tribal area are a rich source of valuable traditional information on plant. This area is well known for the luxuriant vegetation of its forest and medicinal plants.

The diversity of plant life is an essential part of most terrestrial ecosystems in India. India is rich in medicinal plant wealth, having about 3,000 plant species of known medicinal value. India is thus endowed with one of the world's riches biodiversity and cultural traditions in respect of medicinal plants. The human population subsisting on this unique ecosystem exerts pressure on the biological resources of the Vindhyan Range forest and necessitate conservation of biodiversity actions. The importance of retrieving information on medicinal flora of the state of U.P. is to initiate the proper scientific management and exploitation for economic development of the area. (cf. S. Kumar et al 2003, Tewari 2000, Vartak 1982 Sustainable use of biological resources based on local knowledge system and practices in context with the medicinal flora of Vindhyan Range, has been studied and the results are presented below.

Study Area

The forest of Vindhyan Range is located between geographical limit of 23° 45′ - 25°14′ N & 83°45′ - 82°15′ E. The forest has specific geographical situation and comprises of the treasure of medicinal plants used by all sections of society. The climate is hot and humid is summer and dry cool season in winters. The annual rain fall ranges from 100-160 cm, mainly received with in June to September months of years. Average maximum and minimum temperatures range from 30-35°C in summer and 20-30°C in winter respectively.

Materials & methods

Periodic extensive survey has been made from August 2004 to September 2006 in order to collect medicinal data on plants of Vindhyan Range Forest, regular field work trips were organized and interview held with people of the Tribal community of Vindhyan Range forest, who use plants as medicine. Plants are arranged in alphabetical order. Table 1 Botanical names, trade/ vernacular names, families, habit, parts used and medicinal uses are provided. In this study 136 plants species which are used as medicine by rural population. The plants are preserved following the standard methods[1].

Results and Discussion

In 136 plants species belonging to genera and families are documented in present work (Table 1-3). Fabaceae with 14 genera (28 species) was highly represented followed by Amaranthaceae with 5 and Cucurbitaceae with 4 genera (Table 1-3). Most of the 30 families are represented by a single genus and species. Most of them are herbs (65), followed by shrubs (35) and trees (31).

In this region the increasing demand of medicinal plants has resulted in the rapid dwindling of these natural resources. There is urgent need of systematic approach for conservation and sustainable production of medicinal plants, involving local

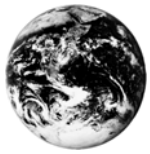


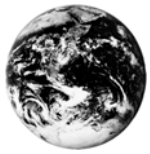
Table 1. Habit wise distribution of medicinal plants of Vindhyan Region (U.P.)

Sl. No.	Habit	No of Species
1.	Herb	65
2.	Perennial Climber	2
3.	Perennial Grass	2
4.	Perennial Sedge	1
5.	Shrub	35
6.	Tree	31
	Total	**136**

Table 2 . Medicinal plant of Vindhyan Region (U.P.)

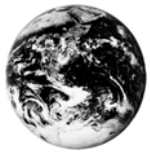
S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
1.	*Abrus precatorius*	Ghumchi	Fabaceae	Shrub/seed	Sore throat, cough, chronic inflammation of mucus membrane of eyeball & eyelid.
2.	*Abutilon indicum*	Kanghi	Malvaceae	Shrub/whole plant	Astringent, anthelmintic, diuretic, alexiteric, toothache, demulcent tonic, rheumatism, piles, laxative, gonorrhoea.
3.	*Acacia catechu*	Khadira	Mimosaceae	Tree/Bark, Leaves	Useful in diarrhoea, sore throat, stomatitis and ulcerations.
4.	*Acacia farnesiana*	Vilayati Babul	Mimosaceae	Tree/Bark	Bark and pods astringent. Gum demulcent, nutrient and emollient.
5.	*Acacia nilotica*	Babool	Mimosaceae	Tree/leaves, bark, gum	Eye sores in children, sexual impotency, diseases of urino-genital system, Astrigent, demulcent, asthma, diarrhea.
6.	*Acacia senegal*	Kumatia	Mimosaceae	Tree/gum	Emollient, demulcent, burns, sore nipples, haemorrhage, intestinal mucous, food for diabetics.
7.	*Achyranthes aspera*	Apamarg	Amaranthaceae	Herb/whole plant	Asthma, cough, cholera, renal dropsy, gonorrhea, eye dis. piles, laxative, purgative, anthelmintic, anti-periodic in malaria, insect bit, pneumonia, hydrophobia.
8.	*Adhatoda zeylanica*	Adusa	Acanthaceae	Shrub/ whole plants	Diuretic bronchitis, gonorrhea, jaundice, anti-spasmodic, ophthalmic, heart trouble, loss of memory, leucoderma.

S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
9.	*Aegle marmelos*	Bel	Rutaceae	Tree/root, leaves, fruit	Abdominal pain, heart palpitation, urinary troubles, laxative, febrifuge, ophthalmic, deafness, dysentery.
10.	*Aerva persica*	Bui	Amaranthaceae	Shrub/flower	Inflammation, swelling demulcent, diuretic.
11.	*Ageratum conyzoides*	Goatweed	Asteraceae	Herb/leaves, root	Styptic, sores cuts; Root: antilithic.
12.	*Alangium salvifolium*	Akola	Apiaceae	Tree/Bark, Root	Bark and root used in jaundice.
13.	*Albizia lebbeck*	Siris	Mimosaceae	Tree/bark, leaf, seed	Bark decoction used in Leprosy. Leaf & seeds used for eye troubles.
14.	*Alstonia scholaris*	Chhitwan	Apocynaceae	Tree/leaves, bark	Bark decoction used in malarial fever and dysentery. Leaves used in beri-beri dropsy etc.
15.	*Amaranthus tricolor*	Marsa	Amaranthaceae	Herb/whole plants	Plants are astringent and emollient, used in diarrhoea, dysentery and haemorrhage.
16.	*Amaranthus viridis*	Jangli Chauli	Amaranthaceae	Herb/leaves	Emollient, laxative.
17.	*Anagallis arvensis*	Neel	Primulaceae	Herb/whole plant	Inflammation, diseases of kidney, epilepsy, ophthalmia, cerebral problems.
18.	*Anogeissus latiofolia*	Dhaura	Combretaceae	Tree / Leaves	Leaves used in dysentry
19.	*Argemone mexicana*	Satyanashi	Papaveraceae	Herb/whole plant	Eczema, skin disorders, blood purifier, laxative, emetic, expectorant, demulcent, jaundice, asthma, diuretic, leucoderma, liniment of head, aphrodisiac, whooping cough.
20.	*Asparagus racemosus*	Satawari	Liliaceae	Shrub/root	Aphrodisiac, laxative, expectorant, galactagogue, tuberculosis, leprosy, epilepsy, night blindness, diseases of kidney, liver, blood, eye & throat.
21.	*Asphodelus tenuifolius*	Banpiyazi	Liliaceae	Herb/seed	Seeds diurectic
22.	*Azadirachta indica.*	Neem	Meliaceae	Tree/whole plant	Anthelmintic, diuretic, blood & skin diseases, leprosy, insecticidal, ophthalmia, biliousness.
23.	*Barleria priontis*	Bajra-danti, Kala-bans	Acanthaceae	Shrub/whole plant	Alexiteric, bronchitis, complaints, leucoderma, laceration, cracking of feet, fever, catarrhal affections, cough, diarrhea, toothache, boils, glandular swellings, dropsy.
24. &	*Bauhinia variegata*	Kachnar	Caesalpiniaceae	Tree/bark	Bark powder used in worms, piles, diarrhoea skin diseases etc.



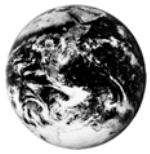
S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
25.	*Blepharis linaraefolia*	Bhangri	Acanthaceae	Herb/seed	Earache, tonic, increase milk production.
26.	*Boerhavia diffusa*	Punarnava	Nyctaginaceae	Herb/whole plant	Astringent, biliousness, anaemia, night blindness, leucoderma, inflammation, blood purifier, diuretic, laxative, expectorant, intestinal inflammation, fever.
27.	*Bombax ceiba*	Semal	Bombacacea	Tree/fruit	Fruits stimulant, expectorant and diuretic used in calculus affections & ulceration of bladder and kidneys.
28.	*Bombusa arundinacea*	Bans	Poaceae	Herb/stem	Used in thread worm and bronchial troubles, fever.
29.	*Borreria articularis*	Guthari	Rubiaceae	Herb/leaf	Leaf used in haemorrhoids and gall stone. Seeds used in diarrhoea & dysentery.
30.	*Boswellia serrata*	Salar	Burseraceae	Tree/bark, fruit, gum	Biliousness, dysentery skin diseases, ulcer, blood purifier, leucoderma, piles, antipyretic, astringent, emmenagogue, rheumatism, vaginal discharge, diabetes, bronchitis.
31.	*Butea monosperma*	Palas, Dhak	Fabaceae	Tree/root, bark, leaves flower, gum	Nightblindness, elephantiasis, aphrodisiac, laxative, dysentery, stomach worms, piles, astringent, tonic eye disease, diuretic, chronic diarrhoea, round worm.
32.	*Cadaba fruticosa*	Kodhab	Capparaceae	Shrub/root, leaves	Anthelmintic, emmenagogue, antiseptic, purgative, urinary obstruction.
33.	*Calotropis procera*	Madar	Asclepiadaceae	Shrub/whole plant	Toothache, stomachic, appetizer, piles, asthma, tonic.
34.	*Capparis decidua*	Ker	Cappareaceae	Shrub/whole plant	Carminative, aphrodisiac, appetizer, emmenagogue, alexipharmic, lumbago, rheumatism, hiccup, analgesic, diaphoretic, laxative, anthelmintic, ulcer, cough, asthma, piles, cardiac troubles, inflammation.
35.	*Cassia auriculata*	Tarawar	Caesalpiniaceae	Shrub/ whole plant	Skin diseases, astringent, anthelmintic, diabetes, urinary disorders, conjunctivitis.
36.	*Cassia fistula*	Amaltas	Caesalpiniaceae	Tree/fruit	Fruit pulp in dengu fever, gastric complains, in constipation.
37.	*Cassia occidentalis*	Anwal	Caesalpiniaceae	Climber/whole plant	Skin diseases, astringent, anthelminitc.
38.	*Cassia siamea*	Sami	Caesalpiniaceae	Tree/leaves	Leaves used as tonic.
39.	*Cassia sophora*	Kasundi	Caesalpiniaceae	Tree/leaves, bark, seed	Bark, leaves & seeds are cathartic, bark infusion or seeds powder given in diabetes.
40.	*Cassia tora*	Chakwar	Caesalpiniaceae	Herb/seed	Useful in skin diseases (ringworms, foul, ulcers)

S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
41.	*Celosia argentea*	Surli Garke	Amaranthaceae	Herb/leaves, seed	Antipyretic, aphrodisiac, liver tonic, gonorrhoea.
42.	*Chenopodium album*	Bathua	Chenopodiaceae	Herb/whole plant	Appetizer, anthelmintic, diuretic, laxative, aphrodisiac, abdominal pain, eye disease, piles, tonic, disease of blood, heart & spleen.
43.	*Chrozophora rottleri*	Shadevi	Euphorbiaceae	Herb/whole plant.	Emetic, corrosive.
44.	*Citrullus colocynthis*	Indrayan	Cucurbitaceae	Herb/root, fruit	Purgative, jaundice, rheumatism, urinary disease
45.	*Cleome gynandra*	Karalia	Cleomaceae	Shrub/seed, leaves	Anthelmintic cough sores, rubefacient, intermittent fever, muscular pain, rheumatism, headache, intestinal wounds.
46.	*Cleome vahlina*	Khiramar	Cleomaceae	Herb/seed, leaves	Carminative, anthelmintic, rubefacient, vesicant, piles, round worms leucoderma, skin diseases, earache, fever, dysentery.
47.	*Cleome viscosa*	Handi-bagro, pili-hulhul	Cleomaceae	Herb/whole plant	Laxative, anthelmintic, diuretic, ulcer, leprosy, malaria, piles, lumbago.
48.	*Clitoria ternatea*	Gokari	Fabaceae	Shrub/root, seed	Laxative, diuretic, alexiteric, anthelmintic, brain tonic, corneal ulcer, elephantiasis, eucoderma.
49.	*Cocculus pendulus*	Pilawan	Menispermaceae	Shrub/leaves	Skin disease
50.	*Commelina benghalensis*	Bukana	Commelinaceae	Herb/whole	Emollient, leprosy.
51.	*Commelina obiqua*	Kanjuna	Commelinaceae	Herb/root	Vertigo, laxative, biliousness, fever.
52.	*Convolvulus microphyllus*	Santari	Convolvulaceae	Herb/whole plant	Laxative, brain tonic
53.	*Cucumis prophetarum*	Khat-Kachrio	Cucurbitaceae	Herb/root fruit	Indigestion, fever; purgative, emetic.
54.	*Cuscuta hyalina*	Amar bel	Cuscutaceae	Shrub/whole plant	Purgative, itch, protracted fevers, sores, chest pain.
55.	*Cynodon dactylon*	Doob	Poaceae	Perennial grass/ whole plant	Astringent, diuretic, dropsy, cut, wound, genital-urinary disorder.
56.	*Cyperus rotundus*	Motha, Mothee	Cyperaceae	Perennial sedge/ root-tuber	Diuretic, emmenagogue, anthelmintic, diaphoretic, astringent, stimulant, stomach disorder, bowel irritation.
57.	*Datura innoxia*	Dhatura	Solanaceae	Shrub/root, leaves, seed	Toothache, insanity, catarrhal, cerebral complaints, skin diseases, lumbago, fever asthma, hydrophobia, malarial fever.
58.	*Datura metal*	Dhatura, Kalo-dhaturo	Solanaceae	Herb/root, leaves, seed.	Toothache, insanity, catarrhal, cerebral complaints, skin diseases, lumbago, diarrhoea, asthma, hydrophobia, malarial fever.



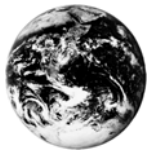
S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
59.	*Datura stramonium*	Dhatura	Solanaceae	Herb/leaves, seed, fruit	Antispasmodic, narcotic, anodyne, sedative, intoxicant, carbuncles.
60.	*Digera muricata*	Khanjuru	Amaranthaceae	Herb/whole plant	Astringent, laxative, biliousness, urinary discharge.
61.	*Eclipta alba*	Bhangro	Asteraceae	Herb/whole plant	Emetic, purgative, antiseptic, tonic, hepatic & spleen enlargement, jaundice, catarrh, skin diseases, hair dye.
62.	*Ehretia aspera*	Tombolan	Ehretiaceae	Shrub/fruit	Venereal diseases.
63.	*Enicostema hyssopifolium*	Chota-chirayata	Gentianaceae	Herb/whole plant	Blood purifier, dropsy, rheumatism, abdominal ulcer, hernia, swellings, itches, malaria.
64.	*Euphorbia hirta*	Dubhali	Euphorbiaceae	Herb/leaves	Dysentery, worms, colic, bowel complaints, cough, asthma, virmifuge, diseases of urino-genital tract, diarrhoea, leucorrhoea, menorrhagia.
65.	*Evolvulus alsinoides*	Shankhpuspi	Convolvulaceae	Herb/leaves	Bronchitis, asthma, fever, diarrhoea, tonic, vermiguge, dysentery.
66.	*Feronia limonia*	Kaitha	Rutaceae	Tree/leaves, seed, fruit	Cough, dysentery; alexiteric, heart diseases, aphrodisiac, leucorrhoea, opthalmia, biliousness.
67.	*Ficus benghalensis*	Bargad	Moraceae	Tree/whole plant	Biliousness, ulcer, erysipelas, vaginal complaints, fevers, liver troubles, diabetes, cooling tonic.
68.	*Ficus religiosa*	Peepa	Moraceae	Tree/whole plant	Leucorrhoea, biliousness, ulcer, diseases of vagina, and uterus, alexipharmic.
69.	*Fumaria indica*	Pithpaparo	Fumariaceae	Herb/whole plant	Diuretic, diaphoretic, aperients, anti-spasmodic, CNS depressant.
70.	*Glinus lotoides*	Gandhi-butti	Moluginaceae	Herb/whole plant	Diuretic, purgative, boils, wounds, indigestion, bilious attacks.
71.	*Grewia tenax*	Gangeran	Tiliaceae	Shrub/wood, root	Cough, pain, diarrhoea.
72.	*Heliotropium ellipticum*	Kalibui	Boraginaceae	Herb/leaves	Ulcers, earache, emetic.
73.	*Indigofera argentea*	Neel, Surmaineel	Fabaceae	Herb/leaves, root, seed	Anthelmintic.
74.	*Indigofera linifolia*	Sidio bakario	Fabaceae	Herb/flower	Febrile eruptions, amenorrhoea.
75.	*Indigofera oblongifolia*	Khuara	Fabaceae	Shrub/whole plant	Roots: Appetizer, in rheumatism; Whole plant: spleen and liver problems.
76.	*Indigofera tinctoria*	Neel	Fabaceae	Shrub/ whole plant	Laxative, expectorant, alexipharmic, anthelminitc, leucoderma, abdominal complaints, heart disease.

S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
77.	*Ipomea hederacea*	Kirpan-beli	Convolvulaceae	Herb/seed	Laxative, carminative, fever, abdominal & liver troubles, leucoderma.
78.	*Justicea procumbens*	Kagner	Acanthaceae	Herb/whole plant	Biliousness, intoxication, fever, diuretic, enriches blood, leprosy, mental and blood diseases.
79.	*Leucas aspera*	Chota-halkusarq	Lamiaceae	Herb/leaves	Chronic rheumatism, psoriasis, skin diseases, swellings.
80.	*Leucas ceaphalotes*	Gomia	Lamiaceae	Herb/whole plant	Diaphoretic, stimulant, laxative, bronchitis, jaundice, dyspepsia, paralysis, leucoderma, urinary, fever, scorpion sting.
81.	*Malva parviflora*	Khumbasi	Malvaceae	Herb/leaves seed	Nerve tonic, profuse menstruation, wounds & swellings; Seed: demulcent in cough, bladder ulcer.
82.	*Mimosa pudica*	Shiah-Kanta, Jinjanio		Mimosaceae	Shrub/seed Stimulant
83.	*Moringa oleifera*	Sanjna	Moringaceae	Tree/whole plant	Aphrodisiac, alexiteric, analgesic, anthelmintic, ulcers, heart troubles, ophthalmia, muscular and spleen diseases.
84.	*Ocimum basilicum*	Kali tulsi	Lamiaceae	Herb/whole plant	Plants usefull in fever, cough, worms, stomach complaints and gout.
85.	*Ocimum sancatum*	Tulsi	Lamiaceae	Herb/leaves	Leaf juice dropped in ear to relieve earache. Also used in skin diseases.
86.	*Opuntia dillenii*	Nagphani	Cactaceae	Shrub/fruit	Baked fruit used in whooping cough, syrupincreases the flow of bile and control spasmodic cough and expectoration.
87.	*Oxalis corniculata*	Khatari,	Oxalidaceae Khatti-buti	Herb/whole plant	Appetizer, dysentery, diarrhoea, refrigerant, stomachic, anti-scorbutic, piles, skin diseases.
88.	*Panicum antidotale*	Gramma, Garmano	Poaceae	Perennial grass/ whole plant	Small pox, would.
89.	*Parkinsonia aculeata*	Vilayati kikar	Caesalpiniaceae	Shrub/leaves	Plant diaphoretic, antipyretic, leaves aborfi facient.
90.	*Pedalium murex*	Baragokhru	Pedaliaceae	Herb/root, leaves, fruit	Anti-biliousness, gonorrhoea, dysuria, anti-spasmodic, aphrodisiac, diuretic, demulcent, emmenagogue.
91.	*Phaseolus trilobus*	Jangli-Moth	Fabaceae	Herb/leaves	Sedative, intermittent fever
92.	*Phyllanthus amarus*	Gugaria	Euphorbiaceae	Herb/whole plant	Diuretic, dropsical affections, gonorrhoea, genitor-urinary diseases, sores, stomachic, dysentery.
93.	*Phyllanthus maderaspatensis*	Hazarmani	Euphorbiaceae	Herb/leaves, seed.	Expectorant, diaphoretic, carminative, laxative, diuretic, bronchitis, earache, ophthalmia, liver tonic.



S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
94.	*Plumbago zeylanica*	Chitrak	Plumbaginaceae	Shrub/root bark	Dysentery, leucoderma, piles, inflammation, rheumatism, bronchitis, anaemia, liver & intestinal complaints
95.	*Portulaca oleracea*	Lunkha	Portulaceaceae	Herb/leaves, stem	Alexipharmic, laxative, diarrhoea, asthma, ulcer, blisters, boils, dysentery, leproxy, piles, kidney & spleen diseases, burning sensation.
96.	*Portulaca quadrifida*	Lunki	Portulacaceae	Herb/whole plant	Alternative, laxative, asthma, cough, urinary discharge, ulcers, eye & skin diseases.
97.	*Prosopis juliflora*	Bawari Khejri	Mimosaceae	Tree/bark, pods	Rheumatism, astringent.
98.	*Pterospermum acerifolium*	Karnikara	Sterculiaceae	Shrub/flower	Flowers used for ulcers, tumors and leprosy.
99.	*Salvadora oleoides*	Mitho-jal	Salvadoraceae	Tree/whole plant	Vesicant, purgative, cough, aphrodisiac, laxative, carminative, bronchitis, spleen enlargement, piles.
100.	*Salvadora persica*	Kharo-jal	Salvadoraceae	Tree/leaves, fruits	Rheumatism, scurvy, astringent, anthelmintic, diuretic, analgesic, liver tonic, carminative, deobstruent, aphrodisiac.
101.	*Salvia aegyptiaca*	Tukham malanga	Labiatae	Shrub/whole plant	Diseases of eye, diarrhoea, gonorrhoea, haemorrhage.
102.	*Saraca indica*	Ashok	Caesalpiniaceae	Tree/bark, flower, seed	Dried bark – astringent, used in excessive uterine bleeding, flower used in haemorr hagic dysentery. Seeds used in urinary discharges.
103.	*Sesamum indicum*	Til	Pedaliaceae	Herb/root, seed, seed oil.	Aphrodisiac, spleen troubles, piles bleeding, menorrhoea, diuretic diaphoretic, cooling, hari growth, diarrhoea, lungs diseases, small-pox,syphilis.
104.	*Sida acuta*	Bal	Malvaceae	Shrub/root, leaves	Aphrodisiac, demulcent in gonorrhoea, astringent, nervous and urinary trouble.
105.	*Sida cordifolia*	Bariar	Malvaceae	Shrub/whole plant	Astringent, cooling, tonic, emollient, aphrodisiac, urinary troubles, blood disease, bleeding piles.
106.	*Sida ovata*	Bal, Dhabi	Malvaceae	Shrub/seed, root	Lumbago, tonic, cooling effect.
107.	*Sida rhombifolia*	Bariara	Malvaceae	Shrub/root, leaves	Aphrodisiac, tonic, febrifuge, nervous and urinary troubles, strangury, heart diseases, piles, rheumatism.
108.	*Solanum indicum*	Nar-kanta	Solanaceae	Shrub/root, fruit	Astringent, anthelmintic, digestive, cardiac troubles, bronchitis, leucoderma, fever.
109.	*Solanum nigrum*	Makoi, Chirpoti	Solanaceae	Herb/whole plant	Diseases of eye, ear, nose, ulcer on the neck, laxative, boils, headache, aphrodisiac, alternative, diuretic, inflammation, asthma, bronchitis, fever, diarrhoea, hydrophobia, leucoderma, cathartic, liver enlargement, piles, dysentery.

S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
110.	*Solanum surattense*	Ringni, Kateli, Bhoringi	Solanaceae	Herb/whole plant	Expectorant, cough, asthma, chest pain, catarrhal fever, vomiting, rheumatism, cough, toothache, buring, feet. Malaria.
111.	*Tamarindus indica*	Imli	Fabaceace	Tree/leaves	Anodyne, aperient, astringent, diuretic and febrifuge.
112.	*Tamarix aphylla*	Lal-jhau	Tamaricaceae	Tree/bark	Astringent, aphrodisiac, eczema.
113.	*Tecomella undulata*	Rugtrora	Bignoniaceae	Tree/bark, seed, young branches	Eczema, abdominal & liver complaints, laxative, anthelmintic, abscess, ulcers, blood & eye, diseases
114.	*Tephrosia purpurea*	Sarphoka	Fabaceae	Herb/whole plant	Dyspepsia, chronic diarrhoea, enlarged liver, colic, stomach troubles, alexipharmic, ulcers, wounds, spleen complaints, anthelmintic, antipyretic, leprosy, asthma, bronchitis, gonorrhoea, lung troubles.
115.	*Tinospora cordifolia*	Amrita gulbel	Minisper-maceace	Perennial climber/ root, fruit	Emetic, visceral obstruction, rheumatism, jaundice.
116.	*Tribulus terrestris*	Gokhru, Kanti	Zygophyllaceae	Herb/whole plant	Aphrodisiac, alternative, diuretic, appetizer, strangury, leprosy, piles, heart diseases, gout, kidney diseases, impotency.
117.	*Terminalia alata*	Asna	Combretaceae	Shrub/ bark	Bark extract diuretic, cardiotonic; used in diarrhoea.
118.	*Terminalia arjuna*	Arjun	Combretaceae	Tree/bark, leaves	Bark is astringent, febrifuge; used in bilious affections.
119.	*Terminalia bellirica*	Bahera	Combretaceae	Shrub/fruit	One of the ingredient of "triphala" Fruit – astringent, laxative, antipyretic. The frueits are locally used in piles, dropsy, diarrhoea and headace.
120.	*Terminalia catappa*	Desi-badam	Combretaceae	Tree/leaves	Leaves applied in rheumatic pains; leaf-juice in ointments of ulces.
121.	*Terminalia chebula*	Harra	Combretaceae	Herb/fruit	Fruit and bark astringent, laxative, diuretic, cardiotonic.
122.	*Thevetia peruviana*	Pili-kaner	Apocynaceae	Shrub/ bark	Bark cathartic, emetic, febrifuge, seeds abortifacient, purgative; used in rheumatism and dropsy.
123.	*Trachyspermum ammi*	Ajwain	Apiaceae	Herb/fruit	Fruits antispasmodic, stomachic, carminative, used in diarrhoea, atonic dyspespsia, colic, flatulence & cholera.
124.	*Trapa natans*	Singhara	Trapaceae	Herb/fruit	Fruits antispasmodic, stomachic, carminative, used in diarrhoea, atonic dyspepsia, colic, flatulence & cholera.
125.	*Trichosanthes anguina*	Chirchinda	Cucurbitaceae	Shrub/root	Roots and seeds used in diarrhoea and as a vermifuge.



S. No.	Botanical Name	Local/Trade/ Vernacular Name	Family	Habit/Part(s) used	Medicinal Uses
1	2	3	4	5	6
126.	*Trichosanthes cucumerina*		Jangali-chirchinda		Cucurbitaceae Shrub/root Roots used as cure to bronchitis, headache and boils. Seeds anthelmintic and antifebrile.
127.	*Urgenia indica*	Ban	Liliaceae	Herb/tuber	Anthelmintic, alexiteric, diuretic, emmenagogue, purgative, bronchitis, asthma, dropsy, rheumatism, skin diseases, leprosy.
128.	*Vallisneria spiralis*	Sawala	Hydro-charitaceae	Herb/whole plant	Diuretic, anthelmintic, nephritic troubles, haemorrhage in kidney & uterus, jaundice.
129.	*Veronica anagalisaquatica*	Titlokia	Scro-phullariaceae	Herb/Root	Herbs antiscorbutic. Roots used in preparation of fargles.
130.	*Vicia faba*	Bakla	Papilionaceae	Herb/leaves	Decoction of leafy shoots used as a diuretic.
131.	*Vigna unguiculata*	Lobia	Fabaceae	Herb/seed	Seeds diauretic.
132.	*Withania somnifera*	Asgandh	Solanaceae	Shrub/root, tuber, seed, leaves	Alternative, aphrodisiac, abortifacient, tonic, narcotic, bronchitis, psoriasis, ulcers, senile debility, rheumatism.
133.	*Wrightia tinctoria*	Kerni	Apocynaceae	Tree/whole plant	Aphrodisiac, biliousness, piles, skin diseases, dropsy, aphrodisiac, anthelmintic, amoebic dysentery.
134.	*Wahlenbergia*	Campanulaceae	Herb/seed	Herbs used for skin troubles.	Roots employed for pulmonary infections.
135.	*Zizyphous nummularia*	Jhar-Beri	Rhamnaceae	Herb/leaves	Leaves used in scabies and other cutaneous diseases.
136.	*Zizyphous oenoplia*	Makia	Rhamnaceae	Herb/root	Roots used in hyperacidity and infection.

Table 3 . Family, genera and species of medicinal plants of Vindhyan Region (U.P.)

S. No	Family	No. of Genera	No. of Species	S. No	Family	No. of Genera	No. of Species
1.	Amaranthaceae	5	6	10.	Bombacaceae	1	1
2.	Asteraceae	2	2	11.	Cyperaceae	1	1
3.	Apocynaceae	3	3	12.	Convolvulaceae	3	3
4.	Asclepiadaceae	1	1	13.	Chenopodiaceae	1	1
5.	Apiaceae	2	2	14.	Cleomaceae	1	3
6.	Acanthaceae	4	4	15.	Capparaceae	2	2
7.	Boraginaceae	1	1	16.	Commelinaceae	1	2
8.	Burseraceae	1	1	17.	Cucurbitaceae	3	4
9.	Bignoniaceae	1	1	18.	Cuscutaceae	1	1

S. No	Family	No. of Genera	No. of Species
19.	Combretaceae	2	6
20.	Campanulaceae	1	1
21.	Cactaceae	1	1
22.	Euphorbiaceae	3	4
23.	Ehertiaceae	1	1
24.	Fabaceae	17	28
25.	Fumariaceae	1	1
26.	Genetinaceae	1	1
27.	Lamiaceae	3	5
28.	Liliaceae	3	3
29.	Hydrocharitaceae	1	1
30.	Moringaceae	1	1
31.	Moluginaceae	1	1
32.	Malvaceae	2	6
33.	Menispermaceae	1	1
34.	Moraceae	1	2
35.	Meliaceae	1	1
36.	Nyctaginaceae	1	1
37.	Oxalidaceae	1	1
38.	Poaceae	3	3
39.	Papaveraceae	1	1
40.	Plumbaginaceae	1	1
41.	Pedalaceae	2	2
42.	Portulaiceae	1	2
43.	Primulacaceae	1	1
44.	Salvadoraceae	1	2
45.	Scrophullariaceae	1	1
46.	Sterculiaceae	1	1
47.	Solanaceae	3	7
48.	Trapaceae	1	1
49.	Tamaricaceae	1	1
50.	Tiliaceae	1	1
51.	Rubiaceae	1	1
52.	Rhamnaceae	1	3
53.	Rutaceae	2	2
54.	Zygophyllaceae	1	1
	Total	**93**	**136**

communities, university students and departmental field group with stronger linkage of collaborative work to meet future demand on a sustained manner.

Acknowledgement

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Biodiversity Threatening Plant Species, Their Biology, Ecology and Management in Different Protected Areas of Uttar Pradesh

Kaushalendra Kumar Jha, I.F.S.

"Weeds cause environmental damage and threaten the diversity of natural resources. Introduced weeds displace native vegetation, including rare and endangered species, and adversely affect livestock and wildlife habitat."

Abstract

The Protected Areas of Uttar Pradesh are scattered through all the three physiographic regions, eg., Moist Deciduous Forests, Dry Deciduous Forests, and the Gangetic plains. There are three categories of Protected Areas namely, National Park, Wildlife Sanctuaries and Bird Sanctuaries. Dudhwa is the only National Park in the Moist Deciduous *Tarai* Forest region. The important Wildlife Sanctuaries are Kishanpur, Katerniaghat, Sohelwa and Sohagibarwa (in Moist deciduous forest) and Chandraprabha, Kaimur, Ranipur (in Dry Deciduous Forest). Okhla, Patna, Saman, Lakhbahoshi, Sandi, Nawabganj, Samaspur and Surhatal are some of the notable Bird Sanctuaries scattered in the Gangetic plains of the state.

The National Park and Wildlife Sanctuaries are intended for conservation of tiger, leopard and blackbuck, and their associate species. The Bird Sanctuaries are meant for hosting and sheltering the migratory and resident birds like teals, coots, storks, ducks, herons, doves etc. The Wildlife Preservation Organization of Uttar Pradesh has been successfully managing the habitat of the wild animals and birds to achieve the objectives of the conservation. However, there are some invasive plants

posing the threat of habitat change and hence affecting the habit of the inhabitants. Some such important plant species in different forms are exotic and indigenous herbs (*Sesbania, Solanum nigrum, Cannabis, Cassia tora, Parthenium histophorus*), grasses (*Cymbopogon martini, Oryza rufipogon*), climber (*Tiliacora racemosa*), and hydrophytes (*Ipomea carnea, Ipomea aquatica, Eicchornia crassipes, Polygonum barbatum, Polygonum limbatum*) and shrubs (*Lantana camara*). Certain habitat altering tree species of the protected areas are *Tectona grandis, Eucalyptus* hybrid, *Prosopis juliflora, Bombax ceiba and Randia uliginosa*. As far as their management aspects are concerned chemical and biological control methods are in experimental stage. Mechanical and manual removal of some of these weeds have shown positive results of habitat restoration and rehabilitation of few important species like hog deer, swamp deer, hispid hare, storks, egrets etc. However, integration of research input for managerial optimization and wholehearted weed eradication effort is still required.

Introduction

Uttar Pradesh (77°05′ – 84°38′ E; 23°52′ – 30°24′ N), comprises three physiographic regions namely, the submontane region lying between the Himalayas and the plains, the vast alluvial Gangetic plains and the southern hills and plateau. The state has a diverse range of habitats for varied types of biodiversity that include forest area in the sub-Himalayan tarai and also the dry deciduous forests of Bundelkhand and Vindhyan region. This state has a tropical climate with a wide temperature fluctuation from 2°C to 48°C. There are three seasons: summer from March to mid June, the rainy season from mid June to September, and, winter from October to February. There is great variation in rainfall. The Himalayan foothill receives 1200 mm to 2500 mm. In the remaining parts rainfall varies from 600 to 1200 mm (Islam and Rahmani 2000), Bundelkand-Vindhyan region getting the lower share.

The floral diversity of Uttar Pradesh can be classified as vegetation types among the distinct ecological landscapes of the state, viz., Tarai landscape, Gangetic plains and Bundelkhand-Vindhyan landscape. Major vegetation categories are as follows:

Tarai landscape

Sal forests
Mixed Sal and Teak forests
Miscellaneous forests
Riparian fringe forests
Aquatic vegetation system

Gangetic Plains

Sal forests
Mixed forests
Mixed deciduous forests
Dry thorn forests
Swamp forests
Aquatic vegetation system

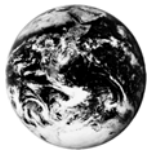
Bundelkhand-Vindhyan landscape

Mixed deciduous forests
Dry thorn forests
Aquatic vegetation system

The above mentioned forest types and vegetation systems were delineated after the promulgation of Wildlife (Protection) Act 1972 as Protected Areas at the places where the flora and fauna of ethnic, ecological and genetic importance were needed to be conserved. The nomenclature given to these conservation areas were National Park and Sanctuaries (Both Wildlife and Bird Sanctuaries). The state presently has altogether one National Park and 23 Wildlife Sanctuaries (twelve of Avian importance popularly known as bird sanctuaries). These PAs harbour the biodiversity of very high values.

Biodiversity Values of the Protected Areas

The *Tarai* with its characteristic complex of Sal forests is one of the most threatened ecosystems in India. The Vindhyan-Bundelkhand forests are also unique in its composition. Most of the moist and dry deciduous forests of the state have succumbed to the social pressure with agriculture and homestead replacing the rich natural vegetation of the past. However, the remaining state biodiversity is of great significance from anthropogenic as well as ecological point of view.



Animal diversity

Major predators of the National park and Wildlife sanctuaries are tiger (*Panthera tigris*), leopard (*Panthera pardus*) sloth bear (*Melursus ursinus*), hyena (*Hyaena hyaena*) and jackal (*Canis aureus*). The important preys are samber (*Cervus unicolor*), spotted deer (*Axis axis*), swamp deer (*Cervus duvauceli duvauceli*), hog deer (*Axis porcinus*), chinkara (*Gazella gazelle*), barking deer (*Muntiacus muntjak*), blackbuck (*Antilope cervicapra*). The endangered species being harboured in the area are rhino (*Rhinoceros unicornis*), hispid hare (*Caprolagus hispidus*), Bengal florican (*Houbaropsis bengalensis*), swamp francolin (*Francolinus gularis*) and swamp deer. Red Data Book (A1) species of the Bird sanctuaries are greater spotted eagle, swamp francolin, Bengal florican, sarus crane, Dalmatian pelican, Indian skimmer, bristled grass warbler, yellow weaver, Pallas's sea eagle etc.

Threatened avian fauna (Vulnerable, V; near threatened, NT and critically endangered, CE) of the aquatic systems are *Anhinga melanogaster* (NT), *Aquila clanga* (V), *Aythya nyroca* (NT), *Ephippiorhynchus asiaticus* (NT), *Grus antigone* (V), *Gyps benghalensis* (CE), *Gyps indicus* (CE), *Haliaeetus leucorhyphus* (V), *Haliaeetus leucogaster* (V), *Leptoptilos javanicus* (V), *Mycteria leucocephala* (NT), *Phoenicopterus minor* (NT), *Rynchops albicolis* (V), *Sarcogyps calvus* (NT), *Sterna acuticauda* (NT), and *Threskiornis melanocephalus* (NT).

The wetlands harbour a host of commercially as well as ecologically important piscifauna namely, *Cirrhinus mrigla, Channa punctatus, C. marulius, C. orientalis, Clarias batracus, Heteropneustes fossilis, Mystas cavaceus, Puntius ticto, P. chola, P. sarana, P. sofore, Wallago attu etc.*

Plant diversity

The dominant tree species are *Shorea robusta, Terminalia tomentosa, Adina cordifolia, Dalbergia sissoo, Bombax ceiba, Ougenia ougeniensis, Terminalia belerica, Syzygium cumini, Diospyros melanoxylon, Madhuca latifolia, Lagerstromia parviflora, Hardwickia binnata,* etc. A host of medicinal plants of ethnic value (*Ocimum sanctum, Adhatoda vasica, Calotropis procera, Asparagus racemosus, Acorus calamus, Solanum nigrum, Convolvulus puricolis, Rauwolfia serpentina, Gymnema sylvestris Vitex negundo, Boerrhavia difusa* etc.) grow in the forest. Variety of grasses (*Imperata cylindrica, Themeda arundinacea, Vetiveria zizanoides, Saccharum spontaneum, S. munja, Phragmites karka, Aundo donax* etc.) is found in plenty.

Biodiversity Threatening Species

The forest weeds, unwanted plants in its present locality, are a menace and have adverse impacts on biodiversity, ecosystem services and productivity on a large scale. *Lantana* and *Parthenium* are representatives of this category and are included in the top ten world's worst invasive species (Babu et al. 2006). They are capable of changing the native vegetation composition and habitat condition. Similarly, the invasive aliens of inland fresh water aquatic ecosystems like, *Eicchornia crassipes, Pistia stratiotes* etc., have also become a menace and some of them figure in the list of top ten world's worst weeds.

Weeds cause environmental damage and threaten the diversity of natural resources. Introduced weeds displace native vegetation, including rare and endangered species, and adversely affect livestock and wildlife habitat. Replacement of native vegetation can cause decline in soil stability and water quality.

Cymbogon martini, an aromatic unpalatable grass was found to invade *Themeda arundinacea* grassland, the habitat of rehabilitated rhinoceros, and spread very fast posing danger of replacing native fodder grass in Dudhwa National Park.

Last year is an example of devastating effect of *Eicchornia crassipes* at Samaspur Sanctuary where severe infestation of this species caused hypoxia to the fish population resulting in large number of fish death at one time.

Overgrowth of *Ipomea carnea* and *E. crassipes* in several bird sanctuaries was found to restrict the growth of food plants that directly affected the life of herbivores of the aquatic system. Almost complete mat cover of *Eicchornia* in Okhla and other sanctuaries affected the incidence of avian population in past few years.

Known harmful effects of *Parthenium* in cattle and human beings prompt us to speculate that presence of this species in the park and sanctuaries is detrimental to the health of wild animals and an ethnic tribal population which need protection. Similarly, we should protect wild animals from consuming the *Prosopis* pods which is reported to cause tooth decay in cattle.

The presence of *Pistia stratiotes*, encourages the breeding of mosquito vectors of yellow fever and malaria. *Eicchornia crassipes* and *Ceratophyllum demersum* provide good habitat and grazing material for *Bilharzia* carrying snails (FAO 2005). *P. stratiotes* and *C. demersum* harbour the snails transmitting schistosomes.

Invasive Alien and Native Species (IAS and INS)

Alien species are non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential. Some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express their capability to establish, invade and outcompete native species. The threat to biodiversity due to invasive alien species is considered second only to that of habitat destruction. Invasive species cause loss of biodiversity including species extinctions, and changes in hydrology and ecosystem function. About 40% of the species in the Indian flora are alien, of which 25% are invasive (Raghubansi et al 2005).

Invasive plant species, either alien or native, are a threat to natural areas in the state. They displace native plants, eliminate food and cover for wildlife, and threaten rare plant and animal species. Most of the invasive species in Protected Areas of UP is aliens belonging to the American continents. Some such examples are *Ageratum conyzoides, Argemeone mexicana, Parthenium hysterophorus, Lantana camara, etc.* The examples of native invaders are *Cannabis sativa, Solanum nigrum Tiliacora racemosa* etc.

Habitat Altering Species (HAS)

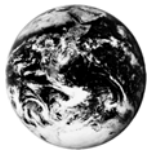
Before Wildlife Protection Act 1972 came into being certain species like, *Tectona grandis*, *Eucalyptus* hybrid and *Prosopis juliflora* were planted in the refractory areas like grasslands of *Tarai* and ravines of semiarid forests of the state with an objective of commercial gain from these species. However, with the change management objectives of conservation, certain parts of the state forests converted in to Protected Areas, the role of these species have now changed. They have become unwanted since these aliens are altering the habitat by changing the composition of the original flora. Few indigenous woodland species like *Bombax ceiba* and *Randia uliginosa* are spreading in the grassland producing same effect as that of exotic aliens mentioned beforehand.

Invasion strategy

The invasive weeds have faster growth rate, biomass production and very high reproductive abilities along with various morphophysiological adaptations. They also possess very high tolerance to different abiotic conditions. They have negative allelopathic influence on the associated native species. It is mainly due to the richness of allelochemicals like, triterpenes, phenols, steroids, flavonoides etc. in them (Ghayal and Dhumal 2006).

Successful biological invasion by a plant would require among other factors (a) possession of chemical weapons acting as strong deterrents against herbivory and (b) capacity to win a chemical war against other plants (Gupta 2006).

Generally, the invasive species are minor components of their native communities but become overwhelming dominants of invaded communities. Their demographic success results in



long term large scale population abundance. The alien invasive species are successful because they have evolved greater size or fecundity in their introduced environments compared with environments in which they are native (Singh 2006). They also do not encounter their natural enemy in the new environment.

Prosopis juliflora foliage has allelopathic effects on seed germination and seedling growth of Bermuda grass (*Cynodon dactylon*) cultivars of *Zea mays*, four cultivars of *Triticum aestivum* and *Albizia lebbeck* (Prasad 2006).

Lantadene A and lantadene B released from *Lantana camara* leaves reduce the biomass of the aquatic weed *Eicchornia crassipes* at low concentrations and thus use *L. camara* alleleopathy against *E. crassipes* (Kong 2006).

Biology and Ecology IAS, INS and HAS

As mentioned in preceding paragraphs the biological as well as ecological characters of a species play very important role in successful invasion by alien or native plant species. A host of invasive species or biodiversity threatening plants found in the PAs of UP with some such characters are described below:

Ageratum conyzoides: This is an annual weed native to South America. It has invaded and now is naturalized in many parts of India. The invasive potential of weed is attributed to its fast growth, production of large number of small sized wind and water disseminated seeds and vegetative proliferation through stolons. Although it has not occupied the sylvan PAs to alarming proportion its presence around the wetlands is of serious concern.

Argemone mexicana: The prickly poppy or yellow poppy is very common in waste places. It is found in the vicinity of wetland. The plant is prickly all over its body. The plant produces yellow latex that contains harmful alkaloids. Seeds are reported to be poisonous. The animals stay away from this plant.

Bombax ceiba: This is the top storey species of Low Alluvial Savannah Woodland and Moist Sal Savannah. This has invaded the nearby grassland and is spreading profusely to alter the composition of grassland causing disturbance to the grassland inhabitants. Removal of trees from the invaded grassland is a must for habitat rehabilitation.

Calotropis procera: It is a common shrubby weed of wasteland. It is found growing around the water body and sometimes on the island of the water body. Unmistakable purplish white flowers are scented also. The plant contains white latex, which is poisonous to the human beings. No part of the plant is reported to be eaten by any wildlife.

Cannabis sativa: At the moment the spread of this species is limited in the protected area as such. However, its fast proliferation in nearby human settlements and abandoned farm and entry in the Sanctuary poses potential danger. The leaves and inflorescence of this species contain some intoxicating ingredients and is unpalatable for animals.

***Cassia tora*:** This is an annual indigenous herb encroaching upon the grasslands of dry deciduous area. The leaves and pods are non-edible and also contain strong smelling ingredients, which work as repellent. Strong allelopathy is also reported in this species.

Ceratophyllum demersum: This is a submerged aquatic plant. This generally grows in shallow water with decaying vegetation. This species was found growing in association with *Nelumbo nucifera* in Sandi sanctuary.

Cymbopogon martini: This non-palatable grass comes up in sandy soil with low water holding capacity. The oily and aromatic odour acts as repellant to the animals and awny inflorescence works as the deterrent. After eradication of this species in Dudhwa the area was covered by a palatable grass ulla (*Themeda arundinacea*) and baib (*Eulaliopsis binata*).

Eicchornia crassipes: Most of the wetland PAs like, Nawabganj, Saman, Sursarovar, Surahatal, Samaspur, and Patna, are highly infested with water hyacinth. This weed invades the water body very fast and restricts the

movement of waterfowl and other birds which feed on fish or other aquatic life. It is very essential to remove the hyacinth before the water body gets choked down. As a result of eutrophication of the weed large amount of phosphates and nitrate or organic matter is released into water resulting in lowering of oxygen level in the water body. This affects the life of flora and fauna. Water body looses its life or becomes dead. Eradication of water hyacinth in different Sanctuaries has resulted in rehabilitation of the resident and migratory birds.

***Eucalyptus* hybrid**: This is also one of the exotics introduced in Dudhwa for commercial purpose. The plantations were raised either as pure crop or mixed with teak in the grasslands and empty woodland. The overall performance was not well, in fact in some places they exist as deformed trees. The adaptability of the species in the new climate was not found good. This species could not naturalize and did not support the life of animals and birds. The current management strategy is to remove the exotic plantations in series and to reconvert the grasslands to their original state.

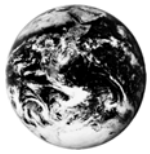
Hydrilla verticillata: It is a submersed, rooted aquatic plant. It grows from the substrate to the water's surface in both shallow and deep water. It is common in almost all the wetlands of the state. It makes thick mat in open water. It is mostly found to grow alongside of *Najas*. Sometimes it is found to grow in large number competing successfully with the neighbouring species for space.

Ipomea carnea: Several sanctuaries, few notable examples as Nawabganj, Lakhbahosi, Saman, Patna etc., are suffering from *Ipomea* menace. This perennial bank weed has high latex content and no palatability. Its multiplication is so fast and survival against the odds is so good that once it invades the water body it is very difficult to remove it completely. This keeps converging towards the core and many a times it chokes the ecosystem. This species checks the run off of silt causing enhancement of sedimentation, ultimately resulting in shrinkage of water area. Although it provides nesting groups for resident birds, heavy infestation becomes unfavourable for the diving ducks.

Lantana camara, a native of tropical and subtropical America, was introduced in India as an ornamental shrub around 1810. It is an aromatic perennial weed. The shoot has no palatability. Leaves have strong odour and stems have tiny pricles. This quality of the shrub keeps the herbivores away from it. Although some birds (jungle fowl) eat the fruits of this species but they help in spread of *Lantana* as they act as the seed dispersal agents. It has occupied several hectares of land in the buffer area of Dudhwa. It is reported that the impenetrable bush is hampering the regeneration of a very important species of the park, e.g., *Adina cordifolia*. The management strategy is to uproot the *Lantana* bush and allow the natural species to come up. It is also planned to replant the area with some useful natural species like, *Dalbergia sissoo, Accacia catechu, Eugenia jambolana, Terminalia arjuna*, and *Albizzia* spp. Kaimur wildlife Sanctuary and Sohelwa wildlife sanctuary, particularly towards the southern fringe, is infested with a lot of *Lantana*; the eradication of which is a very difficult task.

Oryza rufipogon: This is an annual, grassy, emergent aquatic weed. The leaves are unpalatable but the seeds of this species are eaten by jungle fowl, and aquatic birds like, redcrested pochard, pintail, shoveller, common teal etc. However, ducks (bar headed geese), storks (open billed, lesser adjutant, wooly necked, black necked and white necked storks) and egrets (lesser, intermediate, and large egret) avoid entering the area for the fear of getting trapped. This is a marginal weed of the aquatic body and comes up at the shallow end and then spreads within the water body. Uprooting of the weed resulted in rehabilitation of geese in certain swamps of Dudhwa.

Nelumbo nucifera: This rooted floating annual is very common in most of the wetlands. Seeds of this species are consumed by certain birds and human beings. However, this plant was found to behave like weed at several point



of time. In certain past years it was observed that *Nelumbo nucifera* flowered profusely. As a result there was copious production of fruits, locally known as *kamalgatta*, and in turn seeds. Following year there was enormous spread of this species in the wetland affecting the balance of other essential plants in the habitat. As a weed control strategy to this problem in the good seed year immature *kamalgatta* were chopped off manually in order to reduce the enormous availability of seeds, in turn to check the spread next year. Knowledge of the causal factors of this unusual behaviour of the species may lead to the clue of controlling enormous flowering by limiting that unknown factor.

Parthenium hysterophorus, known as congress grass, carrot grass, white top, bitter broom, baby flower etc. is a native to Gulf of Mexico and Central South America. This has spread all over the tropical and subtropical world. Its spread in forest is becoming a problem for native medicinal plants and wildlife (Shabbir and Bajwa 2006). Physical contact with *Parthenium* or inhalation of pollen grains may cause dermatitis, bronchitis, fever and asthma in humans or in cattle (Labrada 2006).This is an annual exotic herb which emerged near the human interfering locality first but afterwards has spread in the grassland as well as woodland. This is unpalatable species also causing skin allergy to the human beings.

Factors such as high fecundity, efficient seed dispersal, absence of natural predators, allelopathic impacts on other plants, presence of antifeedants and wide adaptability to varying soil and agroclimatic conditions have enabled this plant to invade a variety of natural environments (Yaduraju et al. 2006)

Pistia stratiotes: This free floating aquatic weed is not reported in the protected wetlands except Sandi Bird Sanctuary where it has shown its presence for the first time last year only. It is believed that some local migratory birds have brought it from the neighbouring water body. During the survey of water bodies in UP the author had recorded presence of *Pistia stratiotes* in Sitadwar jheel. The observation of the sanctuary staff of Sandi suggests that no bird was found to show affinity towards this species.

Prosopis juliflora: Popularly known as mesquite, this species was introduced in the countries of Middle east, East and Southern Africa, India and Australia for improving environment of arid and semi-arid zones. This invaded both natural and managed habitats. Its canopy takes over the ground cover, making it difficult for other grasses to grow. Pods of this leguminous plant have high sugar content, which causes teeth decay in animals ingesting them (Labrada 2006).

This is an easily propagative tree most suitable for refractory areas. Therefore, it was planted in the vicinity of forests where the barren land was difficult to be reclaimed with the help of an indigenous species. Owing to fast propagation and easy adaptation to new environment this plant has invaded the natural forest and influenced the composition of natural biodiversity. Although *P. juliflora* has several ecological and socioeconomic advantages, this species has spread as pest in the agriculture area surrounding the forests where it was introduced for reclamation of barren land. It is a major problem in the National Chambal Sanctuary and Hastinapur Wildlife Sanctuary. Several of the Bird Sanctuaries of Gangetic plains like, Samaspur, Lakhbahosi, Patna and Saman are some of the major Wetland Protected Areas where this weed occurs in varying degrees. *P. juliflora* bush is thorny and supports no undergrowth. Perhaps this quality makes the species unfavoured by certain birds and other wildlife. Large birds of prey, eagles, and chinkara avoids entering *P. juliflora* infested area. Eradication of the species might help in restoration of the area but a caution is that regeneration of indigenous species must be ensured to check soil erosion. *Azadiracta indica* (margosa tree), *Ailanthus excelsa* and *Dalbergia sissoo* have been found to regenerate in *Prosopis* infested ravine area.

Randia uliginosa: This is the middle storey crop of Low Alluvial Savannah and Moist Sal

Savannah. Like *Bombax ceiba* this species has also infested the grassland and has spread in it. The fruit of *Randia* is not eaten by animals but it is edible for the human being. The tree provides good perching habitat to some of the birds. Fast spread of this species is making the grassland habitat maintenance difficult. To check the spread and minimize the adverse effect on the habitat number of the tree per hectare is maintained 3-5. Reduction in the density of this tree from grassland has resulted in rehabilitation of representative species like, hispid hare and hog deer.

***Sesbania sesban*:** This is an annual nitrogen fixing herb encroaching upon the natural habitat of Barasinga, the swamps of Dudhwa. While passing through the patch of *Sesbania* the antler gets trapped. Fawning, feeding and hiding of this mammal are adversely affected in the dense stocking of *Sesbania*. The swamp deer tend to leave the area as it was not found suitable living area.

***Solanum nigrum*:** This is an annual herb found regenerating in disturbed habitat along with coppicing natural grass. The disturbance is created inadvertently due to control burning of the grasses to create fire lines and to get new palatable shoots of some coarse grasses. Although the fruits of this herb is eaten by birds and animals and the species is not a threat at the moment but the speed of its spread can be envisaged as potential danger.

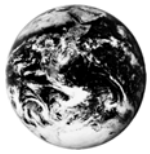
Tectona grandis: Teak (*Tectona grandis*), being highly valuable commercial timber species, was introduced in several pockets of *Tarai* Landscape during the pre wild life protection period, much before 1972. The grasslands and empty woodlands were planted with this species mostly in 1950s and 60s. In several areas it has naturalized and has started regenerating also. But the conversion of grasslands into woodlands in the protected areas started showing adverse effect since the grassland deer (hog deer) started moving out of its shrunk and vegetation altered habitat. Teak has also caused scarcity of food materials in the woodland where it has good density and regeneration as there is poor growth of ground flora.

Tiliacora racemosa: It is a woody climbing perennial shrub that forms thick mat at ground level. This not only prevents the recruitment of most important timber species, Sal but also restricts the fast movement of hoofed animals, the preys of tiger. Although there is rare reporting of feeding on leaves by rhinoceros, no other frequently roaming herbivores in the area eat the leaves. *Tiliacora* was removed from the experimental area of the park to observe its effect on the wildlife. There was direct and indirect sighting of Sambhar in the rehabilitated area.

Lesser known water weeds: In certain Bird Sancturies specially, Sandi, Lakh Bahosi, Samaspur and Nawabganj some of the plants, though useful when their growth is checked, are known for their utility towards the migratory as well as resident birds. These plants are *Eleocharis dulcis, Ipomea aquatica*, *Phragmites maximus*, *Polygonum limbatum*, *Polygonum verbatim*, *Potamogeton pectinatus*, *Typha angustifolia*. They provide good feed to the birds; however, their uncontrollable growth due to favourable environment becomes harmful for the other food providing macrophytes as they over compete and suppress the useful species. This way they start behaving like weeds or invasive species.

Management of Invasive Plants

Any plant growing as a weed in the natural habitat of the animals and birds ought to change the composition of the flora resulting in new environment where the life of ecologically important components of the food chain and the food web gets disturbed. This affects the feeding, fawning, nesting, and shelter patterns of the inhabitants. Any imbalance or disturbance in habitat may result in decline in the diversity, animal as well as plant. Therefore, habitat improvement becomes the part of management of the protected area where weed infestation has attained grotesque proportion. The prevention strategy has not yet been developed but available



cures are being practiced to improve the change and disturbed habitat. Some of the common weed controlling methods adopted in the Protected Areas of UP is as follows:

Mannual removal: The weeds like *Lantana, Eicchornia, Ipomea, Sesbania, Cymbopogon* etc. are uprooted regularly to keep the spread of these plants under check. Trees like, Eucalyptus and *Bombax ceiba* are cut and removed from the grassland. The density of *Randia uliginosa* is regulated at 3-5 trees per ha.

Simple manual removal of *Lantana* is not sufficient to get rid of its infestation. Love et al (2006) have evolved successful method for *Lantana* eradication. This includes (i) removal of Lantana clumps by cut rootstock method and drying the clumps by keeping the clumps upside down after its removal, and subsequent use of dried biomass as fuel; (ii) identification of perching trees and uprooting of all the seedlings and young plants in and around perching trees and also along the surface drainage channels; (iii) restoration of *Lantana* free habitats by planting native grasses and legumes and simultaneous inoculation of soils with rhizospheric microbial communities of native species; (iv) addition of other species assemblages based upon the end use of the habitat by the managers; and (v) monitoring of ecosystem redevelopment.

Habitat alteration: Tested method of habitat manipulation is available for *Lantana* and some aquatic weeds. Seed sowing of bamboo (*Dendrocalamus strictus*) could be tried as once it emerges over the *Lantana* it cuts of the light and suppresses it. This has been taken up as experimental basis. The result is awaited. In the case of bank or marginal weeds planting of shade trees has been done in some of the Bird Sanctuaries. The result in this case also is yet to come. Teak and Eucalypt plantations are to be replaced by indigenous species in one of the Wildlife Sanctuaries of the Moist Deciduous Forest region.

In the ravines of semi-arid region where *Prosopis juliflora* has turned into a pest the habitat is being modified by enriching the area with plantation of indigenous species like, *Acacia nilotica, A. leucophloea, Prosopis cineraria, Salvadora, Ailanthus exelsa, Azadiracta indica, Dalbergia sissoo,* and *Ficus religiosa*.

In certain bird sanctuaries de-silting is primarily done to regain the depth of the water body but it keeps the check on spread of certain vegetation, propagules of which remain dormant in the sediment.

Biological control: Use of insects to attack the weeds and destroy them especially in the case of *Eicchornia* is well established. The experiment in one of the bird sanctuaries was tried with limited success. However, NRCWS (2005) have reported control of *Eicchornia* population through its herbivore beetle *Neochetina* spp.

NRCWS (2005) have also claimed that *Zygogramma bicolorata*, an herbivore of *Parthenium hysterophorus*, is very effective in controlling the population. It is also reported that *Parthenium* can not dominate where the natural flora have not been disturbed. The botanical agents like, *Cassia sericea, C. tora, Heptis sauveolens* and *Amaranthus spinosus* were proved effective to minimize the occurrence of *Parthenium* (Agasimani et al 2006).

Chemical control: In spite of the effective herbicides available for certain weeds this method has not been tried in the National Park and Wildlife Sanctuaries with the apprehension of transfer of the harmful chemical into the food chain. However, initial attempts of *Eichhornia* treatment with unconvincing results at this stage are in progress in two of the Bird Sanctuaries.

Conclusion and Suggestion

The PAs of UP are the most precious gene pool of our irreplaceable biological heritage and natural refuge of the migratory avian species. They must be protected by different management intervention methods suited to the inhabitants. The weeds or invasive plants must be eradicated or kept under strict

control as these endanger the ecological process and survival of threatened wildlife. The efforts of conservation of the PAs of UP being done so far have been positive. However, integration of research input for managerial optimization is still required.

Although immediate concern of Wild life Preservation Organization of UP is eradication or control of invasive species from the conservation areas their removal from non-protected areas is equally important as they could play the source of inoculums. It is suggested that the experiments or trials, chemical or biological method of control, be perfected in non-PAs and replicated in the park and sanctuaries. Author also feels that instead of half-hearted efforts taken here and there on several species the forest managers should concentrate on most alarming species in very high priority area and continue their efforts till the perceptible success is achieved.

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Ethnobotanical Diversity in Shrawasti District

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Forest Range Officer

"They never use forest produce commercially but they use the produce for their daily need. Most of the Tharus are non vegetarian in fooding habit but they do not believe in hunting of big games and wild animals but they like to hunt Fish and Rats. "

Abstract

The Paper deals with the Ethnobotanical information collected exclusively from Forest areas of district Srawasti U.P. these plants are frequently used by Tharus and other local rural inhabitants living near the forest area. Tharus are living on the fringes of forest and they are mainly dependent upon wild plants for their daily needs. Tharus are not only using these plants but they are also conserving these plants as medicine, food, beverages, hairwash, making dyes, baskets, brooms, fibres, fodder, thaching and other daily needs.

Introduction

Srawasti district is situated in the Sub-Himalayan Terai Region of Uttar Pradesh. The district is bounded on the East by district Balrampur, district Bahraich makes western and southern boundary of the district while on northern side of the district International boundary of Nepal is situated. Geographical area of the Forest is 34255.50 ha. out of which 17186.77 ha. is under administrative control of Shrawasti forest division and rest of the area is under administrative control of Sohelwa wild life division Balrampur. It is located with in 27° 20′ and 28°10′ N latitude and 81°25′ and 82°5′ E. The thick forest belt of the district is situated in Terai belt of the foot hills of Himalyas in close vicinity of the territory of Nepal. The altitude of forest areas ranges from 154 m to 200m. The soil is mainly composed of Gangetic alluvium showing a succession of beds of sand and loam, varying

in depth according to the configuration of the ground. The climate of Srawasti district is of monsoon type, temperature ranges from 5ºC upto 40ºC. The district is rich in forest and forest are Ethnobotanically very rich.

There are 10 Tharu villages in Srawasti district, occupying an area of 4831 hectares in vicinity of Sohelwa wild life division. According to latest cense the Tharu have a population of 4735.

The Present study deals exclusively with forest areas of Srawasti disrict with a view to explore the possibilities of utilizing the wild plants of the district in different ways by Tharu tribes Bharrs, Kurmis, Kewats and other forest neighbouring people.

Materials and Methods

The author conducted an ethnobotanical survey during the period April 2006 to April 2007 of the areas Tharus inhabiting the following 10 villages viz Masha Kalan, Rawalpur, Bhachkahi, Raniyapur, Motipur, Kathkuiyan, Bachhupurwa, Dhathupurwa, Dhondpurwa and Bangai and prepared inventories of wild plants and their products used by tribals in their day to day life. The same survey also made in other neighbouring village of forest area to cross cheque the information of Plants and their utility by other forest based local people. The different uses of wild plants were recorded in field books. The data obtained from different localities and village's were compared. The herbarium specimens of Plants were collected and subjected to proper identification and preserved as specimen.

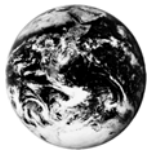
Ethno botanically Forest area of Srawasti district has not been investigated so for.

Enumeration

Botanical names are arranged in alphabetical order followed by their usable properties as reported by the Tharu tribe and other local people are also included.

1. Medicinal Plants:

Abrus precatorius L.
Abutilon indicum (L) Sweet
Acacia arabica Lamk.
Achyranthes aspera L.
Acorus calamus L.
Adhatoda vesica
Aegle marmelos (L) Correa.
Alstonia scholaris L.
Andrographis paniculata (Burm. f.) Wall.
Asparagus racemosus Willd.
Azadirachta indica A. Juss.
Bacopa monneiri (L) Wettst.
Bauhinia racemosa Lam.
Boerhaavia diffusa L.
Bombax ceiba L.
Buchanania lanzan spr.
Caesalpinia crista L.
Calotropis procera (Ait) R.Br.
Capparis zeylanica L.
Carissa opaca stapf.
Cassia fistula L.
Celastrus paniculatus willd.
Centella asiatica (L.)
Chlorophytum tuberosum Roxb.
Cissampelos pariera L.
Cleome viscosa. L.
Clerodendrum viscosum L.
Clerodendrum serratum. L.
Cocculus hirsutus L.
Costus speciosus (Koen) Sm.
Cretavia uniloculoris Burch. Haw
Cuscuta reflexa Roxb.
Curculigo orchioides Gaertn.
Cyperus rotundus L.
Dillenia pentagyna Roxb.
Diospyros melanoxylon Roxb.
Eclipta prostrata L.
Emblica officinales. L.
Euphorbia hirta L.
Euryale ferox salisb.
Evolvulus alsinoides L.
Ficus racemosa L.
Ficus religiosa L.
Flacourtia idica (Burm.f.)
Gardenia turgida Roxb.
Gloriosa superba L.
Grewia hirsuta. VahL.
Grewia sclerophylla Roxb.
Helictris isora L.
Helminthostachys zeylanica Hook.
Hemidesmus indicus (L.)
Holarrhena antidysentrica



(Pruch Ham) WalL.
Jatropha gossypifolia L.
Lannea coromandalica outt.
Leucas cephalotes. Sprang.
Litsea glutinosa Lour.
Madhuca indica koen.
Mallotus phillipinensis Lam.
Mimosa pudica L.
Momordica dioca Roxb.
Mucuna pruriens. (L.)D.C.
Nyctanthes arbortristis L.
Ocimum basilicum L.
Oxalis corniculata L.
Phyllanthus niruri
Peristrophe paniculata forsk.
Piper longum L.
Plumbago zeylanica L.
Pueraria tuberosa Roxb.
Pongamia pinnata (L.)pierre.
Peterocarpus marsupium L.
Rauvolfia serpentina L.
Sida cordifolia L.
Smilax zeylanica L.
Solanum melanogena Variety incanum L.
Tephrosia purpurea L.
Terminalia arjuna Roxb.
Terminalia bellerica (Gaertn.) Roxb.
Terminalia chebula Retz.
Tinospora cordifolia
Tribulus terrestris L.
Urgina indica L.
Vernonia cinerea Less.
Vitex negundo L.
Ziziphus mauritiana Lam.
Ziziphus oenoplia (L.)MilL.

II- Edible Plants

1- Vegetable

a. Young Leaves & Twigs.

Amaranthus spinosus L.
Amaranthus viridis L.
Bauhinia variegata L.
Chenopodium foliolosum
Ipomoea aquatica Forsk.

b. Tender fruits

Ampelocissus latifolia Roxb.
Antidesma diandrum. Roth.
Antidesma ghaesembilla Gaertn
Capparis Zeylanica L.
Dillenia pentagyna Roxb.
Ficus virens Ait
Gardinia turgida Roxb.
Madhuca longifolia koen.
Momordica dioca Roxb.
Moringa olifera Lamk.
Xeromphis uliginosa Retr.

c. Seeds

Bauhinia vahlii W&A
Mucuna pruriens (L.)D.C.
Nelumbo nucifera Gaertn.

d. Corms, Rhizomes & Tubers

Asparagus racemosus willd.
Costus speciosus (koeng) sm.
Dioscoria bulbifera. L.
Nelumbo nucifera Gaertn.
Nymphea nouchali Burm.
Puereria tuberosa Roxb. Ex. Willd.

2. Tender sprouts & floral buds

Bombax ceiba L.
Dillenia pentagyna Roxb.

3. Corolla

Madhuca longifolia koen.

4. Fruits

Aegle marmelos L.
Bauhinia racemosa Jamk.
Bridellia retusa Gaehrm.
Calamus tenuis Roxb.
Capparis zeylanica L.
Carissa opaca stapf.
Cordia dichotoma forest f.
Diospyrus melanoxylon.
Emblica officinalis Gaertn.
Feronia limonia L.
Grewia subinequalis D.C.
Momordica dioca Roxb.
Moringa olifera Lamk.
Randia dumetorum Lam.
Solanum nigrum L.
Streblus asper Lour.
Spondias pinna L.f.
Syzygium cumini L.
Tamarindus indica L.
Ziziphus mauritiana Lamk.
Ziziphus nimmularia Burm.
Ziziphus oenoplia L.

5. Kernels

Buchanania lanzan speng.

6. Fleshy aril

Schleichera oleosa Lour.

7. Seeds

Shorea robusta. Gaertn. f.

8. Gums

Gardinia turgida. Roxb.

9. Lightening of Lamps. (oil from seeds)

Madhuca indica koen.
Pongamia pinnata. L.

III. Beverages

a. Local liquor

Ficus virens Ait.
Madhuca indica koen.

Pueraria tuberosa Roxb.
Syzygium cumini L.

b. *Bidimaking*

Diospyrus melanoxylon Roxb.

IV. Hairwash

Caesalpinia sepiaria Roxb.
Eclipta prostrata. L.
Emblica officinalis Geartn.
Terminalia bellerica Geartn.
Terminalia Chebula Retz.

V. Hairdye

Lawsonia inermis L.

VI. Detergents

Caesalpinia sepiaria Roxb.
Gardenia turgida Roxb.

VII. Dyes.

Butea monosperma Lam.
Mallotus Philipinensis Lam.

VIII. Gums & Resin

Acacia arabica
Anoeigissus latifolia.
Azadirachta indica A.Juss.
Pterocarpus marsupium.

IX. Baskets & Mats

Bambusa arundinacea (Retz.) willd.
Dendrocalamus strictus Roxb.
Hemidesmus indicus
Ichnocarpus frutescens. L.
Lantana camara L.
Mallotus phillipinenesis

X. Brooms

Cymbopogon fulvus. Stapt.
Sida spinosa L.

XI. Fibre

Bauhinia vahilli wight Arn.
Crotalaria spectabilis Roth
Grewia sclerophylla Roxb.
Sida spinosa L.
Vetiveria zizianoides L

XII. Umbrella

Butea monosperma (Lam.) Taub
Bauhinia vahlii wight & Arn.
Dendrocalamus strictus. Roxb.

XIII. Pattal (Meal Plates)

Bauhinia vahlii wight & Arn.
Ficus benghalensis L.
Shorea robusta Gaertn. f.
Butea monosperma (Lam.) Taub.

XIV Thatching

Demostachya bipinnata
Saccharum munja L.
Saccharum spontaneum L.
Dendrocalamus strictus Roxb.
Haplophragma adenophyllum. L.

XV. Musical Instruments

Pterocarpus marsupium Roxb.
Dendrocalamus strictus Roxb.

XVI Hunting

Bumbusa arundinacea (Retz.) Willd.

XVII Cultural & Redigious ceremonies

Achyranthes aspera L.
Aegle marmelos L.
Butea monosperma (Lam.) Taub.
Calotropis gigantea (L.)R.Br.
Cynodon dactylon (L.)Pers.
*Datura mete*L. L.
Ficus benghalenses L.
Ficus religiosa L.
nelumbo nucifera. Gaertn.

XVIII. Tooth Brush

Achyranthes aspera L.
Azadirachta indica. A. Juss.
Clerodendrum viscosum. L.
Jatropha gossypifolia L.
Streblus asper lour.

XIX Fooder

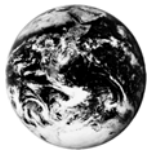
Albizzia lebbeck (L.)Willd.
Bauhinia racemosa Lam.
Bridellia retusa L.
Dalbergia sissoo Roxb.
Cynodon dactylon (L.)Pers.
Schleichera oleosa. Lour.

XX Fishpoision

Albizzia lebbeck (L.)*Willd.*
Mellatia auriculatta Baker ex. Brand.
Randia dumetorum. Lam.
Syzygum cumini L.

XXI Agricultural Implements

Adina cordifolia Roxb.
Acacia catechu willd.
Albizzia lebbeck (L.)willd.
Anogeissus latifloia Roxb.
Bambusa arundinacea (Retz.) willd.
Dalbergia sissoo Roxb.
rocalamus strictus Roxb.
Molostelea integrifolia Roxb.
Lannea coromandalica (Houtt) Merr.
Mitragyna parviflora Roxb.
Shorea robusta Gaertn f.
Tectona grandis L.
Terminalia tomentosa Heyne. ex. Roth.



Terminalia arjuna Roxb.
Prosopis juliflora D.C.
Vitex negundo L.

Results and Discussion

During Ethnobotanical survey information of 147 plant species identified and studied their different uses. During field visit Sri Ram Prasad, Sri Ainthu Ram, Sri Kali Prasad and Sri Ram Kishun R/o Motipur Kalan were with author. They helped in collection of plants from forest area of the district Srawasti. These plants are not only utilized by Tharus but other forest neighboring persons are very frequently using these plants in their day to day life.

Tharu of Srawasti district are residing on the fringes of forest area of west Sohelwa range. Even today, the Tharus depend upon the out side world for only such articles like Kerosene oil, Edible oil, Cloths and Salt for their other day to day needs, they depend upon plants. Tharus of Srawasti district are very helpful in conserving the biodiversity of area. They never use forest produce commercially but they use the produce for their daily need. Most of the Tharus are non vegetarian in fooding habit but they do not believe in hunting of big games and wild animals but they like to hunt Fish and Rats. They use poles & thatching grass to built their houses and now a days they are using mud tiles, these tiles are prepared by them selves and they prepared it locally. So by this way Tharus are also minimising their dependency on the forest Tharus are very much ecofreindly persons, they are using *luffa cylindrica* (Lauki) as water bottle instead of cool cag or bottles.

Acknowledgement

The author is greatfully acknowledge his sincere thanks to Sri Rampasad, Sri Ainthuram, Sri Kali Prasad and Sri Ram Kishun Tharu for rendering their kind co-operation during the field work. The help extended by local forest feild staff of Srawasti forest division is also acknowleged. The author is also greatfully acknowledge his sincere thanks to Dr. Anand Prakash senior scientist N.B.R.I & Dr. B.D. Singh, Reader K.S. Saket R.G. College Ayodhya for providing cop-operation in proper Identification of the plants. The author also puts his sincere thanks to Sri R. K. Dubey A.C.F. Forest Deptt. to giving his full support in completion of work.

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Conservation of Fruit Tree Diversity for Nutritional and Environmental Security

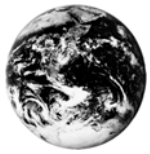
Sushil Kumar Shukla

CISH, Rehmankhera, PO Kakori, Lucknow

"The exploited mining sites are usually abandoned but can be utilized for plantation of phalsa (*Grewia subinaequalis*), jharberi (*Ziziphus nummularia*), custard apple (*Annona spp.*), oleaster (*Eleagnus* sp.), aonla (*Emblica officinalis*), Seabuckthorn (*Hippophae rhamnoides*), tamarind (*Tamarindus indica*) and ber (*Ziziphus mauritiana*). "

Uttar Pradesh has a total geographical area of 2,40,928 km^2 or 7.33 per cent of the land area of the country. It is the fifth largest state of India, lying between latitude 23^{0}52'-30^{0}24' N and longitude 77^{0}5'-84^{0}38'E. The human population of the state is 166.05 million as per Census 2001. It is one of the most densely populated states of India with population density of 689 per km^2. More than 87.39 per cent of the total geographical area of the state is under agriculture followed by 8.84 % under forest/tree cover (FSI, 2002). Paddy-wheat is common crop rotation in the eastern, central and western parts of the state. Bundelkhand region characterized by low rainfall, rocky, gravelly red soils or black soils, lack of irrigation water is dominated by monocropping either during rabi or kharif season. This region has the unique potential of being revolutionized with fruit production by promoting suitable underutilized fruit crops, fruit tree based agroforestry systems and topworking of wild seedling trees/bushes with improved cultivars. This will go a long way in ensuring nutritional, environmenatal and food security of the region, besides opening new vistas of employment generation.

The wheat-paddy rotation and increasing population pressure in the state has started creating many problems. The water table is receding at alarming rates with every passing year due to the over exploitation of underground water in both agriculture sector and urban areas. Both wheat and paddy are high input requiring crops, causing imbalances in nutritional structure of the soil and



polluting the underground water. Moreover, the present day constraints like restriction on water use, high cost of production, labour shortage and management problems have compelled to think in terms of getting maximum returns per unit area with minimum cost in the least possible time period. In order to over-come these problems, in the present socio-agricultural-economic scenario, horticulture in general and underutilized fruits in particular can play an important role in the development of fruit tree based agro-forestry systems to enhance the land productivity on sustainable basis. Different approaches of horticulture and fruit based agroforestry systems, which can be adopted in the days ahead for conserving biodiversity and ensuring nutritional and environmental security are given below :

Popularizing under-utilized fruit crops and fruit tree seedling plantations

During the past, there has been major emphasis on the crops like mango (*Mangifera indica*) , guava (*Psidium guajava*), citrus (*Citrus* spp.), banana (*Musa* spp)., aonla (E*mblica officinalis*), etc throughout the state, while the fruit crops like ber *(Ziziphus mauritiana)*, bael *(Aegle marmelos)*, amra (Spondias mangifera), barhal (*Artocarpus lakoocha*), jackfruit (*Artocarpus heterophyllus*), carambola (*Averrhoa carambola*), lasora (*Cordia myxa*), custard apple (*Annona* spp), loquat (*Eriobotrya japonica*), rose apple (*Syzygium jambos*), mulberry (*Morus* spp), phalsa (*Grewia subinaequalis*), wood apple (*Feronia limonia*), chironji (*Buchanania lanzan*), tamarind (*Tamarindus indica*), khirni (Manilkara hexandra) (*Manilkara hexandra*), jamun (*Syzygium cumini*), mahua (*Bassia latifolia*), karonda (*Carissa carandas*), subtropical peaches (*Prunus persica*), plums (*Prunus domestica* and *Prunus salicina*), sapota (*Achras zapota*) have been ignored. These crops invariably have high anti-oxidant value and are used in medicinal preparations. Besides this, many of them can successfully be grown in degraded lands, salt affected soils, ravines, etc. Moreover, popularizing commercial varieties of mango, guava, aonla (*Emblica officinalis*), bael *(Aegle marmelos)* and other fruit crops has leads to drastic loss of diverse gene pool, as seedling trees, a potential source of diversity are rarely planted by people due to burgeoning population pressure and declining per capita land availability. Most of the varieties like Dashehari, Langra, Chausa of mango; Allahabad Safeda and Sardar of guava have resulted from selection of superior seedlings. The loss of gene pool will affect the improvement of these fruit crops adversely. Under such circumstances, there is a need to identify new areas for promoting plantation of promising seedling trees of both commercial and under-utilized fruit crops to conserve the genetic diversity for future use.

Plantation of fruit trees and fruit tree based agroforestry systems in marginal and degraded lands

Promotion of under-utilized fruits and fruit based agroforestry systems, viz. agrihorti, agrihortisilvi, agrihorti-silvipastoral, hortipastoral, hortisilivipastoral sytems will go a long way in revolutionizing both agriculture and horticulture production in such lands. In Bundelkhand region, guava, kinnow mandarin (*Citrus reticulata*), aonla (*Emblica officinalis*), ber, bael, wood apple based aforesaid agroforestry system with enhance the productivity of degraded lands on sustainable basis.

Plantaion of suitable underutilized fruit trees in degraded lands

A. Fruit trees suitable for sandy wastelands

Sandy soils occur in coastal, riverine, island or cold desert areas and have low productivity and poor moisture storage characteristics. The species

suitable for such areas are

1. **Arid regions** : Jharberi *(Ziziphus nummularia)*, boradi (*Ziziphus mauritiana* var. *rotundifolia*), ber *(Ziziphus mauritiana)*, ker (*Capparis* spp.), lasora (*Cordia myxa*), khejri (*Prosopis cineraria*) and the desert date (*Phoenix dactylifera*)
2. **Semi-arid regions** : custard apple (*Annona* spp), *bael (Aegle marmelos)*, fig (*Ficus carica*), tamarind (*Tamarindus indica*), khirni (*Manilkara hexandra*), Palmyra palm (*Borassus flabellifer*), wild date palm (*Phoenix sylvestris*), mahua (*Bassia latifolia*), phalsa (*Grewia subinaequalis*) and wood apple (*Feronia limonia*)
3. **Coastal sands** : *Ber (Ziziphus mauritiana)*, Nicobar bread-fruit (*Pandanus lerum*), nipa palm (*Nipa fruticans*) and double coconut (*Lodoicea maldivica*)
4. **Cold sandy deserts** : Seabuckthorn (*Hippophae rhamnoides*), ghain (*Elaeagnus umbellata*), oleaster (*Eleagnus* sp.) and chilgoza nut (*Pinus gerardiana*), apricot (*Prunus armeniaca*)

B. Fruit trees suitable for undulating uplands

These lands, found over a wide range of agroclimatic conditions in tropical, subtropical and temperate regions at high elevations are generally prone to degradation and may or may not have scrub cover.

Arid Temperate : Oleaster (*Eleagnus* sp.), ghain (*Eleagnus umbellata*), chilgoja nut (*Pinus gerardiana*), Seabuckthorn (*Hippophae rhamnoides*)

Semi-arid Temperate : Turkish hazelnut (Corylus colurna), chestnut (*Castanea indica*) and pecannut (*Carya illinoensis*)

Arid Tropical and Subtropical : ker (*Capparis* spp), *ber (Ziziphus mauritiana)*, aonla (*Emblica officinalis*), plum (*Prunus* spp), boradi (*Ziziphus mauritiana* var. *rotundifolia*), fig (*Ficus carica*), wood apple (*Feronia limonia*)

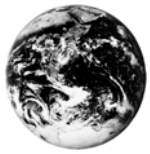
Semi-arid Tropical : Tamarind (Tamarindus indica), custard apple (Annona spp.), chironji (Buchanania lanzan), mahua, aonla (*Emblica officinalis*), *Annona* spp., Indian butter tree (*Diploknema butyracea*) and kokam (*Garcinia indica*)

C. Gullied and ravinous lands

As a result of localized surface run-off, gullies are formed resulting in undulating terrain. Ravines are formed generally in deep alluvium and consist of extensive system of gullies along the rive courses. The suitable fruit species are aonla (*Emblica officinalis*), *ber (Ziziphus mauritiana)*, custard apple (*Annona* spp.), mulberry (*Morus* spp), jamun (*Syzygium cumini*), palmyra palm (*Borassus flabellifer*), tamarind (Tamarindus indica), khirni (Manilkara hexandra), chironji (*Buchanania lanzan*), khejri (*Prosopis cineraria*), bael *(Aegle marmelos)* and ker (*Capparis* spp.)

D. Mining and industrial wastelands

Mining leads to degradation and loss of top soil, salinity, water and air pollution. The exploited mining sites are usually abandoned but can be utilized for plantation of phalsa (*Grewia subinaequalis*), jharberi *(Ziziphus nummularia)*, custard apple (*Annona spp.*), oleaster (*Eleagnus* sp.), aonla (*Emblica officinalis*), Seabuckthorn (*Hippophae rhamnoides*), tamarind (*Tamarindus indica*) and ber *(Ziziphus mauritiana)*. Industrial complexes produce affluent discharges having high soluble solids and dissolved metals which cause land degradation. Some fruit species which can be



successfully grown in such wastelands are cashewnut (*Anacardium occidentale*), oleaster (*Eleagnus* sp.), seabuckthorn (*Hippophae rhamnoides*), jamun (*Syzygium cumini*), tamarind (*Tamarindus indica*), ber *(Ziziphus mauritiana)* and jharberi *(Ziziphus nummularia)*

E. Waterlogged and marshy lands

The fruit species suitable for such areas are water chestnut, gorgan nut (*Eurale ferox*), Palmyra palm (*Borassus flabellifer*), mahua (*Bassia latifolia*), screw pine (*Pandanus odoratissimus*) and nipa palm (*Nipa fruticans*).

F. Strip lands

The long narrow strips of land on either sides of rail and road networks, canal and rivers and foreshore banks can be planted with fruit trees like jamun (*Syzygium cumini*), *ber (Ziziphus mauritiana)*, mahua(*Bassia latifolia)*, bael *(Aegle marmelos)*, karonda (*Carissa carandas*), ker (*Capparis spp*.) to protect erosion and to improve the environment.

G. Degraded pastures and grazing lands

Temperate region : Himalayan mulberry *(Morus serrata)*, crab apple (*Malus baccata)*

Semi-arid Tropics : Jamun (*Syzygium cumini)*, monkey jack (*Artocarpus lakoocha*), aonla (*Emblica officinalis*), bael *(Aegle marmelos)*

Semi-arid Subtropics : Aonla (*Emblica officinalis*), mulberry *(Morus spp.)*, tamarind (*Tamarindus indica*), chironji (*Buchanania lanzan*), jamun (*Syzygium cumini)*, fig (*Ficus carica*)

Arid regions : Khejri (*Prosopis cineraria*), jharberi *(Ziziphus nummularia)*, boradi (*Ziziphus mauritiana* var. *rotundifolia*), ker (*Capparis spp*.), pilu (*Salvadora oleoides*) and phalsa (*Grewia subinaequalis*)

4. Plantation of fruit tree seedlings as wind breaks
5. Plantation of promising seedling trees in parks, protected forest areas for improvement through selection
6. Fruit trees on farm boundaries
7. Fruit trees as fruiting forests
8. Intercropping
9. Road and canal side planting
10. Multistorey cropping
11. Fruit trees in kitchen gardens
12. Rejuvenation of seedling trees with commercial varieties/rare germplasm.

Diversification through Horticulture – the role of government

In the state of Uttar Pradesh, diversification of agriculture with horticultural crops and fruit tree based agro-forestry systems will only be feasible if horticulture is promoted and substantial areas are shifted from wheat and paddy. This can be done by creation of progeny orchards and Government nursery at district/block level for supplying high quality disease free plant material on large scale to the farmers. The Government should also fix minimum support-statutory prices for major fruit crops and make arrangements for the purchase of produce, if need be. After the shifting of substantial area under fruit crops, the priority should be given for setting-up of market network and fruit processing units for value addition. The grading and packaging centres should be established for sustained export of horticultural produce. This will help the farmers to undertake fruit growing on large scale and it will also save our environment from further deterioration. The environment protection will save the human kind.

STATUS OF TURTLES IN UTTAR PRADESH

Mohd. Ahsan[1] & Dhruvajyoti Basu[2]

"There is a massive international trade of turtles with China as destination, where there is a demand of an order that has been assessed as clearly unsustainable for certain species.. "

Introduction

Turtles are significant components of the zoo communities living in aquatic ecosystems. Iverson 1982 estimated biomass values for individual turtle species to be as high as 586 kg/ha. This biomass is of an order greater than those typical of mammals and birds and comparable to that of amphibians and fishes. As elimination of turtles from aquatic environments is likely to have a major impact on aquatic ecology, it becomes imperative to evaluate the status of turtles in the state and formulate a conservation strategy for implementation.

The Diversity of Freshwater Turtles and Tortoises

With 28 species of freshwater turtles and tortoises, India is considered as one of the chelonian 'hotspots' of the world along with southeast Asia and Amazonian South America. With more than 54% of India's turtle species occurring in UP, the state has an enviable diversity of Chelonian fauna, which comprises of 15 species belonging to 11 genera. The chelonians that occur in our state are listed in Table 1.

1. Chief Wildlife Warden, U.P., Lucknow
2. Surveyor (Crocodile) Endangered Species Project, U.P.

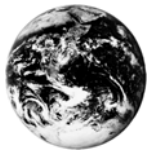


Table 1. Diversity of freshwater turtles and tortoises of Uttar Pradesh

Family	Genus	Species Common Name	WL(P)A Listing	IUCN Status	Distribution	Confirmed Current Occurrence
Bataguridae	1. *Pangshura*	1. *tentoria* -Indian Tent Turtle	Not listed (NL)	LR lc	Major rivers	Ganga and tributaries
		2. *tecta* Indian turtle	Sch. I Part II	LR lc– roof	Minor rivers and associated wetlands	Small streams in Pilibhit, Hardoi
		3. *smithii* – Brown roof turtle	NL	LR lc	Major rivers	Ghagra R.
	2. *Kachuga*	4. *kachuga* – Painted roof turtle	Sch. I Part II	Cr End	Major rivers	Chambal R.
		5. *dhongoka* – Three striped roof turtle	NL	En	Major rivers	Chambal, Ganga in Bulandshahr
	3. *Hardella*	6. *thurjii* – Crowned river turtle	NL	En	Large and medium rivers and associated	Gomti, Dudhwa, Ganga, Chambal -rare in larger rivers
	4. *Geoclemys*	7. *hamiltonii* – Spotted pond turtle	Sch. I Part II	Vu (In India) Global LR nt	Wetlands and associated minor river	Pilibhit, Katernia WLS
	5. *Morenia*	8. *petersi* – Indian eyed turtle	NL	LR nt	Minor rivers and associated wetlands	Pilibhit
	6. *Melanochelys*	9. *trijugal* – Indian black turtle	NL	LR lc	Minor rivers, wetlandsand associated grasslands	Katernia WLS
		10. *tricarinata* Tricarinate turtle	Sch. I Part II	Vu – hill	Forest areas associated with wetlands and rivers	Pilibhit
Trionychidae	7. *Nillsonia*	11. *gangetica* Indian soft shell turtle	Sch. I Part II	Vu -	Large rivers, lakes, ponds	Throughout state
		12. *hurum* – Peacock softshell turtle	Sch. I Part II	Vu	Rivers	Chambal (rare), Balrampur stream
	8. *Chitra*	13. *indica* – Narrow headed soft shell turtle	Sch. IV	Cr En	Large sandy rivers	Ghagra, Chambal, Ganga, Yamuna
	9. *Lissemys*	14. *punctata andersonii* – Indian flapshell turtle	Sch. I Part II	LR nt	Ubiquitous in aquatic habitats	Throughout state
Testudinidae	10. *Testudo*	15. *elongata* – Elongated or Sal forest tortoise	Sch. IV	En	Hilly Sal forests	Reported from Corbett Park; in similar hilly forested tracts in UP

Conservation and Legal Status of Turtle and Tortoise Species

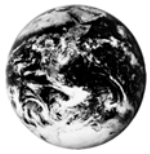
Legal status of turtles in India and the degree of protection it is entitled to is conferred by the provisions of the specific Schedule of the Wildlife (Protection) Act 1972, to which the species belongs. The field conservation status is determined by the IUCN Red List Category in which the species has been included. The IUCN Red Listing reflects global status of those species which have cross border distributions. It is worth noting that no species, which occurs in Uttar Pradesh, is endemic to the state or even to the country although several are endemic to the South Asian Region. The Red List category is determined by the criteria fulfilled by these species, of which the most important are rates of decrease of populations and/or the extent of their distribution. It may be seen from the table that in the case of several species, the legal status of a species does not reflect its conservation status and vice versa. For example, species that are endangered, such as *Kachuga dhongoka* and *Hardella thurji*, have not been included in the Act in spite of several revisions and species like *Chitra indica*, which have been designated as Critically Endangered, find a place in only Schedule IV. In contrast, species like *Lissemys punctata andersoni* and *Pangshura tecta* that must be amongst the commonest and most widespread species in the country, are listed in Schedule I. The Act has another major lacuna – only 2 of the 3 families of turtles that occur in our country have been included in Schedule IV. As a result, the species of the family Batguridae that would receive blanket legal protection by the family's inclusion in Schedule IV do not do so.

The Critically Endangered Species

Two species of turtles occur in the State, which have been deemed as Critically Endangered by the IUCN. These are:-

1. The Painted Roof Turtle *Kachuga kachuga* – This is a large, herbivorous, hard-shelled river turtle (carapace length 560 mm) that has been described as one of the most beautiful turtles of the world. The head of the males during the courtship season become adorned with three crimson stripes that are strikingly offset by yellow, white and steel blue coloration of its face. *K. kachuga* is endemic to the Ganges River system in India, Nepal and Bangladesh. Surveys of the major rivers of UP over the last three decades suggest that the species distribution has shrunk drastically and occurrence is currently restricted to the Chambal River in the National Chambal Sanctuary. The species, like other hard shell turtles, is extremely prone to mortality in fishing nets, which is the single most important reason for the critical endangerment of this species. The status of two other morphologically similar species *Kachuga dhongoka* and *Hardella thurjii*, are slightly better than *K. kachuga*, respectively because of past greater abundance and wider distribution.

2. Narrow-headed Soft shell Turtle *Chitra indica*: This is a giant form reaching a record length of 1800 mm. It is mostly a piscivorous species specially adapted for catching fish by stunning them with ultra swift thrusts of its telescopic neck. It lays large clutches of up to more than 200 eggs once or twice in a year. This species may have been affected by hydrological changes in rivers as a result of dams and barrages in addition to turtle hunting for local consumption and export. The critical endangerment of the species has been assessed on the basis of its disappearance from trade in the recent past.



Threats to Other Species

All species of turtles are consumed either locally in the areas of their occurrence or they are additionally exported to other regions of India. There is a massive international trade of turtles with China as destination, where there is a demand of an order that has been assessed as clearly unsustainable for certain species. The turtles chiefly affected are species of soft shells, which are being exploited to harvest the cartilaginous leading edges of their carapaces. These body parts are processed and dried so that they are no more perishable and are known by the term calipee in trade. These are in particularly high demand being regarded as delicacies.

In Uttar Pradesh, recent confiscations of clandestine shipments reveal that the species overwhelmingly prevalent in trade is *Lissemys punctata andersoni*. A number of cases are detected every year by the Forest or Police Departments, all of which are registered in courts of law because of the provisions of the WL (P) Act. However, the volume of trade that is detected is the proverbial 'tip of the iceberg'. The current mode of transportation of calipee is by road although previously rail transportation was often utilized for export of turtles. Live turtles are packed and booked as consignments of fish. Either calipee or turtles are sent to eastern states of Assam or West Bengal and beyond to South East Asia and China via Bangladesh. A major proportion of people involved in the clandestine turtle trade belong to the community *Kuchmadhia* that is also known as *Kanjar* or *Nat*. Fishermen or members of the *Mallah* community from Eastern parts of the state also hunt turtles in significant numbers.

The next most important factor threatening the survival of turtles are loss of habitat due to cultivation on riverbanks and midstream islands and other anthropogenic pressures.

There may also be other subtle threats but it will be possible to identify these only by sustained research on species biology. Species of small body size, especially those that are categorized by IUCN as Low Risk – Least Concern, have a good ability to adapt to the changing environmental condition in the contemporary world and in spite of sustained illegal harvesting, either for local consumption or for export, the populations of species like *Lissemys* and *Pangshura* spp. have not been significantly impacted.

CRITICALLY ENDANGERED BIODIVERSITY OF UTTAR PRADESH – VULTURES

Mohd. Ahsan[1] & Dhruvajyoti Basu[2]

"Post mortem investigations of gout affected birds showed residues of the non-steroidal anti inflammatory drug (NSAID) Diclofenac, in their kidneys. The vultures had ingested the drug while eating the flesh of dead animals that had recently been administered Diclofenac."

Introduction

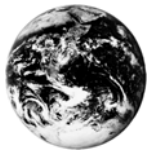
Although much biodiversity is threatened today, only few charismatic species of the state's fauna fulfill the criteria of critically endangered species. Among the few species that have been classified as endangered or critically endangered, are the vultures belonging to the genus *Gyps*. These birds are commonly known as *'Gidh'*. They were in the recent past readily visible in flight at great altitudes or perching on large trees. They could also be observed at close range while feeding, clustered around carcasses of cattle or other animals.

Ecology of *gyps* vultures:

Eight species of *Gyps* occur in the world, of which four are restricted to Asia, three to Africa and one breeds in Eurasia but migrates into Africa and S. Asia. *Gyps* vultures disperse widely for foraging, a tendency which is more marked in sub-adult birds.

Vultures of the genus *Gyps* are large birds weighing up

1. Chief Wildlife Warden, U.P., Lucknow
2. Surveyor (Crocodile), Wildlife Preservation Organisation, U.P.



to 10 kg. Their massive wings and other flight adaptations allowed them to soar for long periods without flapping their wings, using atmospheric phenomenon like updraughts and thermals. They forage on corpses and carcasses, which are located while flying, often in response to movements of other vultures that may have spotted the carcass first. Vultures stuff their crop with sufficient food while feeding so that they need to eat only once in several days. Only flesh, offal and intestines are eaten while contents of the GI tracts are rejected.

Gyps have a known life span of thirty eight years and become sexually mature at the age of four to six years; thereafter they pair and build nests on large trees like aged Banyan (*Ficus*) or sometimes on rocky crags on hillsides. Vultures produce one egg per year for the rest of their lives. Survival rates of large birds of prey on reaching adulthood range at around 95% but only 10-20% of fledglings are estimated to reach maturity.

Occurrence of *Gyps* vultures in UP, past and present and current population trends:

The species of *Gyps* that occur in U.P. are

1. The oriental white-backed vulture *Gyps bengalensis*
2. The long billed vulture *G. indicus*

Gyps *tenuirostris* or the slender billed vulture is a species, which was discovered in the early 1990s and it is not known if the species commonly occurred in the state or not.

Past occurrence

In the past *Gyps* must have been numerous as well as widely distributed in all districts of Uttar Pradesh, as has been documented in other locations in India as well as Southeast Asia. Their notably high densities in the past were no doubt because of high abundance of food, as carcasses of dairy and draught cattle are generally not utilized in any manner because of religious restrictions. Also, there is very little persecution by any mode because of socio-religious sentiments towards animals that prevail in this part of the world.

Present population trends

Documentation of the decline of *Gyps* vultures in India did not begin until the phenomenon had become conspicuous because of its severity. This ongoing phenomenon was first recorded by Davidar & Davidar, in the Sigur region of the Nilgiris. They pointed out the disappearance of a population of 200-300 vultures as far back in 1987. The present day population trends of *Gyps* vultures could be summarized as 'a drastic decline' throughout the entire geographical distribution of these birds. The precise rates of decline are suitably characterized by the quantified findings of Dr. Vibhu Prakash of the Bombay Natural History Society, who studied *Gyps* populations in Koeladeo Ghana National Park in eastern Rajasthan. Here their populations had been observed to rapidly decrease in the latter part of the 1990s, and breeding pairs became completely extinct from the Park by the year 2000. Studies of populations over a wider area in north India by repeated road transects, carried out from 1991-1993 had yielded similar results. The decline over a consolidated period from 1992 to 2003 was computed to be at least 99.7 for *Gyps bengalensis* and 97.4 for *Gyps indicus/ tenuirostris*. The annual rates of decrease were computed at 34% for the former and 27 % for the latter species. There is evidence that the decline has accelerated during the current decade.

In Uttar Pradesh investigations into 'presence' or 'absence' of vultures in all Forest Divisions, elicited a 'present' response in only six Forest Divisions. These Forest Divisions are Najibabad, Bijnor, Pilibhit, Katerniaghat Wildlife Sanctuary and Gonda. Vultures have also been reported from Lalitpur, Chitrakoot, Chandouli, Kaimur Wildlife Sanctuary, Dudhwa National Park and from Barabanki. It may therefore be surmised that the

situation in Uttar Pradesh is similar to the rest of the country and geographic region, with vultures surviving mostly in some remote forested areas.

Causes of decline

Puzzled by the inexplicable rapidity in the decline of *Gyps* numbers, a number of potential causes were perceived as an explanation to this phenomenon. These are mentioned as follows:

1. Loss of nesting habitat
2. Infectious diseases
3. Impact of veterinary drugs
4. Other environmental pollution
5. Poisoning as a by effect of the poisoning of animals on which vultures feed
6. Decrease of food resources
7. Exploitation and/or persecution
8. Environmental impact of transportation, infra-structure and recreation

Each of the above factors would in turn be generated by a single or a combination of causative factors. However, it is now widely accepted that the impacts of all other factors were marginal in comparison to the impact of the drug 'Diclofenac' in veterinary use. This discovery was precipitated by observations of vulture mortality in Pakistan due to visceral gout. Post mortem investigations of gout affected birds showed residues of the non-steroidal anti inflammatory drug (NSAID) Diclofenac, in their kidneys. The vultures had ingested the drug while eating the flesh of dead animals that had recently been administered Diclofenac. Subsequent experimentation and other investigations confirmed that this common NSAID, which is widely used in treatment of humans and which had come into widespread veterinary use, over the same duration of time, in which the vultures had disappeared, was primarily responsible for near extinction of *Gyps* vultures. These investigations were spearheaded by J. L. Oaks and others, who published their results in *Nature* in 2004, more or less conclusively establishing the relation between the veterinary use of DIclofenac and the disappearance of *Gyps* while eliminating other possible causes.

Impact and implications of the extinction of *Gyps* vultures:

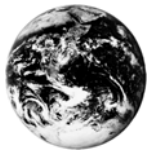
While *Gyps* vultures have not yet become extinct, the acute reduction in abundance and distribution is tantamount to virtual extinction. The following ecological impacts are apparent because of the dissappearance of vultures

1. An increase in the population of other resident scavengers like feral dogs and the steppe eagle (*Aquila nipalensis*) as well as in the number of migratory scavenger species such as Eurasian Griffon vulture (*Gyps fulvus*). The increase in feral dog populations could result in outbreaks of diseases like rabies and distemper that are fatal for humans.
2. Stockpiling of dead animal refuse because of non disposal through the scavenger activity increases the chances of contamination of ground water and outbreaks of diseases like tuberculosis and anthrax.
3. The traditional funeral practices of the Parsi community in India have been completely disrupted.

Conservation of *Gyps* vultures

The Governments of South and South East Asian nations, in which the decline of *Gyps* species has been the most acute, have quickly formulated and initiated strategies to reverse the population trends of these previously ubiquitous birds of these lands. The strategies include the following actions

1. The discontinuation of veterinary use of Diclofenac: This is regarded as indispensable and the



key to successful conser-vation of *Gyps* vultures. As long as use of Diclofenac continues, nothing can be done to prevent wide ranging vultures from reaching and consuming drug contaminated carcasses resulting in further decimation of their populations. This requires the replacement of Diclofenac with viable alternative that are cost effective veterinary drugs. Sustained public awareness programmes for stake-holders such as farmers, cattle growers, veterinary doctors as well as the pharmaceutical industry to ensure acceptance of the alternative drugs among stakeholder. **The Drug Controller General, Government of India on the 11-05-2006 issued instructions to all State Drug Controllers to phase out Diclofenac within a period of three months.**

2. Monitoring surviving populations of vultures: Remnant populations of vultures continue to survive in some forest areas and these have to be located population strengths assessed and their status monitored. Comprehensive research on biology, ecology and habits of surviving populations of vultures is necessary to accomplish this.
3. Captive breeding: This is a contingency action as a safeguard against the eventuality that the decline of vultures by terminating use of Diclofenac cannot be achieved in time to prevent extirpations of still surviving vulture populations. This involves establishing technically feasible vulture captive-breeding centres, collection and incubation of eggs from nature to establish nucleus captive-breeding groups, providing them with a Diclofenac free environment, inducing successful breeding under captive conditions; successful rearing of captive bred chicks to adult vultures. The output from the captive breeding programme can be reintroduced in areas from which Diclofenac has been eliminated.

Animal Genetic Resources and Their Conservation

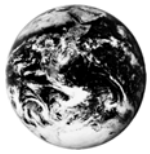
S. P. S. Ahlawat
Indian Veterinary Research Institute,
Izatnagar

"It is now well accepted that grazing of livestock in forests have never led to the degradation of forests, rather reverse has caused the extinction of breeds or species of livestock by destruction of forests."

Introduction

Domestication of livestock species began nearly 12,000 years ago. Man started herding of animals for food, fibre, work, power and other agricultural purposes. Though 40 mammalian species have been domesticated for food but the major contribution in livestock production is only from 14 species. Within these farm livestock species around 5,000 breeds have been classified. India is the seventh largest country in the world and nearly 75% people are engaged in vocations related to agriculture and animal husbandry. Traditionally, India has been a mega biodiversity centre and rearing of domesticated animals was practiced since time immemorial. Almost donkeys, yak and mithun are found in India. Apart from poultry, domesticated species of avian such as ducks, geese, quils, turkey, pheasants and partridges also exist in India.

Conservation of all forms of life has been the ethos of human society in India since ancient times. The major basis of maintaining such a large bio-diversity was through the sustainable management of resources and their ecosystem. The vast livestock genetic resources have been the integral component of Indian agriculture.



Only during recent years, due to commercialization of agriculture, mor eemphasis has been given on cash crops, which contribute very little to the animal food. As a result, the livestock breeds sustainable on agricultural byproducts are becoming relatively uneconomical on competitive agricultural farming and are being replaced by more productive indigenous or exotic breeds from a different environment.

Livestock genetic resources in India is undergoing an unprecedental change between plenty and poverty. In the absence of planned efforts to conserve and maintain purebred populations, indiscriminate breeding within the native stock as well as with exotic breeds has continued. It has been estimated that nearly 80% of indigenous animals are non-de script and practically useless for resource development. This is in sharp contrast to the situation in developed countries where each animal is known for its pedigree.

The traditional method of animal conservation are still very important yet new approaches are emerging to meet the growing challenge of saving the native germplasm from being extinct. These may include keeping of a representative population of the breed in *situ* as well as *ex-situ*. The biotechnological tools developed in recent years can be effectively used for the conservation of livestock genetic resources in India. In this paper these approaches vis -a-vis the traditional wisdom have been reveiwed to develop an effective strategies for the conservation of indigenous livestock genetic resources.

Global situation of animal genetic resources

It has been estimated that some 1500 of the 4500 breeds of the world's domestic animal species are now at high risk of extinction. Moreover, little is known about most of these resources as the scarce funds and other support currently available especially in the developing countries is concentrated on a small number of breeds rescue projects. There is little doubt that together the 160 or so developing countries harbour the majority of the world's farm animal genetic resources and associated animal diversity, and that country interdependency in animal genetic resources is now increasing. Currently, there is no framwork provided by or within a single international instrument regarding policies on access, utilization, and conservation associated with the application of biotechnology to animal genetic resources. Lacking also is harmonization among or across Governments,' concerning the various policy-issues involved. No single national system has yet emerged as a desirable model. Therefore, within each developing country, emphasis must be on implementing a sound management infrastructure and a broad technical programme that has the potential to help countries design and implement national action strategies, as required under the CBD. With these considerations firmly in mind, the imperative actions for the conservation of domestic animal genetic diversity have been identified by FAO as follows :

1. Each country must identify and understand the unique genetic resources so that the global gene pools for each of the important domestic animal species used for food and agriculture can be made sustainable globally.
2. The livestock diversity should be made to increase production and productivity under the local sustainable agricultural systems that meet the demands for specific product types in a given ecological niche.
3. Each country should have a sound arrangement to monitor all the gentic resources, particularly where small propulations have been left or are being dispalced by one breed or another.
4. All the unique genetic resources must be

preserved immediately even if they are poor in production as they may have other traits of value in animal adaptability or survivability under given ecological niche.

5. The people involved in the management of animal genetic resources should be trained at national or international level.

Domestic livestock diversity in India

According to World Watch List there are 61 breeds of cattle, 19 of buffaloes, 29 of goats, 59 of sheep, 9 of horses, 3 of donkey, 3 of pigs and 18 of poultry. However, there are about 130 breeds consisting of 30 of cattle, 10 of buffaloes, 42 of sheep, 20 of goats, 8 of camels, 6 of horses and 18 of poultry as documented in literature in India. Thus, India is a repository of a large segment of bio-diversity in domesticated animals. It has been estimated that one-ninth of the total cattle breeds and almost all the established breeds of water buffaloes of the world have their home-tract in India. Its share in sheep and goat breeds is approximately one-fifth and one third to that of the world breeds. In addition numerous other breeds and genotypes exist which have not been properly documented and hence, nothing can be recorded with confidence about their status. The rich biological heritage of farm animals and poultry is fast getting eroded and trends in the last few decades are alarming. There is a marked decline in the population of unique animals conforming to the true attributes of native breeds. Thus, the possibility of certain Indian breeds coming under the endangered category or getting extinct cannot be ruled out.

Livestock breeds with unique traits showing declining trends

Indigenous livestock breeds were developed for their utility under a certain set of agro-climatic conditions and many of such breeds developed some unique traits, which not only distinguish them from others but have a special economic role to play. Important breeds of livestock known for unique qualities and showing declining trends (Table 1) are as follows :

Cattle: Sahiwal, Red Sindhi, Tharparkar and Gir were prominent breeds for milk production. The main breeding tract of Sahiwal, Tharparkar and Red Sindhi has gone to Pakistan after partition but a considerable population of elite animals remained in India. Now, their population is dwindling over the years. These unique germplasm of fairly good milk yield and good fat percentage can be economical under any agro-ecosystem. The leftover population of these breeds needs to be conserved at all cost. Sahiwal and Red Sindhi breeds have been restricted mainly to a limited number of *Government farms/gaushalas/pinjrapoles.* Vechur is a miniature cattle highlands in Kerala. Punganur is a dwarf cattle breed. Hariana, Ongole are excellent dual-purpose animals. All those cattle breeds having one or the other unique traits are on list showing endangerment trends.

Buffaloes : Bhadawari buffalo is known for excessive high fat. Its population is very small and is on continuous decrease. Toda buffalo is a dual-purpose breed (meat and milk) and is found on Nilgiri Hills in Tamil Nadu. The morphological features of this breed are quie similar to those of swamp buffaloes, but they are pure riverine buffaloes. Kaziranga buffaloes are the wild Asiatic buffaloes. Their distribution has been limited to the Kaziranga Wildlife Sanctuary in Assam. Thus, all these unique breeds of buffaloes are showing decline at very fast rate. The buffalo populations of Orrissa has shown vast diversity and as many as seven breed/ populations have been reported. However, it has to be seen that how these populations are distinct amongst them as well as from other established breeds of buffaloes.

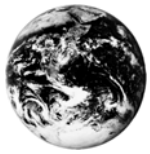


Table 1. Indigenus livestock and poultry breeds at risk of extinction

Species	Breeds	Population	Present status
Buffalo	Wild Asiatic	<2000	Decreasing
	Bhadawari	<20000	Decreasing
	Toda	<5000	Decreasing
Cattle	Sahiwal	<10000	Decreasing
	Red Sindh	<5000	Decreasing
	Punganur	<1000	Almost extinct
	Vechure	<500	Near extinction
	Ponwar	<15,000	Decreasing
	Krishna Valley	<15,000	Decreasing
Sheep	Breeds of J & K	Few hundreds of each Breed	Nearly extinct
	Nilgiri	<2000	Endangered
	Hissardale	<500	Rare
	Pugal	<10,000	Endangered
Camel	Bacterian	<100	Critical
Poultry	All indigenous poultry except Ascel and Kadaknath	Few thousands each	Nearly Extinct

Sheep : All breeds of sheep found in Jammu and Kashmir are nearly extinct. These were the oly indigenous germplasm producing fine wool. Population of other fine wool breeds like Hissardale. Nilgiri, Changthangi, is also dwindling, Muzaffarnagri is the tallest of Indian breed, showing sharp decline. The number of Pugal sheep, a good carpet wool breed, is not more than few hundreds. The Garole sheep of South 24 Pargana district of West Bengal is unique breed to survive in mangrove ecology as well as producing mutiple births.

Goats : Jamunapari is probably the most important breed of goat in Asia. It is under serious threawt of extinction. Beetal, a very good milch breed is found in limited number. Changthangi, a pashmina goat is also endangered.

Pack animals : Zanskari and Spiti breeds of horse, known for their working ability under hypoxic environment at high altitudes are declining very fast. Bactrian camel of India are about 72 in number and their distribution is restricted to Nubra valley in Ladakh region of Jammu and Kashmir.

Research policies should enable the development of knowledge that provides a basis for making the right decisions when choosing measures to be implementing for the conser-

vation of the various breeds. However, if the deve-loping of expertise in this field progresses too slowly, we may risk losing genetic resources with a potential future use. A well laid out action programme with time targets will have to be prepared so that we do not loose the precious germplasm with in available resources Presumably, we will not manage to conserve all breeds in the future, and we need to decide which breeds to give priortiy to. A major challenge has therefore been to clarify whether the endangered breeds are unique or genetically closely related to other breeds. This is done by genetic characterization using modern biotechnological tools.

The genetic characterization using microsatellite (simple short tandem repeat sequences) located in non coding regions of genomic DNA have been used and sufficient data has been generated on different livestock and poultry breeds at NBAGR and other laboratories in the country. This data should be used to know the following aspects :

- Genetic distinctness of breed/population in study
- Inbreeding level in the population
- Population bottleneck in the past
- Evolutionary pattern of the breeds or populations
- Genetic endangerment level

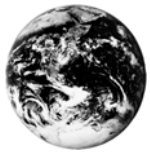
Strategies for genetic characterization and conservation

During last 20 years concerted efforts have been made to create awareness among all the developmental oganizations in the country about the usage of indigenous animal genetic resources by NBAGR. Various programmes have been identified for the evaluation of indigenous animal genetic resources including phenotypic and genetic characterization. Strategies for their conservation and sustainable management have been outlined. Some o them are given below.

- Identification and listing of all the available animal genetic resources.
- Breed description and characterization to understand their unique qualities and potential contributions.
- Prioritizing the breed for characterization and conservation based on their population structure, economic utility and genetic diversity.
- Establishment of breed sociaties for conservation of the breeds *in-situ.*
- Creation of database on indigenous animal genetic resources.
- Development of technology for collection and freezing of genetic material.
- Documentation and creation of mass awareness.

Conservation

Conservation is the management of human use of the biosphere, so that it may yield the greatest sustainable benefits to present generation, while maintaining its potential to meet the needs and aspiration of future generations. Thus, conservation is positive, embracing preservation, maintenance, sustainable utilization, management and enhancement of the natural resources of the environment. The gene resource of our farm animals consists of the genetic variation between and within the breeds of the various species. It has been estimated that the variation between breeds, accounts for approximately 50% of the total genetic varition within each species, while the variation within each breed accounts for the remaining 50% of the total variation. The extinction of breeds thus results in the reduction of genetic variation within a species. The best way to conserve the resources is with in their native environment themselves. The indigenous animal genetic resources especially those are less productive can only be maintained as long as their minimum feed/fodder requirement are met under zero or low input system.



In-situ conservation also include the ecosystem management and use for the sustainable production of food and agriculture. It would be very important to maintain the grasslands and other feed/ fodder resources, optimally under a production system. Traditionally, all the livestock were grazed on common grasslands, which were earmarked for the aminals of each village. It was the responsibility of village *Panchayat* to maitain these grazing lands through controlled grazing and re-seeding and plantation to sustain the livestock. Besides this, the traditional agricultural crops were providing enough crop residues and byproducts for supplementary feeding. Livestock breeders of the arid and semi-arid regions normally take their herds to other areas during lean period of availability of feed/fodder resources by adopting different measures.

Improvement of migration system

Majority of distinguished and established animal breeds, especially small ruminants are found in rain-fed and dry ecosystems. In main agricultural areas only draft or dual-purpose cattle breeds prevailed, and for milch main thrust ahs been on buffaloes. These animals for their economic values are stall-fed or maintained on supplementary feeding. Animals from drier regions go on long migration and certain communities are specialized in pastoral livestock, keeping of large herds of cattle or flocks of sheep. They move to the forests, riverside wastelands and harvested agricultural fields at the beginning of summer and do not return to their native place until monsoons. This way they reduce the grazing pressure on depleted vegetation and feeding resources under these vulnerable ecologies. This allows these lands to refurbish their grazing resources to sustain livestock till winters. In this way, the cycle of migration and return has been going on since thousands of years, and the grassland ecologies of this fragile ecosystem are maintained. This type of traditional nomadic livestock raising system is also predominant in hills.

This method of livestock husbandry has also helped in conservation of important livestock breeds. Otherwise, many of these breeds would have become extinct on stationary or stall-feeding system on economic grounds as compared to more productive ones. This fact is widely accepted now. Some efforts are now being made to intercept the migratory flocks for vaccination and other mass medication at certain checkpoints for the control of disease outbreaks. Now, more emphasis should be given to provide all veterinary aid and other inputs to improve the productivity of animals, besides socioeconomic benefits to those people who have been maintaining the valuable germplasm and the overall biodiversity.

Re-seeding of wastelands/grasslands and controlled grazing

All the commonn pasturelands, wastelands and forests are shrinking every year and more and more land is coming under agriculture farming. Whatever grasslands are remaining is having poor vegetation cover due to two main reasons : (i) uncontrolled grazing and (ii) failure of reseeding. Indigenous breeds, which were economical under traditional livestock raising system, are unable to thrive under changing economic scenario. Fewer breeds of high productivity, which can be maintained on stall-feeding, are replacing these livestock breeds. Therefore, to save the indigenous livestock breeds, which are having unique characteristics but are becoming relatively less economical, it is essential to conserve the grassland and pasture ecology, so that important genes present in our indigenous breeds because of millions of years of adaptability and natural selection are preserved *in-situ*. In common grasslands and pastures, practices of silvi-pasture and multi-tier vegetational needs to be popularized. This would help

improving the stocking density of livestock. High-yielding species of plants providing optimal lopping, needs to be planted in these lands, so that when grazing resources are depleted in lean season, the livestock can be supplemented with the tree lopping.

Controlled grazing in forests

It has been quite controversial whether the grazing of livestock should be allowed in forest or not.It is now well accepted that grazing of livestock in forests have never led to the degradation of forests, rather reverse has caused the extinction of breeds or species of livestock by destruction of forests. During my survey in Nagaland, it was noticed with concern that wherever, the forest cover is depleted, mithun and other cattle population has shown declining trends. Loss of vegetation because of animal grazing is well compensated by seed dispersal by the animals and providing nutrients through dung and urine. Therefore, controlled grazing should be allowed in forests to maintain the forest ecology, besides providing good and nutritive fodders to important livestock breeds for their survival.

In another survey of Bhadawari buffalo in Chambal ravines, the local farmers that the vegetation cover is disturbed not because of over-grazing buy the animals but because of reduction of population of small-sized grazing Bhadawari buffaloes and tall browsing Jamunapari goats highlighted it. Therefore, the livestock and grassland ecology are complimentary to cach other for the overall maitenance of sustainable ecological balance. By adopting these traditional and modern methods, the grassland ecosystems and animal diversity of indigenous breeds can be conserved *in situ*.

Improving economic efficiency of indigenous breeds

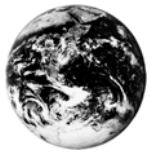
There is no reason to assume that imported breeds will be superior to indigenous breeds. To the contrary, in most cases, established locally adapted breeds should be superior to imported breeds, especially when production conditions and market forces are static. It has been seen time and again that the fertility and survivability of imported stock are poor as compared to local breeds and by the time these are improved in these traits under local environmental conditions, their production levels are no better than the indigenous ones. Therefore, emphasis should be on restriction of use of imported germplasm and on improving the performance of local breed through improved germplasm through selective breeding, improvement in feeding resources and adequate health coverage to improve their economic efficiency. The *In situ* conservation can be done on institutional herds and in farmers' herd.

Capacity-building imperatives

For implementation of effective national action plan for the conservation and sustainable management of animal genetic resources will largely depend on human resources and institutional capacities.

Strengthening of Institutional herds

In India, a large network of infrastructural facilities in terms of Research Institute ! University/Animal Breeding Farms, Central and State Animal Breeding Farms, AI centres and Bull Mother Farms exist. They have population of some important indigenous breeds. However, until recently their main emphasis was only on improvement of productivity by crossbreeding. There are some pure breeding herds also, however, the population size is too small to carry out effective selection for improvement. These institutional herds needs to be strengthened both in terms of superior germplasm as well as modern tools and techniques.



Stack-holder's involvement

Considerable success has been made in European countries in the conservation of some breeds, which are not economical otherwise, and their population trend is upward now. This has been possible through Breed Societies or the Rare Animal Trusts. In India farmers raise the livestock and no data recording system is followed in field, therefore, proper evaluation of indigenous animals for further improvement is not feasible at present. Although India was one of the signatories in 1936 for the Herd Registration Programme held in USA.

The MInistry of Agriculture, Government of India for the registration of outstanding animals of six breeds of cattle and two breeds of buffaloes in their respective home tract launched the Herd Registration Scheme but no headway could be made. It may be very important to form the Breed Societies in India for the conservation of rare and endangered breeds. Moreover, the improvement of indigenous livestock breeds through selection of outstanding animals true to their breed types from the larger population maintained in the breeding tract in collaboration with these Breed Societies can be taken up simultaneously. Very recently, the Chetak Horse Society has undertaken the conservation and improvement of Marwari horse in India whose population may be less than 1,000 at present.

Incentives to farmers

The objective is to compensate the farmer or who keeps the animals, for the difference in levels of production between the breed under consideration and the replacement breed under the same animal management system and agro-ecosystem. This will attract the farmers and will ensure the conservation of the breed *in-situ*. However, the incentives are subject to the political decisions and are unlikely to be sustainable for long term, but in the present situation, it may be useful in checking the erosion of important germplasm and in the meantime other options can be sought. Incentive payments can be made in different ways.

Ex-Situ Conservation

The representative population of the breed or germplasm can be maintained both in vivo as well as in vitro.

In-vivo method

Maintenance of small population at a place away from the main breeding tract of the breed is the *ex situ* conservation of the live animals. This may be in the form of organized herd maintained in research institution, bull mother farm, state owned livestock farm, zoo or breed park keeping of a small herd/flock. It is widely accepted that small populations suffer from the ill effects of higher level of inbreeding, which may result into the appearance of deleterious genetic defects. It is therefore, very important to maintain the breeding population in such a manner that the inbreeding rate is kept at minimal level and production performance can be improved over the years to make the breed self-sustaining. The effective population size of breeding females and male either through natural mating or through A1 can be maintained either under scientifically managed farms under organized sector or with the farmers in their native breeding tract or under breed safari/parks.

Livestock Breed Parks

It has been globally recognized that there may be a place for the animal resources for the on the pattern of the wild animals. This may help in preserving the environment, which include all species of plants, animals and other organisms. If managed appropriately, can be an ideal example of such system to conserve the precious germplasm of domestic breed of livestock. More over it should be self-sustaining unit. This approach is gaining popularity in developed countries with tourist industry. They give opportunity to urban people to get an impression of livestock. Keeping in view of increasing global urbanization, such type

of amusement parks having diverse population of distinct breeds may get increasing importance.

In vitro Method

It is now possible to store a wide variety of living cells for long period of time. Outstanding progress has been made with sperms of most domestic species and techniques are now in routine. Embryos of several mammalian species can be frozen and subsequently are used to produce a normal animal. The basic objectives of *in vitro* conservation are :

1. Cryopreservation of sperms and oocytes
2. Cryopreservation of embryos
3. Storage of DNA
4. Etablishment of embryonic stem cell-lines
5. *Conservation of somatic cells*

Recommendations

1. The livestock census should be on breed basis, so that the correct picture on pure breeding populations can be generated and effective breeding programmes can be framed.
2. Systematic surveys for all the breeds should be undertaken for preparing the comprehensive inventory with proper identification and cataloguing.
3. Each state should have a sound data bank with a network facility to hook-up with national data bank on AnGR at NBAGR.
4. Networking approach should be further strengthened for the genetic characterization and conservation of livestock genetic resources.
5. Relevant ecological and socio-economic issues should be identified which affect conservation and utilization of domsticated animals.
6. The live animal gene-banks (*in-situ* conservation) should be established in the native ecology of the breed.
7. Organization such as breed survival trusts, breeding societies, animal welfare bodies and similar other endeavours, involving public participation should be created for all endangered breeds and supported both technically and financially.
8. All facilities and infrastructure available for *ex-situ* conservation programmes should be co-coordinated on mission-mode basis for genetic security and revival of lost breeds.
9. Training and human-resource development programmes should be undertaken in a big way to support the livestock breed conservation programmes.
10. Publication of literature, monographs, maps and watch lists should be encouraged and rewarded.
11. Livestock conservation like other development programmes in livestock husbandry should become a major activity of extension services and awareness generation programmes.
12. Research and training programme should be strengthened on developing new techniques in biotechnology for the economical generation of biological material and its conservation for posterity.

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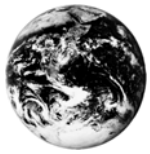

Bio-diversity in Goats and Its Conservation

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"Goats can be milked as often as required unlike cows and buffaloes and are, therefore, called moving refrigerator. The goatskins are highly valued and have large export potential both in the processed form and as products."

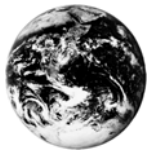
The goat was the first farm animal to be domesticated around 8000 BC in Ganj Darech presently known as Iran. The Harappa toys contain representations of a goat. Two seals from Mohanjo-daro show a wild Bezoar goat with enormous curled horns and a bearded domestic male goat with side-spreading horns. The goat has the widest ecological range of all the species of domesticated animals except dog, Originating in Asia, goats have spread over all the continents and inhabit almost all climatic zones from arctic circle to the equator. Goats have served the mankind earlier and longer than cattle and sheep. The goat is now present in society, religion, economy, nutrition, customs and daily habits of the people around the world. The domesticated goat is a hollow-horned ruminant belonging to the mammalian order Artiodactyla, sub-order Ruminantia, family Bovidae, genera *Capra* and species *hircus*.

Socio-economic Importance of Goat

The socio-economic importance of goats in India is evident by the sharp increase in their numbers and contributions during the last about 30 years. Goats contribute milk, meat, fibre, skins and manure to the subsistence of small holders and landless rural poor. They play an important role in income generation, capital storage, employment

generation and house hold nutrition. Importance of goats lies in the fact that human population is increasing very rapidly creating increasing demands for animal protein foods on the one hand and the feed resources for increasing large ruminants are decreasing due to shrinkage of grazing lands on the other. This demand can, therefore, be met with by increasing population of goats. It is easier to increase the population of goats than cattle and buffaloes because the capital investment is relatively low, land requirements per animal are small, reproductive rates are higher both due to shorter breeding interval and high prolificacy and they can be managed by spare family labour and do not require any serious housing facilities and management skills. There is much less risk in goat farming in drought prone areas where large mortality occurs due to frequent droughts. The goats act as an insurance against disaster under pastoral and agriculture subsistence system. Goats have religious and ritualistic importance in India. They are offered as sacrificial animals both by Muslims on Id and by Hindus especially the worshippers of Goddess Kali. They are worshipped for their creative and generative powers and sexual virility. There are no religious taboos against consumption of goat meat. Goat meat is preferred over sheep meat as it is leaner. Goat milk is easily digestible because of small sized fat globules. It has much less allergic problems than the milk of other livestock species. It also has medicinal value and can ward off many diseases as the goats browse on variety of plants including medicinal ones. Goats can be milked as often as required unlike cows and buffaloes and are, therefore, called moving refrigerator. The goatskins are highly valued and have large export potential both in the processed form and as products. The value addition in goat skin processing is much larger than other products. The bones of slaughtered and dead goats are also utilized for bone meal manufacture. A goat produces about 150 kg of dry manure per year for use in crop production and gardening. Goat browsing accelerates growth of trees, shrubs and surface vegetation. They also act as seeding machines. They are much less prone to the adverse effects of toxic plants. They have higher dry matter and fibre digestibility and can subsist on poor woody vegetation. Goats are able to obtain more nutrients from the given environment in all seasons than other livestock species and are often the last species to leave the ecology during severe and continuous drought conditions.

Goats make important economic contributions in India. The size and magnitude of the contributions have not been adequately assessed. However, a few reports available do justify their claim to equality if not superiority with other livestock. They are so vital to a very large human population that their contribution to national economy can not be over looked. Goats require relatively much lower investments and facilities in terms of housing, feed, labour and health care. There is quick pay off due to fast multiplication and early maturity. Further, the risk involved in goat farming is much lower when compared to other livestock and crop production. Goats are reported to be more economical than cattle and sheep under natural grazing/browsing on arid zone range. The indigenous goats were found 2.5 times more economical than indigenous sheep when maintained on a free range grazing on highly degraded land in semi arid ecology of Rajasthan. Significantly more meat and milk production per unit live weight per year from goats than buffalo, camel and sheep has been recorded. The cost of production of goat milk worked out to be less than half than for cow's milk while milk from buffaloes was intermediate. The results of a socio-economic survey in Rajasthan have revealed that the number of goats increased 3 times between 1951- 1983 and goats accounted



for 28-31% of the value of the livestock assets and for 16-19% of the gross receipts from crops and livestock. Studies have also revealed that the goats contributed up to 50-55% to the total cash income of a farm family in the hot arid region of the country. There are growing scientific evidences to suggest that goat keeping is more economical in drier regions which are not suitable for water spreading and dry land cropping. The estimated values of goat produces worked out to over Rs.10, 000 crores for the year 2004. It is thus evident that goats make very sizeable economic contributions to the economy of India. It is therefore, important that development programmes should focus on the efficient use of these renewable resources as well as explore ways and means of increasing the current level of production.

Goat Population and Production

World's current population of cattle, buffaloes, sheep and goats is around 1355, 174, 1080 and 807 million respectively. Asian region possesses about 33.61, 96.88, 42.29 and 64.33 % and India 13.65, 56.31, 5.79 and 14.87 % of the total world population of the four respective livestock species (FAO, 2005). Although the population of all the four livestock species has shown increasing trend since 1951 the buffalo and goat population has increased at a much faster rate than cattle and sheep in India. World's current goat population is around 807.25 million. Asian region has the highest and over 64.33 % of the world population of goats. India possesses 124.4 million making 23.11 % of Asia and 14.87 % of the world goat population. The developing countries of the world have about 94.5 % of the goats and the developed ones only the rest 5.5 %. The growth rate in India varied from 0.94 to 5.13 % with an average of 3.55 % during 1951-2004. The goats around the world contributed 12435.2 TMT of milk, 4534.1 TMT of meat and 985.3 TMT of fresh skins annually. The Asian region contributed 54.26 % of the milk, 74.09 % of the meat and 79.71 % of the fresh skins of the world production of goats. India produced 21.71 % of the milk, 10.48 % of the meat and 13.15 % of the fresh skins of the world and 41.05 % of the milk, 14.67 % of the meat and 16.70 % of the fresh skins of the Asian goat production. Around 89 % of the goats in the world are reared primarily for meat. In India about 41 % of the total population of goats is slaughtered for meat every year. The per capita annual availability of goat milk was 2.63 kg and meat was 462.5 g in India. Goats around the world contributed only 2.12 % of the total meat and 1.60 % of the total milk production from all species. The livestock sector in India contributes about 23 % of the GDP from agriculture and the goats contribute 7.60 % of the GDP from livestock sector. The total annual contribution of goats accounts to over Rs.95,770 million.

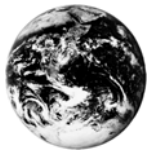
Goat and Ecology

Man, Animal and Nature are in symbiotic relationship for their survival and sustenance. The balance maintained among the three for several millennia has been disturbed by over exploitation of natural resources for meeting the demands of increasing population of men and animals. The gravity of the situation can be gauged from the fact that India, with about 2.30 % of land area of the world, is maintaining nearly 16.65 of the world's human population and about 10.71 % of the livestock. The livestock in general and the goats in particular have been held responsible by the foresters and environmentalists for causing ecological degradation and desertification in Asian continent. The goat is perhaps the earliest ruminant to be domesticated and of all the species of domesticated animals except dog, has the widest ecological range. Originating in Asia, the goats have spread over all the continents and inhabit almost all-climatic zones from arctic- circle to the equator. Goats have served the mankind earlier and longer than cattle and sheep. They are often termed as the poor man's cow and are linked with desert like paddy

with poverty in Asia. The distinct social, economical, managerial and biological advantages of goats over other livestock species and their contributions to the livelihood and economy of the small and marginal farmers and landless labourers in the form of protective foods, industrial raw materials and organic manure have now been realized.

The rapid growth of livestock prompted by rapid growth in demand has been perceived by many critics as a phenomenon that could have adverse impact on environment, human health, up ward pressure on cereal prices, etc. These critics have pointed out that increase in livestock food production primarily from increased livestock population rather than from higher carcass weight or milk out put per unit input, may lead to increased desertification due to over grazing. Also they contribute to greenhouse effect by producing methane as an end production of rumen digestion. However, if a holistic view is taken, it can be seen that expansion of shifting cultivation due to poverty and human population growth are the prime contributors to tropical deforestation in developing countries like India. Contribution of livestock to the greenhouse effect has been exaggerated as the ruminant livestock contribute only 2.5 % of the total greenhouse gases.

There has been a lot of controversy over the role of goats in ecological degradation and in desertification especially in India. Of the domesticated animals, no animal has suffered from so much abuse as the goat due to this rather wrong conception. Two conflicting views prevail on the goat's role in land use (i) The goat is the major cause of deforestation, rangeland destruction and soil erosion, and as such, its propagation should be checked, and (2) Goat acts as regenerator of vegetation through dispersal of seeds in its droppings and vegetative propagation through browsing. It is undoubtedly true that an uncontrolled population of goats roaming in open can be extremely harmful to the growth and development of vegetation especially where new reseeding/ plantation has been done. But it is just as true that any over grazing by any other ruminant will have similar consequence. The high pressure on and shrinking of the grazing lands, especially in view of their low carrying capacity results in their over use and depletion of natural vegetation. The man to land ratio in the arid and semi-arid zones is fast declining. The livestock population is increasing due to low farm incomes from marginalization of land holdings and increased dependence on livestock, leading to over exploitation of the shrinking grazing lands. In addition, indiscriminate felling of trees and deforestation, removal of shrubs, bushes and roots for fuel purposes, use of mechanical powers for cultivation and continuous neglect of the grazing lands are the real reasons causing damage to the ecology. Most of the deteriorated rangelands have been caused by over grazing by cattle and sheep. The scrub vegetation left behind could only be utilized by goats and goats may have stayed in such degraded ecologies when other species have already left. Sheep because of their bifid upper lip are able to graze closer to the ground than cattle and goats and in doing so in dry weather and on loose soils, frequently uproot the small grass species and thereby permanently damage the soil. The cattle with their large size hooves and heavier body weights cause more loosening of the soil rendering it susceptible to water and wind erosion. When the sheep move towards the water points or night shelters, they follow each other in a row because of the flocking instinct and generate tracks, which become free of vegetation and subject to erosion. These habits of sheep and not of the goats are distinctly destructive to the rangelands. It was observed that the human interferences viz. (a) over-and uneconomic exploitation of resources, (b) overgrazing by domestic animals and wild ungulates, (c) deforestation and indiscriminate lopping of trees and (d) uneconomic land use practices-cultivation on sand dunes and



marginal lands causing sands to shift and deposit on the adjoining fertile lands greatly contribute towards desertification. These cause soil erosion and expansion of deserts. Agriculture operations in general and on the arid and semi arid lands in particular cause more soil erosion than by the livestock grazing. Contrary to cattle and sheep, goats are mainly browsers and would seldom go for grown up trees. They dislike the leaves of timber trees. They also do not prevent the establishment and spread of grasses which are so essential for soil conservation. It was found that goats spend more than 90% time on browsing and hardly graze for 10% time on surface vegetation. Goats have been found to defoliate smallest branches of trees without damaging the twigs in several behavioural studies. Their browsing habit tends to reclaim saline soils by consuming salt-laden leaves of the range plants and contribute fertility to soil by even distribution of essential manure on the lands they graze. Cattle exploit 5-6 times more of phytomass than goats. It was reported that intensity of grazing of 2-4 goats/ ha had no effect on run off and soil loss in hot arid regions of Rajasthan in normal rainfall years. Stocking rate of 3 sheep or goats per hectare produced satisfactory performance especially of goats and no deterioration in the physical and chemical properties of the soil was observed for 3 years.

Goats also help in dispersal of grass, bush and tree seeds. They consume grass and bush seeds and fodder tree pods while grazing/browsing and defecate hard coat undigested seeds especially of pod-bearing and xerophytic trees after providing acid treatment while passing through digestive system and fortifying with nutrients in the form of faecal pallets and spread uniformly all over the grazing land. These seeds germinate in large number as soon as soil moisture conditions are favourable. Such grazing lands would require only protection from grazing for 3-4 years to develop into a high class three-tier silvi-pasture for livestock grazing. The goat saliva left on the bitten foliage adds nitrogen directly to the plant cells inducing quick regrowth. Saliva is also said to detoxify the high tannin available in many of the tree leaves found in the desert areas. The biting of tender leaves and twigs by goats also induce tillering and faster luxuriant regrowth of both branches and foliage. Vegetative regeneration was found to be 27 % more in goat paddocks comprising *Cenchrus ciliaris*, *Dichrostachys nutans* and *Lacaeuna leucocephala* as compared to sheep paddocks. The New South Wales Forestry Commission has been running goats on forests to control weeds. Large number of feral goats in Australia could form the basis for a new livestock industry in Australia's semi-arid scrub- lands. Goat keeping proved economical in the drier areas of Australia, which were not suitable for water spreading or dry land cropping. Goats also create fire brakes while grazing in the dense forests and thereby prevent fire accidents. Goats are less prone to toxic effects of noxious shrubs.

The differences of opinion towards goats have caused varied approaches in different countries. Countries like Switzerland, Portugal, Egypt and Israel do not favour large free ranging goat flocks. On the other hand France, Italy, Syria and Cyprus have no official bias against the goats. In some countries like Venezuela and Pakistan laws were passed to eliminate goats with little success and had to be subsequently withdrawn. In India, the National Commission on Agriculture recommended reduction in goat numbers from then existing 67 to 40 million. The population has since then doubled. A task force to evaluate the impact of goat rearing in ecologically fragile zones was constituted by the Govt. of India in 1987 under the Chairmanship of Professor K. Hanumantha Rao one of the leading economists and then a Member of Planning Commission with a large number of foresters

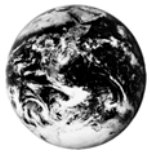
and environmentalists as Members. The task force observed that there was no definite evidence to prove that goats pose a threat to the ecology as is generally believed. In any case their negative effect, if any, on ecology has been vastly exaggerated. It further observed that within the desired grazing pressure, sheep and goats are more economical and less harmful than large ruminants.

It was thus, revealed that goats should not be categorized as animals responsible for the destruction of ecology. It is unwise to put the blame on goats for land degradation and desertification caused by activities of human and other livestock. What is needed, therefore, is to maintain a balance between the number of goats and other livestock species and the quantity and type of feed resources, which are available for the combined population. In a developed three-tier silvi-pasture system, the goats should be introduced first followed by cattle and then sheep. After the sheep are out of the grazing area, the land should by given rest for regeneration/ reseeding. This way the goat will go for bush, shrub and low set tree branches, cattle would utilize taller grasses and the sheep shorter and closer to surface vegetation resulting is most efficient and judicious utilization of the available feed resources.

Goat Genetic Resources

Approximately 300 breeds of goats have been suggested to be existing world over by Devendra (1975). Majority of these are primarily meat breeds and found in the tropics with only a few identifiable tropical dairy breeds. Goat breeds belong to dairy, meat, fibre and pelt types or their various combinations and meat being an important component in economics of production of most of the goat breeds except highly specialized dairy goat breeds. In addition to the important descript breeds, there are a large number of descript but less important breeds and non-descript populations. India is endowed with large and biologically diverse population of goats. They are widely distributed through out the country. Mason has made major efforts for inventorization of the described breeds of goats since 1951. CAB International has published the Mason's *World Dictionary of livestock breeds, types and varieties.* Attempts made in India under the auspices of FAO include "Breeds of Sheep and Goats in India". There is serious need to describe and evaluate the existing genetic resources in terms of their population, population trends, flock size and structure, ecology, feed resources, management practices, body size and weight, confirmation and production characteristics using modern biological and statistical methods for accurate description and determining genetic differences. The availability of cytological, biochemical and molecular methods for determining gene marker characters will help in discriminating among breeds. An Expert Panel on Animal Genetic Resource Conservation constituted by FAO has prepared descriptors for various livestock species so that uniform system of description of available genetic resources in different countries is utilized for comparison among different breeds within and across different countries. Some breeds have been identified as improver breeds and have been utilized within the country or in the region. For example Angora goat originated from Turkey has been utilized for mohair production all over the world. Similarly Indian breeds of goats like Jamunapari, Barbari and Beetal have been utilized as improver breeds for milk and meat within India and in a number of South East Asian countries. Specialized dairy breeds such as Saanen, Alpine, Toggenburg and Anglo-Nubian have been used all over the world for improving milk production. Chinese LioNing breed has been used for improving Cashmere production in the cashmere producing breeds in China and appears to be a choice as improver breed elsewhere.

Most of the goat breeds in India are found very well adapted to harsh climate, long migration, tropical diseases, poor nutrition



and shortage of drinking water. Goat breeds in India have been classified according to (i) the agro-climatic zones, (ii) their body size and (iii) their production functions as shown in Table 1-3.

Breed Habitat and Population Size

The breed habitat and population size of various breeds of goats are given in Table-6. There is no clear demarcation on the habitat of the breeds as most of the breeds have spread to contiguous areas by various means, which encompass migration, market dictation and economic compulsion, besides natural existence beyond the political boundaries. Thus, the breed boundaries are obliterated. Similarly, the population size does not reflect the true picture as there is existence of non - descript animals in very large numbers in the habitat of most of the breeds due to genetic admixture. It is observed that there is regular migration of the goats of the western Rajasthan to the adjoining States during the period of feed, fodder and water scarcity. In the process, they mix with the local goats resulting in indiscriminate crossing and loss of identity of the recognized breeds. There is no Breed Registration Society in India so far to ensure breed purity in goats and to provide identity to the enlisted animals.

Table 1. Classification of Goat Breeds according to Agro-Climatic Zones

Zone	States	Breeds	
1. Temperate-Himalayan Region	Jammu and Kashmir, Himachal Pradesh and Uttranchal	1. Gaddi 3. Chegu	2. Changthangi
2. North – Western Region	Delhi, Punjab, Haryana, Uttar Pradesh, Rajasthan, Gujrat, Madhya Pradesh and Chhattishgarh	1. Beetal 3. Barbari 5. Marwari 7. Kutchi 9. Gohilwadi 11. Mehsana	2. Jamunapari 4. Sirohi 6. Jhakrana 8. Surti, 10. Zalawadi,
3. Southern Peninsular region	Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu	1. Sangamneri 3. Kannai Adu	2. Osmanabadi 4. Malabari
4. Eastern Region	Bihar, Jharkhand, Orissa, West Bengal, Meghalaya, Assam, Mizoram, Manipur, Nagaland, Sikkim and Tripura	1. Ganjam	2. Bengal

Table 2. Classification of Goat Breeds according to their Body Size

Large Size	Medium Size		Small Size
1. Beetal	1. Barbari	2. Chegu	1. Black Bengal
2. Jamunapari	3. Changthangi	4. Gaddi	
3. Jhakrana	5. Ganjam	6. Gohilwadi	
	7. Kannai Adu	8. Kutchi	
	9. Malabari	10. Marwari	
	11. Mehsana	12. Osmanabadi	
	13. Sangamneri,	14. Sirohi	
	15. Surti	16. Zalawadi	

Table 3. Classification of Goat Breeds according to their Production Functions

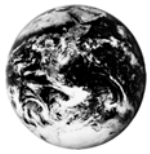
Milk	Meat	Fibre	
1. Beetal	1. Barbari	2. Black Bengal	1. Changthangi
2. Jamunapari	3. Gaddi	4. Ganjam	2. Chegu
3. Jhakrana	5. Gohilwadi	6. Kannai Adu	
4. Surti	7. Kutchi,	8. Malabari	
	9. Marwari	10. Mehsana	
	11. Osmanabadi	12. Sangamneri	
	13. Sirohi	14. Zalawadi	

Threatened Breeds and Their Conservation

The International Union for Conservation of Nature (IUCN) has classified the animals into seven categories on the basis of their viability viz. a. Extinct, b. Endangered, c. Vulnerable, d. Rare, e. Intermediate, f. Insufficiently known and g. Out of danger. The goat breeds available in India are generally placed under Endangered and Vulnerable categories, although some wild predecessors once existing in the mountainous regions have already become extinct. A breed is considered endangered when its effective number is too small to prevent genetic loss of the population. As per FAO, a breed with a population below 5000 breeding females may be declared as Endangered. Some of the recognized goat breeds in India are threatened due to lack of breeding policy, non- availability of breeding males and indiscriminate cross breeding and intermixing with local populations. The other problems are spread of home tract of a goat breed in two or more districts/states, non availability of breed wise figures in the Indian Livestock Census Reports, migration of flocks, higher slaughter rate of fast growing goats and the increase of ratio of non- descript to descript animals in different parts of home tracts of recognized breeds. However, the need for conservation depends upon several factors e.g. (i) the actual number of animals (ii) the rate of decline in the population size, (iii) the closeness of relationship between individuals within the population (iv) the sex ratio (v) the geographical range and the rate of reduction of that range (vi) special threats from introduced species, (vii) rapid changes in the environmental conditions including climate, (viii) predators (ix) parasites etc. A breed is vulnerable, when the population is rapidly declining numerically or its security is under threat. The purebred

Table 4. Habitat and Projected Population size of different Goat Breeds in India

Breed	Habitat	Population (Lakhs)
Milk Breeds		
Barbari	Agra, Mathura, Eath and Aligarh districts in U.P.	5.10
Beetal	Gurdaspur, Amritsar and Firozpur districts in Punjab	1.19
Gohilwadi	Bhavnagar, Amreli and Junagarh districts in Punjab	5.19
Jakhrana	Jakhrana villages in Alwar district of Rajasthan	0.02
Jamunapari	Chakarnagar Block in Etawah district of U.P.	0.08
Kutchi	Kutch district of Gujrat	4.69
Malabari	Calicut, Cannanore and Malapuram district in Kerala	5.24
Marwari	Western Rajasthan	74.29
Mehsana	Mehsana and Banaskantha districts in Gujrat	6.26
Sirohi	Sirohi and Ajmer districts in Rajasthan	7.20
Surti	Surat and Vadodara districts in Gujrat	3.80
Zalawadi	Surendranagar and Rajkot districts in Gujrat	4.10
Meat Breeds		
Bakharwal	Hill Regions in Kashmir	—
Black Bengal	West Bengal, Jharkhand, Orissa, Bihar and Assam	629.64
Gaddi	Chamba, Kangra, Kulu, Bilaspur, Kinnaaur and Lahul Spiti districts in Himachal Pradesh	5.33
Ganjam	Ganjam district in Orissa	3.70
Kannai Adu	Ramanthpuram and Tirunelveli districts in T. N.	9.74
Khasi	Khasi, Jayantia and Gargo hills in Meghalaya	2.02
Osmanabadi	Osmanabad district in Maharashtra	4.52
Sangamneri	Ahmednagar district in Maharashtra	9.08
ashmina Breeds		
Changthangi	Ladakh districts in Jammu & Kashmir	3.02
Chegu	Uttrakashi, Chamoli and Pitoragarh district in Uttaranchal	4.84



Jamunapari population has declined seriously and it is less than 8,500 in its habitat due to different reasons. **Beetal** is drawing attention for conservation as the number is declining due to changing agricultural patterns in Punjab. **Barbari** is facing dilution in breed characteristics due to cross breeding with Sirohi and Jamunpari breeds in its home tract. Due to decrease in natural browse and geographical restriction, **Surti** of Gujarat and **Jakhrana** of Rajasthan are decreasing in number. The **Changthangi** breed of the Ladakh region is the subject for special concern as it is declining both in number and performance. More weightage on improvement of some breeds and extensive use of breeds such as Beetal, Barbari and Jamunapari may result in elimination of other distinct breeds due to cross breeding. Means for conservation, multiplication and improvement of these breeds using Open Nucleus Breeding Scheme (ONBS) have been suggested.

Uncontrolled breeding in the periphery of the home tracts of some well known breeds has resulted in percolation of diversity of colour, body size, horn and ear size and shape I goats. This also indicates the presence of diverse genetic components with unknown interactions. The need for conservation of distinct and well-adapted breeds has now been realized. It is apparent from the current population size, loss of habitat and introduction of other breeds in the area that Jamunapari, Beetal, Jakhrana and Surti in North Western Region, Sangamnei, Osmanabadi and Malabari in Southern Region, Khasi and Ganjam in Eastern Region and Chegu and Changthangi breeds of goats in the Temperate Himalayan Region are threatened. The position of several other breeds is also not very comfortable due to acute shortage of elite breeding males except Marwari and Black Bengal which presently seem to be in safe position with respect to population and size of their breeding tracts. The conservation of goat genetic resources is essential and is of paramount importance owing to their widespread destruction, over exploitation and degradation all over India. The overall aim should be sustainable utilization, restoration and enhancement of goat resources so as to meet the needs of mankind. There has been awareness for conservation of natural resources since long. However, the goat gained attention only recently when it was realized that the production oriented propagation of goat through crossbreeding and upgrading did not work.

Generally two approaches viz. **ex situ** and **in situ** methods of conservation may be adopted for conservation of the goat breeds in India. Since the generation and loss of alleles is a dynamic process, it should be maintained at close equilibrium through sound management system. The maintenance of animals in natural habitat or in their adaptive environments as close as possible is called in situ conservation. Under ex situ conservation the sperms and embryos of goats like other farm animal species can be frozen and subsequently used to produce normal off-springs. Embryos are considered to be the best material for ex situ conservation because they store all genetic material in a single entity which can give rise to new off-springs. Cryogenic storage of DNA is another method for preservation of genetic material. It has several advantages over live cells viz. avoiding the spread of diseases, requirement of less space and more economical. DNA can also be conserved in the form of transgenic animals. The other important aspects of conservation of goat genetic resources may involve establishment of National Goat Data Bank, National Gene Bank, National Goat conservation Board, Regional Goat Gene- cum -Data Bank and Global Data Bank etc.

Conservation Efforts

In situ conservation efforts have been tried at the Central Institute for Research Institute, Makhdoom, Mathura and the Centres of All India Coordinated Research Project on Goat

Improvement in a number of goat breeds with variable success. The list of goat breeds involved in this programme is given in Table 5.

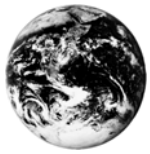
Table 5. Centres of AICRP on Goat Improvement

S. No.	Breed	Location	State	Purpose	Unit
1.	Barbari	CIRG, Makhdoom	Uttar Pradesh	Milk & Meat	Farm
2.	Jamunapari	-do-	-do-	-do-	Farm
3.	Jamunapari	-do-	-do-	-do-	Field
4.	Sirohi	CSWRI, Avikanagar	Rajasthan		Farm
5.	Sirohi	MPUAT, Udaipur	Rajasthan	Meat & Milk	Field
6.	Marwari	RAU, Bikaner	Rajasthan	Meat	Field
7.	Black Bengal	WBUV&FS Calcutta	West Bengal	Meat	Field
8.	Ganjam	OUA&T Bhubaneshwar	Orissa	Meat	Field
9.	Sangamneri	MPKV, Rahuri	Maharashtra	Meat	Field
10.	Surti	NAU, Navsari	Gujarat	Milk & Meat	Field
11.	Malabari	KAU, Trichur	Kerala	Meat & Milk	Field

BREEDING OF GOATS

Goats are reared for three distinguished production objectives, viz., milk, meat and fibre. In fact, all goats are utilized for meat irrespective of their utility for other purposes like milk and fibre. Milk surplus to the requirement of kids from dairy animals is utilized for human consumption whereas meat animals are either not milked or milked partially. It does not mean that the selection programme for meat improvement does not require attention towards milk production in meat animals. In fact meat animals should also have good milking ability to sustain the young ones in their early stage of growth. The greasy fleece yield, staple length, medullation and fibre diameter are the important traits that need attention while selecting animals for fibre production. Knowledge about genetic potential of different breeds and the genetic parameters namely genetic correlation, heritability etc. of various traits is always necessary. For efficient use of selection a moderate number of traits should be considered at a time.

The major selection objectives for dairy animals are quantity and quality of milk. These traits have relationship with some of the morphological traits. The breed of the animal, body conformation, udder and teat development are such traits which can be considered for their use in selection for milk improvement. Correlation between milk yield and body weight at kidding is found to range from 0.23 to 0.33 and with body weight at 5 weeks after kidding from 0.19 to 0.29. Body length and heart girth are found to affect the lactation yield in goats. The progeny of the male born of a high yielding dam should be considered for future breeding. Some traits are negatively correlated. The correlations are negative between milk, meat and fibre production as there is competition for available nutrients. Meat animals must show good maternal ability. The important traits to be considered for selecting goats for meat include high prolificacy, higher pre-weaning survivability and low inter parturition period. Prolificacy and pre-weaning survivability rate have low heritability of less than 0.10. However, family selection could be successfully used because of higher variability of these traits. Other traits which are of significance from the meat production point of view are growth rate, feed conversion



efficiency, carcass yield and quality. Selection for meat production can be based on body weight at 3 or 6 months age which have high heritability.

Breeding Strategy: The breeding strategy involves decision on objective and approach in bringing genetic improvement. This also depends on socio-economic and ecological consideration, existing genetic resources, their productivity, possibility of their improvement through selection within a breed, grading with indigenous improver breeds, or replacing an indigenous breed within exotic breed if it is arising from similar ecological region and thus will be adaptable, or cross-breeding for evolving new breed combining the adaptation and hardiness of local breed and higher productivity of the exotic breed.

Breeding Objectives: Major breeding objectives may be for milk, meat and fibre (Cashmere and Mohair) or their combinations. For milk production, major consideration will be given to lactation yield, lactation length and milk composition. In meat production, live-weight gain, efficiency of feed conversion, carcass yield and quality, reproductive performance, survival and milk yield of the dam are important characters. In fibre production the greasy fleece weight, scoured fleece yield, fibre diameter and fibre length are important characters.

Breeding Approach: Breeding approach may involve (i) selection within local breeds, (ii) grading a local breed with superior indigenous breed (iii) crossbreeding with exotic breed for evolving new breeds combining adaptation and hardiness of the indigenous and higher productivity of the exotic and (iv) replacement of an indigenous breed with higher productivity exotic breed. The breeding approach will have to be decided on the basis of the performance of local breed, the size of the genetic variability in the characters of interest, physical environment and feed resources available to sustain higher production. Decision will also depend upon the demand for the products in markets close to the centre of production and distant markets, and handling, processing and marketing infrastructure available. There is likelihood that increased production or improvement in quality without assessing market demand and developing handling and marketing system may lead to serious economic privation to the producers.

Selection Criteria: A wide range of diversity exists in the genetic material of goats and sheep available in the country. Under this situation selection is the best tool to bring about improvement in the productivity of our goats and sheep. Selection criteria will depend upon the phenotypic and genetic variances in and co-variances among important characters, their relative economic values and sources of information. The age at first kidding/ lambing and kidding/ lambing interval have moderate to high heritability and litter size and pre-weaning survival have low heritability. Body weight, growth rate, carcass yield and quality have reasonably high heritability. Milk yield and milk composition have medium heritability. Most of these characters except reproduction and survival have large phenotypic variability allowing superior animals to be identified easily both through subjective and objective assessment. Attempts have been made to develop selection criteria for improving production for various economic traits. For improving milk production in goats, selection based on age at first kidding and the first lactation milk yield combined into an index will provide maximum gains in reproduction and milk production. For improving meat production, selection on 6-month body weight may be most feasible and bring reasonable genetic progress in meat production through improving reproduction, body weight gain and carcass yield. The process of improvement by selection is more difficult in sheep than in goats. There are more traits influencing productivity and all traits are not measurable at the same time. Several of the important traits are negatively correlated. Selection of sheep for

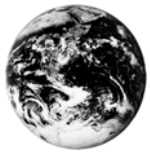
fleece traits is difficult. The fleece weight is an important trait and clean fleece weight is a better measurement than greasy fleece weight, but it is difficult to obtain.

***Performance Recording*:** Institution of selection would require identification of animals and recording of their performance. On station recording is more convenient, but the population size is generally small to provide sufficient intensity of selection and even accuracy of selection. Further it does not allow production of required number of superior males. The subjective assessment made by the farmers themselves may result in some improvement. Objective assessment both in terms of quantity and quality would be more desirable. In addition to the production, reproduction and survival are also important traits and will need recording. On-farm recording of dairy goats is being practiced in Europe and America where large commercial dairy herds are maintained under intensive management. Once a month AM-PM milk recording is sufficient to determine lactation yield. Milk recording may also be done by separating the kids on the day of recording. In case of meat production, recording of body weight at weaning and 6 months of age may be sufficient. Where there are possibilities of studying individual feed lot performance, the fortnightly body weight gain along with fortnightly feed consumption, efficiency of feed conversion, carcass yield and quality could also be recorded and involved in selection of males. For improving prolificacy in meat breeds selection of males from larger litters and on their body weight at 6-months can help in improving mothering ability and reproductive performance in addition to body weight gains.

***Selection In Farmer Flocks*:** Through recording of performance of a large number of farmers' flocks preferably through objective assessment, flocks which are superior than average can be identified and used as flocks for producing genetically superior breeding males which could subsequently be distributed to the flocks which are inferior to the average of the population. This will require identification of superior males and females based on the characters of importance and mating them to produce male progeny, getting them reared in the farmers' flocks and/or in rearing centres and making them available to the flocks to be improved on male to male replacement basis.

***Selection In Institutional Flocks*:** Institutional flocks may be established through selection of superior males and females from farmers' flocks. This is the usual system of genetic improvement in majority of developing countries where the government has responsibility for providing superior breeding males to the flock owners. Such flocks are properly recorded and performance data are utilized in selecting the breeding males and females. The best males are retained in the institutional flock for breeding with elite females for producing young males and the rest are made available to the flock owners. In majority of cases the flock size is small allowing a few males to be used for breeding and thus the performance, may not be better than in the private flocks and males produced on such farms are not thus acceptable to the farmers. The number of males available are also rather small than those required. In case of selection for milk, the number of daughters per sire is usually small and considering the reproductive performance, the age by which the progeny performance becomes available, the male is too old to breed. The selection in such small institutional flocks is essentially based on the dam's performance or at best sister's performance. A large number of superior males can be produced by identifying superior males and females from farmers' flocks and utilizing the technique of Multiple Ovulation Embryo Transfer (MOET). This can be done either in the farmers' flocks or in institutional farms.

Selection In Open Nucleus Flocks: It may be desirable to organize farmers into co-operative group breeding



schemes. Open nucleus flocks can be established through selection of better performing animals on the basis of objective assessment from the farmers' flock and utilized for producing breeding males through intensive selection and their distribution to the co-operating and other farmers. Keeping nucleus flock open would help in reducing in breeding and increasing selection intensity through continuous introduction of superior animals from the farmers' flocks. After distribution of the males to the co-operating flocks, rest could be distributed to the other flocks to be improved. Subsequently, flocks of co-operating farmers could also be utilized in breeding males using the selected males from the nucleus viz. multiplier flocks. The use of MOET can help in improving genetic gains through selection especially in case of dairy goats where selection of males can be based on the performance of collateral relatives (full and half sisters) rather than the progeny. Such a selection scheme will bring faster genetic progress specially through reducing the generation interval, although the accuracy of selection is slightly lower than based on progeny performance. These selected breeding males could be more extensively utilized through artificial insemination with frozen semen.

Grading With Superior Indigenous Breeds: The main objective of any genetic evaluation programme is to identify available genetic material and then to use the information to improve the genetic value of future generations. Grading up is the easiest breeding approach involving use of males of superior genetic value generation by generation to improve the animals of low genetic value. Through this approach a genetically poor population can be replaced with a genetically superior material in about 7 generations. This will require similar approach as described earlier for producing superior males and their distribution to the flocks to be improved. This could be done with the Farmers' flocks or in Institutional farms. There are a number of superior breeds of goats for example Jamunapari, Beetal, and Barbari which have been utilized with success for improving body size, milk yield and prolificacy in medium and small size breeds.

Importance of Biodiversity Conservation

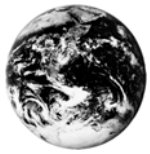
S.K.Upadhyaya*, I.F.S

"India contains a great wealth of biological diversity in its forests, its wetlands and in its marine areas. This richness is shown in absolute numbers of species and the proportion they represent of the world total. "

Introduction

E.O.Wilson once said about ants "we need them to survive, but they don't need us at all." The same, in fact, could be said about countless other insects, bacteria, fungi, plankton, plants, and other organisms. This central truth, however, is largely lost to most of us. Rather, we act as if we were totally independent of Nature, as if it were an infinite source of products and services for our use alone, and an infinite sink for our wastes. During the past 50 years, for example, we have squandered one fourth of the world's topsoil, one fifth of its agricultural land, and one third of its forests, while at the same time needing these resources more than ever, having increased our population from 2.5 billion to over 6.1 billion. We have dumped many millions of tons of toxic chemicals onto soils and into fresh water, the oceans, and the air, while knowing very little about the effects these chemicals have on other species, or, in fact, on ourselves. We have changed the composition of the atmosphere, thinning the ozone layer that filters out harmful ultraviolet radiation, toxic to all living things on land and in surface waters, and increasing the concentration of atmospheric carbon dioxide to levels not present on Earth for more than 420,000 years. These carbon dioxide emissions, caused mainly by our burning fossil fuels, are unleashing a warming of the Earth's surface and a change in the climate that will increasingly threaten our health, and the survival of other species worldwide. And we are now consuming or wasting almost half of all the planet's net photosynthetic production on land and more than half of its available freshwater. Most disturbing of all, we are

* C.C.F., Bareily



so damaging the habitats in which other species live that we are driving them to extinction, the only truly irreversible consequence of our environmental assaults, at a rate that is hundreds or perhaps even thousands of times greater than natural background rates. As a result, some biologists are calculating, on the basis of habitat destruction alone, that as many as two thirds of all species on

Earth could be lost by the end of this century, a proportion of lost species that matches the great extinction event, 65 million years ago, that wiped out the dinosaurs. That event was most likely the result of a giant asteroid striking the Earth; this one we alone are causing. We have done all these things, our species, Homo sapiens, one species out of perhaps ten million or more, and a very young species at that, having evolved only about 130,000 years ago, behaving as if these alterations were happening someplace other than where we live, as if they had no effect on us whatsoever. This mindless degradation of the planet is driven by many factors, not the least of which is our inability to take seriously the implications of our rapidly growing populations and of our unsustainable consumption, largely by people in industrialized countries, of its resources. Ultimately, our behavior is the result of a fundamental failure to recognize that human beings are an inseparable part of Nature and that we cannot damage it severely without severely damaging ourselves. This report was first conceived ten years ago at the Earth Summit in Rio de Janeiro when the great promise of that event and its ambitious goals for controlling global climate change and conserving the world's biodiversity were first elaborated. What was recognized then, and what is even more widely appreciated now, was that, in contrast to the issue of climate change, there was inadequate attention being paid to the potential consequences for human health resulting from species loss and the disruption of ecosystems. This general neglect of the relationship between biodiversity and human health, it was believed, was a very serious problem. Not only were the full human dimensions of biodiversity loss failing to inform policy decisions, but the general public, lacking an understanding of the health risks involved, was not grasping the magnitude of the biodiversity crisis, and not developing a sense of urgency to address it. Unfortunately, aesthetic, ethical, religious, even economic, arguments had not been enough to convince them.

What Is Biodiversity?

Biodiversity is the variety of life—its ecosystems, species, populations, and genes. Human actions towards the land, freshwater, and oceans have already caused biodiversity to decline. Even greater losses will occur in the future if humanity continues its present unsustainable use of natural resources. In documenting this decline, there has been a focus on species extinctions, the most obvious manifestation of biodiversity loss. In addition, there is the loss of ecosystems, populations, and genes. All these are the only truly irreversible consequences of environmental change. When any of these is lost, it is gone forever. Species losses are also the aspect of biodiversity loss that is most often considered, for example, by the U.N. Convention on Biological Diversity. This chapter, too, will focus on species extinctions. The subject is broader and more complex than this. However. Even a species that survives can lose much of its genetic diversity if local populations are lost from most of its original range. Furthermore, ecosystems may shrink in area dramatically and lose many of their functions, even though their constituent species manage to survive. The loss of ecosystems, species, populations, and genes all have implications on human health.

Biodiversity in India

India is the seventh largest country in the world and Asia's second largest nation with an area of 3,287,263 square km. The Indian mainland stretches from 8 4' to 37 6' N latitude and from 68 7' to 97 25' E longitude. It has a land frontier of some 15,200 kms and a coastline of 7,516 km (Government of India, 1985). India's northern frontiers are with Xizang (Tibet) in the Peoples Republic of China, Nepal

and Bhutan. In the north-west, India borders on Pakistan; in the north-east, China and Burma; and in the east, Burma. The southern peninsula extends into the tropical waters of the Indian Ocean with the Bay of Bengal lying to the south-east and the Arabian Sea to the south-west. For administrative purposes India is divided into 24 states and 7 union territories. The country is home to around 846 million people, about 16% of the World's population.

Physically the massive country is divided into four relatively well defined regions - the Himalayan mountains, the Gangetic river plains, the southern (Deccan) plateau, and the islands of Lakshadweep, Andaman and Nicobar. The Himalayas in the far north include some of the highest peaks in the world. The highest mountain in the Indian Himalayas is Kanchenjunga (8586 m) which is located in Sikkim on the border with Nepal. To the south of the main Himalayan massif lie the Lesser Himalaya, rising to 3,600- 4,600 m, and represented by the Pir Panjal in Kashmir and Dhaula dhar in Himachal Pradesh. Further south, flanking the Indo-Gangetic Plain, are the Siwaliks which rise to 900-1,500 m.

The northern plains of India stretch from Assam in the east to the Punjab in the west (a distance of 2,400 km), extending south to terminate in the saline swamplands of the Rann of Kachchh (Kutch), in the state of Gujarat. Some of the largest rivers in India including the Ganga (Ganges), Ghaghara, Brahmaputra, and the Yamuna flow across this region. The delta area of these rivers is located at the head of the Bay of Bengal, partly in the Indian state of west Bengal but mostly in Bangladesh. The plains are remarkably homogenous topographically: for hundreds of kilometres the only perceptible relief is formed by floodplain bluffs, minor natural levees and hollows known as 'spill patterns', and the belts of ravines formed by gully erosion along some of the larger rivers. In this zone, variation in relief does not exceed 300 m (FAO/ UNEP, 1981) but the uniform flatness conceals a great deal of pedological variety. The agriculturally productive alluvial silts and clays of the Ganga-Brahmaputra delta in north-eastern India, for example, contrast strongly with the comparatively sterile sands of the Thar Desert which is located at the western extremity of the Indian part of the plains in the state of Rajasthan.

Species Diversity in India

India has a rich and varied heritage of biodiversity covering ten biogeographical zones, the trans-Himalayan, the Himalayan, the Indian desert, the semi-arid zone(s), the Western Ghats, the Deccan Peninsula, the Gangetic Plain, North- East India, and the islands and coasts (Rodgers; Panwar and Mathur, 2000). Biodiversity, which is defined as the variety and variability among living organisms and the ecological complexes in which they occur, is measured at three levels — the gene, the species, and the ecosystem. India is rich at all levels of biodiversity and is one of the 12 mega diversity countries in the world.

India contains a great wealth of biological diversity in its forests, its wetlands and in its marine areas. This richness is shown in absolute numbers of species and the proportion they represent of the world total (see Table 1).

Biodiversity management in India – issues, threats and concerns

Despite the many measures taken for the protection, conservation and sustainable use of biodiversity, many species and ecosystems are seriously threatened. The 2000 IUCN Red List of Threatened Species (IUCN, 2000) is provided in table 2.

Switzerland

Fragmentation and loss of habitats, conversion to agriculture, increased biotic pressure, developmental projects, erosion of traditional conservation and wise use practices, the introduction of exotics, pollution and unwise land use practices are some of the major factors adversely affecting the biodiversity of the country. These pressures and

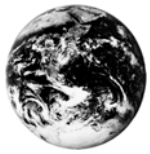


Table 1. Comparison between the Number of Species in India and the World

Group	Number of species in India (SI)	Number of species in the world (SW)	SI/SW (%)
Mammals	350(1)	4,629(7)	7.6
Birds	1224(2)	9,702(8)	12.6
Reptiles	408(3)	6,550(9)	6.2
Amphibians	197(4)	4,522(10)	4.4
Fishes	2546(5)	21,730(11)	11.7
Flowering Plants	15,000(6)	250,000(12)	6.0

Source: Botanical Survey of India (1983). Flora and Vegetation of India - An Outline. Botanical Survey of India, Howrah. 24 pp.

Table.2 Threatened species of India

Taxonomic group	Number of threatened species
Mammals	86
Birds	70
Reptiles	25
Amphibians	3
Fish	3
Molluscs	2
Other Invertebrates	21
Plants	244
Total	**459**

Source. IUCN (2000). Red list of threatened animals. IUCN. Gland,

problems are compounded by the lack of complete and detailed databanks and species inventories. Also the inadequate emphasis given to biodiversity conservation is responsible for the loss, for example: biodiversity is largely considered the preserve of wildlife wing of the forest department, although a significant portion of biodiversity lies outside the protected areas in territorial forests.

Biodiversity and Climate Change: The New Great Threat

The Secretariat of the Convention on Biological Diversity has announced that the focus of the 2007 International Day for Biological Diversity (IBD), 22 May, will be on **'Biodiversity and Climate Change'.** Since the mid-800s global temperatures have increased by about 0.6°C, impacting the entire world, from low-lying islands in the tropics to the vast Polar Regions. During the last Century the largest glacier on Mount Kenya has lost 92% of its mass, while sea levels have risen by 10 - 25 cm, and the thickness of sea ice in the arctic has decreased by 40%. Current climate change predictions are not encouraging; they estimate further increases in temperatures of 1.4°C to 5.8°C by 2100.

Predicted impacts from a temperature increase of only 2.5°C include:

- 210 million more people at risk from malaria,
- up to 3.1 billion more people suffering from water scarcity, and
- 50 million more people facing hunger.

Even if all human sources of greenhouse gas emissions are stopped immediately, the impacts of climate change would continue for 50 years.

Global climate change

The global climate has warmed

over the last century by about 0.6 degrees C., and animals and plants have responded in many ways as a consequence. Plants leaf out or flower earlier, migratory birds arrive earlier in the spring, and species ranges move towards the poles or to higher altitudes. Some ecosystems such as alpine meadows, cloud forests, arctic tundra, and coral reefs are especially sensitive to warming, and species in these regions may be particularly at risk.

While many species have demonstrated changes in the timing of life stages and in their ranges that could affect survival, it is not certain whether global climate change has caused any extinction to date. Two possible examples are the golden toad and the harlequin frog from Costa Rica's Monteverdi Cloud Forest Reserve, whose disappearances seem strongly linked to unusually warm and dry weather caused by the powerful El Niño event of 1996 and 1997. There is rowing evidence, although not conclusive, that global warming has played a role in the increased strength and duration of El Niño events over the past decade. Mean global Biodiversity 11 surface temperatures are expected to increase by 1.4 to 5.8 degrees C. (2.5 to 10.4 degrees F.) by the year 2100. The magnitude and the rate of this increase, unprecedented for the last 10,000 years, will threaten the survival of many species, especially those unable to migrate to new ranges or otherwise adapt. Global climate change, by itself or acting synergistically with other environmental changes secondary to human activity, could well become the factor most responsible for species extinctions over the next 100 years.

Values of biodiversity

Biodiversity has an intrinsic value that is worth protecting regardless of its value to humans. This argument focuses on the conservation of all species, even if they are ecologically equivalent species. Biodiversity performs a number of ecological service to humankind that has economic, aesthetic or recreational value. This argument focuses on conserving ecologically nonequivalent species since ecologically equivalent ones are redundant in terms of services rendered. Both points of view (intrinsic and anthropocentric) need not be contradictory, as they serve the same ultimate purpose. Yet they often are considered incompatible because they stem from two very different philosophies: one which views nature as innately valuable and one that regards it as economically valuable.

Intrinsic Value

The first argument for the intrinsic value of biodiversity is the idea that humans are part of nature.

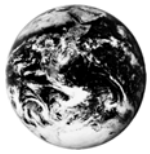
"We know now what was unknown to all the preceding caravan of generations: that men are only fellow-voyagers with other creatures in the odyssey of evolution... Above all we should, in the century since Darwin, have come to know that man, while now captain of the adventuring ship, is hardly the sole object of its quest, and that prior assumptions to this effect arose from the simple necessity of whistling in the dark." - Aldo Leopold, *A Sand County Almanac*.

The argument for conservation of biodiversity often emphasizes the need to facilitate continued evolution. As humans are and were part of nature, they benefited from the evolutionary process. The tenet that humans are part of nature questions whether humans should endanger their own milieu and the process from which they stem.

A corollary to the above argument is reflected in the *Noah principle* , named for the biblical Noah who saved one pair of every creature on earth in the Ark, which argues that the usefulness of a species is not considered when discussing its conservation, but rather its very presence in the long history of evolution is sufficient to warrant its preservation.

Environmental ethicists also stress that humans should protect biodiversity because they are the cause of most of the loss of biodiversity through loss of habitat, overexploitation and other perturbations.

"99 percent of all species that ever lived are now extinct. But I



think we have an obligation, now, in our generation and in foreseeable generations, to try to protect every species, try to maintain every species, because virtually every species that is going extinct now is going extinct due to human activity not because of natural processes" R Noss 1996

Anthropocentric Value

While intrinsic arguments for protection of biodiversity are compelling, it is ultimately arguments of human benefit that pragmatic conservationists find most appealing: as humans, we are inextricably and wholly dependent on this diversity of living things for survival. Biodiversity, encompassing genetic diversity, species, populations, communities and ecosystems, and landscapes and regions, provides countless benefits to humans at all these scales. Some of these benefits include:

Economic benefits, both direct and indirect; Aesthetic benefits; Scientific and ethical knowledge; Insurance against the future

Economic benefits

The notion that biodiversity has provided us with many benefits is well understood. Some of these benefits come in the form of **goods** that can be directly valued and costed because they provide something that can be extracted and sold. These goods include everything from all the domesticated agricultural crops that form the basis of the world's food supply, to medicines that protect and cure us to the fibres that make up the clothes we wear. Thus biodiversity is widely valued as food pantry, genetic storehouse for biotechnology and a place to retreat to when we need to get away from our hectic urban existence.

Biodiversity also provides critical indirect benefits to humans that are difficult to quantify because we have never had to put a price tag on them. These benefits encompass ecosystem **services,** such as air and water purification, climate regulation, and the generation of moisture and oxygen. A group of ecologists who recently attempted to quantify the price of replacing these ecosystem services calculated that they would cost over $3 trillion. That's greater than the entire global GNP! In other words, the world cannot afford to replace these services; therefore we must work to protect our ecosystems.

Natural communities maintain proper gaseous concentrations in the atmosphere and prevent rapid climate changes. Drastic changes in the Earth's atmosphere can have catastrophic effects. Such changes are believed to have led to the disappearance of dinosaurs from Earth 65 million years ago. Much less drastic changes resulted in several global ice ages, the last of which ended 10 thousand years ago.

Vegetation helps recycle moisture into the atmosphere. A single corn plant (1 lb dry weight) can transfer 60 gallons of water from soil to atmosphere in a few months. A single rainforest tree, in its 100 year lifespan can transfer approximately 2.5 million gallons from soil to air. Their role in the hydrologic cycle is crucial.

A multiplicity of organisms is required to create soils and maintain fertility through complex cycles and interactions. Plant roots break up rock to create soil particles, small animals like earthworms, mites, insects and millipedes help give soil its texture and fertility and are crucial to its aeration. Even tinier soil microorganisms and fungi are responsible for cycling essential nutrients like nitrogen, phosphorus and sulfur and making them available to higher plants. And their numbers are staggering. A gram of fertile agricultural soil may contain 2.5 billion bacteria, 400 000 fungi, 50 000 algae and 30 000 protozoa. All these organisms have particular functions and interact with each other and with their physical environment to create the fertile soil that humans depend on for agricultural production.

Natural ecosystems also help absorb the wastes we create and render them nontoxic. Wetlands are large filters which purify freshwater and remove heavy metals and other contaminants from it. We often depend on rivers to flush away and break down the sewage and effluents that we put into them, which again depends on the array of

small and large organisms that decompose and transform wastes in water. Soil organisms can slowly decompose food items, paper products and other wastes produced by human activities.

Economic arguments for protecting biodiversity are criticized for being too utilitarian and human-centered. Indeed, an excessive emphasis on the economic values of different species is seen as dangerous for two reasons: there is bias towards the protection of species and ecosystems that have attributable economic value and this perspective may also lead to the conclusion that ecosystems that are not directly benefiting humans are worth more to humans developed than undeveloped.

Aesthetic value and recreation

In North America, protected wild areas where indigenous organisms live undisturbed give people a sense of satisfaction in knowing that there are bears and wolves and rare plants and insects that still exist on their continent. Natural and wild landscapes are aesthetically pleasing and provide opportunities to get away from human-dominated landscapes. They also provide opportunities for recreational activities such as hiking, canoeing, bird watching and nature photography.

This argument is criticized for two reasons: first, aesthetic value is not necessarily equated to biodiversity; some of the most aesthetically pleasing landscapes are poor in diversity of habitats and species (e.g. mountains) while some unspectacular landscapes are incredibly rich in biodiversity (e.g. swamps and wetlands). Second, this aesthetic argument is relevant only to a minority of wealthy citizens in developed countries and holds little relevance to the majority of the world's population

Future potential

While there are hundreds of examples of known economic and aesthetic benefits of biodiversity, biologists and other scientists frequently outline that more is unknown than known. Important ecosystem services and uses for plants and animals are still unknown and await discovery. Yet these cannot be discovered, and benefit humankind, if they disappear before discovery. The threat to biodiversity can be compared to book burning (the obliteration of former and future knowledge).

Many of our valuable goods, from spices (cinnamon, pepper) to critical medications (aspirin, tamoxifen, quinine, digitalis) have been discovered "accidentally" because plants or animals produced chemicals for defense or attraction. We would not have otherwise considered the organisms from which these chemicals originated as valuable and worthy of conservation.

Responding Actions

Given the importance of biodiversity and links with the factors which govern the continuity of life on earth, it is important to:

- ❑ conserve biodiversity that is especially sensitive to climate change,
- ❑ preserve habitats so as to facilitate the long-term adaptation of biodiversity,
- ❑ improve our understanding of climate change – biodiversity linkages, and
- ❑ fully integrate biodiversity considerations into mitigation and adaptation plans.

Also there is an urgent need to focus greater attention and public awareness on importance of biodiversity and its related values. A typical communication programme to generate awareness and familiarity with the issues of biodiversity conservation consisting of appropriate strategy should be devised within the formal institutions as well as civil society at large.

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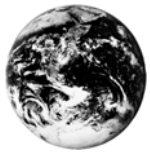

BIOLOGICAL DIVERSITY

Sanjaya Singh*, I.F.S

"This loss of genetic, species and ecosystem's diversity both comes from and invites the loss of cultural diversity. We must understand the causes and mechanisms of biodiversity loss so that we can address the causes to conserve biodiversity. "

The totality of genes, species and ecosystems in an area is biological diversity or these are three hierarchical categories of biodiversity. The variation of genes within species is *genetic diversity*. It includes distinct population of the same species (e.g., different varieties of traditional rice in India) or generic variations within a population (e.g., very high among Indian rhinos or very low among cheetahs). Presence of a number of species in a given region is *species diversity*. A given area with two species of birds and one species of frog has more species or taxonomic diversity than an area with three species of birds and no frog or no birds and three species of frogs. It is very difficult to estimate *ecosystem diversity* because association of species goes beyond a given boundary. But at national and sub-national levels a set of criteria is used to define communities and ecosystems.

Human cultures (land-management practices, crop selection, diet, religious beliefs, social structure, art, music) have developed and adapted, over the millennia, to local biotic resources by discovering, using and altering them. Therefore they are suited to particular environment for the survival in that environment. Therefore *human cultural diversity* is also part of diversity. This biodiversity has two components-wild as well as domesticated. Human cultural diversity helps people adapt to changing conditions.

This variety of life has enormous value as it enables ecosystem to maintain soil fertility and micro-climates, purify water, absorb pollution and other invaluable services. It is well known that by raising wide range of crops and livestock helps to stabilize and enhance productivity. Active ingredients extracted from plants and

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micro-organisms are part of modern pharmaceuticals. Earlier nearly all medicines came from plants and animals. World Health Organization is now encouraging traditional medicines and their use is expanding rapidly in developed countries.

A diverse array of genes, species and ecosystems is a resource that is life insurance policy for life itself. The biodiversity is closely intertwined with human needs and its conservation has an element of national security. All the religions of the world teach respect for the diversity of life and show concern for its conservation.

But it is also true that human development has led to reduction in biodiversity. The development of agricultural economy converted species-rich forests and wetlands into species-poor farmlands. What should we call such developments- beneficial or harmful? Since the start of *industrial revolution*, in the name of human interest and human benefit, we are very rapidly modifying and altering natural ecosystems, there by causing habitat loss. This habitat loss causes extinction of species or population of living dead (population below the level necessary for long-term survival may hang for several decades without hope of recovery). Genetic loss also occurs along with loss of species and ecosystem. This is an important threat and could imperil agriculture.

This loss of genetic, species and ecosystem's diversity both comes from and invites the loss of cultural diversity. We must understand the causes and mechanisms of biodiversity loss so that we can address the causes to conserve biodiversity.

Six Fundamental Causes of Biodiversity Loss

1. The unsustainably high rate of human population growth and natural resource consumption.
2. The steadily narrowing range/spectrum of traded products from agriculture, forestry and fisheries.
3. Economic systems and policies that fail to value environment and its resources.
4. Inequity in the ownership, management and flow of benefits from both the use and conservation of biological resources.
5. Deficiencies in the knowledge and its applications.
6. Legal and institutional systems that promote unsustainable exploitation.

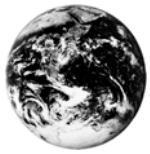
Mechanisms for the Loss of Biodiversity

1. Fragmentation and loss of habitat.
2. Introduction of species, especially on islands.
3. Over-exploitation of plant and animal species.
4. Pollution of soil, water and atmosphere.
5. Global climate change.
6. Industrial agriculture and forestry.

Ten Principles of Conserving Biodiversity

These ten principles have guided the individuals and institutions involved in development of the Global Biodiversity Strategy:

1. Every form of life is unique and warrants respect from humanity. An ethic based on respect and care for each others is the foundation of sustainable living.
2. Biodiversity conservation is an investment that yields substantial local, national and global benefits.
3. The cost and benefits of biodiversity conservation should be shared more equitably among nations and among people within nations. Sharing should be continued between our generations and those who will come after us.
4. As part of the larger efforts to achieve sustainable development, conserving biodiversity requires fundamental changes in patterns and practices of economic development worldwide. We should minimize the depletion of non-renewable resources.
5. Increased funding for biodiversity conservation



will not, by itself, slow biodiversity loss. Policy and institutional reforms are needed to create the conditions under which increased funding can be effective. A national framework for integrating development and conservation should be provided.

6. Priorities for biodiversity conservation differ when viewed from local, national and global perspectives; all are legitimate and should be taken into account. All countries and communities also have vested interest in conserving biodiversity; the focus should not be exclusively on a few species-rich ecosystems or countries.
7. Biodiversity conservation can be sustained only if public awareness and concern are substantially heightened and if policy-makers have access to reliable information upon which to base policy choices.
8. Action to conserve biodiversity must be planned and implemented at a scale determined by ecological and social criteria. The focus of activity must be where people will live and work, as well as in protected wild land areas.
9. Cultural diversity is closely linked to biodiversity. Humanity's collective knowledge of biodiversity and its use and management rests in cultural diversity; conversely, conserving biodiversity often helps strengthen cultural integrity and values.
10. Increased public participation, respect for basic human rights, increased popular access to education and information and greater institutional accountability are essential elements of biodiversity conservation.

At Rio de Janeiro on the 5th June, 1992 under the auspices of the UNEP Convention on Biological Diversity was signed and India is a party to it. Thereafter India took following steps:

- ❑ Formulated a detail NAP (National Action Plan) on Biodiversity.
- ❑ In 1994 hosted a meeting of Asian countries for regional cooperation.
- ❑ Prepared a detailed status report on biodiversity of India.
- ❑ Started dialogues with industries and scientific agencies.
- ❑ Issued notification regulating transfer of genetic resources out of India.
- ❑ Drafted a comprehensive legislation on biodiversity – Biodiversity (Rights & Protection) Bill,1998.
- ❑ Enacted The Biological Diversity Act, 2002.

Important Issues

- ❑ Although conservation of biological resources are very important but exploitation of biological resources without clear cut standards for sustainable use is counter to conservation.
- ❑ Conservation of biological resources may raise the issue of fundamental rights of an individual over his property.
- ❑ Documentation of indigenous and local resources (genetic, species and habitat) and its dissemination.
- ❑ Biodiversity Management Committees (under section 41(1) of The Biological Diversity Act, 2002) are to be constituted at local body levels and infrastructures with local bodies are not suited for the same.

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BIODIVERSITY AND PUBLIC AWARENESS

R.N. Joseph* & Himanshu Rai**

Abstract

Biodiversity is a sum total of all forms of life of an area. It plays an crucial role in maintaining the ecological balance of nature. It also provides the basic needs for man's survival on the earth. But man's activities have affected biodiversity globally in the name of development and progress of human race and his society.

The Govt. agencies and NGOs are working in conserving biodiversity but without participation of the general public, it will not work effectively. Since it has become imperative to make people aware about the biodiversity to conserve plant and animal species.

The biodiversity awareness projects can help people of urban and rural areas to conserve plant and animal species of their areas.

"Biodiversity forms the web of life of which man is an integral part and due to its highest evolutionary position, can play a crucial role in preserving and conserving the both plant and animal species."

Introduction

The earth has physical conditions of its atmosphere, lithosphere and hydrosphere to sustain all kinds of life. Since different types of plant and animal species are existing with environmental adaptation in different climatic regions of the earth, both plant and animal species constitute the biodiversity of the earth, which is

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especially called Biosphere. Biodiversity is a sum total of all species of plants and animals of the city, state, country or continent of the earth. i.e. biodiversity refers to the variation in the flora (plant life) and fauna (animal life) of the area.

Biodiversity varies greatly from place to place due to uneven distribution of plant and animal species over the earth. Biodiversity has varied markedly through geological time, and is now understood at three levels:

1. **Species diversity** which refers to the variety of different species of plants and animals.
2. **Genetic diversity** which refers to the different gene conditions found in varieties of species of both plants and animals.
3. **Ecosystem diverersity** which refers to the different habitats found in different climatic conditions of the earth to sustain different species of plants and animals

Biodiversity plays and important role in maintaining ecological balance of the nature which is essential for existence of human race on the earth. Besides maintaining ecological balance, biodiversity provides biotic resources in the form of animal and plant produce, which is essential for both existence and progress of mankind. Biodiversity forms the web of life of which man is an integral part and due to its highest evolutionary position, can play a crucial role in preserving and conserving the both plant and animal species. But at present biodiversity is being destroyed by human activities. The deforestation and encroachment that has occurred over the years in different parts of the country has been mainly caused by indiscriminate logging of trees for timber and fuel woods, over grazing, extension of agriculture land and urban area. The pressure on the natural biodiversity has now increased due to increasing population, its poverty and illiteracy. The illegal and over-exploitation of biodiversity resources is also one of the factors of biodiversity destruction. Biologically rich regions of the country continue to be at loss due to the high priority given to the other non-forestry development projects such as mining, hydroelectric project, road construction, urbanization, industrialization, irrigation project and tourism.

The term "biodiversity" gained immediate acceptance and was brought to popular attention by the world media during the Earth Summit in Rio de Janeiro, Brazil in the year 1992. The first landmark global agreement on the conservation and sustainable use of biodiversity, the Convention on Biological Diversity (CBD), was adopted in 1992 at the Earth Summit, at UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil. The convention recognizes, for the first time, that Under natural conditions there has been a extinction of both plant and animal species brought about by geological and evolutionary changes in due course of time but at present the extinction process has been accelerate due to the predominance activities of man in the name of development and progress of human race and his society. The UN World Commission on Environment and Development (WCED) has now emphasized the need for conserving world's biodiversity. The conservation of biodiversity is "a common concern of human kind" and is an integral part of the development process.

Strategy

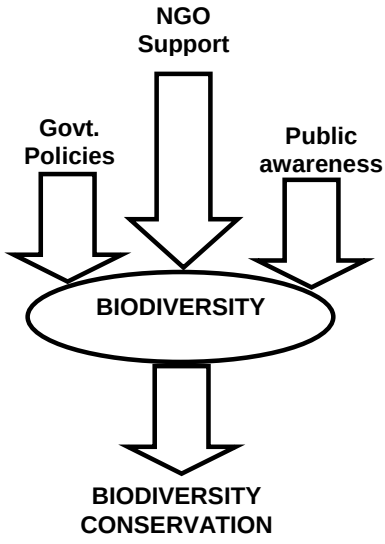

Fig: Biodiversity conservation involves Government as well as public participation.

The conservation of biodiversity can be achieved by full participation of the general public, which has to be made aware about biodiversity. The most important task for conservationists is to educate the general public about the importance of biodiversity conservation and change their attitudes towards nature. For this, small-scale biodiversity conservation awareness project should be started with different groups of local people living in urban and rural areas. The aim of these projects should be to improve "biodiversity understanding" of the general public of both urban and rural areas by making them understand that biodiversity is linked to each and every aspect of our life may it be our economy, religion and above all is very important for our own survival.

The Govt. agencies and NGOs working for environment especially biodiversity should start small-scale biodiversity conservation awareness project for people of urban and rural areas to enable them to actively contribute towards biodiversity conservation. At present time the general public must be made aware about the destruction and conservation of biodiversity-

- **Destruction of biodiversity:** It is caused by mainly habitat alteration, over exploitation and pollution-a) Habitat alteration – The growing need of land by man has now increased, which is catalysed by population explosion, urbanization, over grazing and deforestation. All these factors have deprived uncountable plant and animal species from their habitat. b) **Over exploitation-** The growing demand of biotic resources by man brings catastrophic effects upon the fate of the plant and animal species. c) **Pollution:-** The growing population in urban and rural areas has created pollution causing ecological imbalance in eco systems. Pollutants in any sort of form are harmful for animals and have a ripple effect on dependent animals in food chain of ecosystems.

- **Conservation of biodiversity :** The conservation of biodiversity means the management of biotic resources of the earth so that they may yield the greatest sustainable benefits to both present and future generations. It involves the following objects- a) Maintenance of natural habitats, b) Preservation of gene pools of different species of both plants and animals c) Ensuring the optimum utilization of the existing plants and animals with minimizing the chances of their disappearance during the course of time.

Biodiversity awareness projects must be targeted-

a) To educate people about basics of biodiversity,

b) To make people alert about consequence of loss of biodiversity and

c) To make people aware about conservation of biodiversity.

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Biodiversity Conservation for the People

S. P. Yadav* &
C. P. Goyal **

"A large number of non-forest produce, herbs, medicinal plants, animal products, products of micro organisms are being utilized commercially. Indian as well as European market has fancy for herbal products. "

The human beings are the best product of nature and the evolutionary process. Human beings are the part of the biological diversity. All the flora and fauna have evolved in to a stage where only the fittest survives. Each species is unique in its own way. In a given ecosystem plants and animals coexist and interact each other. They also interact with the non living things in the system. In an ecosystem flora and fauna always try to maintain their population at optimal level. The rapid rise and fall in population of any species disturbs the equilibrium. The ever increasing human population is fast exploiting the other natural resources, resulting in extinction of many species from our planet. Many species of flora and fauna have become either threatened or endangered and are on the brink of extinction. The disbalance in equilibrium of ecosystem leads to increase in population of insect-pests, disease causing bacteria, fungus, virus etc. at alarming rate.

Realizing that spectrum of biodiversity i.e. plants, animals, micro organisms, affects the environment on which very existence of life depends, we need to conserve it for future generations. Biodiversity conservation is especially crucial to the poor people whose wellbeing largely depends on biomass.

* IFS, CF/DFO, Agra. **IFS, CCF/CF, Agra.

Biodiversity is the sum totals of all the variations in the species i.e. the number of species of flora and fauna, which are part of ecosystem. Biodiversity includes all inter, intra and trans species variations. The biodiversity conservation has become a holistic concept which encompasses the whole spectrum of biota and of activities ranging from ecosystem at macro level (*in situ*) to the DNA libraries at molecular level (*ex situ*). Conservation is however, not an end by itself, but only a starting point for a chain of actions. (Khoshoo, T.N., 1991)

India has a geographical area of 329 million hectares. It is bound on the North by the youngest and the most fragile mountain ranges of the Himalayas, by oceans in the East, West and South. Climate in the country ranges from perpetual snow covers to tropical, from cold deserts to hot deserts, mangroves to ever green forests to humid tropics. India has about 47,000 species of flowering and non-flowering plants representing about 12 % of recorded world's flora. It also has about 90,000 animal species identified so far representing 7.28 % of world's recorded faunal species. (India's Forests, 2007)

India is located in one of the 12 mega biodiversity regions of the world. McNeely et al (1988) identified Mexico, Colombia, Ecuador, Peru, Brazil, Zaire, Madagascar, China, Malaysia, Indonesia, Australia and India as mega biodiversity countries. These 12 countries are home to around 70% of the earth's biodiversity. Mittermeier, et al.(2000) have identified the Eastern Himalayas and Western Ghats regions of India as amongst the 32 biodiversity hot spots on the earth.

Biodiversity Conservation

We need to conserve our precious biodiversity with following strategy:

Preservation of biodiversity

Steps must be taken to conserve and protect the existing biodiversity. It needs identification, inventorization, and conservation of biodiversity in *in situ* and *ex situ* conditions.

Research on Biodiversity

There is enormous potential and scope for research in this field which may help the mankind in many useful ways. Methodologies and techniques need to be developed for efficient and sustained utilization of products.

Use of Biodiversity

Only protection, preservation and research are not going to serve any purpose, unless biodiversity is linked to economic benefits. Biodiversity is an important resource which needs to be utilized for meaningful purposes. The utilization of biodiversity has to be judicious, scientific, equitable and in sustainable manner.

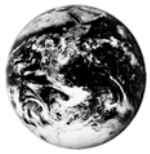
Poverty alleviation through biodiversity conservation

Biodiversity in our country has great potential for creating new avenues as a source of employment for poor people as well as industrialists. A large number of non-forest produce, herbs, medicinal plants, animal products, products of micro organisms are being utilized commercially. Indian as well as European market has fancy for herbal products. The traditional knowledge of people needs to be respected, documented and researched

Traditionally people were protecting biodiversity in the form of sacred groves. Some species trees like Peepal, Bargad, Khejri, Mahua, Neem etc. have attracted care and protection from the people for their religious and economic values.

Loss of biodiversity

The key factors in the loss of biodiversity are biotic factors like over exploitation, fire, and grazing, poaching and illegal removal of some species by people, gregarious invasion of some weeds like *Parthenium, Eupotorium* etc. All efforts are required to check the factors affecting the biodiversity adversely.



Bio-sphere Reserve

At present there is no bio-sphere reserve in the state of Uttar Pradesh. The concept of bio-sphere reserve has its origin from Man and Bio-sphere Programme of UNESCO. The main objective of this concept is to save the diversity and integrity of biotic communities of plants and animals within natural ecosystem for sustainable use and to safeguard the genetic diversity of species on which their continuous evolution depends.

Path ahead

The areas which are rich in biodiversity must be identified, recorded, inventorized and protected.

All such biodiversity site representative centers need continuous monitoring at all levels of flora and fauna species. Base line data and periodical data must be recorded meticulously.

External/environmental factors affecting the biodiversity positively or negatively must be recorded along with monitoring of variation in species diversity and composition.

All such areas may be protected through Joint Forest Management involving the local people and their empowerment. Participatory approach is advocated for natural resource management and conservation.

The wetlands need to be conserved and protected in addition to the wildlife sanctuaries and national parks.

Areas important from biodiversity point of view should be declared as bio-sphere reserve.

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जैव विविधता संरक्षण का महत्व

सुखजिन्दर सिंह, भा.व.से.
मुख्य वन संरक्षक

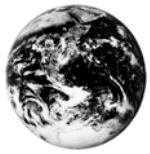
"जैव विविधता क्षरण के मुख्य कारणों में बढ़ती आवश्यकताएं तथा अनियोजित विकास, प्राकृतिक पर्यावास का विनाश, बदलती कृषि तथा वानिकी पद्धतियाँ, व्यावसायिक लाभ के लिए अत्याधिक दोहन, पर्यावरणीय प्रदूषण, पारम्परिक ज्ञान की कमी, कानूनी एवं प्रबन्धन तंत्र की प्रकृति एवं अन्तर्राट्रीय व्यापार शामिल है।"

जैव विविधता पृथ्वी पर पाये जाने वाले जीवन के सभी स्वरुपों की संख्या, प्रकार तथा परिवर्तनशीलता को इंगित करती है। इनमें लाखों की संख्या में वनस्पतियाँ, जन्तु, सूक्ष्म जीव उनमें पाये जाने वाले जीन तथा घनिष्ठ सम्बन्धों वाले विद्यमान पारितन्त्र शामिल है।

जैव विविधता का महत्वः हमें इस बात पर आश्चर्य हो सकता है कि हमारा जैव विविधता से सरोकार क्यों होना चाहिये? पारिभाभिषक तौर पर जैव विविधता एक अमूर्त धारणा प्रतीत होती है, जिसका हमारे जीवन से कोई सम्बन्ध नहीं है, लेकिन वास्तव में जैव विविधता हमारे जीवन के प्रत्येक पक्ष को प्रभावित करती है। जैव विविधता का क्षरण मानव जाति के लिए चेतावनी है। जैव विविधता क्षरण तथा इसके संरक्षरण के प्रति हम सभी चिन्तित हैं क्योंकि :

जीवन अस्तित्वः बिना जैव विविधता के हम सभी समाप्त हो जायेंगे। जीन्स, जातियों, पर्यावासों तथा पारितन्त्रों का विश्वव्यापी समूह हमारे लिए धन से अधिक महत्वपूर्ण है। भारत जैसे देश में जैव विविधता का सर्वाधिक महत्व इसलिये है कि इससे अधिसंख्य लोगों की आधारभूत आवश्यकताओं की पूर्ति होती है। आज भी बहुत से पारम्परिक समुदाय अपने भोजन, आवास, वस्त्र, गृहोपयोगी वस्तुओं, दवाओं, उर्वरक तथा मनारेंजन के लिए आंशिक या पूरी तौर से अपने आस–पास के प्राकृतिक संसाधनों पर निर्भर हैं।

स्वास्थ्य के लिएः विकासशील देशों की 80 प्रतिशत से अधिक आबादी स्वास्थ्य सम्बन्धी आवश्यकताओं के लिए पारम्परिक दवाओं पर आश्रित है।



इनमें से अधिकांश पौधों से प्राप्त होती है तथा शेष जन्तुओं या खनिजों से। केवल पारम्परिक दवाएँ ही जैव विविधता पर आश्रित नहीं हैं वरन विकसित देशों द्वारा प्रयोग की जाने वाली दवाओं का एक हिस्सा भी पौधों पर आधारित है।

खाद्य सुरक्षाः– विश्व के लिए आवश्यक भोजन की कुल खपत का 90 प्रतिशत हिस्सा 20 वनस्पति प्रजातियों से प्राप्त होता है। जीनिक विविधता फसलों तथा पालतू पशुओं के प्रजनन के लिए महत्वपूर्ण है। फसल प्रजनकों को, उच्च प्रतिरोधक क्षमता वाली फसलों के विकास के लिए फसलों में विविधता की आवश्यकता होती है।

कई फसलों को उनकी वन्य या पारम्परिक प्रजातियों के जीन का प्रयोग करके बचाया गया है। 1970 के प्रारम्भिक दशक में भारत की एक वन्य धान प्रजाति के जीन की सहायता से धान की फसल को एशिया के कई हिस्सों में 'ग्रेजी स्टण्ट वाइरस' से बचाया गया था। फिलीपीन्स स्थित अंतर्राष्ट्रीय धान शोध संस्थान के वैज्ञानिकों ने, वाइरस प्रतिरोधी जीन की खोज के लिए धान की 6723 प्रजातियों का अध्ययन किया। उन्हें केवल धान की एक प्रजाति (ओराइजा निवारा) में वाइरस प्रतिरोधी क्षमता मिली जिसे 1963 में पूर्वी उत्तर प्रदेश से एकत्र किया गया था। इस नमूने का प्रयोग करके धान की जो नस्ल तैयार की गयी वह अब पूरे दक्षिण तथा दक्षिण पूर्व एशिया में बहुतायत से उगायी जाती है।

सौन्दर्य सुखः– प्रत्येक जाति तथा पारितन्त्र पृथ्वी पर समृद्धि तथा सौन्दर्य की वृद्धि करता है। सम्भवतः किसी कृत्रिम माध्यम से हमें वैसा अप्रतिम आनन्द नहीं मिल सकता जैसा पहली बारिश के बाद उठने वाली माटी की सोंधी महक, चिड़ियों के गाने की आवाज, दौड़ते हिरन या समुद्र में डूबते सूर्य को देखने में मिलता है।

नैतिक कारणः– हर जाति अपने आप में अनूठी है, और हर जाति को बने रहने का अधिकार प्राप्त है। मनुष्य को किसी भी जाति को समाप्त करने का अधिकार नहीं है। 1982 में संयुक्त राष्ट्र द्वारा स्वीकार किये गये नेचर चार्टर के अनुसार, ''जीवन का प्रत्येक स्वरूप अनूठा है और सम्मान का अधिकारी है, बिना इस बात की परवाह किये कि वह मनुष्य के लिए कितना उपयोगी है अथवा किसी अन्य जीव की तुलना में उसकी स्थिति क्या है? मानव को आदर्श आचार से प्रेरित होकर कार्य करना चाहिये।''

पारिस्थितिकीय योगदानः– जातियों का विकास किसी पारिस्थितिक परिवेश (निश) को भरने के लिए होता है। बहुत सारी प्रजातियॉ भी एक दूसरे पर अपनी जीविका के लिए गहनता से आश्रित होती है। एक प्रजाति का विनाश दूसरी प्रजाति के विनाश या किसी अन्य परिवर्तन का कारण हो सकता है। एक निर्दिष्ट परिवेश में रहने वाली प्रजातियॉ उसी परिवेश की दूसरी प्रजातियों के रहने के लिए सहायक स्थितियों का निर्माण करती है। उदाहरण के तौर पर यहाँ पर डोडो का उदाहरण याद रखना समीचीन होगा। डोडो नामक पक्षी न्यूजीलैंड,आस्ट्रेलिया,तासमानियां व समीपवर्ती टापुओं में आहार विहार करने वाला पक्षी था । डोडों का मांस स्वादिष्ट होने के कारण वह शिकार के फलस्वरुप विलुप्त हो गया। डोडो पक्षी के लुप्त होने के पश्चात् पाया गया कि कैल्वेरिया प्रजाति के वृक्ष भी कम होते जा रहे है। शोध के उपरान्त पाया गया कि कैल्वेरिया प्रजाति के स्वस्थ बीज भी कठोर आवरण के कारण प्राकृतिक रुप से अंकुरित होने बन्द हो गये। डोडों पक्षी के इन बीजों के खाने के उपरान्त उसके गले के अन्दर (Crop) के शक्तिशाली मसलन की क्रिया से बीज के ऊपर का आवरण कमजोर हो जाने के फलस्वरुप मल से बाहर आने के उपरान्त बीज अंकुरित हो जाया करते थे । इस अध्ययन के फलस्वरुप इन देशों मे विशेष प्रकार के शुतुरमुर्ग आयात कर कैल्वेरिया प्रजाति को आज पुनर्स्थापित कर लिया गया। हमारे प्रदेश में भी कतरनिया घाट में लालसर (रेड क्रेस्टेड़ पोचार्ड) नामक पक्षी सम परिस्थिति में पाया जाता है। यह भी शिकारियों की भेंट चढ़ रहा है अब तक ज्ञात नही है कि यह किस–किस प्रजाति पर अन्योन्याश्रित है। इसके लुप्त होने पर मानव जाति को महत्वपूर्ण जैवविधि ाता खोने का खामियाजा भुगतना पड सकता है।

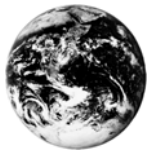
धार्मिक तथा सांस्कृतिक जुड़ावः– भारत में कई पौधों तथा जन्तुओं का धार्मिक महत्व है और ये विभिन्न धार्मिक,

आध्यात्मिक तथा सांस्कृतिक गतिविधियों से जुड़े है।

भारत तथा दूसरे कई देशों में कुछ वन प्रदेश सुरक्षित रखे जाते थे, क्योंकि उनमें किसी भगवान का निवास माना जाता था। इन्हें पवित्र वन (सैक्रेड ग्रोव) माना जाता था और इसी कारण स्थानीय जनजातियों ने युगों तक इनकी सुरक्षा की। युगों तक इन वनों की जैवविविधता बड़ी मात्रा में संरक्षित रह सकी। सुरक्षा के कारण ये क्षेत्र जैवविविधता को समाहित और संरक्षित रख सके।

जैव विविधता का प्रादेशिक खजानाः– उत्तर प्रदेश में जैव विविधता पहले की तुलना में कम जरुर हो गयी है लेकिन वर्तमान जैवविविधता प्रदेश के लिए पहले से अधिक महत्वपूर्ण हो गई है। हमारे प्रदेश में प्रति ईकाई भूमि पर देश का सबसे अधिक जैविक दबाव होने के कारण परिस्थितिकीय को संरक्षित करना अधिक चुनौतीपूर्ण है। प्रसन्नता का विषय है कि प्रदेश में जनजागरुकता का अभाव नही है। जैव विविधता किसी क्षेत्र के पर्यावरण में वनस्पतियों, पशुपक्षियों, कीट पतंगों, सरी–सृप और सूक्ष्य जीवों की विविधता के संरक्षण को महत्व देते है। उ0प्र0 का कुल भौगोलिक क्षेत्रफल 2,40928 वर्ग कि. मी. है जो 77.5 डिग्री. पूर्वी देशान्तर से 85 डिग्री.पूर्वी देशान्तर तथा 23.0डिगी उत्तरी अंक्षाश से 30.4 डिग्री. उत्तरी अंक्षाश के मध्य स्थित है। प्रदेश के विभिन्न भागों में शीतकाल में न्यूनतम तापमान 0 डिग्री सेल्सियस व अधिकतम 50 डिग्री. सेल्सियस तक पहुँच जाता है जहाँ कुछ क्षेत्रों में 25 से.मी. से कम वर्षा होती है वही कुछ क्षेत्रों में 150 सेमी. से भी अधिक वर्षा होती है। प्रदेश में बहने वाली नदियो में गंगा, यमुना चम्बल व घाघरा प्रमुख है गंगा यमुना के मैदानों में स्थित मीठे पानी की झीले प्रवासी पक्षियों एवं कृषि की फसलों की जंगली किस्मों के प्रमुख प्राकृतवास है। प्रदेश की भूमि व जलवायु में विविधता होने के कारण प्रदेश में चार प्रमुख पारितन्त्र (इको सिस्टम) के प्रतिनिधि क्षेत्र उपलब्ध हैं उत्तर में महराजगंज, गोरखपुर, श्रावस्ती, बलरामपुर, बहराइच, लखीमपुर, पीलीभीत के तराईवन, नम जलवायु का पारितन्त्र है। दक्षिण में एक ओर बुन्देलखण्ड व दूसरी ओर विन्ध्याचल की पहाड़ियों का शुष्क जलवायु का पारितन्त्र है। मध्य गंगा का विशाल मैदानी परितन्त्र है। पश्चिम में अर्धमरुस्थलीय पारितन्त्र आगरा व इटावा में उपलब्ध है। प्रदेश का पारितन्त्र प्रदेश की सर्वाधिक उल्लेखनीय पहचान है, इसीलिए समस्त प्रदेश अपने क्षेत्र में विश्व के 12 सर्वाधिक जैव विविधता वाले देशों में एक है। हमारे देश ने पृथ्वी की 2 प्रतिशत भूमि पर, विश्व की 5 प्रतिशत जैव विविधता सहेज रखी है। अनुमानतः हमारे देश में 45,000 वन्य वनस्पतियाँ तथा 77,000 वन्य जन्तु प्रजातियाँ है। भारत में सूचीबद्ध की गयी कुल वनस्पति तथा जन्तु प्रजातियाँ, विश्व की चिन्हित वन्य प्रजातियों का 6.5 प्रतिशत हैं। भारत में प्रजाति, पारितन्त्र तथा जीनिक जैव विविधता का विशाल भण्डार है। भारतीय उपमहाद्वीप तीन जैव भौगोलिक क्षेत्रों के संगम क्षेत्र में स्थित है तथा इसी कारण भारतीय उप महाद्वीप में अफ्रीकी, यूरोपीय, चीनी या हिन्दमलाया सभी मूलों के लक्षणों से युक्त वनस्पतियाँ तथा जन्तु पाये जाते है। इस जैव विविधता का कारण यहाँ पायी जाने वाली जलवायु तथा पर्यावासीय विविधता भी है। हिमालय की ऊँचाइयों से लेकर समुद्र तट और मैदान तथा अत्यधिक वर्षा प्रदेश से लेकर शुष्क मरुस्थल प्रदेश सभी भारत में विद्यमान हैं।

भारतीय उप महाद्वीप को फसल तथा वानस्पतिक विविधता के 'हिन्दुस्तान उद्गम केन्द्र के रूप मे जाना जाता है। 166 फसली जातियों तथा इनसे सम्बन्धित 320 जंगली प्रजातियों का उदगम यहां माना जाता है। इन सभी प्रजातियों में विविधता चकित कर देने वाली है। भारत विश्व के उन आठ देशों में से है, जो उगाई जाने वाली वनस्पतियों का मूल देश है। भारत में अनाज आदि की 51 प्रजातियाँ, फलों की 104 प्रजातियाँ, मसालों तथा भोजन को महकदार बनाने वाले पौधों की 27 प्रजातियाँ, सब्जियों तथा दालों की 55 प्रजातियाँ, रेशेदार पौधों की 24 प्रजातियाँ, तेल युक्त बीजों की 12 प्रजातियाँ तथा चाय काफी, तम्बाकू और गन्ने की कई वन्य प्रजातियाँ भी पायी जाती हैं। भारत में जन्तुओं की भी कई प्रजातियाँ पाई जाती है। जिनमें, गाय–बैल की 27 प्रजातियाँ, भेड़ों की 40 प्रजातियाँ तथा बकरियों की 22 प्रजातियाँ प्रमुख हैं। उदाहरण के तौर पर भारत में



पायी जाने वाली भैसों की 8 प्रजातियाँ पूरे विश्व की भैंसों की जीनिक विविधता का प्रतिनिधित्व करती हैं। ये केवल सूचीबद्ध प्रजातियॉ हैं। भारत के कई महत्वपूर्ण जैव विविधता वाले क्षेत्रों जैसे उत्तर पूर्व का तो अभी पूरा अध्ययन ही नहीं हुआ है। इसलिए कोई भी नहीं बता सकता है कि वहाँ कितना खजाना छिपा है?

भारतीय जैव विविधता का अपरदनः–भारत की समृद्ध जैव विविधता का तेजी से अपरदन हो रहा है। वन्य प्राणियों का एक बड़ा हिस्सा तथा लगभग 10 प्रतिशत वनस्पति प्रजातियों का अस्तित्व अंधाधुंध दोहन के कारण खतरें में है और इनमें से कई विलुप्त होने के कगार पर हैं।

जैव विविधता की हानि कारण तथा परिणामः–जैव विविधता का महत्व जान लेने के बाद इसके हानि के कारणों को समझना आवश्यक है। जैव विविधता क्षरण के कुछ प्रमुख कारणों को प्रत्यक्ष अथवा परोक्ष रूप से मानव जाति की लगातार बढ़ती जनसंख्या की आवश्यकताओं को पूरा करने के लिए किए जा रहे कार्यकलापों से जोड़ा जा सकता है।

जैव विविधता क्षरण के मुख्य कारणों में बढ़ती आवश्यकताएं तथा अनियोजित विकास, प्राकृतिक पर्यावास का विनाश, बदलती कृषि तथा वानिकी पद्धतियाँ, व्यावसायिक लाभ के लिए अत्याधिक दोहन, पर्यावरणीय प्रदूषण, पारम्परिक ज्ञान की कमी, कानूनी एवं प्रबन्धन तंत्र की प्रकृति एवं अन्तर्राट्रीय व्यापार शामिल है।

जैव विविधता क्षरण के इन कारणों से एक कठिन प्रश्न उभरता है कि जैव विविधता संरक्षण की आवश्यकता तथा विकास की मांग के बीच संतुलन कैसे स्थापित किया जायें? आर्थिक विकास के प्रति चिन्ता उचित है लेकिन वह विकास स्थायी नही हो सकता जिससे वे संसाधन ही नष्ट हो जाएं जिन पर यह आधारित है। विकास योजनाओं की सफलता अंततः परिस्थितिकीय सामाजिक तथा आर्थिक स्थायित्व में निहित है । हमारे अपने जीवन के तौर तरीके तथा खपत के तरीके का मूल्यांकन करने और इस पर पुनर्विचार की चुनौती है।

जैव विविधता संरक्षण– जैव विविधता विश्व की एक अनमोल धरोहर है यह अमूल्य विरासत खतनाक गति से विनष्ट हो रही है। इस विनाश को रोकने के लिए राष्ट्रीय और अन्तर्राष्ट्रीय स्तर पर प्रयास किये जा रहे हैं। हम अपनी कार्य पद्धति में थोड़ा परिवर्तन लाकर व सावधानी प्रदर्शित कर जैव विविधता संरक्षण में महत्वपूर्ण योगदान प्रस्तुत कर सकते है। मृदा में ऐसे हजारों सूक्ष्म जीव हैं जो मृत कार्बनिक पदार्थो का अपघटन करते हैं, और भूमि की संरचना बनाये रखने में सहायक होते हैं। मृदा के एक चम्मच में अनेक सूक्ष्म जीव पाये जाते हैं। जलीय जीवों का मुख्य आहार जल में पाये जाने वाले सूक्ष्म जीवाणु जैसे– फाइटोप्लाक्टान,जूप्लाक्टान,आदि है। आप समझ सकते है कि यदि यह जल प्राणी आहार लुप्त हो जाये तो जल जीवन का क्या होगा। उदाहरण–एक अध्ययन के अनुसार आई.टी.आर.सी. लखनऊ के वैज्ञानिक डॉ जसवन्त सिंह एवं अन्य ने पाया कि पंकी ताप विद्युत गृह कानपुर में गंगाा नदी से बॉयलर के लिए जल ग्रहण करने के बाद उसे उच्च ताप पर गर्म किया जाता है तथा उत्पन्न वाष्प से टरवाइन संचलित किया जाता है । उपयोगोपरान्त गर्म पानी को सीधे गंगा नदी में छोड़ दिया जाता है। फलतः थोड़ी देर के लिए नदी का तापमान अत्यधिक एवं जल प्राणी जगत के लिए आसहनीय हो जाता है तथा जल जन्तु तंत्र निष्क्रिय हो जाता है। देखा गया कि प्लाक्टान की संख्या में भारी ह्रास होने के साथ–साथ जलीय जन्तुओं की संख्या में भी कमी आयी है। उचित हो अगर यदि इस जल को साधारण तालाब में पहले सामान्य तापमान तक ठन्डा कर लिया जाएं, तथा बाद में नदी में छोड़ा जाये। इससे प्लाक्टान जो कि जलीय जीवन का मुख्य स्रोत है बना रहेगा तथा गंगा नदी की जल पारिस्थितिकीय को कोई नुकसान न होगा।

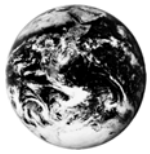
Biodiversity Conservation for Protection of Environment and for Livelihood Sustenance of Tribal and Rural Poor in India

Unnikrishnan. M. & S. Edison,
CTCRI, Trivandrum

"Conservation of biodiversity in India is of global importance especially that of food and agriculture. In recognition of this fact, FAO has launched the Global plan of action for the conservation and sustainable utilization of Plant Genetic Resources for Food and Agriculture (PGRFA)."

Threats to Biodiversity through human and natural causes

Exploitive Agriculture and extensive destruction of the biodiversity, both flora and fauna are the bane of the present practice of 'mining nature' for easier and quicker benefits as seen all over the world. As far as India is concerned, agriculture is our main stay as an occupation for the masses and as the sustainer of our economy. Presently, global agriculture is in a state of transition. Farm size is getting larger and larger in the industrialized countries where farming is supported by heavy input of capital, technology and subsidy as in the U. S.A. But the situation is different in many of the developing countries like India where average farm size is getting smaller and smaller. Our farmers are lacking access to technology and credit and have to produce crops facing the competition from the open market economy ushered in by globalization. Corporate agriculture and contract farming are the other options left for us to reap the maximum benefit from available resources. This demands for



intensive agriculture to maximize production using heavy dose of chemical fertilizer and Pesticides. Experience from the developed countries has shown that this sort of exploitive agriculture leads to grave environmental problems affecting soil health, water resources, prevalence of pests, diseases and total breakdown of the micro flora, fauna and ultimately heavy crop loss. Examples are available from India also such as the Wayanad districts of Kerala.

Destruction of Biodiversity happen also due to developmental activities like building of roads, dams, Industry and so on especially in areas where population density is high and demand for land is more. Excessive bio prospecting of selected species for timber and non timber products like lac, resins, seeds, bark, root and herbs for medicinal use also is threat to forest flora. Modern agriculture practices using improved varieties has also contributed to genetic erosion of land races.

Besides all these threats by human interventions, natural calamities like earth- quakes, tsunami, cyclones and vagueries of climate like drought and floods have also resulted in total or partial destruction of the natural diversity. The cyclone in Orissa and the tsunami of 2004 that affected the Andaman & Nicobar Islands and the coastal areas of Tamil Nadu are examples that occurred in the recent past.

Importance of Biodiversity in sustenance of lively hood of native people

1. Andaman & Nicobar islands:

In India, there are over 550 native or tribal communities under 227 ethic groups. We have a rich diversity in these groups also, such as the oldest stone age peoplelikethe Jarawas, Ongies (negros), Great Andamanese, Sentinelese, Shamjens & Nicobarese (mongoloids) of Andaman & Nicobar Islands to the Dravidians of Paniyas & Katunaikas of Wayanadu.They are all distinctly different groups dwelling in the islands. All these primitive and some of the semi advanced tribes like Nicobaris are even now totally dependent upon the natural resources of forest food like wild root and tubers, wild fruits, mushrooms, wild greens, crabs, mussel and fish. Even the semi advanced and educated Nicobaris also depend upon the coconut groves or forests which are the natural flora of these widely dispersed (572 islands in 780 kilometers) islands in the Bay of Bengal, for their food and merchandise (the copra) following their traditional system of cultivation without disturbing the ecosystem.

2. Wayanad district in Kerala:

Wayanad is an ecological nische set on the edge of the Western Ghats and the Deccan Plateau, situated at an attitude of above 750 m (MSL) it is a chain of low hills and valleys surrounded by lofty peeks like Chembra (2100mts) Banasuramala, Vellarimala and Brahmagiri. The low hills are filled with plantation of tea, coffee, pepper and cardamom while the valleys have predominance of rice fields. The average rainfalls in 2322 m.m Highest rainfall of 3000 to 4000 mm is also experienced in some areas like Lakkidi, Vaithtiri and Meppady. Soil is humous forest soil and rich in plant diversity. Wayanad is having the largest triabl population (17%) in Kerala. Comprising *Paniya* (46%), *Kurichya* (16.8%) *Kuruma* (14.6%) *Kattunaikka* (11%) *Adiya* (7.4%) and others (4%). Kurichyas cultivate rice and are the farming group among the tribals. Adiyars are generally farm laboures. Others like paniya, Kattunaikka and Kuruma collect wild food from the forests which include leafy greens, tubers, mushrooms fruits and seed, Honey, Crab and fish (Narayanan, *et al*. 2004) Kattunaikas of Wayanad are experts in the collection of tubers from the forest which are mainly *Dioscorea* species. They can distinguish 21 taxa of *Dioscorea,* of which they consume 19. (Balakrishnan *et al*.

2003) They have developed their own system of classification based on eating quality of the tuber and morphology of the under ground tuber. This shows the importance of these wild species diversity in sustaining the livelihood of these natives, which is a continuous practice, passed on to generations from the past to the present. In fact, many of the wild species of tuber crop genera like *Dioscorea*, *Canna*, *Costus*, *Curcuma*, *Alocasia*, *Alpinia Amorphophallus* etc. are used in tribal food and medicine. (Edison *et al*. 2006). This indicates the richness and utility potential of our floral diversity.

Biodiversity erosion and its after effects

a. **Over exploitation of resources:** In India there has been serious erosion of biodiversity due to different reasons like the "shifting" cultivation in Assam, the intensive and exploitive agricultural practices in Wayanad, the rice cultivation in kuttanad, Kerala and so on. Every where it has resulted in denudation of environment and crop failure leading to blockage of livelihood. The advent of high yielding rice varieties lead to loss of lands races, introduction of new diseases and pests leading to use of over dose of pest control chemicals which polluted the water bodies. Changing the rice fields into banana plantation, a resultant of contract farming, lead to not only deterioration of soil health but also to market restrictions for the produce (the bunches)in Wayanadu which was suspected to contain high dose of systemic pesticides. Now Wayanad has been identified as a problem district in Kerala requiring immediate attention by the planners, research workers and government functionaries.

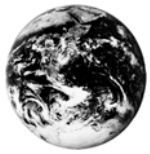
b. **Colossal changes in nature:** Natural calamity like tsunami has also affected vegetation due to seepage of saline water into fresh water sources, as in the case of Carnicobar islands in the Nicobar district of A & N Islands. Similar destruction has happened in Puducherry and Kadallur districts of Tamil Nadu. In the Andaman, earthquakes of serve intensity (9.0 in the Richter scale) followed by Tsunami has effected geological and geomorphological changes. In Diglipur, in the North Andaman the land has risen 0.5 to 0.8m with the result that ground water has receded in ponds, lagoons and lakes. The littoral forests and mangrove swamps have dried up. Similarly in south Andamans, the rice fields have been inundated with sea water affecting paddy cultivation. The Nicobar (district) islands are the worst hit. Carnicobar has been partially washed out by the sea. The jetties and roads have been totally destroyed. Mangrove forests in the Nancowri group of islands have been submerged. In Campbell's bay (Great Nicobar) the Natural coconut forests and agricultural fields have been destroyed, this place being closer to the epicenter of the earthquake.

It is evident that nature can protest with striking force and colossal effect. Unless we follow judicious use of the natural resources in a sustainable way correcting and reconstructing the methodology and materials, we will be ushering in our own "dooms day"

Conservation of existing and reconstruction of lost Biodiversity.

1. Conservation of existing Biodiversity

India is one of the regions where many of the crop plants have originated and got diversified due to the conducive climatic conditions existing here. We have not only species diversity but also genetic diversity with in each species. This is evident



even in introduced crops like cassava (*Manihot esculanta crantz*.) which has got only 500 years history in this country. In native crops like rice (*Oriza Sativa*) we have 50,000 varieties and 1000 varieties in mango (*Mangifera indica*). Other Crops like banana, ginger, turmeric, pepper, sugarcane, wheat, legumes, sesame, bhindi, brinjal, jack fruit and jute also possess rich diversity in this country. Thus conservation of biodiversity in India is of global importance especially that of food and agriculture. In recognition of this fact, FAO has launched the Global plan of action for the conservation and sustainable utilization of Plant Genetic Resources for Food and Agriculture (PGRFA).

Some of the important objectives of the Global Plan of Action are:

1. To improve the ability of countries in decision making on the conservation and sustainable utilization of Plant genetic Resources.
2. Build stronger partnership among stake holders in genetic resources research and management with in country.
3. Increase understanding about the status of plant genetic resources in the country
4. Increase the ability of countries to monitor the implementation of GPA.
5. Improve the quality of information on PGR and its accessibility at national, regional and global levels.
6. Enhance the capacity of countries to meet international reporting obligation.

There are 4 main categories of information on PGRFA collected and shared among the stake holders. They are

I. *In situ* Conservation

II. *Ex situ* conservation

III. Utilization Of plant Genetic Resources

IV. Institutional and capacity building

I. ***In situ* Conservation:** This can be done through different approaches for Forest and agricultural diversity conservation.

1. Formation of national Parks, Bio reserves or sanctuaries where all types of human activities like property development, Possession of private land cultivation, bio prospecting or cattle grazing are prevented.
2. Formation of community gene banks and seed villages through active participation of the farmers or villagers who are the stake holders. The locals have to be provided with infrastrauctural facilities for seed storage, seed certification, multiplication and distribution.
3. Educating the farmers on making inventories of the local diversity, recording and registering for protecting from biopiracy.

Example: In situ conservation through the active participation of the local villagers is done in the village Forest Panchayath in Kumta Taluk of Uttar Kannada (North Kanara) of Karnataka State or the maintenance of common grazing land in Bundi District of eastern Rajasthan (Veerabhadraiah, 2006)

II. ***Ex situ* Conservation:** This has to be taken up by the national organizations and the Non- Governmental organization with the support from the national Biodiversity Authority (NBA).

The different methodologies that are being recommended and in practice are

1. *Ex situ* – Seed conservation- the Seed gene banks.
2. *Ex situ* – Field/ glass house/ net house/ conservation- the Field Gene Banks
3. *In vitro* conservation – for

vegetatively propagated crops and for crops with recalcitrant seeds.

There are two types of *in vitro* gene banks like.

a. *In vitro* Active Gene Banks (IVAG) for short to medium conservation using slow growth cultures for active collections and breeder's lines.

b. *In vitro* Base Gene Banks (IVBG) for long term conservation of base collection- using cryo presentation techniques

2. Reconstruction of lost Biodiversity:

a. The reconstruction can be done only on case to case basis making melody and remedy analysis selecting appropriate technologies suited to the situation and location. The reconstruction programme involves different steps like.

1. Survey and inventorisation of the bio resources.

2. Characterization and documentation of resources

3. Educating the local people and tribal communities on the importance.

4. Forming self help group or working units to implement the programme.

5. Select and chalk out appropriate activities and mode of implementation with total involvement of the resident people.

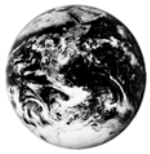
6. Setting up achievable shorter goals and motivate the participants to launch their own efforts for long lasting benefits to themselves.

7. Provide education, health and communication facilities through governmental agencies and local bodies.

Examples of reconstruction are available from the work of the M. S. Swaminathan research Foundations' (MSSRF, Chennai) work in Wayanad (Kerala) and Jeypore (Orissa) through setting up of Community Agro biodiversity Centers. (MSSRF. 2004- 05). The past five years activity has helped in the conservation of local land races (rice, millets etc...) in the community gene bank, at the same time helping the tribals and local people in supporting their livelihood through the utilization of their bio- resources. In Wayanad, the MSSRF has helped the tribal people by multiplying and supplying planting materials of edible tuber crops species, their preferred diet. Besides, their traditional knowledge on the species supplying wild food has been documented. Studies are in Progress in analyzing the nutrient qualities of these species (Narayanan *et al*. 2004) Programmes have been initiated for enriching the nutritive qualities of the varieties used for food.

MSSRF has also contributed to the preparation of an action plan for development of post – tsunami "New Andamans" through studies conducted by a team of experts assembled by the organization who visited the islands. They have recommended the following action to protect the environment and its re-establishment.

- Integrated system for watershed management for agri, silvi – and aquaculture with owners SHGs formed for this purpose in the North Andaman.
- Develop mangrove – based bio – shield with focus on aquaculture to prevent infiltration of saline water.
- Setting up community grain banks to avert transient hunger hotspots.
- For ecological rehabilitation of flora with economic viability, it was suggested to have community – based coconut nurseries with buy back arrangement and erection of mangrove or casurina based bio-shield with coconut, pandanus, arecanut and spices as inter crop in the Nicobar Islands



- The team identified the great potential of the Islands to become organic agriculture islands of the world.(MSSRF. 2004-05)

- They have recommended the cultivation of orange fleshed sweet potato in Nicobar, to fight the vitamin A deficiency, Sweet potato being a favorite food of the Nicobarese, besides *Dioscorea*. In this context, CTCRI, Trivandrum also has contributed to the recunstruction by collecting and multiplying the *Dioscorea* variety preferred in the islands named 'ACHIN' and making the same available for rehabilitation in Carnicobar. The collection was made in a joint exploration conducted in the A & N Islands during 2003 under the NATP-PB programme,of ICAR lead by the NBPGR before the tsunami. The tsunami had resulted in the loss of several local germplasm lines including this one (Unnikrishnan *et al*. 2006)

Biodiversity and Climatic change

Studies have shown that global warming and climatic change are the resultant effects of destruction of large areas of forests flora in Amazon and elsewhere. It is also reported that methane, one of the green house gases is produced in large quantity from rice fields (Rosamond L. Naylor *et al* . 2007). Hence destruction as well as utilization of natural wealth have detrimental effects. We know that plants, terrestrial as well as marine, are the main agents that remove the green house gases like Carbon dioxide from the atmosphere. We cannot stop utilization, but we can stop destruction and strike a balance between that which is used and that which is rejuanated by nature. This is essential for the survival of all living beings on this earth. . "As far as we can tell, our planet is the only place in the black immensities of the Universe where life exists. We are alone in space. And the continued existence of life on this planet now rests in our hands"- David Attenborough.

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Bio-Diversity Conservation in Agro-Ecosystems: Partnership of Banks, Self Help Groups and Farmers Interest Groups

Sukhbir Singh, H. Bharat Kumar & Maddi S. Rao
National Bank for Agriculture & Rural Development

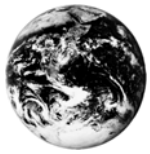
"Biodiversity conservation efforts would be effective only when the economic agenda of the farmers / tribals (who are still depend on *jhum* cultivation/ minor forest produce) is brought to the fore by involving grass root level organizations, banks and private sector, besides Research & Development Institutions and Government Policy."

1. Introduction

Biodiversity in agro-ecosystem is the full range of variety and genetic variability within rural areas viz., agriculture crops, forests, animals, fishery, weeds, pests, diseases, soil micro-organisms, etc and their associations and habitat oriented ecological complex. Bio-diversity conservation has ecological, economic and social agenda for a sustainable development.

Before the advent of the 'Green Revolution', a fine balance was maintained in the agro-eco system by using organic manures, natural control of pests (balance of predators and parasitoids) and use of botanicals from various forest resources. Over-exploitation of natural resources like forests and water bodies, indiscriminate use of fertilizers, pesticides and practice of mono-cropping system has led to erosion of genetic variability and threatening the very sustainability of agriculture in the country.

Food security achieved during Green Revolution is due to close working of the triad viz., Research & Extension,



Government Policy (supply of inputs like seeds, fertilizers, water and Government Procurement) and Rural Financial Institutions with the farming community. In the mean while two new players have come to fore like Private sector and grass root level organizations like Self Help Groups and Farmers Interest Groups.

"The Convention on Biological Diversity" emphasizes the link between conservation and commercialization. Bio-diversity conservation efforts would be effective only when the economic agenda of the farmers / tribals (who are still depend on *jhum* cultivation/ minor forest produce) is brought to the fore by involving grass root level organizations, banks and private sector, besides Research & Development Institutions and Government Policy. Sustainability can be ensured by empowering the workers in the field for which promoting peoples organizations like SGHs and FIGs is essential (www.enrap.org).

M.S.Swaminathan Research Foundation (MSSRF) has been advocating multi-dimentional approach for promoting agro-biodiversity conservation with a combination of activities viz. creating an economic stake in conservation, crop development through participatory productivity enhancement activities, seed supply through network and institutionalization, recognizing, rewarding and supporting women's contribution through appropriate documen-tation and polices, capacity building and enhancing farmers' skills based on needs etc. In this context, the paper dwells at the experiences and possible role of banking system, SHGs and FIGs in agrobio-diversity conservation (www.mssrf.org)

The success of leveraging SHGs in bio-diversity conservation in jhum cultivating areas under North Eastern Region Community Resource Management Project for Upland Areas (NERCRMP), a joint initiative of GoI, IFAD and North Eastern Development Council implemented in Assam, Manipur and Meghalaya can be replicated in other areas. The project interventions have led to optimization (linking jhum clearings with labour availability in the household for subsequent weeding) and rationalization (selection of jhum sites by avoiding critical water sources, stream banks, sites of dense and large trees, canes, etc.) of areas under shifting cultivation leading to improved biodiversity conservation and livelihoods of the communities. New conservation practices achieved through SHGs are summarized below:

An un-jhumed area of 50-100 meters of forest reserve maintained along the perennial streams.

The villagers have started expanding and maintaining natural cane and bamboo reserves artificial regeneration.

SHGs have started recording various flora and fauna available in the village as part of Community Biodiversity Register. Availability of revolving fund and credit opportunity have given them new lessons and responsibility in life, besides improving their livelihoods, income, savings, and above all the total family resource capital. (www.enrap.org)

2. Role of SHGs in Bio-Diversity Conservation

Self Help Groups (SHGs) are a homogeneous groups of 15-20 people (mostly women) coming together for thrift and credit among themselves in order to achieve common economic and social development objectives. SHGs are primarily promoted by NGOs/ Voluntary organizations/ banks for the purpose of accessing credit from the formal banking system. The SHG-Bank linkage program of National Bank for Agriculture and Rural Development (NABARD), since 1992 has created a net work of 25 million SHGs in the country.

SHGs are unique grass root organizations (primarily of poor

GREEN Foundation has revived the seed bank concept in Tamilnadu and Karnataka for conservation of genetic variability of rice, while MSSRF is extensively working in rice genome hot spot among tribal areas of Orissa. Seed mapping of genetic types was done through SHGs and a large number of fast disappearing genetic variation in rice, sorghum, minor millets, oil seeds, wheat, pulses are conserved through management of Grain banks in Green Foundation Areas. Through SHGs, agricultural rituals and ceremonies were tied to the biodiversity conservation efforts by reviving local traditional knowledge of seed conservation. www.greenconserve.com

women in rural areas) who are formed on the principle of "Mutual help, Voluntarism and Thrift & Credit" and have access to unlimited bank credit and not dependent on SUBSIDIES. The systematic capacity building programs, multi stage rating/ grading system evolved by NABARD and implemented by banking system and support structures created for marketing supports, micro-enterprise development can be leveraged for engaging SHGs in the bio-diversity conservation programs.

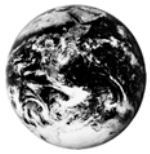
SHGs as peoples organizations can be utilized for education of people on the bio-diversity conservation, developing seed exchanges, linking with markets, developing eco-friendly micro-enterprises etc., Marketing linkages between Government agencies (TRIFED/ IFFCO/ MARKFED/ NAFED/ FCI etc), with SHGs for sale of minor forest produce and traditional agriculture/horticulture crops can ensure economic benefits to the community under bio-diversity conservation programs. TRIFED-SHG linkage in Kolli hills in procurement of minor millets, marketing of traditional scented/medicinal rice varieties in Waynad, Kerala through SHGs, marketing of organic turmeric by SAMANWITA (SBI promoted NGO) and SHGs in Khandamal district, Orissa, are few successful examples of SHGs' role in promotion of bio-diversity conservation through marketing linkages with private/ government sector.

Seed multiplication and exchange among the comm-unities is another crucial link in bio-diversity conser-vation among local commu-nities, specially in crops like minor millets, local varieties/types of pulses, vegetables, oil seeds etc. Traditionally, in local comm-unities, specially among tribals and dry land farmers, *Grain Golas* or Seed banks are in vogue for storage and exchange of seed of local varieties of millets, pulses, oil seeds and vegetables.

Recognizing the economic importance of seed banks in tribal areas and in dry land farming systems, NABARD pilot tested the revival of Grain Golas in Kalahandi, Bolangir and Koraput (KBK Region) of Orissa through SHGs. In collaboration with Kalahandi Anchalik Grameen Bank, SHG-Grain Golas are promoted, where SHGs could save either in the form of cash or grain stored in Golas. This way the savings in the grain are also monetised for accessing the credit from banking system. Seed stored in grain golas ensure availability of suitable seed to the farmers, a major drought proofing method in dry land farming systems.

Self Help Groups are also trained in identification of economic plants in forests, their sustainable method of harvest, drying and packing and linkage with markets so that loca communities receive major share of the value of medicinal plants and minor forest produce (MFP). Capacity building of SHGs and linking with bank credit for trading in MFPs can be a major initiative in bio-diversity conservation of forest resources. NABARD has pilot tested such programs in Orissa, North Eastern India, Uttar Pradesh. Similarly, genetic banks can explored in animal and fish resources. (Jena, Rao & Dora, 2002)

Compilation, documentation and standardization of Indigenous Traditional Knowledge (ITK) on bio-diversity conservation can be cost effectively done through SHGs as they happen to be the



owners and users of this knowledge. Ethno-botanical studies of bio-diversity in forest eco-system could be effectively done through SHGs and with suitable training, SHGs can monitor the bio-diverisity position of respective micro-eco systems.

Non-traditional vegetables and fruits collected from forest provide nutritional and health security to tribal communities, therefore, maintaining bio-diversity in forest and agro-eco-systems are crucial. Methods, frequencies and cultural norms of collection of wild edible food species are indicators of sustainable management of the resources with considerable in-built eco prudence by women. The top young leaves are harvested from plants that are used as leafy vegetables, thus allowing the plants to regenerate. Nuts and fruits are harvested when ripe and only when necessary to meet food requirements; this ensures that the seeds within the fruit mature with viable seed. In tubers, the portions adjacent to the climbing vines are left behind for regeneration. Similarly, areas where mushrooms usually occur are never disturbed; instead, they are made conducive by adding leaves and other forest litter to encourage better natural sporulation. Cultural norms discourage over-exploitation; surplus food is shared with the neighbors. (Rao & Dora, 2002)

3. Role of Farmers Interest Groups

Farmers Interest Groups (FIGs) viz., farmers associations, Farmers Clubs (promoted by NABARD), Farmers Field Schools (promoted by UP Bhumi Sudar Nigam), Van Samrakshan Samities (promoted by Forest Department) and similar institutions can play an important role in promotion of eco-friendly agriculture technologies.

Eco-friendly technologies successfully transferred through Farmers clubs in the country include vermi-hatcheries, bio-fuels, seed production, seed exchanges, bee keeping, fish hatcheries, tree based cropping systems, organic farming, nutritional home gardens, scientific irrigation management through formation of water users' associations etc., Uniqueness of Farmers Clubs is their sustainability because of linkage with credit institutions, rather than depending on subsidies, and mutual benefit of farmers and banks in collaborative working.

There are more than 20000 farmers clubs promoted by banking network (commercial banks, Regional Rural Banks, Co-operative Banks), spread in 505 districts in 29 states and Uts. In Uttar Pradesh, banks with assistance from NABARD have promoted over 500 farmers clubs spread across all districts.

Associating Farmers Interest Groups, Farmers' Field Schools and Van Samrakshan Samities with banking sector can provide the crucial credit resources to their members, besides getting technical/policy support from their respective sponsoring agencies. Supplementing with credit facilities can reduce dependence on government subsidies and most importantly in promoting eco-friendly micro-enterprises among the stake holders.

NABARD is also creating awareness about the bio-diversity conservation through " Environmental Protection program" " Farm Innovation Fund" and "Research & Development Fund" which are implemented through NGOs/ Research Institutions, for demonstration of eco-friendly technologies in rural areas. Eco-friendly technologies promoted, thus far, are bio-fuel, bio-gassifiers, vermi-composting, bio-fertilizers, watershed development, conservation of local breeds of animals/fishes, through setting up of demonstration units, field testing of economic viability of these technologies and providing backward and forward linkages.

4. Eco-Friendly Credit Products from Banking Sector

From the traditional security

Farmers Clubs are promoted by NABARD since 1982 to promote principles of "Development through Credit". 15-20 progressive farmers who have taken bank loan, utilized on scientific cultivation and repaid the loan come together to form a farmers club under aegis of the service areas branch of the village. Members meet regularly to discuss the developmental problems of the village and prioritize their needs. Under assistance from NABARD and sponsoring bank, farmers clubs undertake leadership development programs, technology-transfer programs under farm and non-farm sector and also assist the banks in expanding their reach in providing credit services to the entire village. Now the scope of the farmers clubs have been expanded to work as suppliers of key inputs (specially of organic farming), pooling agents of produce for linking with commodity exchanges/marketing agencies, transfer of eco-friendly technologies and promoting Self Help Groups, etc. www.nabard.org

based or financial viability appraisal of banks in funding projects, environmental appraisal and stake holder analysis are introduced in banks' appraisal to factor in the ecological impact of the projects. Ecological costs and benefits of the projects are factored in while evaluating the viability, thus promoting eco-friendly technologies/projects.

Prioritized financing of non-conventional energy sources like solar, wind energy projects and implementation of capital investment subsidy schemes like vermi-hatcheries, bio-fertlizers and fruit & vegetable waste composting are helping the bio-diversity conservation, specially in restoring the soil-microbial balance.

Special credit products are developed for diversified multi-cropping systems in tribal areas namely "Homestead Farming", Cyclical Credit for dryland farmers, "Watershed based micro credit plans" and a special line for credit for tribals from Nabard for facilitating collection, marketing of minor forest produce.

In recent time, new models of financing have been introduced for financing of traditional breeds of animals, local varieties of fruits (eg pickle variety of mango; financing of minor fruits like bael, star apple, karonda etc), minor millets and tree-based cropping systems through suitable redesigning of the schemes. .

Shift from the erstwhile working capital term loan under "crop loaning system" to revolving credit system under Kisan Credit Cards to meet flexible credit/ consumption needs of the family will suit the multi-enteprise strategy under bio-diversity conservation strategy.

5. Conclusion

Bio-Diversity Conservation efforts needs multi-dimentional approach and peoples organizations promoted by banking sector like SHGs and Farmers Clubs can be co-opted by Bio-diversity Conservation board for extending the reach and effectiveness. Banking sector under leadership of NABARD can play an important role in promoting bio-diversity conservation compatible banking financing in the country. NABARD can support the initiatives of Government and NGOs in bio-diversity conservation through soft loan or grant funding though Rural Infrastructure Development Fund (RIDF), Rural Innovation Fund, Watershed Development Fund and Research & Development fund programs, etc.

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Informatics for Biodiversity Conservation: Scope, Present Status And Future Perspective

Ajai Kumar Srivastava, P.F.S., U.P.

"A computerized system for storage and manipulation of biodiversity data is known as Biodiversity Conservation Information System. This is a global partner-ship to use Internet Technology."

1. Introduction

Biodiversity is contraction of the phrase, "biological diversity". Variation is the law of nature. It occurs everywhere and every moment. The variation takes place at macro levels at short space and small time period, but these become apparent only over a large space and big a time gap. The variety and variation of organisms and ecosystem is referred to as biological diversity. The biodiversity is measured as a degree of variety in natural resources.

The future of life on our planet has become a matter of great concern. Efforts are being taken to conserve the environment and save plants and animals. The conservation of biodiversity is distinct but related to biological resources. It is linked with the maintenance of ecological stability and productivity. It involves number of parameters such as number of species, genes and ecosystem they occupy, their population dynamics, and distribution, habitat, structure, microhabitat physical environment, climate, and present management etc. Advanced and updated knowledge of different species is essential for successful biodiversity conservation efforts.

Information plays an important role in study and conservation of biodiversity. Objective of informatics is to create system for combined use of Information Technology and Telecommunication in the particular field. Bioinformatics or computational biology is the use of

mathematical and informational techniques, including statistics, to solve biological problems, by using computer programmes, mathematical models or both. One of the main areas of this field is data mining and analysis of the data collected from various sources. It is a process of economic and scientific co-operation. The database facilitates use and reuse by different user groups. Common / Standard protocol is used to store and retrieve the data in the Information System. This paper is to discus the relevance of informatics / bioinformatics in biodiversity conservation (specifically termed as Biodiversity Information system" and an overview of information related databases.

2. Definitions

A. Biodiversitiy :

Biodiversity has been defined in different ways covering many aspects of biological variations. In popular usage, biodiversity describe all the species living (all plants, animals and micro-organisms) in a particular area and their interaction with non living things in the ecosystem. It is variation of taxonomic life forms within a given ecosystem, biome or for the entire earth. No definition could completely eliminate overlap with other activities or preclude variations in interpretation of biodiversity by different individuals and organizations. Some of the most widely used definitions are as below:

i. "Biodiversity" encompasses the variety of all living forms on the planet, extending from genes to species and species to ecosystem.

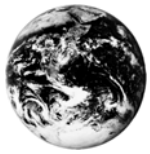
ii. "Variation of life at all levels of biological organizations".

iii. "Totality of genes, species and ecosystem of a region". This definition describes most circumstances and presents a unified view of three levels of biodiversity, i.e. genetic diversity (variation of genes with in the species), species diversity (variety of species within region) and ecosystem diversity (composition and structure of communities).

B. Biodiversity Conservation

Loss of biodiversity and the alteration of ecological processes are difficult to measure directly. Information about genome and systems biology (i.e. coordinated study of biological systems by investigating the components of cellular networks and their interactions with experimental efforts) is essential for successful biodiversity conservation practices. The extent of extinction of many species is being more significant. The biodiversity conservation has become a global concern, but the financial stakes are high. It refers to a range of actions like protection, maintenance and management, sustainable use and restoring biodiversity. It is categorized as, in-situ conservation (in their natural habitat) and ex-situ conservation (outside their natural habitat). In-situ conservation is treated as ideal conservation strategy but its implementation is some time infeasible. In forests and "Protected Area" in-situ conservation ensures proper preservation. For conservation of rare and endangered species ex-situ conservation is a more effective method. It is done through planting germplast in seed banks or growing the species in nurseries. It allows protection, preservation and conservation of large populations of plants with minimal genetic erosion. Some biologists believe that Ex-situ conservation is useful to provide a backup solution to in-situ conservation and desired results are seen. Combination of in-situ and ex-situ conservation methods can ensure proper and better preservation.

The first step in bio diversity conservation is documentation based on the availability of information about each species with data starting from its taxonomic / systematic position to genetic / molecular aspects. In most of the biodiversity databases, data is held either about the species or specimens such as: nomenclature, descriptive data, economic importance, conservation status,



images and bibliography sources of data used in the database.

C. Informatics

Informatics for biodiversity is to assist the scientists, biologists, environmentalists and conservationists etc. in their respective role to conserve biodiversity. The informatics for biodiversity is broadly included in bioinformatics. It is rapidly developing branch of biology and is highly interdisciplinary. Bioinformatics describes any use of computers to handle biological information. It derives knowledge from computer analysis of different databases. The database can consists of the information stored in the genetic code, experimental results from various sources, patient statistics and scientific literature about the species. The "Classical" bioinformatics is defined as, "the mathematical, statistical and computing methods that aim to solve biological problems using DNA and amino acid sequences and related information".

3. Informatics for Biodiversity Conservation

Biodiversity is distributed all over the world but the scientific information about biodiversity is largely concentrated in major centers in developed countries, especially in the scientific collections of the world's natural history museums, herbaria and microorganism repositories. Data about biodiversity are either scattered in many databases or reside on paper or other media not amenable to interactive searching. There is an enormous amount of information already collected about the world's biodiversity. However, most of this information is not digitized. Thus, in most case, the only way a potential user can find data is to travel physically to the place where the specimen is housed or to contact the repository where a relevant specimen may be housed. The suitable use and management of biodiversity will require data about it be available when and where that information is needed by decision-makers and scientists alike. Because biodiversity information is not immediately at hand, it is often not applied in policy or management decisions that affect the organisms involved, nor is that information readily accessible by users.

During last few years there have been many interactive initiatives among different organizations towards use of Information Technology and its tools in biodiversity conservation, which will become an integral part of all future molecular biology research as well as biodiversity conservation activity. The ultimate goal of the informatics / bioinformatics is to uncover the wealth of biological information hidden in the mass of data and obtains a clear insight into the fundamental biology of organisms.

4. Biodiversity Conservation Information System

The massive development of biodiversity related information system over the Internet has created much excitement in recent years. A large number of conservation organizations have joined to create the "Biodiversity Information System" and "Biodiversity Conservation Information System". A computerized system for storage and manipulation of biodiversity data is known as Biodiversity Conservation Information System. This is a global partnership to use Internet Technology. These organizations share their data, information and expertise.

The Global Biodiversity Information Facility (GBIF) opened its information system in early 2004. GBIF's data portal now integrates tens of millions of records of primary biodiversity data from hundreds of databases worldwide in museums, botanical gardens, and observation networks such as those of bird watchers. The databases that pertain to the "Biodiversity Information System" of any country and that form a part of "Global Biodiversity Information System" are submitted to an information validation process before being

placed on line for consultation by the general public.

The system is providing ready access to the most current knowledge about biodiversity including location, distribution, trends and protective measures. This data may include a large proportion of geographical (spatial) information along with data specific to the description of plants, animals and their habitats. This new system based knowledge will have profound impact in the field of biodiversity conservation.

The "Biodiversity Information System" (BIS) is most commonly used Information System for study and analysis of biodiversity and "Biodiversity Conservation" activities. It is an effort to characterize vegetation cover, fragmentation, disturbance, variances and biological richness across the landscape. In the Biodiversity Information System (BIS) field samples of key ecological characters have been used for geospatial extrapolation. BIS allows identification of gap areas, species / habitat relationship and helps in biodiversity conservation planning by setting priority areas for different species. Detailed site specific field inventories with this database can be used for identifying areas for bio-prospecting. The knowledge base with respect to ecosystem uniqueness, species richness, biodiversity value is used to create attribute information of the composite strata of vegetation type and disturbance regimes. Indian plant biodiversity has been organized and available in BIS, with its four major components as listed below:

I. BIOSPATIAL (Biodiversity Spatial Query Shell).

II. PHYTOSIS (Plant Information System).

III. FRIS (Forest Resource Information System).

IV. BIOSPEC (Biodiversity Conservation Spatial Decision Support System).

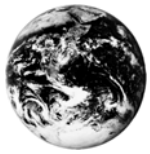
Data from BIS is accessible through authentic username and password. These arrays of new databases and data sources are counterbalanced by the difficulty in knowing the nature and location of the Information System. Analytical results prepared from these sources can form the basic guideline to plan floral and faunal inventories in future. The dataset can provide basic information for monitoring and forecasting of changes in vegetation. Extinction models using multi-temporal data can be prepared. Modeling of results can help in studying the impact of global change in different landscape. Finally the approach can be extended to study genetic and species diversity in biologically rich sites. The study allows fixing prioritized focus on bio-prospecting. Biologists and computer scientists have started functioning together to address the problem of biodiversity conservation. New data types generated by satellite imagery have significant influence over the biodiversity conservation.

5. Advantages of Biodiversity Information System (BIS)

It is expected that Biodiversity Information System will lead to develop major advances for giant "Global Biodiversity Information System". It will provide centralized database for preserving the biodiversity data. The system will help in decision making process. Integrated and combined access to the multifaceted information system opens perspectives for the implementation of new applications. It can reduce expenditure over large group of human for data collection, analysis, and knowledge and information generation.

6. Challenges to Global Biodiversity Information System

The greatest challenge facing the biologists' community today is to make sense of the wealth of data that has been produced through different research projects. The other important challenge facing the bioinformatics community



today is the intelligent and efficient storage of this mass of data. It is then their responsibility to provide easy and reliable access to this data. The data itself is meaningless before analysis and the sheer volume present makes it impossible for even a trained biologist to begin to interpret it manually. Therefore, incisive computer tools must be developed to allow the extraction of meaningful biological information. Data collection, and its subsequent storage, interpretation and analysis are entirely computer dependent tasks. Development of application software involves very high cost. It is believed that the cost of software development will go down subsequently in near future. Benefit sharing among conservationists, researchers, and people affected due to biodiversity conservation efforts; information system developers, and other user groups need to be in well defined equitable way.

7. Funding and Cost / Benefit Analysis of BIS

Informatics is directly related with growth of economy of many countries. Present Indian economy is influenced by growth of IT industry. The social as well as the special benefits in the field of research from the adoption of Informatics are enormous. The projects related to development of "Information Systems" have very high potential of offering cost-effective, improved and easy-to-access services to citizens, and improved processing of transactions both within the government and between the government and other agencies. The planning, implementation, and monitoring of biodiversity conservation programmes, projects, and activities can be significantly strengthened by these applications.

Simply, cost benefit analyses are not a viable way to evaluate BIS. We can explore the extent of benefits by using cost-benefit ratio. Recent estimates suggest at least 70 to 80 per cent of the costs of Information and Communication Technology related projects and activities are taken up in intangible, largely hidden costs. Likewise, the majority of BIS benefits are also intangible. Indeed there is a strong argument for not making cost / benefit analysis, the control plank of decision making. Despite many challenges of developing BIS, many fruits of BIS should be not overlooked by the scientists. BIS can replace higher human costs with lower ICT costs to support efficiency and effectiveness. Important requirement in the field of financing for BIS are as below:

A. Large investment is needed in the areas of Biodiversity Information System enabling subjects of biology, biotechnology, forestry, mathematics and statistics.

B. An increase in funding to Biodiversity Information System by the Government and Private Sectors should be one of the priorities and this increase could be linked to specific outcomes.

C. The benefits of Biodiversity Information System go beyond economic advantages; including environmental benefits helping to preserve biodiversity and mitigate global warming.

8. Security and Privacy Issues in BIS

Informatics plays an important role in wide range of issues to improve efficiency. As it develops more and more, privacy and Intellectual property issues arise. The creation of specific research databases and the storage of data raise privacy concerns through access and potential use of individual's data. Protection of "Intellectual Property Rights" of user groups in the system is very essential. It is required to design and implement a definite information security management plan / system. People related with Informatics have always been concerned about the ability of outsiders to "hack" into their computing environments and

gain access to proprietary information. The threat of hacking is primarily a threat from the insider.

9. Conclusions

Loss of biodiversity is regarded as one of the key problems affecting the environment. Economic and development policies should be oriented, to respect the earth's carrying capacity. Many users of natural resources are undertaking actions that conserve biodiversity. Bioinformatics is a field that has been developing over the last 20 years. It is a discipline that represents a marriage between biology and computer technologies and has evolved through the convergence of advances in each of these fields. Application of information technology has improved Biodiversity Conservation Systems to organize, link, analyze and visualize complex sets of biological data and enables significant gains in renewable resource conservation, and improvement of environmental quality.

Informatics combined with biotechnology can improve the impact of tools and processes used in Biodiversity Conservation. It has provided new group of powerful tools for research and ultimately for accepting development. Successful development and application is possible only when a broad research and knowledge base in the biology, variation, breeding, physiology, taxonomy, pathology, biochemistry and genetics etc. of the plants exist in the easily accessible database. It needs continued commitment to basic research and field practices. Biodiversity Information industry is expected to have a growth rate at par with the national growth rate with greater employment opportunity.

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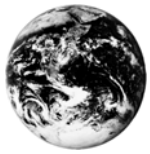
III. Online Journal of Bioinformatics: www.cpb.ouhsc.edu/ojvr/bioinfo.htm

IV. Convention on Biological Diversity: www.biodiv.org

V. Ecosystem and Awareness Research Network ALTER - Net: www.alter.net

VI. International Mechanism of Scientific Expertise on Biodiversity: www.imoseb.net

VII. Global Biodiversity Information Facility (GBIF), GBIF's data portal: www.gbif.org



BIODIVERSITY AND CLIMATE CHANGE*

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"Biological diversity is the abundance of all living beings which includes all plants, animals, microorganisms, the ecosystems of which they are part, and the diversity within species, between species, and of ecosystems."

Introduction

The world's population is expected to reach 9.2 billion by 2050. This year marks a paradigm shift. 2007 will be remembered as a major milestone. For the first time in history, the world's urban population will exceed its rural population. The majority of the world's population is now living in urban areas, mainly in poor countries; poor in terms of money, but very rich in terms of biodiversity. The impact is expected to have far-reaching implications on humanity. India has already 10 of the 30 fastest growing cities in the world. It is expected that 140 million rural dwellers would migrate to Indian cities by 2030 and 700 million, a population equivalent to all Europe by 2050. It is therefore expected that 45,000 rural migrants will arrive in Indian cities every day between now and 2050 or 31 persons per minutes.

India is one of the mega diverse countries and has 45,000 reported plants and 89,492 reported animal and only 70% of its territory has been surveyed. If not managed adequately, the growth of the urban population may accelerate the unprecedented loss of biodiversity of our planet. The millennium Ecosystem Assessment, a study

* *Key Note Address on International Biodiversity Day-2007 at Lucknow.*

carried out by 1,395 experts from 95 countries, has shown that, since their appearance on Earth, human beings have never destroyed the web of life as much as during the last fifty years. In a recent past, 47 percent of the Earth's surface was covered in forest. Since then, forest cover has completely vanished in 25 countries and only 10 percent remains in 29 others. 10 million hectares of forests continue to disappear each year. It is a well-established fact that tropical forests are the richest ecosystem in terms of biodiversity. Although they only represent 7% of the world's surface, tropical forests currently house upto 80% identified living species.

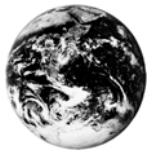
Biodiversity

Biodiversity is vital to all life forms—it defines our ecological systems and landscapes, and is a fundamental part of world's identity. Biological diversity is the abundance of all living beings which includes all plants, animals, microorganisms, the ecosystems of which they are part, and the diversity within species, between species, and of ecosystems. Biodiversity is determined by the interaction of many factors that differ spatially and temporally. Biodiversity has immeasurable social, cultural and aesthetic values, which include the following services:

- **Supporting services:** including, soil formation and retention, nutrient cycling, primary production.
- **Regulating services:** include regulation of air quality, climate, floods, soil erosion, water purification, waste treatment, pollination, and biological control of human, livestock and agriculture pests and diseases;
- **Provisioning services:** include providing food, fuelwood, fibre, biochemicals, natural medicines, pharmaceuticals, genetic resources, and fresh water;
- **Cultural services:** include cultural diversity and identity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage, recreation, communal, and symbolic values.

Economic potential of Bioresources

Biodiversity provides the goods and services that are crucial for human survival and well being. Ecosystems process our air and water and contribute to our national economic wealth through agriculture, forestry, fisheries, biodiscovery and tourism. The combined annual global market for the products derived from bioresources is roughly between US$ 500 billion and US$ 800 billion. India is one of the 12 global mega biodiversity centres harboring approximately 8% of the global biodiversity existing in only 2.4% of the land area. The country is also home to two of the world's 25 hotspots. The varied cultural diversity across the country as well as a very ancient traditional knowledge system associated with the biodiversity represents added assets. Nonetheless, much of this biodiversity is in peril owing, in the main, to anthropogenic causes. Thus, if the goal of converting our bioresources - animal, plant, microbial and marine - into commercially useful products and processes is to be realized, we need to not only conserve the biodiversity and but also utilize it in a sustainable manner. In this context, absence of a good quantitative information network on bioresources combining remote-sensing data and ground surveys is a major constraint. The situation is even worse for microorganisms. Field- and marine biologists rarely work with molecular scientists and chemists, pharmacologists or other experts, and there is practically no bioprospecting industry. While our traditional knowledge base would be the starting for bioprospecting, ethics and equity should be our guiding principles in benefit sharing. For Bioresource development and utilization a



National Bioresource Development Board has been set up by the Department of Biotechnology. Department is also supporting a major programme in the area of Environmental Biotechnology and Biodiversity Conservation.

Climate change

Globally the climate has changed over the last century. For example, since 1900, the average surface temperature of the earth has risen by about 0.6°C, there have been more heat waves and heavy rainfalls, there have been fewer frosts, glaciers and sea-ice have retreated as the oceans have warmed and sea levels have risen by 10–20 cm. The last ten years formed the warmest decade globally, and 1998 was the warmest year since temperature records with adequate global coverage began in 1861. Past changes in the global climate resulted in major shifts in species ranges and marked reorganization of biological communities, landscapes, and biomes. The present global biota was affected by fluctuating concentrations of atmospheric carbon dioxide, temperature, and precipitation, and sea level rise. The current levels of human impact on biodiversity are unprecedented, affecting the planet as a whole, and causing large-scale loss of biodiversity. Human activities have already resulted in loss of biodiversity and thus may have affected goods and services crucial for human well being.

Biodiversity and Climate change: Impacts

Many human activities produce greenhouse gases that can reduce the amount of infrared radiation from the sun that can escape from our atmosphere. This effect can increase temperatures and produce an enhanced' greenhouse' effect. The increased temperatures in the lower atmosphere can cause changes to the weather and climate worldwide and consequently, the enhanced greenhouse effect is often referred to as global warming. Increasing temperatures lead to changes in many aspects of weather and can cause changes in the amount, type, and seasonal patterns of rain, and the types and frequency of severe weather events such as droughts and floods.

Changes in climate over the last few decades of the 20th century have already affected biodiversity. Projected changes in climate during the 21st century will occur faster than in at least the past 10,000 years and combined with land use change and exotic/ alien species spread, are likely to limit both the capability of species to migrate and the ability of species to persist in fragmented habitats. Changes in biodiversity at ecosystem and landscape scale, in response to climate change and other pressures (e.g., deforestation and changes in forest fires, introduction of invasive species), would further affect global and regional climate. Terrestrial and oceanic ecosystems play a significant role in the global carbon cycle and their proper management can make a significant contribution to reducing the build up of greenhouse gases in the atmosphere.

Climate change, mitigation and adaptation option on biodiversity

Land-use, land-use change and forestry activities can play an important role in reducing net greenhouse gas emissions to the atmosphere. Biological mitigation of greenhouse gases through Land Use, Land-Use Change and Forestry (LULUCF) activities can occur by three strategies:

(a) Avoiding deforestation

(b) Afforestation and reforestation, and

(c) Substitution of fossil fuel energy by use of modern biomass.

Most of the world's forests are managed, hence improved management can enhance carbon uptake or minimize carbon losses and conserve biodiversity.

Agro forestry systems have substantial potential to sequester

erosion, moderate climate extremes on crops, improve water quality, and provide goods and services to local people. Agro forestry can greatly increase biodiversity, especially in landscapes dominated by annual crops or on lands that have been degraded.

There are significant opportunities for mitigating climate change, and for adapting to climate change, while enhancing the conservation of biodiversity. Mitigation involves reducing the greenhouse gas emissions from energy and biological sources or enhancing the sinks of greenhouse gases. The ecosystem approach of the Convention on Biological Diversity provides a flexible management framework to address climate change mitigation and adaptation activities in a broad perspective.

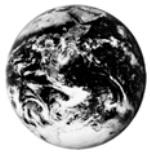
Adaptation is necessary not only for the projected changes in climate but also because climate change is already affecting many ecosystems. Reduction of other pressures on biodiversity arising from habitat conversion, over-harvesting, pollution, and alien species invasions, constitute important climate change adaptation measures. Conservation of biodiversity and maintenance of ecosystem structure and function are important climate change adaptation strategies because genetically-diverse populations and species-rich ecosystems have a greater potential to adapt to climate change.

Government's initiatives and approaches

Climate change has concerned scientists for many years, but it only became a major international issue in the late 1980s. The 1987 report of the United Nations World Commission on Environment and Development focused international attention on the threat climate change posed to the global environment and economy. High-profile international conferences were held in Toronto (1988), the Hague (1989) and Noordwijk (1989) to discuss the issue. United Nations Framework Convention on Climate Change (UNFCCC), signed by over 150 countries at the Earth Summit. The ultimate objective of the Convention is:

"Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

India signed the UNFCCC in 1993 and initiated concerted efforts on several fronts to comply with the relevant obligations under the UNFCCC, including the submission of an initial national communication. India has a large territory represented by complex geography and climate patterns. The high regional and sector variability in levels of social and economic development leads to similar patterns in vulnerability and adaptation measures due to climate change impacts. This necessitates in-depth regional and sector studies to estimate greenhouse gas (GHG) emissions as well as to assess vulnerability and adaptation measures across the country. In order to fulfill the requirements of the UNFCCC, the Indian government, through its various institutions and resources, has strengthened its researches on the (1) science of climate system and climatic change, (2) impact on social and economic development and (3) response strategies. The Ministry of Environment and Forests (MoEF), Government of India, has initiated a National Communication (NATCOM) project for communicating to the UNFCCC about anthropogenic emissions of GHGs from various sources and their removal by sinks not controlled by the Montreal Protocol. As a UNDP project funded under the Global Environment Facility (GEF), NATCOM is as per the commitment under UNFCCC.



There are various approaches for supporting planning and decision making

i. Mutually beneficial activities i.e. policies and projects between the United Nations Framework Convention on Climate Change and its Kyoto Protocol, the Convention on Biological Diversity and broader national development objectives can be implemented to take advantage of the synergies.

ii. The transparent and participatory decision-making processes involving all relevant stakeholders, can enhance the probability of long-term success.

iii. A range of tools and processes are available to assess the economic, environmental and social implications of different climate-change-mitigation and adaptation activities i.e. projects and policies within the broader context of sustainable development.

iv. Strategic environmental assessments and environmental impact assessments can be integrated into the design of climate change mitigation and adaptation projects and policies to assist planners, decision-makers and all stakeholders.

v. For monitoring and evaluating the impacts of climate change and to assess the impacts of climate change mitigation and adaptation activities on biodiversity. National, regional and international systems of criteria and indicators could be used.

vi. Current criteria and indicators developed under the Convention on Biological Diversity, and the many other national and international initiatives could assist in assessing their utility to evaluate the impact of activities undertaken by Parties to the UNFCCC and its Kyoto Protocol.

In India, a Biodiversity Act is already in place under the umbrella of MoEF, to ensure the conservation and sustainable utilization of bioresources.

The extinction of animal and plant species is now between 100 and 1000 times higher than the natural rate. Already 20% of known bird species have disappeared. Forty five percent mammals are in decline and 28% are under direct threat. Unless urgent action is taken, by mid-century up to fifth of the Earth's remaining plant species may be doomed to extinction. We are consuming more natural resources than can be regenerated. Humankind is living beyond the means and capacities of our planet. Cities occupy 2 % of the planet's surface but their residents use 75% of the Earth's natural resources. Large population living in mega cities consume massive amounts of energy, thus contributing to climate change, which has been identified as one of the main drivers of the unprecedented loss of biodiversity. Realizing the significance of biodiversity the international community celebrates the International Day for Biological Diversity on 22 May under the theme biodiversity and climate change.

What we can do

Now what can we do to protect our biodiversity and climate change. As is evident that under climate change, the distribution of many species and ecosystems is likely to change. Existing communities may dissolve, while new ones may form. Patterns of biodiversity in the landscape may change and species that are currently 'protected' in reserves may not be adequately conserved in the future.

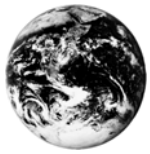
We therefore need to:

- help the natural adaptation of species to climate change
- Protect species that are particularly vulnerable to climate change.

We can take some actions that may make species and ecosystems respond better to

climate change. Such adaptations to climate change could include planning and management interventions that would better protect our biodiversity and help build its resilience (ability to cope) to climate change.

Protected areas like national parks and other types of conservation areas can also be used to facilitate natural adaptation of biodiversity to climate change. Protected areas can be networked and linked within regions and over the whole country. Several actions may be taken that can be included in the design, planning and establishment of protected areas to help biodiversity adapt better to climate change. Special tools (models and computer programmes) may be used to help predict the impact of climate change on our ecosystems and species. There is a need to create refuges and buffer zones. To maximize future conservation of biodiversity we need to identify locations that need buffer zones and refuges. In addition, we need to launch long term monitoring and evaluation programs, in order to identify the best management techniques for the protection of each of our most vulnerable species like fire management, grazing, regeneration of habitats.



International Conventions/ Protocols on Biodiversity and Climate Change

Pawan Kumar[1] & Pratibha Singh[2]

"Levels of exploitation of some animal and plant species are high and the trade in them, together with other factors, such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction."

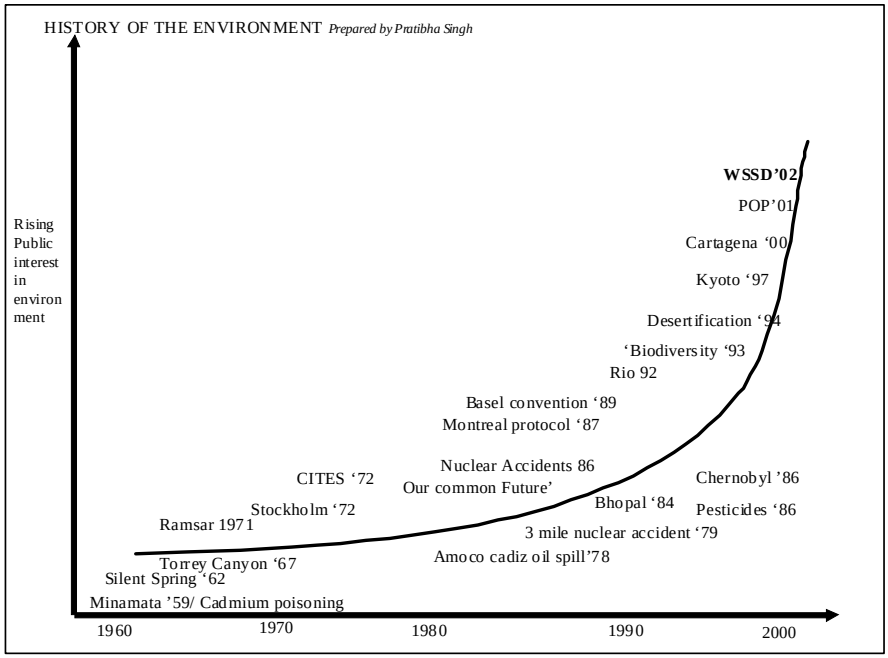
Long before *Silent Spring* was written and Greenpeace activists defied whalers' harpoons, many thousands of "green crusaders" tried to stop pollution, promote public health and preserve wilderness. The forgotten history of the environment comes as a surprise to many people, but the facts have been there all along, in manuscripts, publications and historical archives. Timbering stripped the forests of Babylon, Greece, Lebanon and Italy with the rise of civilization. Lead poisoning was common in upper class Romans who used lead sweetened wine as a condiment. In the middle ages and renaissance timbering in the forests of England, France, Germany left large tracts denuded by 1550 AD. Thomas Malthus (1798) in his essay on population predicted that eventually food and resources will run out as populations will explode. Deadly smog episodes in London (1952), New York (1953), Los Angles (1954) took place leading to the first International Air pollution Conference in 1955.

Silent Spring was written by Rachel Carson[i] and published

1. *Special Secretary Forests , UP*
2. *Officer On Special Duty, Forests, UP*

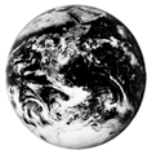
by Houghton Mifflin in September 1962. The book is widely credited with launching the environmentalism movement in the West. The book inspired widespread public concerns with pesticides and pollution of the environment. Silent Spring facilitated the ban of the pesticide DDT[ii] in 1972 in the United States. The book claimed detrimental effects of pesticides on the environment, particularly on birds. Carson accused the chemical industry of spreading disinformation, and public officials of accepting industry claims uncritically. She proposed a biotic approach to pest control as an alternative to DDT, claiming that DDT had been found to cause thinner egg shells and result in reproductive problems and death.

The **Club of Rome** was founded in April 1968 by Aurelio Peccei, an Italian industrialist, and Alexander King, a Scottish scientist. The Club of Rome raised considerable public attention with its report *Limits to Growth*, which has sold 30 million copies in more than 30 translations, making it the best selling environmental book in world history. Five variables were examined in the original model, on the assumption that exponential growth accurately described their patterns of increase. These variables are: **world population, industrialization, pollution, food production and resource depletion**.



The flowering of modern environmental law began in the **1972 Stockholm Conference** on the Human Environment. Since 1960, the environmental and human health impacts of industrial development had begun to attract broad attention in the developed nations. As nations started to expand their environmental laws and regulations, the Stockholm Conference laid the foundation for a similar expansion in the international field. It encouraged states to protect the environment through international agreements, endorsed their right to compensation for pollution from other nations, and without using the phrase, asserted the importance of achieving what has become known as **sustainable development.**

The Stockholm Conference established a new organization to pursue these goals, but did so in an ambiguous way. At the conference's direction, **the UN founded UNEP**, but gave it a relatively small budget and general authority to catalyze international environmental agreements. The next two decades were busy times for environmental lawmakers and diplomats. The U.S. and most other industrialized economies enacted statutes to protect clean air, clean water, safe drinking water, endangered species, and the like. At the international level, with help from UNEP, nations began to negotiate agreements to respond to environmental problems. The top concerns were saving endangered species of animals and plants and their habitats and industrial pollution across borders.



In the 1980s and 1990s, agreements broadened to deal with global issues, such as climate change and biodiversity, which proved much more complicated and tougher to fix. The players expanded too. Civil society groups such as Greenpeace, multinational corporations, and regional and global trade organizations acquired influential voices in international environmental discussions.

There are five important international conventions focus on biodiversity and climate change issues:

1. The Ramsar Convention on Wetlands (1971) ,
2. The World Heritage Convention (1972),
3. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975),
4. The Convention on Conservation of Migratory Species (1983) and
5. The Rio Conventions (1992),

The Convention on Biological Diversity is the most recent of these multilateral environmental agreements, arising out of the Rio Earth Summit of 1992, some twenty years after Ramsar (1971), WHC (1972) and CITES (1975) entered into force, and ten years after CMS did (1983). Each of the biodiversity-related conventions works to implement actions at the national, regional and international level in order to reach shared goals of conservation and sustainable use.

1. The Ramsar Convention on Wetlands (1971)[iii]

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for **the conservation and wise use of wetlands and their resources.** There are presently 154 Contracting Parties to the Convention, with 1669 wetland sites, totaling 151 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

The Convention's mission is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".

The Convention uses a broad definition of the types of wetlands covered in its mission, including swamps and marshes, lakes and rivers, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans.

Contracting Parties (member countries) commit themselves to:

- **at least one wetland** that meets the criteria for inclusion in the ***List of Wetlands of International Importance ("Ramsar List")*** and ensure the maintenance of the ecological character of each of these "Ramsar Sites".
- **Promoter the wise use of all wetlands**
- **Promoter training in wetland research, management and wise use**;

The **Ramsar Secretariat**, which shares headquarters with IUCN - The World Conservation Union, in Gland, Switzerland, manages the day-to-day activities of the Convention. The **MedWet Initiative**, with its outposted Coordination Unit in Athens, Greece, provides a model for regional cooperation for implementation of the Convention. Nationally, each Contracting Party designates an **Administrative Authority** as its focal point for implementation of the Convention.

2.The World Heritage Convention (1972)[iv]

The primary mission of the

World Heritage Convention (WHC) is to identify and conserve the world's cultural and natural heritage, by drawing up a list of sites whose outstanding values should be preserved for all humanity and to ensure their protection through a closer co-operation among nations. World Heritage sites belong to all the peoples of the world, irrespective of the territory on which they are located. The United Nations Educational, Scientific and Cultural Organization (UNESCO) seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. This is embodied in an international treaty called the Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by UNESCO on 16th November, 1972

World Heritage is the designation for places on earth that are of outstanding universal value to humanity and as such, have been inscribed on the World Heritage List to be protected for future generations to appreciate and enjoy. Places as diverse and unique as the Pyramids of Egypt, the Great Barrier Reef in Australia, Galapagos Islands in Ecuador, the Taj Mahal in India, the Grand Canyon in the USA, or the Acropolis in Greece are examples of the 788 natural and cultural places inscribed on the World Heritage List to date. India has almost 26 sites listed starting from the Taj mahal in 1983 to Kaziranga National Park (1985), Keoladeo National Park (1985), Manas (1985), Sunderbans National Park (1987), Nandadevi (1988), Valley of flowers (2005).

So far, more than 33 tropical forest sites – covering more than 26 million hectares – have been included on the World Heritage List. Thus, the programme already plays a key role in conserving a large proportion of the world's biodiversity. But many forests with widely recognized outstanding biodiversity value are not under World Heritage protection, and need to be included before their biological wealth is lost.

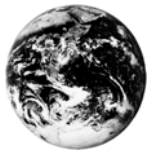
Once a country signs the Convention, and has sites inscribed on the World Heritage List, the resulting prestige often helps raise awareness among citizens and governments for heritage preservation. Greater awareness leads to a general rise in the level of the protection and conservation given to heritage properties.

3. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITIES) (1975)[v]

The Convention on International Trade in Endangered Species of Wild Fauna and Flora, (CITIES) is an international agreement whose aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Annually, international wildlife trade is estimated to be worth billions of dollars and to include hundreds of millions of plant and animal specimens. The trade is diverse, ranging from live animals and plants to a vast array of wildlife products derived from them, including food products, exotic leather goods, wooden musical instruments, timber, tourist curios and medicines. Levels of exploitation of some animal and plant species are high and the trade in them, together with other factors, such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction. Many wildlife species in trade are not endangered, but the existence of an agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future.

Because the trade in wild animals and plants crosses borders between countries, the effort to regulate it requires international cooperation to safeguard certain species from over-exploitation. CITES was conceived in the spirit of such cooperation. Today, it accords varying degrees of protection to more than 30,000 species of animals and plants,



whether they are traded as live specimens, fur coats or dried herbs.

CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finally agreed at a meeting of representatives of 80 countries in Washington DC., United States of America, on 3 March 1973, , and on 1 July 1975 CITES entered in force.

For many years CITES has been among the conservation agreements with the largest membership, with now 171 Parties.

Around 25,000 plant species and 5,000 animal species are covered by the provisions of the Convention, in the following proportions:

1) Appendix I: about 600 animal species and 300 plant species;

2) Appendix II: about 1,400 animal species and 25,000 plant species; and

3) Appendix III: about 270 animal species and 30 plant species.

These figures are only estimates because, for instance, even though the whole orchid family and most cacti are included in Appendix I or II, there does not exist any complete list of all orchids and cacti in the world.

4. The Convention on Conservation of Migratory Species (CMS), (1983)[vi]

Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention signed in Bonn, Germany, on 23 June 1979) *aims to conserve terrestrial, marine and avian migratory species throughout their range*. It is an inter-governmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include *101* (as of 1 January, 2007) Parties from Africa, Central and South America, Asia, Europe and Oceania.

1. **Appendix I -** Migratory species threatened with extinction are listed on Appendix 1 of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States of many of these species.

2. **Appendix II** -Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional Agreements.

In this respect, CMS acts as a framework Convention. The Agreements may range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding, and can be adapted to the requirements of particular regions. The development of models tailored according to the conservation needs throughout the migratory range is a unique capacity to CMS.

CMS is the only global (and UN-based) intergovernmental organization which is established exclusively for the conservation and management of migratory species. Although migratory species in general are included in the Convention on Biological Diversity (CBD) and migratory fish species are covered by the UN Convention on the Law of the Sea (UNCLOS), these conventions do not provide for the special instruments for the conservation work to be done. Other global wildlife conventions, such as Ramsar, CITES and

the World Heritage Convention, have their specific fields of application, with little overlap with CMS. It may, however, arise that regional agreements concluded under the auspices of CMS to a certain extent overlap some global or regional conventions. For this reason, the CMS Secretariat has developed instruments to communicate and co-operate effectively with the secretariats of other international conventions.

The Rio Conventions– Climate Change, Biodiversity And Desertification

Three international treaties showcased at the United Nations Conference on Environment and Development in 1992 in Rio de Janeiro, Brazil — a conference popularly known as the "Rio Earth Summit."

- The Framework Convention on Climate Change (UNFCCC),
- The Convention on Biological Diversity (CBD), and
- The United Nations Convention to Combat Desertification (UNCCD) have been known ever since as the **Rio Conventions**.
- Parties to the biodiversity treaty undertake to conserve species, transfer technology, and share in a fair way the benefits arising from the commercial use of genetic resources.
- Parties to the desertification agreement carry out national, sub-regional, and regional action programmes and seek to address causes of land degradation ranging from international trade patterns to unsustainable land management.
- **The three Rio Conventions are related.** Climate change affects biodiversity and desertification. The more intense and far-reaching climate change is, the greater will be the loss of plant and animal species and the more dryland and semi-arid terrain around the world will lose vegetation and deteriorate

A. The United Nations Framework Convention On Climate Change (1994)

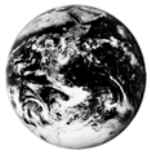
The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 189 countries having ratified.

Under the Convention, governments:

- Gather and share information on greenhouse gas emissions, national policies and best practices
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- Cooperate in preparing for adaptation to the impacts of climate change

Montreal Protocol (1987)

The Convention entered into force on 21 March 1994. India signed UNFCCC on 10 June 1992 and ratified it on 1 November 1993 The Montreal Protocol on Substances That Deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty is structured around several groups of halogenated hydrocarbons that have been shown to play a role in ozone depletion. All of these ozone depleting substances contain either chlorine or bromine (substances containing fluorine-



only do not harm the ozone layer). The treaty was opened for signature on September 16, 1987 and entered into force on January 1, 1989. Since then, it has undergone five revisions, in 1990 (London), 1992 (Copenhagen), 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing). Due to its widespread adoption and implementation it has been hailed as an example of exceptional international cooperation with Kofi Annan quoted as saying it is "Perhaps the single most successful international agreement to date...".

Kyoto protocol (1997)

The Kyoto Protocol was adopted at COP 3 in Kyoto, Japan, on 11 December 1997. The Kyoto Protocol entered into force on 16 February 2005.Indian Government ratified the Kyoto Protocol on 26th August 2002 .

Only Parties to the Convention (UNFCCC) that have also become Parties to the Protocol (i.e by ratifying, accepting, approving, or acceding to it) will be bound by the Protocol's commitments. 171 Parties have ratified the Protocol to date. Of these, 35 countries and the EEC are required to reduce greenhouse gas (CO_2 - Carbon dioxide, CH_4 – Methane, N_2O - Nitrous oxide, PFCs – perfluoro carbons, HFCs - Hydrofluorocarbons ,SF_6 - Sulphur hexafluoride) emissions below levels specified for each of them in the treaty. It has 2 annexures:

Annexe 1 Rich countries

Annexe 2 Includes developing countries

In the protocol :-

Article 2: Ways to fight increasing GHG

Article 3.1 Keep to assigned amounts of GHG with overall worldwide reduction by at least 5% below 1990 levels by 2008-2012

Article 11 The richer countries will provide funds and technology to developing countries to help them better advance towards GHG reduction

Article 12 Richer (annex 1) countries can help developing countries to achieve sustainable development and limit GHG increases and then claim some emission reductions for their own targets

Article 12.5

(a) Voluntary participation by each country

(b) Real, measurable, and long-term benefits related to mitigating climate change

(c) Reductions must be additional to those which would occur anyway

Kyoto Protocol offers considerable flexibility through following **three mechanisms** recognizing that relying on domestic measures alone to meet the emission targets could be difficult, :

Joint Implementation (JI) which allows countries to claim credit for emission reduction that arise form investment in other industrialized countries, which result in a transfer of 'emission reduction units' between countries;

Emission Trading (ET) which permits countries to transfer parts of their 'allowed emissions' (assigned amount units); and

Clean Development mechanism (CDM) through which industrialized countries can finance mitigation projects in developing countries contributing to their sustainable development

The Clean Development Mechanism (CDM) was instituted in 2001, under the Kyoto Protocol to enable developed countries to meet their Green House Gas (GHG) reduction targets at lower cost through project in developing countries.

India signed and ratified the Protocol in August, 2002. Since India is exempted from the framework of the treaty, it is expected to gain from the protocol in terms of transfer of technology and related foreign investments. At the G-8 meeting in June 2005, Indian Prime Minister Manmohan Singh pointed out that the per-capita emission rates of the developing countries are a tiny fraction of those in the developed world. Following the principle of "**common but differentiated responsibility",** India maintains that the major responsibility of

curbing emission rests with the developed countries, which have accumulated emissions over a long period of time

B. The Convention on Biological Diversity (CBD) (1992)[vii]

At the 1992 Earth Summit in Rio de Janeiro, world leaders agreed on a comprehensive strategy for "sustainable development" — meeting our needs while ensuring that we leave a healthy and viable world for future generations. One of the key agreements adopted at Rio was the Convention on Biological Diversity. This pact among the vast majority of the world's governments sets out commitments for maintaining the world's ecological underpinnings as we go about the business of economic development. The Convention establishes three main goals:

- The conservation of biological diversity,
- The sustainable use of its components, and
- The fair and equitable sharing of the benefits from the use of genetic resources.

It was opened for signature on 5 June 1992 and entered into force on 29 December 1993

7 Focal areas

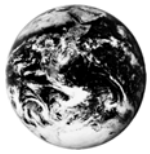
Following the adoption of the Strategic Plan, the Conference of the Parties developed a framework to enhance the evaluation of achievements and progress toward its implementation and that of its 2010 Biodiversity Target. This framework includes the following **seven focal areas**:

1. Reducing the **rate of loss of the components of biodiversity**, including: (i) biomes, habitats and ecosystems; (ii) species and populations; and (iii) genetic diversity;
2. Promoting **sustainable use of biodiversity**;
3. Addressing the **major threats to biodiversity**, including those arising from invasive alien species, climate change, pollution, and habitat change;
4. Maintaining **ecosystem integrity,** and the provision of goods and services provided by biodiversity in ecosystems, in support of human well-being;
5. **Protecting traditional knowledge**, innovations and practices;
6. Ensuring the **fair and equitable sharing of benefits** arising out of the use of genetic resources; and
7. Mobilizing **financial and technical resources**, especially for developing countries, in particular least developed countries and Small Island developing States among them, and countries with economies in transition, for implementing the Convention and the Strategic Plan.

The convention recognized for the first time in international law that the conservation of biological diversity is "a common concern of humankind" and is an integral part of the development process. It also covers the rapidly expanding field of biotechnology through its Cartagena Protocol on Biosafety, addressing technology development and transfer, benefit-sharing and biosafety issues. Importantly, the Convention is legally binding; countries that join it ('Parties') are obliged to implement its provisions.

The convention reminds decision-makers that natural resources are not infinite and sets out a philosophy of sustainable use. While past conservation efforts were aimed at protecting particular species and habitats, the Convention recognizes that ecosystems, species and genes must be used for the benefit of humans. However, this should be done in a way and at a rate that does not lead to the long-term decline of biological diversity.

The convention also offers decision-makers guidance based on the **precautionary principle** that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize



such a threat. The Convention acknowledges that substantial investments are required to conserve biological diversity. It argues, however, that conservation will bring us significant environmental, economic and social benefits in return.

C. The United Nations Convention To Combat Desertification (UNCCD) (1994)

Convention adopted in paris on 17,June 1994 and entered into force on 26 December 1996. 179 countries are parties (till 2002). India signed the convention on 14 Oct, 1994, ratified it on Dec 17, came into force on 17 Mar, 1997.

It is a convention that promotes national strategies to combat desertification and assistance in ensuring that adequate financial resources are available for programs to combat desertification and mitigate effects of drought.

Dangerous myths emerged in the vacuum of history. For example:

- That one book — Rachel Carson's *Silent Spring* — started all the uproar;
- That Biodiversity conservation is just a hysterical reaction to science and technology;
- That Biodiversity Conservation is a passing fad with no serious ideas to offer.

The myths call us like sirens, telling us that Biological Diversity issues can be safely ignored. Nothing could be further from the truth!!!

Status of India In Various Conventions[viii]

	Ramsar Convention on wetlands	Convention on International Trade in Endangered Species	Convention on Migratory Species	Convention on Biological Diversity	Cartegena Protocal on Biosafety	UN Framework Convention on Climate Change	Montreal Protocol	Kyoto Protocol	UN Convention to combat Desertification
Number of countries as Parties	150	169	95	188	131	189	172	169	191
India a Party with effect from	01.02.82	18.10.76	01.11.83	18.5.94	11.09.03	21.03.94	17.09.92	Aug 02	17.03.97

i. **Rachel Carson** (1907-1964), Biologist and author of Silent Spring, a book that animated the environmental awakening of the 1960s.
ii. Dichloro-Dipenyl-Tricloroethane
iii. //www.ramsar.org/
iv. http://whc.unesco.org/
v. http://www.cites.org/
vi. http://www.cms.int/
vii. http://www.biodiv.org/default.shtml
viii. Arora , Sujatha and Ahuja Vibha .(2006). Biodiversity Conservation in Megadiverse Countries: a profile. Persespectives on Biodiversity A vision for Megadiverse countries .Edited by DD Verma, S Arora, RK Rai. MOEF 2006.

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