Environmental Challenges and Solutions 3

Series Editor: Robert J. Cabin

K.P. Laladhas
Preetha Nilayangode
Oommen V. Oommen *Editors*

Biodiversity for Sustainable Development

Springer

Environmental Challenges and Solutions

Volume 3

Series editor
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Aims and Scope

The *Environmental Challenges and Solutions* series aims to improve our understanding of the Earth's most important environmental challenges, and how we might more effectively solve or at least mitigate these challenges. Books in this series focus on environmental challenges and solutions in particular geographic regions ranging from small to large spatial scales. These books provide multidisciplinary (technical, socioeconomic, political, etc.) analyses of their environmental challenges and the effectiveness of past and present efforts to address them. They conclude by offering holistic recommendations for more effectively solving these challenges now and into the future. All books are written in a concise and readable style, making them suitable for both specialists and non-specialists starting at first year graduate level.

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Foreword

The year 2015 is considered as a landmark in recent past where a series of multilateral agreements were agreed to by the member states of the United Nations: the Addis Ababa Agenda for Action (AAAA), the 2030 Agenda for Sustainable Development including a series of sustainable development goals (SDGs), and the Paris Climate Accord that have heralded a new enthusiasm, globally, to focus on shaping our common future more sustainably.

For reasons unclear, governments and policy makers are still unable to suitably consider the foundations of such development – the natural capital – appropriately in designing national policies to deliver in the 2030 Agenda for Sustainable Development.

This publication comes at a time to provide a breadth of experiences and options for practitioners and policy makers on issues of conservation and development focusing on issues such as green growth, poverty reduction using natural capital, food security, biodiversity governance, and sharing of benefits of conservation and access equitably.

The authors as well as the editors of this important volume have taken pains to put on papers with a range of issues that need to be considered, especially in India, to effectively realize and promote issues of conservation for development. This is very welcome since India's quest for sustainable development seems to be unprecedented now with a clear focus on getting the GDP numbers move toward an upward spiral.

The papers, carefully compiled across a series of themes, clearly outline the fact that actions on the ground abound, but the gap is to link the actions to delivering the policy and legal mechanisms in the country. This certainly is a cause for worry.

With the enormity of institutions and experts working on issues of development and conservation, this kind of compilation will go a long way to link the science-policy interface where conservation, social sciences, economics, and welfare need to be appropriately linked.

The need to bridge the gap of global and national indifference based on a narrative of competition to grow at the cost of environmental management is more crucial now than before. The nominalism dealing with environmental and development issues needs to be reversed, using the options and models cited in this volume with chapters that were discussed and debated thoroughly during the National Biodiversity Congress held in 2015.

If we want to secure the political agenda of sustainable development, the base has to be built on appropriately managing and using our natural capital. There should be no second thought!

Division of Environmental Law and Conventions Balakrishna Pisupati
UNEP, Nairobi, Kenya
February 2016

Preface

Biodiversity and ecosystem services are central to sustaining life on Earth and play an important role in realizing sustainable development goals. India, a megadiverse country with only 2.4 % of the world's land area, harbors 7–8 % of all recorded species including over 45,000 species of plants and 91,000 species of animals. At the same time, India, with 17 % of the world's population and 15 % of the global cattle population, faces severe pressure on land. About 50 million people are directly dependent on forests for their subsistence. The transition path to sustainable development, meeting the aspirations of 1.25 billion people in India, will require decoupling socioeconomic development from the unsustainable use of bioresources. Poverty eradication is the greatest challenge to India as 48 % of Indian children are stunted due to chronic undernutrition. Conserving the diversity of crop plants for food and nutritional security and sustainable livelihood forms the core section of this book. The book aims to explore the three pillars of sustainable development – economic, social, and environmental – and its interlinkages at the regional level for a sustainable consumption pattern. The section on access and benefit sharing (ABS) with chapters contributed by experts in the field focuses on the Nagoya Protocol and its key provision on the equitable sharing of benefits leading to improved local economies, livelihoods, and the sustainable utilization of bioresources. The Indian experience of different models of biodiversity governance from protected area network to community conservation and decentralized governance promotes conservation and development and is relevant in the context of the post-2015 development agenda. The empowerment of local institutions for effective biodiversity governance is important for the long-term sustainable management of natural resources, and the initiatives of biodiversity management committees at the local level illustrate this.

The book *Biodiversity and Sustainable Development* is targeted at a wide range of readers including policy makers, researchers, students, and nongovernmental institutions working for the cause of biodiversity conservation. We hope that this publication will further strengthen the effectiveness of biodiversity governance at different levels for a sustainable future. We extend our sincere thanks to all nationally and internationally renowned contributors for providing an in-depth study of the Nagoya Protocol in the Indian context, which is the backbone of this book. We are also thankful to Springer for accepting the publication and for timely support in reviewing the book. We are grateful to all the staff of the Kerala State Biodiversity Board for their valuable inputs and cooperation in completing the book on time.

Kerala State Biodiversity Board
Thiruvananthapuram, Kerala, India
12 April, 2016

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Editors

K.P. Laladhas holds a PhD degree in biochemistry and has more than 15 years of teaching experience. He has published several papers in national and international journals. Currently, he is functioning as member secretary of the Kerala State Biodiversity Board, the state's premier statutory organization dealing with matters relating to the conservation of biodiversity, sustainable use of its components, and equitable sharing of the benefits arising out of biological resources' utilization. He has been instrumental in the establishment of the biodiversity management committee, a statutory organization in all local self-governments of Kerala for the purpose of promoting conservation of biological resources in a decentralized way. Dr. Laladhas has been active in developing guidelines for protecting the interests of biodiversity conservation.

Preetha Nilayangode has a doctorate in forestry from the Forest Research Institute, Dehradun, India. Her major area of research has been on ex situ and in situ conservation of species. She has more than 14 years of experience in various aspects of biodiversity conservation and sustainable utilization, including value addition and development of bioproducts. She has published several papers in international and national journals and is serving as biodiversity specialist in the Kerala State Biodiversity Board. She is qualified in intellectual property management and is coordinating the implementation of access and benefit sharing in Kerala and access to bioresources in the state of Kerala. Dr. Preetha is also actively involved in implementing various conservation projects in Kerala and generating awareness of the intrinsic values of biodiversity among the public.

Oommen V. Oommen is an eminent zoologist and conservationist with three and a half decades of experience behind him. He is dedicated to the integration of scientific knowledge to natural resource management and is actively involved in science popularization programs. Currently, he is the chairman of the Kerala State Biodiversity Board; Hon. director of Centre for Venom Informatics, University of Kerala; Ex-emeritus scientist (CSIR), University of Kerala; and also an adjunct professor in the Central University of Kerala, Kasaragod, Kerala. Dr. Oommen is piloting a large number of conservation programs in Kerala mainly on aquatic and marine biodiversity, traditional breeds and varieties, and the ecosystem. He has initiated capacity-building programs for empowering the local community to manage their natural resources sustainably in Kerala and has promoted a people-inclusive form of biodiversity management of Western Ghats in Kerala.

Introduction

Sustainable development cannot be achieved without considering the environmental dimensions, and poverty eradication cannot be attained if ecosystem services and natural capital are degraded. In September 2015, 193 UN countries adopted the 2030 Sustainable Development Agenda to end poverty and protect the environment. The post-2015 development agenda includes 17 sustainable development goals balancing the three dimensions of sustainable development: environmental, social, and economic. These three dimensions are explored in *Biodiversity and Sustainable Development*, structured into three sections, namely:

- Access and benefit sharing for sustainable development
- Decentralized governance for sustainable development
- Biodiversity for sustainable livelihood

Access and Benefit Sharing for Sustainable Development

The three pillars of the Convention on Biological Diversity – conservation, sustainable use, and fair and equitable sharing of the benefits arising from the utilization of genetic resources – form the principal building blocks toward poverty eradication and sustainable development. The first section, Access and Benefit Sharing (ABS) for sustainable development, concentrates on the international agreements and national legislations for protecting the rights of the providers of bioresources and equitable sharing of the benefits arising out of the utilization of bioresources and associated traditional knowledge. The section details the Nagoya Protocol in the context of bioresource-rich and developing countries as India and the ensuing national initiatives for implementing ABS in India. The major provisions of the Biodiversity Act 2002 and Rules 2004 and salient features of the ABS regulations in India form the backbone of this section. The challenges in implementing the ABS legislations and some gap areas calling for immediate attention are reviewed by experts in the field of ABS, with specific case studies. The section also deals with other related *sui generis* system for protecting the rights of communities as the Protection of Plant Varieties and Farmers' Rights Act and the role of the Traditional Knowledge Digital Library in protecting traditional knowledge and practices in India. The case studies of ABS in different aspects from research to commercialization and the contributions of the corporate sector to biodiversity conservation, sustainable use, and fair and equitable sharing of benefits will serve as a valuable source of information to provide a better understanding of access and benefit sharing in practice in developing countries. In the corporate sector, a wide range of institutes undertake research and develop commercial products from genetic resources. The approaches for benefit sharing with the providers of genetic resources vary, and the case studies illustrate different practices in vogue in India. ABS provisions at the local level contribute to economic well-being and are a long-term financing option for biodiversity conservation. The section through nine chapters delves into the economic aspects of sustainable development.

Decentralized Governance for Sustainable Development

India has devolved considerable powers to local self-government (LSG) institutions in rural areas, through Panchayati Raj Institutions (PRIs) with Gram Sabha and Gram Panchayat as the basic unit, which are usually at the level of a village. Biodiversity management is a multilayered process and the involvement of local communities in conservation planning should be at the core of conservation initiatives. The section expands the process of forming a biodiversity management committee (BMC) at the LSG level and through different case studies highlights the conservation initiatives at the local level. People's participation is a key element in biodiversity conservation and sustainable development and case studies of conservation of native varieties and breeds by local people, a quest worthy of emulation is presented in this section. Local communities depend on bioresources for their livelihood, but still community efforts have led to the conservation of habitats, species, and ecological services. Community conservation efforts, such as the conservation of turtles, crop diversity, etc., along with measures such as payment for ecosystem services which provide incentives to conserve biodiversity and use it sustainably are presented. The chapter on seed care movement illustrates a movement that has promoted conservation and the sustainable use of the seeds of indigenous varieties in smallholders' family farms in the Wayanad District of Kerala especially the tribal communities of *Kurichya*, *Kuruma*, *Pathiya*, and *Wayanadan Chetty*. Branding and promotion of products with unique qualities can generate premium market for such products, thereby providing sustainable livelihood options for the community. This section also outlines five case studies from Kerala, India, wherein GI registration has been obtained for a bioproduct rice variety and has succeeded in enhancing the livelihood of farmers by assuring a niche market. The section with six chapters through case studies explores biodiversity governance at three different levels, such as local self-government, grassroot participation, and community conservation initiatives, and focus on the environmental aspects of sustainable development.

Biodiversity for Sustainable Livelihood

The poor people are the most dependent on ecosystem services for food, clothes, medicine, fuel, shelter, income, and other basic needs, and the unsustainable utilization of natural resources threatens their health and livelihood. Small-scale initiatives on local governance over resources and integration of traditional knowledge into planning and implementation of resource management regimes can ensure the resilience of ecosystems and provide sustainable livelihood options to communities. Poverty eradication and food security are addressed through the initiatives for providing sustainable livelihood to tribal communities through ecotourism, meliponiculture for poverty alleviation, monsoon floodplain fishery for nutritional security, and underutilized and minor crops for the diversity of food basket. The chapter on Idamalakudy, the tribal panchayat, explores the traditional ecological knowledge of Muthuvans and the tribal social structure. The Livestock sector plays an important role in providing sustainable rural livelihood in India, and the section gives an overview of the livestock sector in India and the native breeds of cattle and buffaloes in India and advocates greater thrust on preserving and augmenting superior native breeds of livestock for poverty eradication. The section through seven chapters gives a picture of the importance of biodiversity for sustainable livelihood and poverty eradication and focus on the social dimensions of sustainable development.

The book concludes with reflections on the lessons learned from the case studies and the author's hopes that the discussions generated by this book will help readers understand how international and national agreements relate to issues in their own lives, and the relevance of grassroot initiatives and bottom-up solutions for sustainable development. Sustainable development can be achieved only through finding solutions to local issues, taking into consideration the interests of the communities. *Biodiversity and Sustainable Development* attempts to bring out new approaches for an inclusive development considering that participation and grassroot empowerment are key drivers of equitable and sustainable development.

Part I
Access and Benefit Sharing for Sustainable Development

Chapter 1
International and National Framework on Access and Benefit Sharing

Ashwani Kumar, T.P. Singh, and Shilpa Gautam

Abstract Access and Benefit Sharing (ABS) of genetic resources became an international issue in the early 1980s, leading to the adoption of the Convention on Biological Diversity (CBD) in 1992. With the entry into force of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, in October 2014, countries are gearing up for developing national ABS frameworks considering a range of administrative and regulatory provisions. There is a need to develop fair, transparent, and equal opportunities to the providers of genetic resources and knowledge holders. Benefit sharing can be both monetary and nonmonetary in the form of royalties, joint ventures, technology transfer, capacity building, etc., thus contributing to poverty alleviation and sustainable development of the developing countries. International and national framework on access and benefit sharing are discussed along with other *sui generis* systems of protection in India as Geographical Indications of Goods Act and Protection of Plant Varieties and Farmers' Rights Act and the role of Traditional Knowledge Digital Library in protecting traditional knowledge and practices in India.

Keywords ABS • Biodiversity Act • Sui generis • Farmers' rights • IPR

1.1 Introduction

Genetic resources and associated traditional knowledge were accessible to all from time immemorial. Time and again, individuals, industries, and organizations have accessed the genetic resources and traditional knowledge from the knowledge holders and used them for their own benefits without providing any compensation to them. Recently, a few countries have developed a legal framework for access and

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benefit sharing. Many developing countries felt that their wealth of plant genetic resources would be exploited for commercial purposes under the newly introduced patent or intellectual property regimes by the large multinational companies from the developed countries. Thus, the common heritage concept with respect to the genetic resources became redundant, and control of state over the genetic resources was institutionalized (http://www.icimod.org, Jain 2015).

1.1.1 Genetic Resources

All living organisms, viz., plants, animals, and microorganisms, carry genetic materials of actual or potential economic, environmental, scientific, or societal value. Genetic resources provide essential information and understanding of the natural world. Usage of genetic resources refers to the process of exploring and utilizing their beneficial attributes to enhance scientific knowledge/understanding and above all develop commercial products for human use. Research organizations, universities, and companies/industries involved in the areas of pharmaceuticals, agriculture, horticulture, cosmetics, forestry, fisheries, biotechnology, etc. are the major users of genetic resources for commercial as well as noncommercial purposes.

1.1.2 Traditional Knowledge

Traditional knowledge refers to the innovations and practices developed by indigenous and local communities, from the experience gained over centuries and adapted to the local culture and environment. It is a collectively owned knowledge which is transmitted orally from generations to generations in the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals and community laws. Traditional knowledge is mainly of a practical nature which is valuable not only to those who depend on it but also to the modern industry. The products such as herbal medicines, cosmetics, handicrafts, etc. are primarily derived from traditional knowledge. Most indigenous and local communities are located in areas of rich genetic resources, and they have cultivated and used biological diversity in a sustainable way for thousands of years. These communities act as the natural resource managers and also hold invaluable knowledge about the genetic resources (https://www.cbd.int/).

1.1.3 Access and Benefit Sharing (ABS) for Sustainable Development

ABS refers to the manner in which genetic resources may be accessed and how users and providers reach an agreement on the fair and equitable sharing of the benefits that might result from their use. The ABS is based on the prior informed consent (PIC) issued by the providers. Moreover, the user and country providing the genetic resource need to agree on the terms and conditions of access and use of this resource (mutually agreed terms—MATs). Benefit sharing can be both monetary and nonmonetary in the form of royalties, joint ventures, technology transfer, capacity building, etc., thus contributing to poverty alleviation and sustainable development of the developing countries. The access to genetic material will contribute to the advancement of science and to human well-being through the use of genetic resources in pharmaceuticals, cosmetics, agriculture, forestry, and other sectors (https://www.cbd.int, http://www.giz.de).

1.2 Access and Benefit Sharing: International Scenario

Biodiversity encompasses the variety of all life on earth including terrestrial, marine, and aquatic ecosystems. Biodiversity is essential for the economic and social development of humankind. It is a global asset of tremendous value to present and future generations. As the human population increases, the pressure on biodiversity also increases. The threat to species and ecosystems has never been as great as it is today. Species extinction caused by human activities continues at an alarming rate. It is essential to manage the productivity and resources in a sustainable manner to conserve the biodiversity of the earth. There are several international biodiversity conservations or protection initiatives and frameworks of which some have been enacted in law in signatory countries.

1.2.1 Convention on Biological Diversity (CBD)

Access and benefit sharing of genetic resources became an international issue in the early 1980s, leading to the adoption of the Convention on Biological Diversity (CBD) in 1992. The Convention on Biological Diversity was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit") and entered into force on 29 December 1993. The convention is the only international instrument comprehensively addressing biological diversity. The objectives of the convention are:

- Conservation of biological diversity
- Sustainable utilization of biological diversity
- Fair and equitable sharing of the benefits arising out of the utilization of genetic resources

The third objective of the convention emphasizes the access to the genetic resources and its fair and equitable benefit sharing. The Convention on Biological Diversity (CBD) provides national governments with sovereign rights over genetic resources and associated traditional knowledge with the aim to ensure that countries receive a fair share of benefits from their biological resources and traditional knowledge in return for conserving and allowing access to these resources.

Article 15 of the Convention on Biological Diversity provides a framework for the implementation of the access to genetic resources and benefit sharing. The salient features of the article are as follows:

- Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.
- Each Contracting Party shall endeavor to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of the Convention.
- The genetic resources being provided by a Contracting Party are only those that are provided by the countries of origin of such resources or by the Parties that have acquired the genetic resources in accordance with this Convention.
- Access, where granted, shall be on mutually agreed terms and subject to the provisions of this Article.
- Access to genetic resources shall be subject to prior informed consent of the Contracting Party providing such resources, unless otherwise determined by that Party.
- Each Contracting Party shall endeavor to develop and carry out scientific research based on genetic resources provided by other Contracting Parties with the full participation of, and where possible with, such Contracting Parties.
- Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19 and, where necessary, through the financial mechanism established by Articles 20 and 21 with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms (https://www.cbd.int). Besides, Article 8(j) of the convention states that each contracting Party shall, as far as possible and as appropriate: Subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge,

innovations and practices. Thus it includes the provision to encourage the equitable sharing of the benefits arising from the utilization of knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for conservation and sustainable use of biological diversity.

These provisions are also linked to Article 16, Access to and transfer of technology; Article 17, Exchange of information; Article 18, Technical and scientific cooperation; Article 19, paragraphs 1 and 2, The handling of biotechnology and distribution of its benefits; and Article 20 and Article 21, Financial resources and Financial mechanism.

To clarify the principles and concepts related to ABS, in the fourth meeting of Conference of the Parties in the year 1998, it was decided to establish a Panel of Experts on Access and Benefit Sharing. The panel discussed issues such as prior informed consent, mutually agreed terms, benefit sharing, capacity building, and stakeholder involvement in ABS processes. The Ad Hoc Open-Ended Working Group on Access and Benefit Sharing, a subsidiary body of the Conference of the Parties, with the mandate to develop guidelines and other approaches to assist parties with the implementation of the access and benefit sharing provisions of the convention was established in 2000 at the fifth meeting of the Conference of the Parties.

The Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization was adopted in 2002 to assist parties when establishing administrative, legislative, or policy measures on access and benefit sharing and/or when negotiating contractual arrangements for access to genetic resources and benefit sharing.

Further to the call for action by governments at the World Summit on Sustainable Development in 2002, the Conference of the Parties mandated the working group on ABS to elaborate and negotiate an international regime on access to genetic resources and benefit sharing with the aim of adopting an instrument/instruments to effectively implement the provisions in Article 15 and 8(j) of the convention and the three objectives of the convention.

The Ad Hoc Open-Ended Working Group on Access and Benefit Sharing met 11 times from 2005 to 2010 to negotiate an international regime on ABS. At its ninth meeting, the working group accepted a draft protocol as the basis for further negotiations. The group continued to negotiate on the basis of this text until its last meeting which was held on 16 October 2010, in Nagoya, Japan.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity was adopted at the tenth meeting of the Conference of the Parties, in Nagoya, Japan, on 29 October 2010. The meeting also decided to establish the Open-Ended Ad Hoc Intergovernmental Committee for the Nagoya Protocol on ABS, as an interim governing body for the Nagoya Protocol, to undertake the preparations necessary for the first meeting of the parties to the protocol. The Intergovernmental Committee met three times. The Nagoya Protocol entered into force on 12 October 2014.

1.2.2 International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)

The International Treaty on Plant Genetic Resources for Food and Agriculture was adopted by the Thirty-First Session of the Conference of the Food and Agriculture Organization of the United Nations on 3 November 2001 and came into force in 2004.

The Treaty aims at:

- Recognizing the enormous contribution of farmers to the diversity of crops that feed the world
- Establishing a global system to provide farmers, plant breeders, and scientists with access to plant genetic materials
- Ensuring that recipients share benefits they derive from the use of these genetic materials

The objectives of the Treaty are conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security (http://www.planttreaty.org, http://ftp.fao.org).

1.2.3 The International Union for the Protection of New Varieties of Plants (UPOV)

UPOV an intergovernmental organization based in Geneva, Switzerland, was established in 1961 by the International Convention for the Protection of New Varieties of Plants also known as the "UPOV Convention." The mission of UPOV is to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants, for the benefit of society.

The UPOV Convention provides the basis for members to encourage plant breeding by granting breeders of new plant varieties an intellectual property right: the breeder's right. The introduction of the UPOV system of plant variety protection and UPOV membership have been found to be associated with increased breeding activities; greater availability of improved varieties; increased number of new varieties; diversification of types of breeders (private breeders, researchers); increased number of foreign new varieties, encouraging the development of a new industry competitiveness on foreign markets; and improved access to foreign plant varieties and enhanced domestic breeding programs (http://www.upov.int).

1.2.4 Trade-Related Aspects of Intellectual Property Rights of the World Trade Organization (WTO/TRIPs)

The WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) was negotiated in the 1986–1994, Uruguay Round which introduced intellectual property rules into the multilateral trading system for the first time. The areas covered by the TRIPS Agreement include copyright and related rights and trademarks, including service marks, geographical indications, industrial designs, patents, layout designs (topographies) of integrated circuits, and undisclosed information, including trade secrets (https://www.wto.org).

1.3 Access and Benefit Sharing: Indian Scenario

India is a party to international agreements, viz., CBD, ITPGRFA, WTO/TRIPS, etc., but is not a member of UPOV so far. India has enacted Protection of Plant Varieties and Farmers' Rights Act 2001, Biological Diversity Act 2002, and the Geographical Indications of Goods (Registration and Protection) Act 1999 and amended the Indian Patents Act (1970) in 1974, 1985, 1999, 2002, and 2005 considering its own needs and in compliance with various international agreements.

1.3.1 Biological Diversity Act 2002

To meet the obligations under Convention on Biological Diversity (CBD), to which India is a party, and to deal with the extensive pressure on the biological resources of the country, India enacted umbrella legislation, the Biological Diversity Act 2002, and also notified the Biological Diversity Rules 2004.

The salient features of the act are:

- To regulate access to biological resources of the country with the purpose of securing equitable sharing of benefits arising out of the use of biological resources, and associated knowledge relating to biological resources
- To conserve and sustainably use biological diversity
- To respect and protect knowledge of local communities 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
- To conserve and develop areas of importance from the standpoint of biological diversity by declaring them as biological diversity heritage sites
- To protect and rehabilitate threatened species

- To involve institutions of state governments in the broad scheme of the implementation of the Biological Diversity Act through constitution of committees

The Biological Diversity Act provides for its implementation a three-tier system comprising the National Biodiversity Authority (NBA), the State Biodiversity Boards (SBBs), and the Biodiversity Management Committees (BMCs). Each of these structures is required to be connected for decision-making processes on various issues, including issues of ABS.

1.3.1.1 National Biodiversity Authority (NBA)

NBA is a statutory, autonomous body, under the aegis of Ministry of Environment, Forests and Climate Change (Government of India), which was established in 2003 to implement India's Biological Diversity Act (2002). The NBA with its headquarters in Chennai, Tamil Nadu, delivers its mandate through a structure that comprises of the authority, secretariat, SBBs, BMCs, and expert committees. It performs facilitative, regulatory, and advisory function for the government of India on issues of conservation, sustainable use of biological resources, and fair and equitable sharing of benefits arising out of the use of biological resources. NBA has constituted an Expert Committee on Access and Benefit Sharing which assists NBA in processing all the applications and making recommendations for their approval or otherwise. The NBA has also evolved guidelines for access to genetic resources for collaborative research.

Based on the Nagoya Protocol, NBA issued guidelines on "Access to Biological Resources and Associated Knowledge and Biological Resources Regulation 2014". These guidelines provide the manner in which the financial obligations of the users of genetic resources are to be determined for each of the activity identified earlier for which biological resources are obtained and also how these benefits are to be shared (The Biological Diversity Act, 2002 and Biological Diversity Rule 2004).

1.3.1.2 The State Biodiversity Boards (SBBs)

SBBs focus on advising the state governments, subject to any guidelines issued by the central government, on matters relating to the conservation of biodiversity, sustainable use of its components, and equitable sharing of the benefits arising out of the utilization of biological resources. The SSBs also regulate, by granting of approvals or otherwise requests for commercial utilization or bio-survey and bio-utilization of any biological resource by Indians.

1.3.1.3 Biodiversity Management Committees (BMCs)

At the local level, the Biodiversity Management Committees (BMCs) are established by institutions of local self-government for implementation of specific provisions of the legislation. The local level Biodiversity Management Committees (BMCs) are responsible for promoting conservation, sustainable use, and documentation of biological diversity including preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms, and chronicling of knowledge relating to biological diversity (Wilson 2015; Rana 2012, http://nbaindia.org).

1.3.2 Protection of Plant Varieties and Farmers' Rights Act 2001

In order to provide for the establishment of an effective sui generis system for protection of plant varieties, the rights of farmers, and plant breeders and to encourage the development of new varieties of plants, it has been considered necessary to recognize and protect the rights of the farmers. India as a member of WTO and signatory to the TRIPS enacted the "Protection of Plant Varieties and Farmers' Rights Act 2001" with the following objectives:

- To provide an effective system for protection of plant varieties and rights of farmers and plant breeders
- To recognize and protect the rights of farmers in respect of the contribution made at any time in conserving, improving, and making available plant genetic resources for the development of new plant varieties
- To accelerate agricultural development in the country, protect plant breeders' rights, and stimulate investment for research and development in public/private sector for development of plant varieties
- To facilitate the growth of seed industry to ensure the availability of high-quality seeds and planting material to the farmers

For the purposes of this Act, Protection of Plant Varieties and Farmers' Rights Authority has been established in Delhi under the aegis of Ministry of Agriculture, Government of India (http://www.plantauthority.gov.in/).

1.3.3 Patents Law in India

The Indian Patents and Designs Act 1911 brought patent administration under the management of Controller of Patents for the first time. The Patents Act 1970 came into force in the year 1972, amending and strengthening the existing law relating to patents in India. The patent system in India is governed by the Patents Act, 1970 (No. 39 of 1970), and the Patents Rules, 2003. The Patents Act has been amended several times in 1974, 1985, 1999, 2002, and 2005. The Patent Rules have been amended in 2006.

In the Patents (Amendment) Act, 2005, product patent was extended to all fields of technology such as food, drugs, chemicals, and microorganisms. After the amendment, the provisions relating to Exclusive Marketing Rights (EMRs) have been revoked, and a provision for enabling grant of compulsory license has been introduced.

An invention relating to a product or a process that is new, involving inventive step, and capable of industrial application can be patented in India. If the grant of the patent is for a product, then the patentee has a right to prevent others from making, using, offering for sale, selling, or importing the patented product in India. If the patent is for a process, then the patentee has the right to prevent others from using the process, using the product directly obtained by the process, and offering for sale, selling, or importing a product in India directly obtained by the process (http://ipindia.nic.in/ipr, http://www.vaishlaw.com, http://www.slideshare.net/sauravghoshal/the-patent-act).

1.3.4 Geographical Indications of Goods (Registration and Protection) Act, 1999

Geographical indication has been defined as "an indication which identifies such goods as agricultural goods, natural goods, or manufactured goods as originating or manufactured in the territory of a country or a region or locality in that territory, where a given quality, reputation, or other characteristic of such goods is essentially attributable to its geographical origin, and in the case where such goods are manufactured goods, one of the activities of either the production or of processing or preparation of the goods concerned takes place in such territory, region, or locality, as the case may be." It is a sui generis Act of India for protection of geographical indications.

India, as a member of the World Trade Organization (WTO), enacted the Act to comply with the Agreement on Trade-Related Aspects of Intellectual Property Rights. The GI tag ensures that none other than those registered as authorized users (or at least those residing inside the geographic territory) are allowed to use the popular product name. Darjeeling tea became the first GI-tagged product in India, in 2004–2005; since then 193 goods have been added to the list as of March 2013. A GI is registered for an initial period of 10 years, which may be renewed from time to time (http://ipindia.nic.in/ipr/gi/gi_act.pdf; https://en.wikipedia.org/wiki/Geographical_Indications_of_Goods_(Registration_and_Protection)_Act,_1999).

1.3.5 The Trade Marks Act 1999

"Trade mark" means a mark capable of being represented graphically and which is capable of distinguishing the goods or services of one person from those of others and may include shape of goods, their packaging and combination of colors, or any such combinations. The Trade Marks Act statutorily protects the trademarks, i.e., the name of the product or services rather than the product itself. The statutory protection of trademark is administered by the Controller General of Patents, Designs and Trade Marks, Department of Industrial Policy and Promotion, and Ministry of Commerce and Industry. The law of trademark deals with the mechanism of registration, protection of trademark, and prevention of fraudulent trademark and provides for the rights acquired by registration of trademark, modes of transfer and assignment of the rights, nature of infringements, penalties for such infringement, and remedies available to the owner in the case of such infringement (http://www.slideshare.net/poojagurwani/trademark-ppt-bypooja-gurwani; https://en.wikipedia.org/wiki/Indian_trademark_law).

1.3.6 National Intellectual Property Rights Policy 2014

Intellectual property rights (IPR) refers to rights provided to individuals or organizations pertaining to specific innovation or invention in products or processes for a certain period of time. They are in the form of patents, trademarks, geographical indicators (GIs), copyrights, etc. and intend to encourage and incentivize inventiveness and originality and facilitate access to knowledge in order to achieve social and economic welfare. The government of India has adopted a proactive approach toward drawing a road map for IPR in the country by coming out with a policy to improve investment opportunities in the country and promote innovation and improve national competitiveness. India has declared this decade as the *Decade of Innovation*.

On 22 October 2014, the Department of Industrial Policy and Promotion (DIPP) set up a National IPR Think Tank (NITT) to draft an overarching IPR Policy and advise the government on IPR-related issues. The draft policy touches upon various aspects of the IPR framework in the country and the need to create an innovation ecosystem while ensuring that the policy should work in the larger public interest. The IPR policy recognizes the importance of a comprehensive, vibrant, and balanced IP regime in the country as a means to attain social and economic welfare and to create an innovation ecosystem in the introduction and vision of the draft (http://www.swaniti.com).

1.3.7 Traditional Knowledge Digital Library (TKDL)

India is known to possess a rich traditional knowledge which has passed orally from person to person through generations. Ancient literature contains a part of traditional knowledge, but these texts are not accessible to the people and if available are seldom understood. To preserve the sovereignty of the traditional knowledge and to protect it from unfair practice of patents on non-original innovations, it is required to document the existing knowledge.

In 1999, the Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) constituted an interdisciplinary task force, for creating an approach paper on establishing a Traditional Knowledge Digital Library (TKDL). The project TKDL was initiated in the year 2001. TKDL acts as a bridge between the traditional knowledge information existing in local languages and the patent examiners at International Patent Offices (IPOs) by providing information on traditional knowledge existing in the country, in different languages (five international languages, viz., English, German, French, Japanese, and Spanish) and in a format understandable by patent examiners at IPOs.

TKDL gives authenticity to the existing traditional knowledge and enables protection of such information from getting patented by the fly-by-night inventors acquiring patents on India's traditional knowledge systems. India fought successfully for the revocation of turmeric and basmati patents granted by the United States Patent and Trademark Office (USPTO) and neem patent granted by the European Patent Office (EPO). TKDL will prevent such misappropriation of Indian traditional knowledge, mainly by breaking the format and language barrier and making it accessible to patent examiners at International Patent Offices for the purpose of carrying out search and examination (http://www.tkdl.res.in).

1.4 Conclusion

The Convention on Biological Diversity recognized that the plant genetic resources are the sovereign property of the country in whose territory they are found and that access to them should be negotiated under mutually agreed terms between the donor and the recipient country. With the entry into force of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity (the Nagoya Protocol, NP) in October 2014, countries are gearing up for developing national ABS frameworks considering a range of administrative and regulatory provisions. The access to genetic resources and equitable sharing of benefits are essential for sustainable development; consequently there is a need to develop fair, transparent, and equal opportunities to their providers and users. ABS is of great importance for meeting the three objectives of the CBD, namely, conservation, sustainable utilization, and fair and equitable sharing of benefits.

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Chapter 2
Access and Benefit Sharing Mechanism under the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture

Pratibha Brahmi and Vandana Tyagi

Abstract Sustainable use of plant genetic resources for food and agriculture (PGRFA) is of critical importance for food and nutritional security. The International Treaty on Plant Genetic Resources for Food and Agriculture recognizes the efforts of farmers and local communities involved in on-farm conservation and management of PGRFA. The international exchange of PGRFA for research, breeding and conservation is the key requirement for food security and sustainable agriculture. Access to global gene pool which is a network of international and national gene banks and other institutions is a major benefit under the Treaty. Facilitated access to this vast gene pool under the Treaty is provided under the terms and conditions of the Standard Material Transfer Agreement (SMTA). India has already notified the guidelines for the implementation of the Treaty and is already using SMTA for exchange of PGRFA with Consultative Group on International Agricultural Research (CGIAR). The guidelines are notified under the provisions of national legislation that is Biodiversity Act, 2002. The chapter details the multilateral system (MLS) of Access and Benefit Sharing (ABS) under the Treaty, option for benefit sharing under SMTA, and provisions of providing facilitated access under the Treaty and access to PGRFA as per the provisions of the treaty in India.

Keywords PGRFA • Farmers' rights • ITPGRFA • Facilitated access • ABS • Multilateral system

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2.1 Introduction

Plant genetic resources are materials of plant origin which are of value for present and future generations of humankind. Often used as a synonym to plant germplasm, these include seeds, plants or plant parts including genes and DNA sequences that are held in a repository or collected from wild, useful in crop breeding, research or conservation because of genetic attributes. Plant genetic resources for food and agriculture (PGRFA) specifically cover PGR of actual or potential value for food and agriculture. Sustainable use of PGRFA is therefore of critical importance for food and nutritional security. Since most countries depend largely on PGR that have originated elsewhere, it is essential and extremely important to develop mechanisms for the access and benefit sharing of these resources amongst and within the nations. It is, more so, after the realization of owners' rights, breeders' rights (1970s) and Intellectual Property Rights (IPRs) and owing to the advances in biotechnology during the 1990s.

A paradigm shift of PGR which were regarded as common heritage of humankind to 'sovereign rights of nations' occurred under the Convention on Biological Diversity (CBD). The CBD entrusted the contracting parties, to frame national policies and regulations. The convention thus provided regulations for access to genetic resources and transfer of relevant technologies on Mutually Agreed Terms (MAT) and based on Prior Informed Consent (PIC). The convention recognized the sovereign rights of states over their natural resources and also the authority to determine access to genetic resources.

The CBD addressed all elements of biological diversity and resources, but it did not address the special nature of PGRFA which is crucial for food security and sustainable agriculture. These have moved without restrictions before CBD came into being and were collected and exchanged for crop improvement. Such improvement of PGRFA involved human intervention, and the diversity in crop plants available today is mainly selected/improved by humans. This available diversity is, in turn, the basic requirement to undertake further crop improvement.

During the period CBD was negotiated, FAO simultaneously adopted a resolution for revision of nonbinding International Undertaking on Plant Genetic Resources (IUPGR) on PGRFA in 1992, which aimed at systematic PGR management, international cooperation and PGR in public domain, and had established a Commission on Genetic Resources for Food and Agriculture (CGRFA).

The CGRFA addressed the outstanding issues of access to PGRFA and realization of farmer's rights and adopted the International Treaty for Plant Genetic Resources (ITPGR) in the 31st Conference of FAO. The revision of IUPGR continued for 7 years, and the revised text was adopted as the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) in November 2001. The ITPGRFA (hereinafter referred to as Treaty) entered into force in 2004. The basic concept for the adoption of the Treaty was the distinctive features and special nature of PGRFA (Dua et al. 2004). It is a well-established study that no country or region of the world is entirely self-sufficient in terms of the crop diversity. The extent of dependence is over 50 % in most regions of the world (ITPGRFA Secretariat). During the negotiations of the Treaty, FAO was made to realize that not only plant breeders but also farmers should have rights over their landraces and varieties (Paroda 2013). The Treaty thus provided for facilitated access to PGRFA and established the multilateral system of ABS.

The objectives of the Treaty and CBD are identical; however, the access and benefit sharing mechanisms are being dealt differently. The Treaty has created a multilateral system of ABS, while CBD and Nagoya Protocol on ABS create mechanism for bilateral arrangements (Halewood et al. 2013). Both the Treaty and CBD are however meant to be implemented through national policies in mutually supportive manner.

2.2 International Treaty on Plant Genetic Resources for Food and Agriculture

The Treaty's objectives are conservation and sustainable use of PGRFA and the fair and equitable sharing of the benefits arising out of their use for sustainable agriculture and food security. The Treaty also recognizes the efforts of farmers and local communities involved in on-farm conservation and management of PGRFA. The Treaty urges that country parties need to promote the collection of PGRFA which are under threat and collect information about them. These efforts shall be however compliant with national legislation. Further to promote and develop an efficient system for conservation of ex situ material and to monitor the maintenance of variability of PGRFA all efforts to cooperate with local communities shall be required to be considered.

The core mechanism of the Treaty is the multilateral system (MLS) of ABS. The mechanism thus ensures that the objectives of the Treaty are fulfilled through MLS. The Treaty is broadly divided into six parts, and Part IV of the Treaty is entirely dedicated to this ABS mechanism through Articles 10–13.

The introduction to the Treaty, its objectives, use of terms and scope are covered in Part I through Articles 1–3. General provisions of the Treaty are taken care in Part II (Articles 4–8) such as obligations, conservation, exploration, collection, characterization, evaluation and documentation of PGRFA and sustainable use. Part III describes farmers' rights (Article 9). Part V of the Treaty covers supporting components (Articles 14–17) including Global Plan of Action (GPA), ex situ collections of PGRFA held by the International Agricultural Research Centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR) institutions, International Plant Genetic Resources Networks and the Global Information System on Plant Genetic Resources for Food and Agriculture. Financial provisions are provided in Part VI in Article 18. Institutional provisions for setting up of governing body, secretary, compliance, settlement of disputes, amendments of the Treaty, annexes, signatures, ratification, acceptance or approval, accession, entry into force, member organizations of FAO, reservations, non-parties, withdrawals, termination, depositary and authentic texts are in Part VII (Articles 19–35).

The important provisions, obligations and components of the Treaty related to access and benefit sharing under various articles are that each contracting party shall ensure the conformity of its laws, regulations and procedures with the obligations of the agreement.

The ABS mechanism under the Treaty is described through Article 10 to Article 13, and each article is summarized hereunder in brief.

2.2.1 Multilateral System of Access and Benefit Sharing (Article 10)

In harmony with the CBD, the MLS of the Treaty recognizes the sovereign rights of the nations on their PGRFA and thus lays provisions for facilitated access to PGRFA through the MLS which is efficient, effective and transparent and to share the benefits arising from the utilization of PGRFA accessed from the Treaty in a fair and equitable way. With respect to access, the authority to regulate rests with the national governments and is in compliance with national legislation.

2.2.2 Coverage of the MLS (Article 11)

The MLS of the Treaty includes PGRFA which were identified according to basic criteria of food security and interdependence. The inclusion of PGRFA is to achieve the major objective of the Treaty, that is, conservation and sustainable use and equitable sharing benefits arising from their use. For this purpose ex situ collections of the International Agricultural Research Centres of the Consultative Group on International Agricultural Research (CGIAR), collected before 1993, were designated as FAO material or 'in-trust' material and became part of the MLS through signing of an agreement between the FAO and consortium. This provision is described under Article 15 of the Treaty.

To include maximum crops in MLS, the Treaty urges to include all PGRFA which are in public domain and under the control of the contracting parties and to notify/designate accessions in the MLS. It also refers that the governing body of the Treaty shall assess whether the countries which have not included any PGRFA in the MLS continue to be provided facilitated access.

The MLS applies to 64 major crops and forages (35 food crops and 29 forages) which are listed at Annex I to the Treaty text and includes related species as mentioned in the parenthesis and named below.

2.2.2.1 Food Crops

Breadfruit, *Asparagus*, oat, beet and *Brassica* complex (genera included are *Brassica*, *Armoracia*, *Barbarea*, *Camelina*, *Crambe*, *Diplotaxis*, *Eruca*, *Isatis*, *Lepidium*, *Raphanobrassica*, *Raphanus*, *Rorippa* and *Sinapis*); oilseed and vegetable crops such as cabbage, rapeseed, mustard, cress, radish and turnip (the species *Lepidium meyenii* (maca) is excluded); pigeon pea, chickpea and *Citrus* (genera *Poncirus* and *Fortunella* are included as rootstock); coconut and major aroids (include taro, cocoyam, dasheen and tannia); carrot, yams, finger millet, strawberry, sunflower, barley, sweet potato, grass pea, lentil, apple and cassava (*Manihot esculenta* only); banana/plantain (except *Musa textilis*); rice, pearl millet and beans (except *Phaseolus polyanthus*); pea, rye and potato (section tuberosa included, except *Solanum phureja*); eggplant (section melongena included); *Sorghum*, *Triticale* and wheat (including *Agropyron*, *Elymus* and *Secale*); and faba bean/vetch, cowpea and maize (excluding *Zea perennis*, *Zea diploperennis* and *Zea luxurians*).

2.2.2.2 Forage Crops

The legume forages include *Astragalus* (*chinensis*, *cicer*, *arenarius*), *Canavalia* (*ensiformis*), *Coronilla* (*varia*), *Hedysarum* (*coronarium*), *Lathyrus* (*cicera*, *ciliolatus*, *hirsutus*, *ochrus*, *odoratus*, *sativus*), *Lespedeza* (*cuneata*, *striata*, *stipulacea*), *Lotus* (*corniculatus*, *subbiflorus*, *uliginosus*), *Lupinus* (*albus*, *angustifolius*, *luteus*), *Medicago* (*arborea*, *falcata*, *sativa*, *scutellata*, *rigidula*, *truncatula*), *Melilotus* (*albus*, *officinalis*), *Onobrychis* (*viciifolia*), *Ornithopus* (*sativus*), *Prosopis* (*affinis*, *alba*, *chilensis*, *nigra*, *pallida*), *Pueraria* (*phaseoloides*) and *Trifolium* (*alexandrinum*, *alpestre*, *ambiguum*, *angustifolium*, *arvense*, *agrocicerum*, *hybridum*, *incarnatum*, *pratense*, *repens*, *resupinatum*, *rueppellianum*, *semipilosum*, *subterraneum*, *vesiculosum*).

Grass forages include *Andropogon* (*gayanus*), *Agropyron* (*cristatum*, *desertorum*), *Agrostis* (*stolonifera*, *tenuis*), *Alopecurus* (*pratensis*), *Arrhenatherum* (*elatius*), *Dactylis* (*glomerata*), *Festuca* (*arundinacea*, *gigantea*, *heterophylla*, *ovina*, *pratensis*, *rubra*), *Lolium* (*hybridum*, *multiflorum*, *perenne*, *rigidum*, *temulentum*), *Phalaris* (*aquatica*, *arundinacea*), *Phleum* (*pratense*), *Poa* (*alpina*, *annua*, *pratensis*) and *Tripsacum* (*laxum*). The other forages include *Atriplex* (*halimus*, *nummularia*) and *Salsola* (*vermiculata*).

Under the MLS and the crops covered under the MLS, facilitated access is applicable to 64 crops of Annex I and also to the ex situ collections of the IARCs of their mandate crops collected before 1993. This MLS created by the Treaty has been operational since year 2007. At present, 600–800 samples are being exchanged on a daily basis. All transactions are documented in confidential database that can be accessed by FAO which is the third-party beneficiary of the Treaty, and its role is explained later in the paper.

2.2.3 Facilitated Access to PGRFA within the MLS (Article 12)

The article describes the purpose of providing facilitated access under the Treaty and states that facilitated access to PGRFA shall be in accordance with the provisions as mentioned below. All access is governed however under Standard Material Transfer Agreement (SMTA):

- The purpose for access is utilization and conservation in research, breeding and training for food and agriculture.
- The purpose shall exclude chemical, pharmaceutical or other nonfood/feed industrial uses.
- The access shall be accorded expeditiously.
- Tracking of individual accessions is not needed.
- Access to be provided free of charge.
- Access to be provided with available passport data.
- Intellectual property or other rights that limit the facilitated access to the PGRFA, or their genetic parts or components, in the form received from the MLS not to be claimed.
- For PGRFA under development, access shall be at the discretion of the developer.
- Access shall be consistent with international agreements and national laws for PGRFA protected by IPR.
- Accessed PGRFA shall remain available to the MLS.
- PGRFA found in in situ conditions shall be accessed according to national legislation or, in the absence of such legislation, in accordance with standards set by the governing body of the Treaty.
- The condition of SMTA shall apply to subsequent transfer of PGRFA to another entity.

It is also referred that in the case of any dispute, the contracting parties lay down the provision of recourse which shall be legally binding for providing facilitated access to PGRFA in case the purpose is re-establishment of agricultural systems in emergency disaster situations.

2.2.4 Benefit Sharing in the MLS (Article 13)

The contracting parties to the Treaty have agreed that benefits which arise from the use of PGRFA accessed from MLS that includes commercial use shall be shared fairly and equitably. The mechanisms for sharing the benefits shall be the exchange of information, access to and transfer of technology and capacity building. The sharing of the benefits arising from commercialization shall also take into account the priority activity areas in the Global Plan of Action.

2.2.4.1 Nonmonetary Benefits

Exchange of Information

In accordance to national legislation, the following information may be made for the PGRFA accessed from the MLS. The information shall be shared on these aspects where it is non-confidential. The information shall be shared through the information network made available to the Treaty as:

– Catalogues and inventories
– Information on technologies
– Results of technical, scientific and socio-economic research, including characterization, evaluation and utilization

For facilitating the exchange of the information, it is desired that a global information system shall be developed and strengthened. This information system shall be based on the PGRFA information system already existing with the contracting parties on scientific, technical and environmental matters. The Treaty expects that such exchange of information will contribute to the sharing of benefits by making information available to all contracting parties.

Further, in developing the global information system, early warnings about hazards which may threaten PGRFA shall be provided to safeguard PGRFA. Periodic reassessment through state of the world's PGRFA in collaboration with CGRFA is also done, and for this there is a need that GPA should be effectively implemented through national policies and international cooperation.

Access to and Transfer of Technology

The Treaty recognizes that some technologies can only be transferred through genetic material. Therefore, the Treaty provides for facilitated access to such technologies and genetic material under the MLS and access to improved varieties and genetic material developed through the use of PGRFA under the MLS for the purpose of conservation, characterization and evaluation.

However, applicable property rights and national legislations shall be applicable especially for developing countries and countries with economies in transition. These include a set of measures, such as the establishment and maintenance of crop-based thematic groups, partnership in research and development, partnership in commercial joint ventures and effective access to research facilities.

Capacity Building

As per the needs and priorities expressed by the developing countries and countries with economies in transition in relation to PGRFA plans and programmes, it is agreed that priority is to be given for capacity building in:

– Establishing and/or strengthening programmes for scientific and technical education
– Training in conservation
– Training in sustainable use of PGRFA
– Development and strengthening of facilities for conservation and sustainable use of PGRFA
– Carrying out scientific research in cooperation with institutions
– Developing capacity for such research in fields, where needed

2.2.4.2 Monetary Benefits

Through partnerships and collaboration of the private and public sectors, the Treaty agrees to take measures to achieve commercial benefit sharing. The provision of payment is already included in SMTA and requires payment to the MLS if the recipient commercializes a product that is PGRFA accessed from the MLS or incorporates material accessed from the MLS. The payment shall be equitable sharing of benefits that arises from the commercialization of that product.

The governing body (GB) however may decide form and manner of the payment and shall establish different levels of payment for various categories. Farmers in developing countries and in countries with economies in transition may be exempted from such payments. Further assessment will be done whether mandatory payment shall apply to those cases where commercialized products are available without restriction to others for research and breeding.

The ultimate beneficiaries under the MLS should primarily, directly or indirectly be farmers in developing countries and with economies in transition, as the farmers are the ones who conserve and sustainably utilize PGRFA. The Treaty also looks for the modalities of a strategy for voluntary benefit sharing contributions by food processing industries that benefit from PGRFA.

2.2.5 Access and Benefit Sharing Mechanism

The most immediate advantage of the Treaty is that vast resources are available for access through global gene pool which is designated accessions of the Annex I crops of the Treaty of the MLS for the purpose of agricultural research. The flow of material and benefits within the multilateral system is depicted in Fig. 2.1. Presently, 1.4 million samples of PGRFA are part of this MLS, and more and more number of samples is being added to the MLS through contracting parties as major obligation of the Treaty. Through MLS a simple procedure of agreeing to Standard Material Transfer Agreement (SMTA) online or through signatures is all that is required to access PGRFA involving minimum transaction cost. This MLS offers the first ever internationally agreed formula for sharing benefits associated with the use of PGRFA.

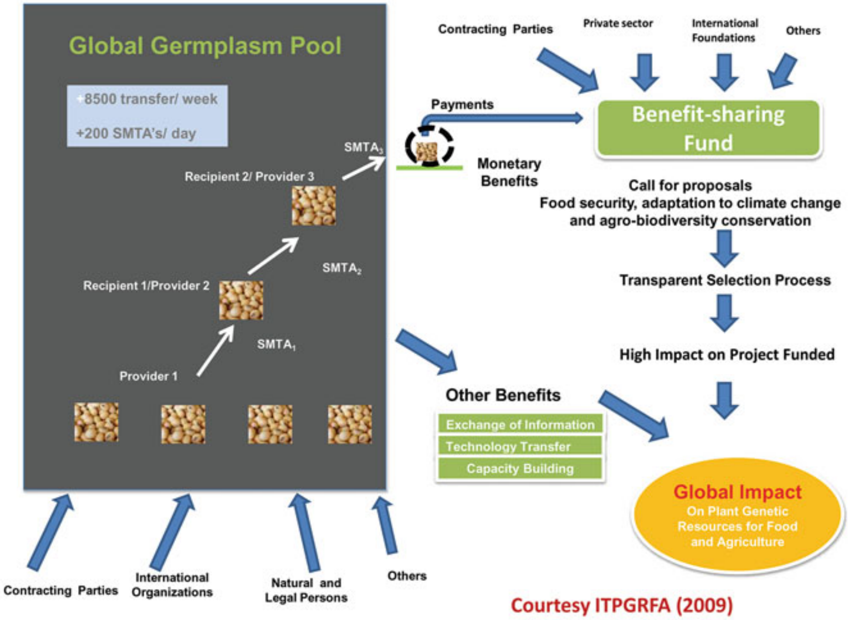

Fig. 2.1 Flow of material and benefits within the multilateral system of ITPGFRA

Access to global gene pool which is a network of international and national gene banks and other institution is a major benefit under the Treaty. Contracting parties to the Treaty thus receive a share of benefits from the use of PGRFA accessed through MLS. Once the crop samples have been included in the MLS, it becomes a part of the common gene pool of and shared for the benefit of the humankind.

Facilitated access to this vast gene pool under the Treaty is provided under the terms and conditions of the SMTA. SMTA is an instrument which has been negotiated and agreed internationally and adopted by the governing body (GB) of the Treaty for use in transfer of PGRFA amongst the contracting parties of the Treaty. It provides for transparent regulations that guarantee legal security in exchanges of PGRFA (ITPGRFA Secretariat 2009a, b). The benefit sharing in SMTA is already agreed upon, and the contacting parties are required to put in place the use of SMTA for accessing PGRFA from MLS.

2.2.6 Benefit Sharing Fund

Benefit Sharing Fund is a trust account set up to collect the financial resources arising from the monetary benefit sharing resulting from commercialization. In addition, it receives voluntary contributions from contracting parties, international institutions, foundations, private sector and other possible sources. The fund supports initiatives that focus on the on-farm management and conservation of PGRFA and sustainable use.

Till December 2014, target was set for US$116 million. Any government/non-government institution and farmer or farmer's organizations from the contracting parties to the Treaty are eligible to apply for financial support from the Benefit Sharing Fund.

Benefit Sharing Fund invests directly in high-impact projects such as supporting farmers in developing countries who conserve crop diversity in their fields and providing assistance to farmers and breeders who adapt crops to our changing needs and demands. Two projects from India were supported by this fund entitled 'Seeds for Life – Action with Farmers in Uttar Pradesh – IGP Region to Enhance Food Security in the Context of Climate Change' and 'Using Rice Genetic Diversity to Support Farmers' Adaptation to Climate Change for Sustainable Food Production and Improved Livelihoods in India'.

The Benefit Sharing Fund prioritizes projects that accelerate on-farm management and conservation in collaboration with farmers and local communities, especially in the developing countries. This includes projects that aim to increase food security, especially for local communities in the developing world; projects that represent innovative partnerships between research centres, farmers, civil society and public/private sector leaders at all levels; and projects which have the potential to be scaled up across agro-ecological zones and ensure maximum positive impact and the best use of current scientific data.

2.2.7 Options for Benefit Sharing under SMTA

Under the SMTA there is a provision that in case the recipient commercializes a product (product that is a PGRFA and that incorporates material accessed under SMTA) and where such product is not available without restriction to others, the recipient shall pay a fixed percentage of the sales of the commercialized product into the mechanism; specifically it is 1.1 % of net sales less 30 % or 0.77 % of gross sales.

In the case that the recipient commercializes a product where product is available without restriction to others, the recipient is encouraged to make voluntary payments into the mechanism.

After the expiry or abandonment of the protection period of an IPR on a product, the recipient is encouraged to place a sample of this product into a collection of the MLS. In case a recipient obtains IPR on any products developed from the material or its components and assigns such IPR to a third party, the benefit sharing obligations of the agreement is transferred to that third party.

2.2.7.1 Rate and Modalities of Payment under *Article 6.7 of SMTA*

1. 1.1 % of the sales of the product or products less 30 %, except that no payment shall be due on any product or products that:
   (a) Are available without restriction for further research and breeding
   (b) Have been purchased or otherwise obtained from another person or entity who either has already made payment on the product or products or is exempt from the obligation to make payment
   (c) Are sold or traded as a commodity
2. Where a product contains a PGRFA accessed from the MLS under two or more SMTA, only one payment is required.
3. The recipient is required to submit within 60 days after each calendar year ending December 31, an annual report to GB on:
   (a) Sales of the product or products by the recipient
   (b) The amount of the payment due
   (c) Information that allows for the identification of any restrictions that have given rise to the benefit sharing payment
4. All due payments shall be payable in US dollars only.

2.2.7.2 Rate and Modalities of Alternative Payment Scheme under Article 6.11 of SMTA which is an Option for Crop-Based Payment

- Discounted rate for payments 0.5 % of the sales of any products and of sales of other products.
- 0.5 % of the sales of any product derived from such PGRFA under development, whether the product is available or not without restriction.
- The recipient may notify the GB to opt out from the application of this article at least 6 months before the expiry of a period of 10 years or 6 months before the expiry of subsequent periods of 5 years.
- In the case the recipient has entered into other SMTA, the 10-year period will commence from the date of signature of the first SMTA.
- If the recipient enters in the future into other SMTA in relation to material belonging to the same crop[s], he needs to pay only sales as determined. No cumulative payments will be required.

The Food and Agriculture Organization (FAO) of the United Nations acts as the third-party beneficiary of the International Treaty. The governing body has established procedures for FAO to perform the role and functions of the third-party beneficiary and is conferred the rights to initiate dispute settlement procedures regarding rights and obligations of the parties, mediation and arbitration. If the dispute cannot be resolved by negotiation, FAO shall commence or encourage the parties to the SMTA to commence mediation proceedings.

FAO shall propose to the parties in dispute that mediation be carried out through a set of Mediation Rules approved by the governing body of the International Treaty and administered by WIPO Arbitration and Mediation Centre.

2.3 Access to PGRFA as per the Provisions of the Treaty in India

Access and benefit sharing mechanisms are properly defined under the Treaty. The procedure for facilitated access to PGRFA is recently notified by the Ministry of Environment and Forests and Climate Change (MoEF & CC), and the facilitated access is regulated as per the guidelines issued by the Department of Agriculture and Cooperation (DAC). This notification is provided under Section 40 of Biological Diversity Act (BDA), 2002, and is in compliance with national legislation as required under the international agreement. The notification is available at www.nbaindia.org. As per these guidelines, PGRFA is provided only for the purpose of utilization and conservation for research, breeding and training for food and agriculture, provided that such purpose does not include chemical, pharmaceutical and/or other nonfood/feed industrial uses as per Article 12.3a of ITPGRFA referred above. As Joint Secretary (Seeds), DAC is the national focal point (NFP) for access to PGRFA under the provisions of the ITPGRFA; all requests for access need to be addressed to NFP, either directly or through NBPGR. Access to PGRFA requests shall be granted only with the approval of NFP. Natural and legal persons from the contracting parties may submit their requests for such access. In addition, the germplasm of mandate crops available with International Agricultural Research Centres (IARCs) collected before 1993 (also known as 'FAO designated' accessions of 'in-trust' material) shall also be facilitated for access as provided under Article 15 of ITPGRFA. All such access will be strictly under the provisions of SMTA adopted by the governing body (GB) of the ITPGRFA, and specific conditions may be added in SMTA in the case of any material 'underdevelopment' as per provisions of the ITPGRFA.

2.4 Conclusion

The international exchange of PGRFA for research, breeding and conservation is the key requirement for food security and sustainable agriculture. India has already notified the guidelines for the implementation of Treaty and is already using SMTA for exchange of PGRFA with CGIAR institutes. The guidelines are notified under the provisions of national legislation, that is, Biodiversity Act, 2002. As Nagoya Protocol enters into force since October 2014, guidelines on access to biological resources and associated knowledge and benefit sharing regulations have also been notified.

Nagoya Protocol on Access and Benefit Sharing includes linkages to the Treaty, and contracting parties are required to consider the importance of GRFA and the role of GRFA in food security as described in Article 8 of the protocol. Further Article 4 also mentions that in countries where specialized access and benefit sharing instrument applies, Nagoya Protocol does not apply to the party or parties to the specialized instrument in respect of specific genetic resources covered for the purpose of special instrument.

Obligations of Nagoya Protocol are very focussed on ABS mechanism. Access shall only be with prior informed consent of the indigenous and local communities, and for benefit sharing compliance, agreement must be negotiated and systems shall be in place for compliance. Further NP states that the Treaty is one of the overarching international regimes on ABS, and the Treaty's governing body also adopted resolution and called on contracting parties to ratify NP and implement in mutually supportive manner (Arora 2013).

Secretariats of both CBD and ITPGRFA have signed Memorandum of Cooperation to share information, coordinate technical assistance, hold workshops and so on (Halewood et al. 2013).

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Chapter 3
Contributions of the Corporate Sector to Sustainable Development

Ramakrishna Arkalgud

Abstract Biological diversity, defined as the variety and variability within species, between species and ecosystems, is crucial to poverty alleviation and sustainable development. The Convention on Biological Diversity (CBD) recognises that biological diversity is about more than plants, animals and microorganisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter and a clean and healthy environment in which to live. Corporate social responsibility (CSR) is viewed as an umbrella concept, which includes corporate citizenship, corporate sustainability, stakeholder management, environmental management, business ethics and corporate social performance. The chapter deals with case studies of Access and Benefit Sharing (ABS) in different aspects from research to commercialisation and the contributions of corporate sector to biodiversity conservation, sustainable use and fair and equitable sharing of benefits. The contributions of corporate sector in India for promoting sustainable development and livelihood are presented.

Keywords Corporate social responsibility • Corporate sustainability • Bioprospecting • Floriculture • Traditional knowledge digital library

3.1 Introduction

The Convention on Biological Diversity (CBD) is a legally binding multilateral environmental agreement on the conservation and sustainable use of all components of biodiversity, including genetic resources, species and ecosystems. The CBD defines biodiversity conservation and sustainable use in their specific socio-environmental context. Its provisions apply to signatory parties, rather than to individual economic actors, which are themselves subordinate to national laws and international codes. The CBD recognises the dependence of traditional populations

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and local communities on biological resources, providing that parties assure traditional knowledge and conservation practices be protected and applied more widely, conditioned on informed consent and equitable sharing of benefits (Article 8 (j)). The work programme for the implementation of Article 8 (j) stressed the need 'to ensure the full and effective participation of indigenous and local communities at all stages and levels of its implementation, and called for mechanisms and guidelines to promote effective participation of such communities in decision-making (Decision V/16)'. Article 10 (e) of the CBD also encourages cooperation between government and the private sector in developing methods for sustainable use. Other articles of CBD are related to societal involvement, impact assessment, incentive measures and financial mechanisms, all of which have pertinent implications for the private sector. 'Viewing biodiversity conservation in terms of sustainability means recognizing the actual value of biodiversity to all people, everywhere' (Earthwatch/IUCN/WBCSD 2002:26–27).

3.2 Biodiversity Conservation and Sustainable Utilisation

'Biological diversity must be treated more seriously as natural resource, to be indexed, used and, above all, preserved', and the rationale for such an idea is based on three criteria. Firstly, exploding human population is degrading the environment at an accelerating rate; secondly, science is discovering new uses of biological diversity in ways that can relieve both human suffering and environmental destruction; and lastly, much of the biodiversity is being irreversibly lost through extinction caused by the destruction of natural habitats. Each species is a repository of an immense amount of genetic information, and therefore the documentation of biotic resource of the country focuses on developing 'indicators to be used in the assessment' which are reflected in a combination of ecological fundamentals, such as biodiversity, critical habitat, key ecological relationships, site specific considerations, environmental stress and potential impacts. Assessment and documentation also provide biodiversity values that are recognised and taken into consideration in the planning, management and decision-making process.

The millennium assessment of biodiversity places human welfare as the central focus for assessment, recognising that people make decisions concerning biodiversity based on a range of parameters related to well-being, including the use and non-use values of biodiversity and ecosystems. This implies the need for contributions from all actors in society. Business remains one of the major sources of both pressures against and potential solutions towards this goal.

Signed by 150 government leaders at the 1992 Rio Earth Summit (now 198 countries), the Convention on Biological Diversity is dedicated to promote sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognises that biological diversity is about more than plants, animals and microorganisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter and a clean and healthy environment in which to live. It includes 42 Articles: the Preamble and Articles 1–5 describe the overall aims of the Convention and the context in which the instrument operates, Articles 6–20 contain the substantive commitments or promises that parties have agreed to in ratifying the Convention, Articles 21–27 mainly deal with institutional structure and reporting, and Article 28 onwards deal with procedural and housekeeping matters, such as amendment of the text of the Convention, adoption of protocols, etc. The *Cartagena Protocol on Biosafety to the Convention on Biological Diversity* is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health.

In India, as in most developing countries, issues of biodiversity conservation and sustainable use are still under discussion. Consensus among stakeholders remains to be achieved over issues such as compensation of undertakings with significant impacts on protected areas, use of genetically modified organisms, regulation of access to genetic resources and to traditional knowledge, the equitable distribution of benefits generated thereby, commerce in environmental goods and services and so on. The complexity of these themes, allied with the lack of clarity of society's expectations with regard to the CBD, has made the role of business one of a number of concerns that demand greater understanding.

The Union Government of India signed the Convention on Biological Diversity on 5 June 1992 and ratified it on 18 February 1994 and signed the Cartagena Protocol on biosafety on 23 January 2001 and ratified the same on 11 September 2003. The main objectives of CBD are:

- *Conservation of biological diversity*
- *Sustainable use of its components*
- *Fair and equitable sharing of the benefits arising out of the utilisation of genetic resources*

In this scenario, decision-makers have developed frameworks whereby biological resources can be conserved partly for their intrinsic values but largely for commercial use and research requirements. Mechanisms for regulation and restriction of access, management and mitigation of impacts and related compensatory regimes are being developed. The ethics of these mechanisms are contentious and perspectives and positions of civil society on them are polarised. The Biological Diversity Act 2002 was born out of India's attempt to realise the objectives enshrined in the UN Convention on Biological Diversity (CBD) in 1992 which recognises the sovereign rights of states to use their own biological resources and associated traditional knowledge as well as facilitate access to them in a sustainable manner and through a just process for the purpose of implementing the objectives of the Act.

3.3 Nagoya Protocol on Access and Benefit-Sharing Mechanism

At its first meeting in 1999, the panel of experts on ABS concluded that 'access legislation will only be feasible and implementable if it is developed with the full participation of all those who will be affected by and administering it, such as certain industry sectors, universities, scientific research organisations, ex-situ collections and local and indigenous communities'. The sixth meeting of the Conference of Parties to the CBD in April 2002 (COP 6) deliberated on the interpretation of Article 15 and arrived at Decision Vi/24. This decision brought forth the 'Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits arising out of their utilization'. One of the stated objectives of the guidelines is to contribute to the development of mechanisms and access and benefit-sharing regimes that recognise the protection of indigenous knowledge, innovations and practices of indigenous and local communities. However, this was adopted and agreed upon in the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting on 29 October 2010 in Nagoya, Japan. The *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilisation to the Convention on Biological Diversity* is an international agreement which aims at sharing the benefits arising from the utilisation of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components. The Ministry of Environment, Forests and Climate Change, Government of India, in its document on the Nagoya Protocol has set the goal to enhance implementation through participatory planning, knowledge management and capacity building:

- By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
- By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.
- By 2020, knowledge, science base and technologies relating to biodiversity, its values, functioning, status and trends and the consequences of its loss, are improved, widely shared and transferred and applied.
- By 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011–2020 (*International Decade of Biodiversity*) from all sources, and in accordance with the consolidated

and agreed process in the Strategy for resource mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource need assessments to be developed and reported by parties.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilisation to the Convention on Biological Diversity ('the Protocol') was adopted on 30 October 2010. It marked the conclusion of a long and arduous negotiation process based on a mandate established at the seventh meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD) held in Kuala Lumpur in 2004. This in turn was prompted by the call by the World Summit on Sustainable Development in 2002 at Johannesburg for the establishment of international rules to ensure that benefits flowed to mainly developing countries that provided genetic resources. Benefit sharing had remained an empty promise since this highly subscribed environmental treaty – the Convention on Biological Diversity (CBD). Governments meeting at the tenth Conference of the Parties to the Convention on Biological Diversity (COP10 CBD) at Nagoya, Japan, have approved a step change for biodiversity. The plan consists of 20 targets designed to tackle the extinction crisis and restore the earth's natural capital. Julia Marton-Lefèvre, IUCN Director General, says 'We've seen history in the making here in Nagoya with a landmark agreement now in place that defines the future for life on earth'. The eleventh Conference of Parties (COP11) was held in Hyderabad, Andhra Pradesh, India, during October 2012, where representatives from 198 countries participated. A number of high-priority points have been discussed in respect of the current situation in implementation of the Strategic Plan for Biodiversity 2011–2020 and progress towards the Aichi biodiversity targets coupled with taking stock of the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefit arising from their utilisation (ABS).

Access and benefit sharing (ABS) is yet another component of CBD to identify *ecosystem value*, a difficult and controversial task, and economists have often been criticised for trying to put a *price tag* on nature. Known by several types, however, two main categories, viz. use values and non-use or 'passive use' values, are important. Use values are based on the actual use of the environment, and non-use values are values that are not associated with the actual use, or even an option to use, of an ecosystem or its services. Thus, use value is defined as the value derived from the actual use of goods and services. The value of biodiversity derives from its role in the provision of ecosystem services and from people's demand for those services. Economists have typically sought to value the individual components of ecosystems or specific services yielded by ecosystems, rather than ecosystems themselves. In some cases – where well-functioning markets exist – the valuation of specific services is straightforward. In most cases it is not, even where markets for specific services do exist, derivation of the value of individual components of ecosystems is hard. Gretchen Daily of Stanford University states that 'There is a renaissance underway; in which people are waking up to the tremendous values of natural capital and devising ingenious ways of incorporating these values into major resource decisions'.

Based on the identification of ecosystem values, CBD introduced the concept of benefit sharing or ‘Access and Benefit Sharing’ or ABS. It was meant to take into account the need to share the costs as well as the benefits of biodiversity conservation between developed and developing countries and to find ways and means of supporting practices and innovations by indigenous and local communities, arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. Under Article 15 CBD access to genetic resources is to be facilitated for environmentally sound use. Access is based on the *prior informed consent* (PIC) of the party providing the resource. Providers and users are to negotiate the *mutually agreed terms* (MIT) defining the sharing of benefits. Article 16 of CBD recognises that both access to and transfer of technology are essential elements for achieving the objectives of the Convention. It requires the parties to provide and facilitate access to and transfer of technologies relevant for conservation and sustainable use of biological diversity as well as to use the technology in an environment-friendly way.

Genetic resources – whether from plant, animal or microorganisms – may be used for different purposes (e.g. basic research or commercialisation of products). Users of genetic resources and/or traditional knowledge associated with genetic resources include research institutes, universities, ex situ collections and private companies operating in a wide range of sectors, including the pharmaceutical, biotechnology, seed, crop protection, horticulture, cosmetic and personal care, fragrance and flavour, botanicals and food and beverage industries. By helping to ensure benefit sharing, the Nagoya Protocol creates incentives to conserve and sustainably use genetic resources and therefore enhances the contribution of biodiversity to development and human well-being. At the same time, it offers both a concrete example for valuing biodiversity and its ecosystem services in practice and an economic tool to take proper account of this value.

Article 15 of CBD on access and benefit sharing can be identified as *the grand bargain* as it is mainly subjected to follow national law, with prior informed consent (PIC) on mutually agreed terms (MIT) with benefit-sharing mechanism. This landmark agreement is a victory for developing countries; developed countries would demand more compromise. ‘What makes disputes over genetic resource control particularly interesting is the fact that, on the one hand, most such resources are to be found in the developing world, yet, on the other hand, most of the scientific and technical expertise and hardware connected to biotechnology is found in the industrialized world’ (Stenson and Gray 1999).

3.4 Biological Diversity Act 2002 and Biological Diversity Rules 2004

In order to achieve the objectives of the Convention on Biological Diversity (CBD), the Government of India enacted the Biological Diversity Act 2002 and notified Biological Diversity Rules 2004. A three-tier structure – National Biodiversity Authority (NBA) at federal level, State Biodiversity Boards (SBBs) at provincial level and Biodiversity Management Committees (BMCs) at community level – is in place to implement the ABS mechanisms. Besides the above, the Biological Diversity Act 2002 also includes the following:

1. Prohibition on transfer of Indian genetic material outside the country, without specific approval of the Indian government
2. Prohibition on anyone claiming an intellectual property right (IPR), such as a patent, over biodiversity or related knowledge, without the permission of the Indian government
3. Regulation of collection and use of biodiversity by Indian nationals while exempting local communities from such restrictions
4. Measures for sharing the benefits from the use of biodiversity, including the transfer of technology, monetary returns, joint Research & Development, joint IPR ownership, etc.
5. Measures to conserve and sustainably use biological resources, including habitat and species protection, environmental impact assessments of projects, integration of biodiversity into the plans, programmes and policies of various departments/sectors
6. Provisions for local communities to have a say in the use of their resources and knowledge and to charge fees for any access
7. Protection of indigenous or traditional knowledge, through appropriate laws or other measures such as the registration of such knowledge
8. Regulation of the use of genetically modified organisms
9. Setting up of national, state and local biodiversity funds, to support conservation and benefit sharing
10. Setting up of Biodiversity Management Committees (BMCs) at local, village and urban levels, State Biodiversity Boards (SBBs) at the state level and a National Biodiversity Authority (NBA) at the national level

The benefit-sharing mechanism in India includes:

Monetary benefits which may include but are not limited to:

(i) Access fees/fee per sample collected or otherwise acquired
(ii) Up-front payments
(iii) Milestone payments
(iv) Payments of royalties
(v) License fees in case of commercialisation

(vi) Special fees to be paid to trust funds supporting conservation and sustainable use of biodiversity
(vii) Salaries and preferential terms where mutually agreed
(viii) Research funding
(ix) Joint ventures
(x) Joint ownership of relevant intellectual property rights

Nonmonetary benefits may include but are not limited to:

(xi) Sharing of research and development results
(xii) Collaboration, cooperation and contribution in scientific research and development programmes, particularly biotechnological research activities where possible
(xiii) Participation in product development
(xiv) Admittance to ex situ facilities of genetic resources and to data bases by participating institutions
(xv) Transfer to India of genetic resources of knowledge and technology under fair and most favourable terms, including concessional and preferential terms where agreed, in particular, knowledge and technology that make use of genetic resources, including biotechnology, or that are relevant to the conservation and sustainable utilisation of biological diversity
(xvi) Strengthening capacities for technology transfer to India
(xvii) Institutional capacity building
(xviii) Human and material resources to strengthen the capacities for the administration and enforcement of access regulations
(xix) Training related to genetic resources with the full participation possibly in India
(xx) Access to scientific information relevant to conservation and sustainable use of biological diversity, including biological inventories and taxonomic studies
(xxi) Institutional and professional relationships that can arise from access and benefit-sharing agreements and subsequent collaborative activities
(xxii) Joint ownership of relevant intellectual property rights

3.4.1 Notification on ABS

The Nagoya Protocol is said to advance significantly the CBD’s third objective by providing a strong basis for greater legal certainty and transparency for both providers and users of genetic resources. Fair and equitable sharing of benefits arising out of the utilisation of genetic resources and associated ITK is the key of the ABS framework. India, being the leading country in ABS legislation with mechanisms in place, developed in true sense the system of fair and equitable sharing of benefits.

On 21 November 2014, the Ministry of Environment, Forests and Climate Change, Government of India, in exercise of the powers conferred by section 64 read with subsection (1) of section 18 and subsection (4) of section 21 of the Biological Diversity Act 2002 (18 of 2003) and in pursuance of the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits of their utilisation to the Convention on Biological Diversity and in consultation with the National Biodiversity Authority issued guidelines on Access to Biological Resources and Associated Knowledge and Benefit Sharing Regulations, 2014, for research and operation of bio-survey and bio-utilisation as well as procedure for access to biological resources. The other aspect covered under the notification includes the option of benefit sharing on sales price of the biological resources accessed for commercial utilisation under regulation, collection of fees as well as procedure for transfer of results of research relating to biological resources. It also included the issues related to IPR and procedure for transfer of accessed biological resource and/or associated knowledge to the third party for research/commercial utilisation.

According to NBA, India's engagement with ABS issues has been progressive and noteworthy. India is perhaps the first country in the world that has been able to tap into the magnitude of ABS, having dealt with over 1500 ABS applications (Figs. 3.1 and 3.2) By August 2015, the NBA signed more than 100 agreements on ABS.

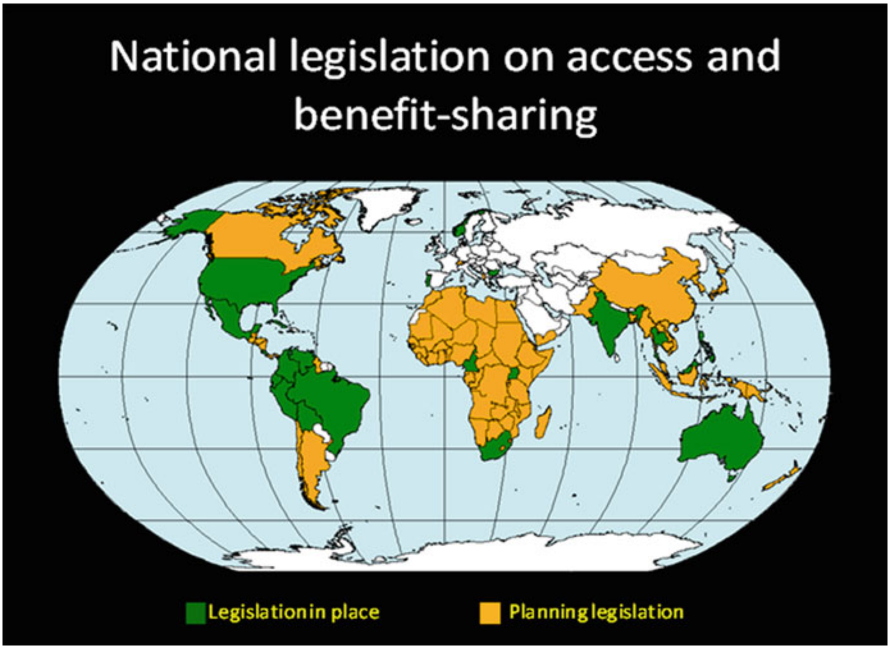

Fig. 3.1 National legislation on ABS

Fig. 3.2 Parties to the CBD

3.5 Equitable Sharing of Benefits: Case Studies

One of the examples of the benefit-sharing mechanism is by the San Trust which received a royalty of 587305.45 rands (US $39,320), and the same was used to strengthen the institutional base of the three San Councils (South Africa, Botswana, Namibia). The product is based on the traditional indigenous knowledge on the use of the *Hoodia* plant that occurs in Southern Africa, originally in the possession of the San people. Another example often cited was that the National Institute for Pharmaceutical Research and Development, Nigeria, worked with Rev. Ogunyale, a traditional health practitioner, and prepared a recipe – Niprisan – a herbal medicine developed to cure sickle cell diseases. The licence for commercial production was sold to Xechem. Benefit-sharing mechanism by way of royalties of 7.5 % of gross sales and good faith payment of $115,000 was received which was utilised for establishing a drug manufacturing facility at Abuja providing jobs for Nigerians, building capacity, generating wealth for the economy and promoting the development of other herbal medicines based on indigenous medical knowledge. The first benefit-sharing mechanism is noticed in India, as early as 1987, by way of developing a scientifically validated, standardised herbal formulation '*Jeevani*' with '*Trichopus zeylanicus*' and three other medicinal plants as its ingredients. Evaluations related to toxicity, efficacy, shelf life and clinical properties were carried out by TBGRI, and the drug was ready by the end of 1994. The host research institute

TBGRI transferred the money due to the Kani tribe (Rs.6,50,000 – aprox.US $9786) in February 1999.

An example of ABS recently from India is from the marine bioresource (*seaweed*, *Kappaphycus alvarezii*/*Eucheuma cottonii*) exported to the tune of 2000 metric tonnes to countries like Malaysia, the Philippines and Indonesia by M/s. Pepsico India Holdings Pvt. Ltd. The carrageen extracted from this seaweed is used for manufacturing toothpaste, soaps, shampoo, cosmetics, ice cream, meat processing and air fresheners. The seaweed is grown by Tamil Nadu coastal-dwelling people, mostly fishermen community from districts of Pudukkottai, Ramanathapuram, Tuticorin and Tanjore. The NBA was paid a royalty at 5 % of free on board (FoB) to the tune of INR 39.09 lakhs[1] (US $58,721.68) by the exporter. Efforts are being made to form Biodiversity Management Committees by State Biodiversity Board of Tamil Nadu in coastal villages to distribute the benefits accrued with 754 benefit claimers spread across four districts in Tamil Nadu. Due to claims that this seaweed is becoming an invasive species, NBA has now stopped providing access permits.

Bio India Biologicals Company exported 2000 kg of neem leaves (*Azadirachta indica*) to Japan. They were collected from Amarchinta village BMC of Mahboobnagar district, Andhra Pradesh. The NBA was paid a royalty at 5 % of FoB by the exporter which was transferred to the BMC for planting neem saplings and creation of awareness about biodiversity conservation. Natural Remedies Pvt. Ltd., Bangalore, purchased *kalmegh* (*Andrographis paniculata*), a medicinal herb, from the Biodiversity Management Committee (BMC) of Malanjkhand in the Balaghat district of Madhya Pradesh and paid INR 21,000 (US $316.19) directly to the BMC.

Examples of usage of microbes (*Bacillus thureungenesis*) under ABS can be seen from the collections made from black cotton soil of Mahanandi BMC of Kurnool district, Andhra Pradesh. An access fee for every packet of 10 g of genetically modified seeds produced was given, resulting in payment of INR 73 lakhs (US$109,914.93) in 2006–2007 and INR 137 lakhs (US $206,278.71) in 2008–2009. Besides, as a follow-up action, the multinational company opened a growth development centre, school for children working in cotton fields as well as infrastructure development in Mahanandi Panchayat. The University of Jadavpur, West Bengal, has made an invention called ‘process for preparing modified bioconcrete’. It is well known that formation of cracks in concrete structures leads to weakening of such structure mainly due to seepage of water and moisture which attack steel reinforcements resulting in rusting and swelling. Such incidents of corrosion occur in seaside areas with pronounced salinity. The invention attempts to find an answer to this problem based on the surprising discovery of the capacity of thermophilic, iron-reducing anaerobic microorganism of the family Showanella isolated from the hot springs. Commercial application and ABS process are underway.

An IPR-related example under ABS that can be cited is by an Ayurvedic doctor from Pune, India, who has applied in the requisite form III (seeking ‘No objection

[1] 10 lakh = 100,000,0 = 1 million
1 crore = 100 lakh
1 US $ = Rs. 66.61/–

Certificate' for obtaining a patent) for preparation of an Ayurvedic anti-snake venom comprising of four medicinal plants. In the treatment of victims of snakebite, this antivenom tablet 'Pinak' acts as a temporary relief instantly before the victim is taken to the hospital. In this case, the NBA has fixed the benefit sharing as '2 % of the gross sales or gross revenue of the product derived from the use of biological resources accessed'. On commercialisation of the patent product and as per the conditions of the agreement, the applicant has paid two instalments towards royalty as benefit sharing to the NBA. It is pertinent to mention that this is the first of its kind in India under the BD Act.

Transferring the results of research to foreign nationals, companies and non-resident Indians for commercial purposes or otherwise in livestock has substantially increased in recent years under ABS. For example, the National Dairy Development Board (NDDB) submitted an application to send DNA samples of the Murrah breed of buffaloes, the Rathi breed of cattle, and the Kankrej breed of cattle from Gujarat to Animal Sciences Research Centre, Columbia, USA. These researches will help in selecting animals for fast genetic improvement, thereby augmenting the milk production and disease resistance in cattle and buffaloes. The MAT has also been developed between parties. The cattle industry in Brazil is the economic activity that occupies the largest land expansion. Brazil has the second largest herd in the world, only surpassed by India. Indo-Brazilian cattle are a Zebu beef breed developed in Brazil from Gir, Kankrej and Ongole cattle brought from India. While this is nearly the same mixture which produced the American Brahman, the two breeds differ in appearance, with the Indo-Brazilian having much longer ears which hang down lower, like the Nellore. This majestic cow from Brazil, belonging to the Gir breed of Gujarat – named She-ra – clocked 62,033 l of milk in a 3-day milk competition at the 40th Expaja in Brazil, beating her own record of 59,947 l.

An example of ABS under collaborative research to commercialisation is under HapMap project from the National Chemical Laboratory by way of sending the DNA of two Indian sheep breeds, viz. Garole and Deccani, to CSIRO, a member of the International Sheep Genome Consortium for Ovine HapMap project. The applicant/country would commercially benefit by having their breeds characterised genetically and evaluated for molecular diversity and genetic relationships with all other breeds in the study. Yet another example is from the endophytic compounds by the Indian Institute of Spices Research by transferring bacterium *Pseudomonas aeruginosa* isolated from internal tissues of black pepper to laboratory of phytopathology, Wageningen University, the Netherlands, for evaluation of antimicrobial compounds from bacterial endophytes against major pathogens of spice crops such as ginger, turmeric, black pepper and cardamom.

NBA also examined imposing of ABS mechanism for the export of red sanders auctioned by the Government of Andhra Pradesh and decided that the NBA shall impose a benefit sharing of 5 % of the auctioned price of red sanders from the successful bidder, who after filling the form prescribed in the BD Act and Rules/State Biodiversity Rules, as the case may be, has to deposit the benefit-sharing component of 5 % of the auctioned amount (excluding taxes and other government dues) to NBA/SBB, before lifting the red sanders wood from the site. Recently concluded

ABS agreement (July, 2015) has resulted in a benefit sharing component of INR 250 lakh (US $376,421.00) to NBA in respect of red sanders export.

As per the BDA, 2002, section 27 (1) and (2), all charges and royalties received by the NBA shall be utilised for channelling benefits to the benefit claimers, conservation and promotion of biological resources and development of areas from where such biological resources or knowledge associated thereto has been accessed and socio-economic development of areas referred to in the clause, in consultation with the local bodies.

3.6 Corporate Social Responsibility and Sustainable Development

The concept of social responsibility by the company is voluntary, wherein the companies decide to contribute to the society to make it better and environmentally cleaner (European Commission 2001). According to Carroll (1983), 'corporate social responsibility involves the conduct of a business so that it is economically profitable, law abiding, ethical and socially supportive. To be socially responsible means that profitability and obedience to the law are foremost conditions when discussing the firm's ethics and the extent to which it supports the society in which it exists with contributions of money, time and talent'. Donaldson (1982) and Donaldson and Dunfee (1999) are of the opinion that there is a tacit social contract between the firm and society; the contract bestows certain rights in exchange for certain responsibilities. However, Freeman (1984) postulated the stakeholder theory wherein a stakeholder is 'any group or individual who can affect or is affected by the achievement of an organisation's purpose'. It is further argued that it is in the company's strategic interest to respect the interests of all its stakeholders. Generally, CSR is understood as 'the commitment of business' to contribute to sustainable economic development by working with employers, their families, the local community and society at large to improve their quality of life, in ways that are both good for business and good for development'. A widely quoted definition by the World Business Council for Sustainable Development states that 'Corporate Social Responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large' (WBCSD 1999). Thus, the meaning of CSR is twofold; on the one hand, it exhibits the ethical behaviour that an organisation exhibits towards its internal and external stakeholders. On the other hand, it denotes the responsibility of an organisation towards the environment and society in which it operates. The broad rationale for a new set of ethics for corporate decision-making, which clearly constructs and upholds an organisation's social responsibility, arises from the fact that a *business enterprise derives several benefits from society*, *which must*, *therefore*, *require the* *enterprise to provide returns to society as well* (the manual, *Business and Biodiversity*, jointly published by Earthwatch, IUCN and WBCSD in 1998).

In 2000, against the backdrop of increasing demands for a more inclusive and sustainable global economy, the then UN Secretary-General Kofi Annan launched the United Nations Global Compact (UNGC), the first corporate social responsibility (CSR) initiative at global level. India is among those countries where not only is the UNGC highly appreciated by a large number of participating companies, but CSR already has a long tradition dating back to the nineteenth century. The role of corporate sectors in contributing to the social interaction is not new to India, as can be seen in Kautilya's '*Arthasastra*' which mentions traders' responsibilities to the local society. In ancient India, such responsibilities were voluntary and not mandatory. In the beginning of the twentieth century, corporate activities were oriented towards the donations to temples and various social welfare causes. Subsequently, it was Mahatma Gandhi's theory of trusteeship, the aim of which was to consolidate and amplify social development. The reform programmes included activities geared particularly to abolish untouchability, empowering women and developing rural areas. Mahatma Gandhi, the visionary, is also of the view of that the ownership of capital was one of trusteeship, motivated by the belief that essentially society was providing capitalists with an opportunity to manage resources that *should really be seen as a form of trusteeship on behalf of society in general*. The next phase was dominated by the paradigm of the 'mixed economy', wherein the corporate sectors largely took the form of the legal regulation of business activities and/or the promotion of public sector undertakings (PSUs). Since then, it is characterised partly by traditional philanthropic engagement and partly by steps taken to integrate CSR into a sustainable business strategy.

The United Nations Global Compact (UNGC) is a voluntary, value-based initiative, complementing regulation and other voluntary initiatives. Its main objective is to mainstream the ten CSR principles in business activities throughout the world and to catalyse actions in support of UN goals. As per 2007 Report on European CSR Survey conducted, the issues of importance are summarised as follows:

1. Climate change
2. Transparency in business practice
3. Ecological diversity
4. Fair trade and fair procurement
5. Corruption prevention
6. Labour rights
7. Health and safety
8. Education
9. Income equality and fair wages
10. Poverty

3.6.1 Case Studies: CSR

There are many ways in which a company can address biodiversity issues. These range from raising employee awareness of conservation issues and managing environmental impacts to enhancing the biodiversity value on their landholdings and using biological resources sustainably. Citing a few international initiatives, the Ontario Power Generation (OPG), an electric power generation utility, acknowledged that a prerequisite for the design of its biodiversity strategy-related activities was to identify priority biodiversity issues, e.g. species at risk and sensitive habitats that may be affected by the company's operations. This was completed for all the company's sites, either by querying existing digital database files residing with the province's central repository for biodiversity data or by conducting site biological inventories at the company's larger generating stations. RMC South Florida-based industry has developed a novel partnership with Florida International University (FIU), backed by the Florida State government and donated 370 ha of acquired land for its industry rather than the procedure of returning quarried land to the government, thus enabling FIU to offer one of the world's first applied study programmes focusing specifically on wetland restoration. Similarly, the Shell's biodiversity strategy includes site selection work to raise appropriate early warning if needed (e.g. if potentially entering a World Heritage Site or an IUCN category I–IV protected area) as well as asking some key biodiversity questions related to endemism, habitat and ecosystem functions. In the framework of a 5-year partnership, Shell and the Smithsonian Institution of the USA are working on a biodiversity assessment and monitoring programme in the Gabon Gamba Complex.

The energy and biodiversity initiative (EBI) brings together four energy companies (BP, ChevronTexaco, Shell, Statoil) and five conservation organisations (Conservation International, Fauna & Flora International, IUCN, Smithsonian Institution, The Nature Conservancy). The Conservation International's Center for Environmental Leadership in Business aims at developing tools and guidelines for integrating biodiversity into oil and gas development. It is structured into four working groups: the business case group promotes the rationale for integrating biodiversity conservation; the biodiversity conservation practice group works on identifying and implementing best practices and conservation techniques; the metric group is developing performance indicators for measuring impacts on biodiversity caused by oil and gas operations; and the site selection group is developing criteria for deciding whether to operate in biologically sensitive environments.

Yet another example of corporate societal responsibility is from HSBC Holdings undertaking a 5-year programme with Earthwatch Institute, which will allow 2000 employees, at all levels, from throughout the world, to work for a fortnight as field assistants on Earthwatch's projects. On return, each employee receives a grant of US $500 to undertake a local community conservation project. This will contribute over 120 years of labour to Earthwatch's field projects, create 2000 biodiversity champions within the bank and generate thousands of conservation projects in local communities. In addition, investment bank UBS Warburg and trading company

Mitsubishi Corporation are among five companies supporting Earthwatch Europe's African Fellowship Programme. A more integrated and sustainable model is developed by Starbucks with the farmers'/growers' point of view in their mind by paying premium price to help farmers to make more profit and support their families. Starbucks created a policy known as Coffee and Farmer Equity (CAFE) to show responsibility towards the moral, environmental and quality aspects of processing and selling coffee. Besides above, Starbucks provides funds for farmers to access credit, purchasing conservation and certified coffee that includes organic and Fair Trade Certified and also investing in social development project in coffee-producing countries.

3.6.2 Corporate Biodiversity Action from India for Sustainable Development

Several companies in India (such as Tata Group, BHEL, Wipro, Bajaj Auto Ltd., Larsen & Toubro, Sriram Investments, Otis Elevator Co. India, ACC, Asian Paints, Brook Bond, Colgate-Palmolive, Escorts, SAIL, ITC, Ashok Leyland and many others) have adopted and followed the CSR with the belief in promoting human and social sustainable development through poverty alleviation by building capacity of rural people such as:

1. Starting social trusts
2. Antipollution measures
3. Adopting villages
4. Family planning clinics
5. Training unemployed youth
6. Community development activities
7. Conducting social audits on a voluntary basis
8. Providing medical and health-related activities
9. Recreational facilities
10. Developing sports, undertaking consumer education campaigns, etc.

The Bajaj Group of Industries, in order to fulfil its corporate social responsibility, set up the *Kamalnayan Jamnalal Bajaj Foundation* (*KJBF*). The foundation has installed 18 gabion structures and 568 loose boulders which benefitted 27,426 farmers and 69,278 acres of land under the water resource development programme. Under the umbrella of KJBF's development projects, 82 rivers/streams have been rejuvenated in the 120.23 km area which has prevented 8547 acres of land from water clogging. Water harvesting measures include construction of 70 check dams, 1858 farm ponds, 177 group wells, 1609 recharging wells and bores, 799 bori bandhs and 17 percolation tanks. Up to 60 % of water used during irrigation is saved by installing 442 drip irrigation systems and 1634 sprinkler irrigation systems. Besides, better cotton initiative is implemented in 112 villages and helps to reduce

15 % of the cost of production by minimising doses of chemical fertilisers, pesticides and insecticides. Sustainable water management remains the top priority of Coca-Cola India Inc. So far, the company's water initiatives have improved the lives of more than 1,40,000 people and spread awareness about the crucial importance of water conservation among million people. Lupin India Ltd. initiated the project for providing sustainable development in 154 villages across Rajasthan. The scheme, instead of providing piecemeal assistance that does not lead to effective alleviation of poverty or adequate development, is designed as holistic action plan that includes an agricultural income generation scheme, land cultivation and fruit plantation programmes, fodder preservation schemes, sericulture and water recycling programmes, establishment of medical and educational centres, adult literacy programmes and credit schemes.

ITC Limited is one of India's private sector companies with businesses in FMCG, hotels, paperboards and specialty papers, packaging, agribusiness, agricultural products and information technology partnering with Earthwatch Institute, UK, and has implemented the Biodiversity Risk and Opportunity Assessment Tool (BROA) across its crop growing regions in 2013 in its crop development regions, in the state of Karnataka and Andhra Pradesh. Through its extension services, Agri-Business Division (ABD) works with more than 100,000 farmers to help them produce quality crops. The identified opportunities are related to terrestrial biodiversity, soil biodiversity and aquatic biodiversity. In a collaborative effort, the company engages with the local community, NGOs, universities, conservation organisations, governments and the farmers, through all the three stages of the implementation of BROA.

The Tata Chemicals Limited, a global company with the presence in chemicals, fertilisers, food additives and agriservices, recognised that biodiversity is vital for livelihood of people, development needs of industries and inclusive growth of the country. At Mithapur fall, in the Okhamandal region of Gujarat, a programme "*Dharti Ko Aarpan*" (giving back to Mother Earth) was implemented. The identified biodiversity issues include:

1. Save the whale shark through Wildlife Trust of India
2. Biodiversity Reserve Plantation by eradicating an invasive species *Prosopis juliflora*
3. Regeneration of mangroves
4. Development of Ecoclubs
5. Building parapet walls around open wells to render them safe for Asiatic lions and other wildlife
6. Coral regeneration in Gulf of Kutch
7. Waterfowl conservation

The Tata Power Supply Ltd., the largest integrated power company in India with installed generation capacity of about 8500 MW, has undertaken biodiversity conservation issues at Walwhan, Maharashtra, with Mahseer Conservation Programme for breeding *Tor khudree* and *Tor putitora*, endangered species of fishes. The facility at Walwhan is one of the few breeding centres in India which breeds and supplies Mahseer fries and fingerlings to various states, mainly Maharashtra, Karnataka, Punjab, Rajasthan, Andhra Pradesh, Haryana and Assam. The Walwhan Garden provides habitat to over 350 species, including selected medicinal plants and some of endangered tree species from the Western Ghats.

The TVS Motor Company, a two-wheeler manufacturer in India, has undertaken several initiatives, viz. women empowerment, poverty alleviation, health, quality education and infrastructure development for integrated and sustainable development. The identified area includes Padavedu watershed development project, with Ford Foundation, covering an area of 1147 ha. The Irumbuli watershed development programme with NABARD covered an area of 2482 ha and is still in process. TVS Motor Company has also planted over one million trees. In Padavedu area alone, 450,000 trees have been planted.

WIPRO Global IT, a consulting and outsourcing company, employs 145,000 people with 950 clients in 57 countries across six continents and has developed a programme known as *Ecoeye*, a programme that aims to bring in ecological sustainability perspectives in its operations. There are four phases in this project – butterfly garden, wetland park, Deccan plateau and one herbal garden in the campus. ACC, formerly known as the Associated Cement Company, is a group company of Holcim, which is a Switzerland-based global cement producer. The company has adopted a long-term biodiversity management system (BMS) in collaboration with the IUCN towards sustainable development. The identified area includes reducing its carbon footprint; for this the company has adopted clinker substitution and energy conservation through the use of green energy, alternative fuels and raw materials (AFRMs) and waste heat recovery systems (WHRS). The company has also installed three wind farms in Tamil Nadu (TN), Rajasthan (RJ) and Maharashtra (MH). These wind farms have a total capacity of 19 MW and partially cater to the needs of the Madukkarai (Tamil Nadu), Lakheri (Rajasthan) and Thane (Maharashtra) facilities. Installation of wind farms reduces the company's dependency on grid power, improves energy security and contributes to the company's renewable purchase obligation (RPO). The company also encourages the pollution abatement issues, invasive species as well as water conservation and mine rehabilitation.

To cite a few more case studies from companies identifying CSR, Dr. Reddy's Laboratories has established a zero liquid discharge facility to ensure 100 % effluent recycling. They have made significant improvements in process development with growing emphasis on green chemistry. Energy saving initiatives and awareness communication on climate change are being accelerated in the company. Infosys Technology Ltd. has five major CSR themes, which include education, healthcare, art and culture, rural upliftment and inclusive growth. They have touched the lives of 1,50,000 beneficiaries during 2007, and they claim they will continue to conduct business responsibly and ethically in the years to come. Reliance Industries Ltd. has launched project Drishti in 2003, in association with the National Association for the Blind (NAB, a non-profit institution serving the blind in India for over five decades) – a nationwide corneal grafting drive to bring light to the lives of visually challenged from the underprivileged segment of the society – and the programme has illumined the lives of over 5000 Indians, all free of cost. For sustainable management and development of natural resources, many companies have been working for tree plantation, watershed management, waste management, wind farm, etc. For example, SAIL has planted 13.5 million trees in and around SAIL plants/mines so far. The watershed development programme of Ambuja Cement Ltd. covered 9000 ha in the last 4 years. Water sinks so developed in mining areas provide habitat for birds such as spoonbills, painted storks, black-headed ibis as well as pheasant-tailed jacana, green shank, black-winged stilt and snipe.

3.7 Genetic Resource Provider and the Genetic Resource User

A key aspect of successful ABS activities is the building of confidence and trust between the genetic resource provider and the genetic resource user. The ABS-Management Tool (ABS-MT) devised is intended for use by providers and users of genetic resources, particularly companies/private enterprises (large and small) involved such as pharmaceuticals, botanicals, crop protection, nutraceuticals, biotechnology, horticulture, local communities and indigenous peoples. Seiler et al. (2001) divide the stakeholders into two categories, viz. users and their representatives and providers and their representatives. According to the authors, the first category includes the private sector, universities, scientific research organisations and ex situ collections such as botanic gardens, museums and culture collections. Providers include national governments, public and private sector in-country suppliers of bioresources, landowners and indigenous and local communities.

3.7.1 Education and Research Stakeholders

Ayurvedic Siddha, Unani and Homoeopathy Practitioners in India The country has 7.37 lakh practitioners of alternative medicine streams like Ayurveda, Siddha, Homoeopathy and Unani registered with the AYUSH Ministry and over 3600 AYUSH hospitals. Among them, Ayurveda practitioners' number is 3,99,000, while Homoeopathy practitioners amount to 2,80,000. As per Ministry of Health and Family Welfare records, there are 47,683 Unani, 8173 Siddha and 1764 naturopathy practitioners registered in the country. Bihar leads the states with regard to Ayurveda practitioners with a whopping 96,648 of them registered there. It is followed by Maharashtra with 69,478 and Madhya Pradesh with 45,461. Uttar Pradesh, the most populous state, stands fourth with 43,332 Ayurveda practitioners (Rajya Sabha Reply on Tuesday, 28 April 2015).

3.7.2 Public Sector Stakeholders

India has established six national bureaus dealing with genetic resources of plants, animals, insects, microorganisms, fish and soil sciences. These are the National Bureau of Plant Genetic Resources (NBPGR), with a total of 4,08,186 plant genetic resource accessions; the National Bureau of Animal Genetic Resources (NBAGR),which has a total holding of 1,23,483 frozen semen doses from 276 breeding males representing 38 breeds of cattle, buffalo, sheep, goat, camel, yak and horse for ex situ conservation; the National Bureau of Agriculturally Important Microorganisms (NBAIM), with a repository of 4668 cultures, including 4644 indigenous and 24 exotic accessions; and the National Bureau of Agriculturally Important Insects (NBAII), with 593 insect germplasm holdings. The National Bureau of Fish Genetic Resources (NBFGR), with a repository of 2553 native finfishes, and Fish Barcode Information System updated with 2570 microsatellite sequences. In terms of fish diversity, the Zoological Survey of India (ZSI) has also recorded 3022 species in India, constituting about 9.4 % of the known fish species of the world. The diversity of cultivated plants and their wild relatives in India and the number of accessions in gene bank holding at NBPGR, New Delhi, are presented in Tables 3.1 and 3.2, respectively.

DNA fingerprinting protocols using different molecular marker techniques such as simple sequence repeats, amplified fragment length polymorphism, inter-simple sequence repeats and random amplified polymorphic DNA have been developed for 33 crops of national importance. A total of 2215 varieties of these crops have been fingerprinted using a variety of experimental protocols and analytical procedures.

Table 3.1 Cultivated plants and their wild relatives in India

Sl. No.	Category	No. of cultivated plants	No. of wild relatives
1.	Cereal	15	37
2.	Millets	13	33
3.	Grain legumes	18	36
4.	Vegetables	105	168
5.	Fruits and nuts	117	176
6.	Oil seeds	19	13
7.	Sugar-yielding crops	03	18
8.	Fibre crops	12	23
9.	Forage and fodder crops	96	33
10.	Spices and condiments	46	123
11.	Plantation crops	20	21
12.	Medicinal and aromatic plants	89	58
13.	Ornamental plants	182	90
14.	Agroforestry species	35	31
15.	Other crops	41	42
	Total	811	902

Table 3.2 Gene bank holding at NBPGR, New Delhi

Crop group/category	Number of accessions in NBPGR
(1) Seed conservation at −18 °C	
Millets and forage	1,56,526
Pseudo cereals	56,472
Cereals	6682
Grain legumes	58,160
Oilseeds	57,479
Fibre crops	11,943
Vegetables	25,084
Fruits	530
Medicinal and aromatic plants and narcotics	6771
Spices and condiments	3721
Agroforestry	2443
Duplicate safety samples	10,235
Subtotal	3,96,189 (1584 spp.)
(2) Cryopreservation in liquid nitrogen at −150 to −196 °C	9915 (729 spp.)
(3) In vitro conservation at 25 ± 5 °C	2082 (138 spp.)
Total	4,08,186

The Botanical Survey of India, with the huge repository of museum specimens in their herbaria, and the National Botanic Garden host nearly 70 % of the country's botanical collections; the details of the species distributed in the country are given in Table 3.2.

It is a well-known fact that no country is self-sufficient in terms of biodiversity, and even the most biologically endowed nations have to look out to the other parts of the world for fulfilling their bioresource-based needs (Kloppenberg 1988). Further, the distribution of world's biodiversity is in inverse proportion to scientific and technological wealth (Macilwain 1988; cited in Laird et al. 2002); research institutions and company's base in the developed countries look beyond their borders for diverse and novel genetic resources for their study and use. The gene banks of national bureaus provide novel genetic resources with potential use value. Bioprospecting is rooted in the sovereign rights of the nation states over their biological resources. Governments of the states being '*dejure* gatekeepers of biological resources' (Dutfield 1999) are in a strong position to negotiate terms for favourable benefit sharing with interested stakeholders.

3.8 Genetic Resources with ABS Potential

Natural products continue to play 'a dominant role in the discovery of leads for the development of drugs' and contribute significantly to the bottom lines of large companies: between January 1981 and June 2006, for example, 47 % of cancer drugs, and 34 % of all small-molecule new chemical entities (NCE) for all disease categories, were either natural products or directly derived there from (Newman and Cragg 2007). India has consistently been the largest supplier to UNICEF since 2007, as well as the largest supplier country in 2012, with $558 million worth of supplies such as vaccines, pharmaceuticals, nutrition and medical supplies. Of the $2.14 billion purchases by UNICEF in 2012, more than 25 % were from India. Serum Institute of India Ltd., an IDMA member, supplied vaccines/biological worth $254 million dollars, making it the largest supplier in India. Other significant suppliers include Hetero Labs, Ranbaxy Labs, Aurobindo Pharma, Haffkine Bio-Pharma Corp., Micro Labs, etc., all members of IDMA. UNICEF has recognised India's contribution to global aid, and international groups have lauded India's role in increasing access to medicines in the developing world. Antiretroviral (ARV) treatment in Europe was $10,000 per patient a year, until Indian-manufactured drugs brought it down to $95 patient a year. India is not only the largest supplier to UN groups but also to the MSF and International Dispensary Association.

3.8.1 Floriculture

Flowers have always been an integral part of Indian culture and society. Presently, nearly about 200 species are used intensively in commercial floriculture (carnations, chrysanthemums, gerbera, narcissus, orchids, tulips, lilies, roses, pansies, etc.) and up to 500 species as house plants, and these represent the mainstay of the industry. Several thousand species of herbs, shrubs and trees are also traded commercially by nurseries and garden centres as ornamentals, many introduced from the wild with little selection or breeding (Heywood 2003). With globalisation and free market economy, floriculture has attained an industrial status and has gained a tremendous momentum in the last few years. However, this sector is still in a nascent stage of development and accounts for a negligible share in the global exports. Floriculture is a viable and profitable alternative for the new generation of farmers. The world trade on floriculture products like cut flowers, ornamental plants, flowering plants, flower seeds and plantlets has gained a tremendous momentum. Trade is estimated at US $100 billion. It has reportedly been growing at the rate of 15 % per annum. Developed countries account for more than 90 % of the total world trade in floriculture products. Many countries, particularly the developed ones, are importing flowers to meet their internal demand. European countries (Germany, France, Italy, Holland, UK), Japan and the USA are the major importers of flowers. The Government of India has identified floriculture as a sunrise industry and accorded it 100 % export-oriented status. About 232.74 thousand hectare area was under cultivation in floriculture in 2012–2013. Production of flowers is estimated to be 1.729 million tonnes loose flowers and 76.73 million tonnes cut flowers in 2012–2013.

The country has exported 22,947.23 MT of floriculture products to the world for the worth of Rs. 460.75 crores (US $69,261,464.83) in 2014–2015 (APEDA 2015). Floriculture products mainly consist of cut flowers, pot plants, cut foliage, seeds, bulbs, tubers, rooted cuttings and dried flowers or leaves. The important floricultural crops in the international cut flower trade are rose, carnation, chrysanthemum, gerbera, gladiolus, gypsophila, liatris, nerine, orchids, achillea, anthurium, tulips and lilies. Floriculture crops like gerberas, carnation, etc. are grown in greenhouses. The open-field crops are chrysanthemums, roses, gaillardia, lily, marigold, aster, tuberose, etc.

India's floriculture business is worth Rs. 9 billion. Among the traditional crops grown for loose flowers, the largest area is under marigold, grown all over the country. In most parts of the country, only local varieties are grown for generations. African marigolds occupy more area as compared to the small flowered French types. Jasmine flowers in view of its scent are also very popular as loose flowers and for use in garlands. The chrysanthemums, particularly the white varieties, are much in demand as loose flowers during the autumn period of October–December when other flowers like jasmine and tuberose are not available.

The demand for food colour in the global market in 2000 was 2400 metric tonnes which increased to 3000 MT in 2005 and 8000 MT in 2010 and is expected to increase to 15,000 MT during 2015. The investment in the food colour market across the globe has touched more than 1 billion US$, and there is a growing demand for natural dyes over the synthetic ones. Marigold oleoresin export from Cochin and Bangalore for a period of 45 days (30 May–15 July 2015) is to the tune of Rs. 15.26 crores (US $2,258,526), showing the export potential. Marigold flowers have now been considered as the major source of carotenoids and lutein. Lutein is becoming an increasingly popular active ingredient used in the food industry and textile colouration. Lutein extracted from the petals of the marigold oleoresin with organic solvents imparts yellow to orange colours and is used as a food colouring agent in a wide range of baked goods, beverages, fats, oils, sauces, dairy products and infant and toddler foods.

Ornamental horticulture is growing both in size and worth; the past few years have been characterised by stagnation in the developed world, due in part to changing demographics. The world import trade value in horticulture (live trees, plants, bulbs, roots, cut flowers and foliage) in 2006 was US $14,386 million, up from the 2005 figure of $12,245 million (UN Comtrade 2007). However, trade is increasing in developing countries such as China and India where increasing numbers of people have disposable incomes. Though floriculture is flourishing in India, it has not made any remarkable breakthrough in the domestic and international floriculture markets due to various constraints. The investments in this sector and per capita consumption of flowers are also considerably low when compared to other developed countries like Western Europe, Japan and the USA. In other words, the vast potential in the country has not been fully tapped.

3.8.2 Medicinal Plants

In India nearly 9500 registered herbal industries and a multitude of unregistered cottage-level herbal units depend upon the continuous supply of medicinal plants for the manufacture of herbal medical formulations based on Indian System of Medicine. Rapid growth of India's herbal industry, especially in the recent past, has caused the emergence of large number of industrial units engaged in the manufacture of herbal formulations under various streams of Indian System of Medicine. Licensing and operation of these units are controlled by the concerned states under the Drug and Cosmetics Act, 1940, and the State Drug Controllers have been designated as the licensing authorities for the purpose. The demand for extract in cosmetics and toiletries is presented in Table 3.3.

India is a global leader in in situ conservation of medicinal plants having established the largest in situ conservation network for medicinal plants in the tropical world. So far, 110 medicinal plant conservation areas (MPCA), each of an average size of 200 ha, have been set up across 13 states of India. There is a need for expansion of the MPCA network at least threefold in order to capture breeding populations of all the currently known 315 species of threatened medicinal plants and its further strengthening through long-term conservation research activities and sustainable community involvement programmes.

The total medicinal plant species in trade is 960 and 178 species are consumed in high volumes exceeding 100 MT per year (FRLHT; http://envis.frlht.org/traded-medicinal-plants-database.php#). The annual demand of raw drugs is to the tune of 3,19,500 metric tonnes, while the annual production of raw drugs is 1,81,483 MT.

Medicinal plants play a vital role in the life of tribals in India and elsewhere. As many as 900 species are used in Ayurveda, 700 species in Unani, 600 species in Amchi and a large number in modern system formulations. Singh et al. (2001, *Flora of India*) have estimated nearly 7000 species of angiosperms as medicinal. About 8000 wild plant species are used by the Indian tribes for a variety of medicinal purposes, which cover about 1,75,000 specific preparations/applications (Pushpangadan 2002); of these 2000 species are found to be new claims and worthy of scientific scrutiny. 'If over 50 per cent of pharmaceutical products in the market now are derived from genetic resources or inspired by natural compounds, the global market

Table 3.3 The demand for extract in cosmetics and toiletries

	Demand value (million US ($)		
Item	1989	1998	2008
Aloe extract	38	63	115
Botanical extracts	180	345	720
Others	22	67	174
Plant acids and enzymes	19	681	173
Essential oils	101	150	258
Other natural products	85	180	385

Source: FREEDONIA GROUP

for pharmaceutical products alone should hold enormous resourcing potential for prospecting based financing for biodiversity conservation agenda'. At present, 80 % of the population in developing countries relies largely on plant-based drugs for their healthcare needs, and the WHO has estimated that in coming decades a similar percentage of the world population may well rely on plant-based medicines. Thirty percent of the drugs sold worldwide contain compounds derived from plant material.

The bulk of the material traded (both domestically and internationally) is still wild harvested, and only a very small number of species are cultivated. It is difficult to provide accurate global data on the volume of wild-harvested medicinal plants as it is very difficult to distinguish between wild and cultivated material. The supply chain is often very long with several marketing stages involving primary collectors and producers, local contractors, regional wholesale markets, large wholesale markets and specialised suppliers. The cost analysis is further complicated as the industry buys from suppliers and wholesalers rather than direct from smallholders.

3.8.2.1 Medicinal Plants in Trade

Total global herbal market is of size 62.0 billion dollars; the European Union is the biggest market with a share of 45 % of the total herbal market. North America accounts for 11 %, Japan 16 %, ASEAN countries 19 % and rest of European Union 4.1 %. Countries like Japan and China have successfully marketed their traditional medicines abroad. Their alternative therapies are well accepted in Europe and the USA. Product like ginseng – the famed aphrodisiac from China – is having the same property as of ashwagandha – an Ayurvedic medicine from India, yet it accounts for over US $800 M of the international market. Herbal remedies would become increasingly important especially in developing countries. India, with its rich bioresource, has a tremendous potential and advantage in this emerging area. A decade ago the medicinal plant trade in India is substantial with the total turnover of Rs. 2300 crores ($346,307,320.00) of Ayurvedic and herbal products, while major over-the-counter products contribute around Rs. 1200 crores (US $180,682,080.00). However, the demand for medicinal plants is increasing every day, and the World Health Organization (WHO) has projected that the global herbal market will grow to $5 trillion by 2050 from the current level of $62 billion.

The pharmaceutical industry has grown from mere US $0.3 billion turnover in 1980 to about US $13.22 billion in 2011–2012. Globally, India ranks 3rd in terms of volume of production (10 % of global share) and 14th by value (1.5 % of global share). The reason for lower value share is the low cost of drugs in India ranging from 5 % to 50 % as compared to developed countries. The exports to the USA account for more than 40 % of the total exports of pharmaceuticals from India (Pharmaceutical Industry-EXPORT IMPORT INDIA, Apr 16, 2014). The percentage of turnover in India's pharmaceutical industry and India's export of AYUSH, medicinal herbs and other value-added products is presented in Tables 3.4 and 3.5, respectively.

Table 3.4 Percentage of turnover in India's pharmaceuticals industry between 2008 and 2012

Year	Trends in exports (in billion US $)	Percentage
2008–2009	6.3	14.4
2009–2010	8.6	36.5
2010–2011	9.1	5.81
2011–2012	13.22	45.6

Table 3.5 India's export of AYUSH, medicinal herbs and other value-added products (value)

Commodity	Export of medicinal herbs (in US$ million)		
	2010–2011	2011–2012	2012–2013
AYUSH	156.96	182.18	163.44
Medicinal herbs and their value-added products	141.63	176.12	232.14
Total	298.59	358.30	395.58

As per the basket of AYUSH products including medicinal herbs and their value-added products, India's exports for the year 2012–2013 were about USD 395.58 million, vis-à-vis USD million 358.30 with a growth rate of 10.40 % over the previous year. The demand for Indian herbs and herbal medicines is growing in the European and other developed countries. India's exports of herbs and herbal medicines to the European Union for the year 2012–2013 were USD million 38.52, vis-à-vis USD million 34.11 in 2011–2012, a growth of 11 %.

Major herbal exports from India are psyllium seeds and husk, castor oil and opium extracts, which together account for 60 % of the exports. Eighty percent of the exports are to the developed countries, viz. the USA, Germany, France, Switzerland, the UK and Japan. A large percentage of the exports are as crude formulation and not as pure phytochemicals. India is the largest grower of psyllium and senna plants and one of the largest growers of castor plant. Twenty other plants are commonly exported as crude drugs worth US $8 million. Five of these, namely, *Glycyrrhiza glabra*, *Commiphora mukul*, *Plantago ovata*, *Aloe barbadensis* and *Azadirachta indica*, are even used in modern medicine. The important medicinal plants exported from India are given in Table 3.6.

3.8.2.2 Cost-Benefit Analysis of Selected Plant Resources

Urtica dioica often called the common nettle or stinging nettle grows commonly in the wild is reported to reduce allergies, purify blood, reduce inflammation, relieve pain, stop bleeding and cure eczema, nosebleeds and skin eruptions and has several other medicinal uses. In folk medicine nettle plants have been used as diuretic. The raw material costs US $5/kg while the finished product US $1500/kg. The cost of raw material of *Nigella sativa*, widely used in various traditional systems of medicine such as Unani, Ayurveda and Siddha, is US $1.0/kg, while the finished product (oil) is sold at US $30/kg. For *Trigonella foenum-graecum* (fenugreek) having

Table 3.6 Important medicinal plants exported from India

1. *Emblica officinalis* Gaertn	18. *Nardostachys jatamansi* De
2. *Withania somnifera* Dunal	19. *Andrographis paniculata*
3. *Saraca asoca* (roxb.) Dc wild	20. *Picrorhiza kurroa* Royle ex Benth
4. *Aconitum heterophyllum* Wal	21. *Garcinia indica* Linnaeus
5. *Embelia ribes* Burm. F	22. *Saussurea lappa*
6. *Aegle marmelos* L. Corr	23. *Glycyrrhiza glabra* Linn
7. *Bacopa monnieri* L	24. *Piper longum* Linn
8. *Santalum album* Linn	25. *Piper nigrum*
9. *Swertia chirata* Buch – Ham	26. *Curcuma longa* Linn.
10. *Tinospora cordifolia* wild miers, ex hook	27. *Gymnema sylvestre* R. Br
11. *Commiphora wightii* (Arn) Bhandari	28. *Asparagus racemosus* Wild
12. *Berberis aristata* DC	29. *Convolvulus pluricaulis*
13. *Plantago ovata* Forsk	30. *Chlorophytum borivilianum*
14. *Terminalia chebula*	31. *Cassia angustifolia* Vahi
15. *Adhatoda vasica*	32. *Syzygium aromaticum*
16. *Cinnamomum zeylanicum*	33. *Elettaria cardamom*
17. *Tribulus terrestris*	34. *Myristica fragrans*

alkaloids, amino acids, flavonoids, fibres and others, the raw material costs US $1.5/kg and the finished product (tablets or oils) US $1000/kg. India exported *Trigonella* extract worth 3,34,648 US$ under HS Code 1302. The USA is the largest buyer of *Trigonella* extract with a market value of 282,961 US$ followed by Hong Kong and Germany which imported the extract worth 20,600 and 13,971 US$, respectively. Bangalore accounted for 39 % of exports followed by Hyderabad with 30.8 %. The average price of *Trigonella* extract per unit is 21.11 US$ and average shipment is 4781. The above facts are based on the export during April 2014 to June 2015. *Alhagi maurorum* is a noxious weed used in folk medicine as a treatment for glandular tumours, nasal polyps and ailments related to bile ducts. The raw material costs US $1.5/kg and the finished product (tablets) costs US $1000/kg. *Colchicum autumnale* commonly known as autumn crocus grows in the state of Karnataka, southern India, and contains the highly toxic alkaloid colchicine, a mitotic inhibitor. The cost of raw material is not clearly known; however, the finished product (tablets) costs US $25,000/kg. Similarly, the cost of (toxic) the finished product (hypericin) from *Hypericum* species is US $150,000,000/kg.

The global herbal personal care and cosmetic sector in 2005 was roughly $12 billion. Total sales of herbs/botanicals in the USA in 2006 were $4.6 billion; sports and nutrition products were $2.4 billion; and natural personal care and household products were $7.5 billion (*Nutrition Business Journal* 2007a). The market improvement has been overwhelming, looking at the recent trend showing nearly $262 billion in 2013–2014. Table 3.7 lists the top five Indian companies that are using bioresources. In comparison to the world market, the Indian biotech market at $4.3 billion is expected to touch $11.6 billion by 2017 (Fig. 3.3).

Table 3.7 Top five Indian companies that are using bioresources

BR-based companies	Segment	Revenue (crores)
Serum Institute of India	Biopharma	1708.00
Biocon	Biopharma	1676.00
Nuziveedu Seeds	Bioagri	745.00
Reliance Life Science	Biopharma	693.00
Novo Nordisk	Biopharma	647.28

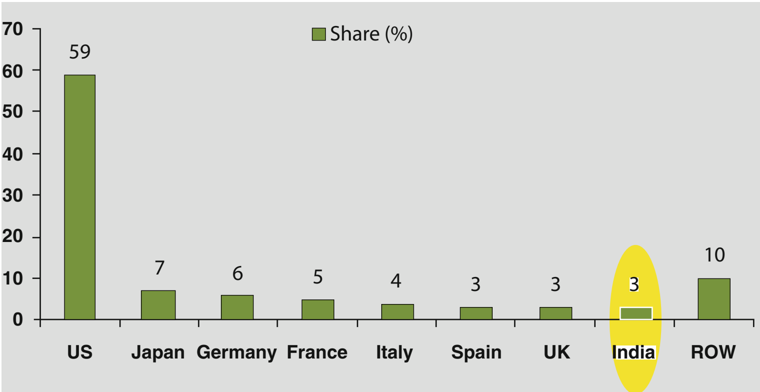

Fig. 3.3 Global biotech revenue

3.9 Trade in Bioresources in India

One of the functions of the State Biodiversity Boards is to regulate by granting of approvals or otherwise requests for commercial utilisation or bio-survey and bio-utilisation of any biological resource by Indians. In this regard the economic valuation or estimation of the value of bioresources at their collection point is an important aspect and a prerequisite in operationalising the ABS mechanism. One of the key issues that will emerge as a critical challenge for countries intending to operationalise the Nagoya Protocol on ABS at national level would be to assess the economic and related potential of resources before arriving at an appropriate mechanism of benefit sharing. In the absence of any knowledge on the economic potential of resources, it is possible that the negotiations on benefit sharing between the provider and user could be skewed and biased putting the fairness and equity elements within an ABS process at risk (Prakash Nelliyat and Balakrishna Pisupati 2013). This is especially true in the case of ecosystem goods, particularly those obtained from common properties; the demand, supply and price mechanisms do not function effectively as they do in the case of other commodities. Providers/sellers and buyers have limited knowledge and information about both the 'price' and 'value' of a product. In exchange, the users of bioresources (those prospecting resources including commercial agencies) have better knowledge about their potential value than the providers. However, the providers (local communities) are often exploited since they are little aware of the potential of resources for value addition, product development and subsequent commercialisation. Thus, the negotiations on determining the benefit-sharing element could be potentially compromised where the provider is unaware of the potential use and value while the user has specific use and potential market in mind. With this in mind, the true value of the manufacturers of bioresources is to be assessed based on the turnover of the individual industry. The following will indicate the extent of turnover and profit made by bioresource industry in the country, on which the claim of ABS can be made.

Shree Baidyanath Ayurvedic Bhawan Ltd., a Kolkata-based firm with a sales volume of about 350 million dollars, specialises in Ayurvedic medicines, though it has recently expanded into the FMCG sector with cosmetic and hair care products. Charak Pharmaceuticals founded in 1947 currently has three distribution centres in India and produces liquids, tablets and veterinary supplies. It has gained a large advantage with its new product Evanova, a preparation containing 33 herbs and minerals and nonhormonal active ingredients used as a menopause treatment alternative to HRT. Soya is one of the main ingredients in this product. The product also contains Ayurvedic herbs that act like selective oestrogen receptor modulators as well as asparagus root (*shatavari*), which reduces the frequency and intensity of hot flushes. Zandu Pharmaceutical Works with a total sales volume of about 45 million dollars focused primarily on Ayurvedic products. Zandu is now acquired by the Emami group and provides a diverse range of products, doing 110 million dollars of business annually. The company is mainly involved with toiletries and cosmetics, but also provides chyawanprash and other health products. Aimil Pharmaceuticals Ltd., engaged in manufacturing and sale of both generic and proprietary Ayurvedic medicines, has a business level of about 20 million dollars annually. Its wide range of Ayurvedic herbal formulations, covering most therapeutic segments, was honoured by the Indian government's National Award for Quality Herbal Preparations and National Award for R&D in the year 2002. It is known for its proprietary formulas for hepatitis, diabetes, menstrual disorders, digestive disorders and urinary diseases.

Arya Vaidya Sala, Kottakkal, Kerala, founded in 1902 with about 2000 employees, has its distribution network in Malaysia, Singapore, and many countries in the Middle East with over 1200 sales outlets lined up under the marketing division. It has its main office functioning in Kottakkal. Natural Remedies Pvt. Ltd., Bangalore, founded in 1951, is a manufacturer and supplier of standardised herbal extracts and phytochemicals used for nutritional, pharmaceutical, cosmeceuticals and food products. All products are kosher certified and halal certified. Natural Remedies has contributed several analytical monographs on Indian medicinal plants to the Indian Pharmacopoeia, Ayurvedic Pharmacopoeia of India and the United States Pharmacopoeia. Natural Remedies has a strong marketing network that represents its product line in almost all the big markets like the USA, Canada, Australia, Japan, Europe, South Africa, etc. The range of human healthcare products includes clinically proven branded ingredients, standardised herbal ingredients, water-soluble

Table 3.8 Trade details of medicinal plants from India

Year	% growth over the previous year	Trend value
2005–2006	–	100
2006–2007	18.57	122.8
2007–2008	24.86	153.32
2008–2009	26.35	193.72
2009–2010	15.19	223.15

range and natural cosmetic ingredients. VICCO has been successfully carving out a niche for itself in the field of dental and skin care globally. The company is exporting its products to countries like the USA, Canada, Mexico, Surinam, Africa, Mauritius, Fiji, Saudi Arabia, Kuwait, the UAE, Qatar, Oman, the UK, Germany, Holland, Italy, Cyprus, Sri Lanka, Hong Kong, Singapore, Malaysia, West Indies, Iceland, Australia, New Zealand and France.

Baba Ramdev's main companies are Patanjali Ayurved and Divya Pharmacy. Ramdev in his interview with Business Standard last year (2014) informs that his profit margins are 16 %, though his products are priced up to 50 % below rivals. Himalaya, yet another natural resource-based industry, has more than 200 products across four main business verticals such as pharmaceuticals, personal care, baby care and animal health. The trade details of medicinal plants from India are given in Table 3.8.

Vis-à-vis with trade, there is a spurt in the collaboration with Indian companies recently, as can be seen from the following: Mylan Labs, USA, with Matrix Labs (2008); Daiichi Sankyo, Japan, with Ranbaxy (2008); Pfizer, USA, with Aurobindo (2009); Fresenius Kabi (2009), Germany, with Dabur India Ltd. (2009); Pfizer, USA, with Claris Lifesciences (2009); GSK, UK, with Reddy's Laboratory (2009); Mylan Labs, USA, with Biocon (2009); Mylan Labs, USA, with Famy Care (2009); Sanofi Pasteur, France, with Shantha Biotechnics (2009); Pfizer, USA, with Strides (2010); Reckitt Benckiser with Paras Pharma (2010); Abbott Labs with Nicholas Piramal (2010); Pfizer, USA, with Vetnex Animal Health (2009); Vetoquinol, France, with Wockhardt (2009); Abbot, USA, with Wockhardt (2009); Litha Healthcare, South Africa, with NATCO (2011); B. Braun, Singapore, with Ahlcon Parenterals (2012); Mylan Inc., USA, with Strides Arco Lab (2013); and many more such collaborations.

One example of the pharmaceutical industry's increased interest in ABS is reflected in the recent development of guidelines by the International Federation of Pharmaceutical Manufacturers and Associations for their members, on 'Access to Genetic Resources and Equitable Sharing of Benefits Arising out of their Utilization' (IFPMA 2006). These guidelines support the objectives of the CBD and lay out the elements of 'industry best practice' including obtaining PIC, reaching mutually agreed terms incorporated into a 'formal contractual benefit-sharing agreement' and avoiding negative impacts on traditional use when commercialising genetic resources. In return, they request governments to assign national focal points, enact

ABS legislation, enter into good faith negotiations and agree on dispute resolution – in short, to provide legal certainty over material accessed.

3.9.1 **Garcinia** ***from India: A Case Study for ABS and Bioprospecting***

The International Plant Names Index (IPNI) has a total of 678 species and subspecies names given in *Garcinia* (family Clusiaceae), but the total number of valid species is not known. However, recently the collaboration between the Royal Botanic Gardens, Kew, and Missouri Botanical Garden enabled the creation of The Plant List (*theplantlist.org*) by combining multiple checklist data sets held by these institutions. It has enumerated as many as 418 valid species of *Garcinia* from all over the world. In India, 30 species are reported by T. Anderson in *Flora of British India* (Hooker 1874). Among the 35 species reported by Maheshwari (1964), 15 species are from Northeast India. Kanjilal et al. (1934) reported nine species from undivided Assam. Kar et al. (2008) reported eight species from Sonitpur districts of Assam. In the present compilation, 31 species have been reported to occur in India and among them 15 are endemic, and many economically important ones are cultivated. Table 3.9 lists the species of *Garcinia* distributed in India. In India, species of *Garcinia* grow extensively in semiwild state, in the Konkan region of Maharashtra, Goa, coastal areas of Karnataka and Kerala, and evergreen forests of Assam, Khasi, Jaintia hills, Gujarat, Nagaland and West Bengal.

3.9.1.1 Uses

In Malabar and Konkan regions of southern India, they are used in garnishing curries and also as a replacement for tamarind. In northeastern India, the sundried slices of the fruits are used for culinary purposes and as folk medicine. Many species of *Garcinia* have fruit with edible arils and are eaten locally. The best-known species is the mangosteen (*G. mangostana*), which is now cultivated throughout Southeast Asia and other tropical countries. The seeds of *G. indica* fruits yield valuable edible fat known as kokum butter. The fruits of *Garcinia* are a food source for several animals. Most species in *Garcinia* are known for their gum resin which is used as purgative or cathartic. Fruits of some *Garc*inia species are also one of the richest sources of red pigments in the plant kingdom. Fruit and syrup of *G. indica* are very popular in Konkan region and are antioxidant and antibacterial.

Mangosteen is a tropical fruit; the fruit, fruit juice, rind, twig and bark of which are used as medicine. Mangosteen is used for many conditions, but, so far, there isn't enough scientific evidence to determine whether or not it is effective for any of them. Mangosteen is used for diarrhoea, urinary tract infections (UTIs), gonorrhoea, thrush, tuberculosis, menstrual disorders, cancer, osteoarthritis and dysen-

Table 3.9 Distribution of *Garcinia* species in India

Sl. No.	Species	Distribution
1.	*G. andamanica* King	Andaman and Nicobar Islands
2.	*G. anomala* Planc.	Khasi Hills
3.	*G. atroviridis* Griff	Northeastern districts of Assam
4.	*G. cornea* L.	Bengal
5.	*G. cowa* Roxb.	Eastern parts of India mainly in Assam, Bengal, Bihar and Orissa and in Andaman Islands
6.	*G. dulcis* (Roxb.) Kurz	Introduced into India from Malaysia to Assam and Nicobar Islands
7.	*G. echinocarpa* Thw. (=*Garcinia rubro-echinata* Kosterm)	Southern Travancore and Tirunelveli at altitudes of 3000–5000 ft and in Ceylon
8.	*G. gummi-gutta* (L.) Rob. (*G. cambogia* (Gaertn) Desr	Within India, it has been recorded in Western Ghats of Maharashtra (Bombay, Konkan), Goa (Anmod, Colem range, Sangeum), Karnataka (Chikmagalur, Dakshina and Uttar Kannada, Kodagu, Hassan, Shimoga), Kerala (Calicut, Cannanore, Nilambur, Palakkad, Thrissur and Thiruvananthapuram) and Tamil Nadu (Coimbatore, Nilgiris, Tirunelveli and Dharmapuri districts) at an altitude range of 400–900 m
9.	*G. hanburyi* Hook. (the gamboge tree)	South India, Cambodia, Ceylon
10.	*G. hombroniana* Pierre	Nicobar Islands
11.	*Garcinia imberti* Bourd	Kerala (endangered, endemic species)
12.	*G. indica* Choisy (kokum butter tree)	Western Ghats, from west coast of India, in northern Kerala, coastal Karnataka, Goa and Konkan belt of Maharashtra. A total of 268 trees were identified during the extensive surveys conducted in Goa for kokum diversity. The kokum accessions studied were spread all over Goa covering all 11 taluks/zones representing different ecoregions
13.	*G. kydia* Roxb	Andaman Islands
14.	*G. lanceifolia* Roxb.	Assam and Khasi Hills up to 3000 ft. In few places cultivated
15.	*G. livingstonei* T. Anders	Introduced into India from tropical East Africa
16.	*G. mangostana* L. (mangosteen)	Lower hills of Nilgiris, between 1200 and 3000 ft, and near Courtallam in Tirunelveli
17.	*G. microstigma* Kurz	Andaman Island
18.	*G. morella* Desr. (Indian gamboge tree)	Assam and Khasi Hills, Western Ghats up to an altitude of 3000 ft
19.	*G. nervosa* Miq.	Assam, Nicobar Islands
20.	*G. prainiana* King	Malaysia but introduced in India
21.	*G. paniculata* Roxb.	Foothills of Himalayas, Assam, Khasi Hills
22.	*G. pedunculata* Roxb.	Assam up to an altitude of 3000 ft and in Manipur

(continued)

Table 3.9 (continued)

Sl. No.	Species	Distribution
23.	*G. pictorius* Roxb.	Western Ghats (Tamil Nadu)
24.	*G. speciosa* Wall	Andaman Islands
25.	*G. spicata* Hook. (*G. ovalifolia* Hook. f.)	Western Ghats from Konkan southwards
26.	*G. stipulata* T. And.	Eastern Himalayas
27.	*G. succifolia* Kurz	South India
28.	*G. talboti* Raizada ex Santapau	Maharashtra (Amboli, Koyana, Phansad and Tamhini)
29.	*G. travancorica* Beddome	Western Ghats (Kerala)
30.	*G. wightii* T. Anders	Forests of South India (Anamalai and Travancore)
31.	*G. xanthochymus* Hook. (*G. tinctoria* Wight)	Lower hills of Eastern Himalayas, Western Ghats and Andaman Islands

tery. It is also used for stimulating the immune system and improving mental health. Some people apply mangosteen to the skin for eczema and other skin conditions. Mangosteen is often eaten as a dessert fruit or made into jams. These days, mangosteen juice is becoming a popular ‘health drink’. It is usually sold under the name ‘xango juice’. Prenylated xanthones isolated from *Garcinia mangostana* have been extensively studied; some members of these compounds possess antioxidant, antitumoural, antiallergic, anti-inflammatory, antibacterial, antifungal and antiviral properties. Xanthones have been isolated from pericarp, whole fruit, heartwood and leaves. The most studied xanthones are alpha-, beta-, and gamma-mangostins, garcinone E, 8-deoxygartanin and gartanin.

Apart from the traditional uses of *Garcinia cambogia*, it finds a wide value of applications in ‘nutraceutical’ field. The major market is in the USA, followed by Japan and Europe (Clouatre and Rosenbaum 1994). *Garcinia cambogia* is a revolutionary component in nutraceutical/dietary supplement areas as a source of hydroxycitric acid (HCA), which is known as a weight-reducing agent (Lowenstein 1971; Sullivan and Triscari 1977). In addition to tablets and capsules, it is marketed as biscuits, chewing gum, snack bar, etc. Water-soluble HCA is available as soft drinks and beverages. *Garcinia cambogia* extract inhibits body’s conversion of glucose into fat and cholesterol by inhibiting certain enzymatic process (Chee et al. 1977; Sullivan et al. 1973). The increase in glycogen stores helps significantly reduce cravings for food, reduce appetite and induce weight loss (Greenwood et al. 1981).

Seed from *Garcinia indica* contains 23–26 % oil, which is used in the preparation of medicines and cosmetics. The outer rind of the fruits of *Garcinia indica* Linn has been shown to have antioxidant activity. The fruit rind also contains polyisoprenylated benzophenones, garcinol, isomer isogarcinol, xanthochymol and isoxanthochymol. The rind also contains hydroxycitric acid (HCA), hydroxycitric acid lactone, citric acid and oxalic acid. Mechanistic studies have shown that it is a competitive inhibitor of the extramitochondrial enzyme ATP-citrate lyase that catalyses the extramitochondrial cleavage of citrate to oxaloacetate and acetyl-CoA, an important precursor involved in the initial steps of de novo lipogenesis in the liver. Hydroxycitric acid also inhibits pancreatic a-amylase and intestinal a-glucosidase, leading to a reduction in carbohydrate metabolism. It also inhibits synthesis of fatty acid and lipogenesis from various precursors. The fruit also contains other compounds including malic acid, polyphenols, carbohydrates, anthocyanin, pigments and ascorbic acid. Garcinol has antioxidative, chelating, free radical scavenging, antiglycation, anticancer, anti-inflammatory and antiulcer activities. Hydroxycitric acid has been patented for use as a hypocholesterolaemic agent. Kokum contains other compounds with potential antioxidant properties as citric acid, malic acid, polyphenols, carbohydrates, anthocyanin flavonoids and ascorbic acid. Free fatty acids are present up to 7.2 % of the total kokum butter. The fatty acid composition is as follows: oleic, 40–50 %; palmitic, 5–8 %; linoleic, 2–4 %; and stearic, 40–50 %.

G. hanburyi Hook is valued because of the resinous sap, called gamboge, which exudes from incisions in the bark. The reddish-yellow to brownish-orange sap contains 70–80 % resin and 15–25 % gum. The main acidic component of the resin is gambogic acid ($C_{38}H_{44}O_8$). The main components of the gum are arabinose (ca. 50 %) and galactose (ca. 40 %); the gum is soluble in water and forms a yellow emulsion in water. This sap is used as a golden yellow colouring matter for varnishes, lacquer, paints and ink. Medicinal uses of gamboge are a drastic purgative, an emetic and a vermifuge for treating tapeworm, but it is no longer used in human medicine.

3.9.1.2 Challenges

One of the common problems with raw drug/medicinal product trade has been the admixtures with morphologically allied and geographically co-occurring species (Ved and Goraya 2008). The possibility of admixtures is particularly high when the species in question co-occurs with morphologically similar species. Frequently, admixtures could also be deliberate due to adulteration (Mitra and Kannan 2007). The consequences of species admixtures can range from reducing the efficacy of the drug to lowering the trade value (Wieniawski 2001), besides threatening the safety of herbal medicines (Song et al. 2009).

G. gummi-gutta and *G. indica* are in great demand, and Himalaya sells the product at the rate of INR 1125 ($16.94) for 100 capsules. In addition to *Garcinia*, *Phyllanthus* (Euphorbiaceae) constitutes one of the most important groups of species traded as raw herbal drug. The annual volume of *Phyllanthus* trade in India is about 2000–5000 metric tonnes (Ved and Goraya 2008). Khatoon et al. (2006) and Ved and Goraya (2008) also reported that several samples contain extracts from wild *Phyllanthus amarus* (keezhanelli) along with *Phyllanthus fraternus* and *Phyllanthus maderaspatensis*, morphologically similar species but with different phytochemistry. Species admixtures may have significant implications on the quality and efficacy of the eventual phytomedicine made from these mixtures (Song et al. 2009).

3.9.2 Sandalwood Trade

The cost of sandalwood oil is anywhere between INR 65,000/kg ($978.69) for smuggled wood and INR 1.5 lakhs per kg ($2258.53) as per government procedure. Because of this difference in the market value, there is a persistent demand for sandalwood and sandalwood oil from the southern states of Karnataka and Tamil Nadu. The Sandalwood Factory, Government of Karnataka, has always been on progressive growth for the last 10 years by increasing its production and sales volumes. The company turnover has increased from 100.00 crores (US$15,056,840.00) during the year 2003 to Rs.262.00 crores (US $39,448,920.80) during the year 2011–2012. Several adulterants from unrelated plants with similarly scented wood or oil are found, viz. *Adenanthera pavonina*, sandalwood tree, red or false red sandalwood; *Baphia nitida*, camwood, also known as African sandalwood; *Eremophila mitchellii*, sandalwood, false sandalwood; *Myoporum platycarpum*, sandalwood, false sandalwood; *Myoporum sandwicense*, bastard sandalwood, false sandalwood; *Osyris lanceolata*, African sandalwood; and *Osyris tenuifolia*, east African sandalwood.

3.9.3 Spices

India is the largest producer, consumer and exporter of spices, and the Indian spice export basket consists of around 50 spices in whole form and more than 80 products in value-added form.

During 2013–2014, a total of 8,17,250 t of spices and spice products valued Rs.13,735.39 crores (US$2267.67 million) has been exported from the country as against 7,26,613 t valued Rs. 12,112.76 crores (US$ 2212.13 million) in 2012–2013 registering an increase of 12 % in volume and 13 % in rupee terms and 3 % in dollar terms of value (Annual Report, Spice Board 2013).

The share of different commodities in the total spice export is given in Fig. 3.4. The data regarding the market of spice globally is presented in Table 3.10.

Apart from India, South Africa (South Africa, Malawi and Zimbabwe), China, Pakistan and Mexico are other major producing and exporting countries. These are mostly low or medium pungency varieties like Indian S4 chillies, Tientsin Chinese chillies or Pakistan Dandicut chillies. Malawi, Zimbabwe and Uganda export limited quantities of the highly pungent ‘east African bird’s eye type’, and China exports some high pungency types (Fukien).

Table 3.10 World Spice Marketing in tonnes (data from ISB)

Developing countries	Tonnes	Percentage (%)
India	1,600,000	85.6
China	66,000	3.5
Brazil	48,000	2.6
Pakistan	45,000	2.5
Turkey	33,000	1.8
Mexico	15,000	1.0
Other countries	60,900	3.0
Total	1,868,700	100

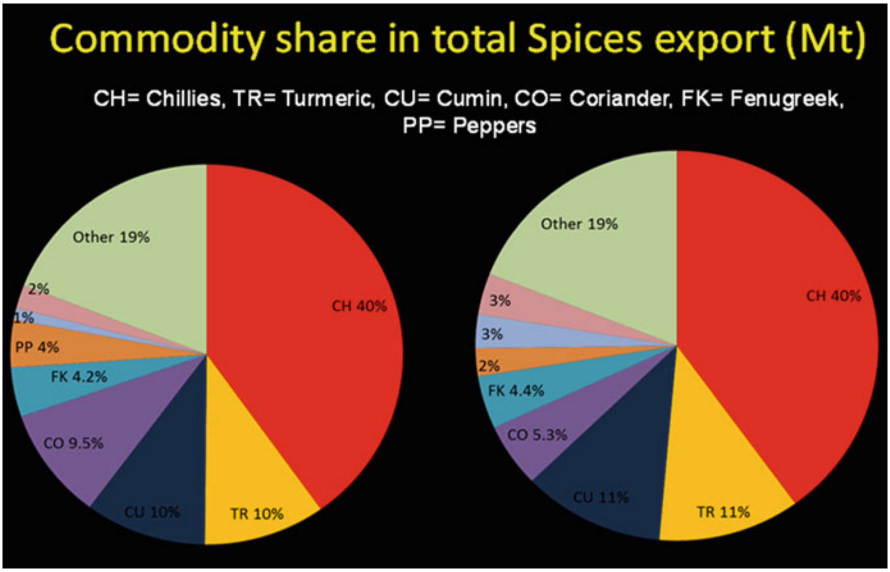

Fig. 3.4 Commodity share in total spice export

3.9.4 Byadgi Chilly for Bioprospecting

India is the world's largest producer, consumer and exporter of chillies in the world and has the largest area under chilly cultivation. In Karnataka, Byadgi has been famous for red chilli. The vast and extensive market yard is famous as the second largest red chilli dealing market in the country. The business involving Byadgi chillies has the second largest turnover among all chilli varieties of India. The varieties (1) Dabbi, (2) Biligay (3) and Kaddi under cultivation differ in the size, shape and colour. The pericarp goes for colour extraction and seeds for oil extraction. Byadgi chilli was grown mainly for the purpose of the extraction of oleoresin, red oil from the pods. Oleoresin is used in the preparation of nail polish, lipsticks and confectionary and beverage industry. The oleoresin produced at Byadgi is then sent to Kerala where it is further refined before being exported to countries like the USA, Japan and Europe.

The red colour of chillies is due to the presence of carotenoid pigments like capsanthin (major pigment, 35 %), capsorubin, zeaxanthin, violaxanthin, cryptoxanthin, β-carotene, etc. These pigments are present in chillies mainly in the esterified form and to a small extent in nonesterified forms. Chilli oleoresins as commercially produced vary in their pigment content, and the colour value ranges from 30,000 to 1,00,000 units as measured by the method prescribed by the Essential Oil Association of America (EOA). The colour content of the oleoresin is directly proportional to the pigment concentration in the raw material used. In terms of colour, index pericarp of Byadgi Dabbi is giving the highest colour value with 8869 colour units (CU). The seeds of Byadgi Dabbi scored the highest for oleoresin content with 19.96 %. In capsaicinoid content 1.39 % was observed by seeds of local Byadgi. Generally, the stalk, which is considered as disposable part, exhibited not only strong scavenging activities against free radicals but also high content of the total polyphenol and total flavonoid content.

Byadgi chillies occupy an area of 1,45,000 ha, covering Dharwad, Gadag and Haveri districts of Karnataka with the production of 87,000 t. In 2010, it has been considered as a geographical indication (GI) under the Geographical Indications of Goods (Registration and Protection) Act, 1999. The process of extracting Byadgi chilli (*Capsicum*) oleoresin is already patented in the USA.

3.9.5 Marine Resource for Bioprospecting and ABS

Marine ecosystems are unique and a rich reservoir of biodiversity with an enormous potential towards providing sustainable livelihood. Pharmaceutical sector is the major area that is actively building its inventory of marine bioresource-based/bioresource-derived drugs. Some of the determining parameters for increased corporate interest in the marine genetic resources include a requirement to combat multidrug resistance, novel drug discovery and increasing market demand of bioresource-based drugs. Thus, marine organisms offer a unique genetic pool that may possess the potential of treating several diseases including rare diseases or the ailments that are still considered incurable (Demunshi and Chugh 2010; Lazcano-Pérez et al. 2012). This can be effectively deduced from the successfully FDA-approved drugs such as cytarabine (ara-C), vidarabine (ara-A), ziconotide, trabectedin and eribulin mesylate (Mayer et al. 2010; Martins et al. 2014).

There is no specific legislation that describes the regulation and benefit-sharing mechanism for marine bioprospecting per se. The International Seabed Authority provides rules and provisions to regulate prospecting, exploration and exploitation of marine minerals in the international seabed area, in order to conserve the marine environment (International Seabed Authority 2012). Also the Valencia Declaration on the Protection of Marine Biodiversity urges for an international governance regime for the regulation of activities in the marine areas beyond the national jurisdictions and to ensure use of the resources for benefit of the mankind with a balanced approach (MarBEF + Outreach: A plea for the Protection of Marine Biodiversity Valencia and Declaration 2008).

Over the last three decades, research and development based on marine genetic resources and associated traditional knowledge advanced tremendously. As a result, five modern 'marine' drugs for six indications were approved since 2004; dozens of marine natural products (MNPs) are under clinical tests; and many thousand MNPs are under scientific investigations. Enzymes from marine organisms are used in scientific and industrial work and marine ingredients found their way into cosmetics. The Swiss company Mibelle Biochemistry sells Helioguard 365/Noriguard as UV filter for sun creams to cosmetic companies, containing a compound derived from the red algae *Porphyra umbilicalis* collected in France. The French company Unipex Innovations developed cosmetic ingredients from microbial mats, called kopara, collected from Mo'orea Island, French Polynesia. Kopara is gelatinous sediment formed by benthic microbial communities, dominated by cyanobacteria. It contains many biomolecules, which bear potential for various industrial applications.

One of the most well-known bioprospecting contracts is the contract executed between the National Biodiversity Institute (INBio) of Costa Rica and Merck Pharmaceutical Ltd. (Eberlee 2000). The contract granted the right for collection as well as evaluation of plant, insect and microbial samples from Costa Rica's 11 forest conservation areas. Another agreement pertaining to bioprospecting is the agreement executed between the International Cooperative Biodiversity Group (ICBG, the US governmental venture) and Bristol-Myers Squibb, Monsanto, and Glaxo Wellcome (consortium of private companies) for collection of Peruvian medicinal plants. ICBG has executed contracts with different organisations for the bioprospecting activities.

3.9.5.1 Case Study for Marine Bioprospecting

The horseshoe crab is a *living fossil*. Forms almost identical to this species were present during the Triassic period 230 million years ago, and similar species were present in the Devonian, a staggering 400 million years ago. Four species of horseshoe crabs are distributed in the world, viz. *Carcinoscorpius rotundicauda*, *Tachypleus gigas*, *Tachypleus tridentatus* and *Limulus polyphemus*. The species of *Limulus* is restricted to northwestern Atlantic coast, Gulf of Mexico and West Indies. All other members are found along the Southeast Asia and Pacific coasts and from Japan and Korea to East Indies and the Philippines. Two species *Tachypleus gigas* (Muller) and *Carcinoscorpius rotundicauda* (Latreille) are found along the east coast of India from Gopalpur coast to Hooghly-Matlah estuarine system including Sundarbans of West Bengal. The crab *Tachypleus gigas* is found along the Orissa coast, whereas *Carcinoscorpius rotundicauda* is common along the West Bengal coast. The blood of horseshoe crabs contains the copper-containing protein haemocyanin at concentrations of about 50 g per litre; the blood also contains a type of blood cell, the amoebocytes. These play an important role in the defence against pathogens. Amoebocytes contain granules with a clotting factor known as *coagulogen*, which is released outside the cell when bacterial endotoxin is encountered. The resulting coagulation is thought to contain bacterial infections in the animal's semi-closed circulatory system. The above-mentioned clotting reaction is used in the limulus amoebocyte lysate (LAL) test to detect bacterial endotoxins in pharmaceuticals and to test for several bacterial diseases. LAL is obtained from the horseshoe crab blood. Horseshoe crabs are also used in finding remedies for diseases that have developed resistance to penicillin and other drugs. A single horseshoe crab can be worth 5000 US$ over its lifetime for periodic blood extractions, and a quart of blood is estimated to be 15,000 US$.

The role of carcinoscorpin, a haemolymph lectin of horseshoe crab, demonstrated that a marine Indian horseshoe crab, *Carcinoscorpius rotundicauda*, showed higher self-defence in an experimental infection upon the induction of its circulatory lectin, carcinoscorpin. Carcinoscorpin is thus functionally an opsonin, a humoral factor involved in the defence of the host. The natural capacity for defending an infection with live *E. coli* per crab suggested that the crabs in the natural habitat hardly face such an infection and is possibly one of the reasons for its survival over millions of years as a living fossil.

At certain seasons of the year in Thailand, the horseshoe crab *Carcinoscorpius rotundicauda* may be toxic to human, and fatal poisoning occasionally occurs. Tetrodotoxin (TTX) and its derivatives were major toxins in the toxic eggs of the horseshoe crab. Patients generally exhibited neurologic symptoms such as paraesthesia, vertigo, weakness, respiratory paralysis and altered consciousness with unreactive dilated pupils in addition to gastrointestinal symptoms such as nausea and vomiting.

3.10 Traditional Knowledge and Traditional Knowledge Digital Library

The Nagoya Protocol (2010) recognises 'the interrelationship between genetic resources and traditional knowledge, their inseparable nature for indigenous and local communities, the importance of traditional knowledge for the conservation of biological diversity and the sustainable use of its components, and for the sustainable livelihoods of these communities'. Traditional knowledge is defined as the 'tradition-based literary, artistic or scientific works; performances; inventions; scientific discoveries; designs; marks, names and symbols; undisclosed information; and all other tradition-based innovations and creations resulting from intellectual activity in the industrial, scientific, literary or artistic fields' (WIPO 2001). The linkage of traditional knowledge to various fields is presented in Fig. 3.5.

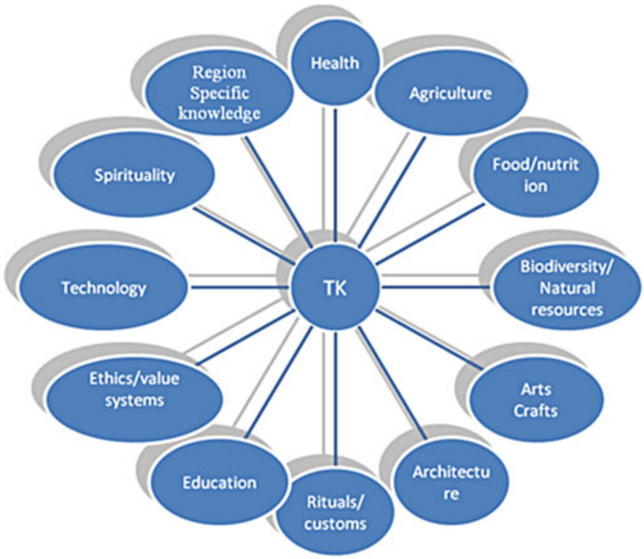

Fig. 3.5 Traditional knowledge

Traditional knowledge, which is centred on tested beliefs, practices and traditional technologies, needs to be documented through a systematic and planned approach. Documentation of such knowledge through established protocols may be the primary requirement. The efforts of community, individual and public domain knowledge systems in creating the database and documentation of traditional knowledge systems should be strengthened. Under participatory management of natural resources, documentation, assimilation and its application into management practices are essential. Steps involved in such methods are as follows:

1. *Participatory rural appraisal* (PRA) is a participatory research method that involves the community in planning for communication programme. PRA helps to identify, define and prioritise the needs and problems of the people and evolve opportunities and solutions. It may also help to identify the stakeholders.
2. The stakeholder meetings were designed and organised in sequence with PRA, to document specific knowledge with respective stakeholder groups identified in the village. This enabled us to interact with each stakeholder group and solicit their needs and concerns about resources and involve them in the development of a framework for participatory management and benefit sharing.
3. Community workshops need to be organised to document and consolidate the knowledge derived from PRA and stakeholder meetings at frequent intervals. The purpose of community workshop is to validate the knowledge and process the information for participatory planning for development of sustainable harvesting methodology.
4. Development of social matrix and indexing method is used for documentation, application and assimilation of traditional knowledge with task team constituted for planning and monitoring of methodology in the village.

5. Decision on location, resources and duration for the documentation process:
   (i) Development of village profile with social mapping
   (ii) Development of species profile
6. Application of more than one method with pre-trained resource persons.
7. Development of participatory steps requires merger of both traditional and modern knowledge. It enables implementation of participatory experimentation and monitoring by local communities.
8. Medicinal profile of selected species.
9. Integration of traditional knowledge and modern scientific knowledge and its assimilation into participatory management practices.
10. Generation of results through experimentation and monitoring.
11. Dissemination and discussion with relevant stakeholder group/s for their acceptance and application of wise practices into general practice.
12. Assimilation of adaptive management practices into forest management plans.

The TKDL database has been created to prevent misappropriation of traditional knowledge at international patent office so that cases of biopiracy can be prevented. India has already signed TKDL Access Agreement with (i) European Patent Office (February 2009), (ii) United State Patent and Trademark Office (November 2009), (iii) Canadian Intellectual Property Office (September 2010), (iv) German Patent Office (October 2009), (v) United Kingdom Patent and Trademark Office (February 2010) and (vi) Intellectual Property, Australia (January 2011). Meanwhile, negotiations are under way to conclude the Access Agreement with the Intellectual Property Office of New Zealand. TKDL references as a prior art have led to significant strides towards achieving the goal of preventing misappropriation of Indian traditional knowledge. This includes cancellation of grant of two patents, withdrawal of 75 patent applications, amendments/modifications of claims in 32 applications and rejection/cancellation of two applications. In Europe, for example, the Traditional Herbal Medicinal Product Directive provides a simplified registration procedure for over-the-counter (OTC) herbal products if they can be proven to have 30 years of documented use (or 15 years within the EC), including the use in traditional medicine (Gruenwald and Wohlfahrt 2007).

3.10.1 Commitment on Traditional Knowledge by India on ABS

By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

The Traditional Knowledge Digital Library (TKDL) database is a value-added digital database developed by the Government of India for (i) preservation of traditional knowledge; (ii) prevention of misappropriation of traditional knowledge by breaking the language and format barriers of traditional knowledge systems and providing access to these knowledge systems to patent examiner(s) in five international languages, i.e. English, German, French, Spanish and Japanese, for establishing the prior art; and (iii) creation of linkages with modern science to initiate active research projects for new drug discovery and development, based on the time-tested traditional knowledge systems leading to more affordable healthcare for the poor.

3.11 Challenges Ahead for Corporate Sectors

The Biodiversity Act gives broad powers to the BMC to promote conservation, sustainable use and documentation of biological diversity. This includes the preservation of habitats and conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms. It is also required to document biological resources and chronicle knowledge related to those resources (Sect. 41.1). However the Rules (Rules 22) made under the Act stipulates the BMCs to document bioresources and associated knowledge with the primary function being the preparation of People's Biodiversity Registers (PBRs). SBBs will guide the BMCs in this primary function. The PBRs would need to contain comprehensive information on availability and knowledge of local biological resources, their medicinal use, other use or any other traditional knowledge associated with them (Rules 22.6).

The People's Biodiversity Register is an innovative decentralised approach to know, use and safeguard biodiversity and traditional knowledge and is expected to serve as a tool to:

1. Document, monitor and provide information for sustainable management of local biodiversity resources.
2. Promote sustainable development in the emerging process of decentralised management of natural resources.
3. Establish claims of individuals and local communities over knowledge of uses of biodiversity resources, and ensure equitable benefit sharing from the use of such knowledge and resources.
4. Perpetuate and promote the development of practical ecological knowledge of local communities and of traditional sciences such as Ayurveda and Unani medicine.
5. Recording of biodiversity-related knowledge, coupled with opportunities to generate funds through imposition of collection fees for access to local knowledge.
6. Innovative decentralised approach to know, use and safeguard our biodiversity and traditional knowledge.

7. Sustainable resource management in native varieties of fishes, crops, wildlife habitats and locally threatened species.

It is for this reason that the corporate sectors should involve themselves completely in helping the BMCs to prepare the Biodiversity Registers of the area, thereby helping to identify the supply chain of bioresources.

One of the first steps for preparing PBRs is to organise group meetings to explain the objectives and purpose of the exercise. Different social groups in the village need to be identified for the purpose of data collection from those groups. In an urban situation, spots where biodiversity are important need to be identified for the purpose of the study and documentation. The documentation process includes information gathered from individuals through a detailed questionnaire, focused group discussion with persons having knowledge and published secondary information. Information provided by the people need to be collated, analysed and crosschecked by the members of the BMCs and technical support groups (TSGs) before documentation. The PBR is an important base document in the legal arena as evidence of prior knowledge, and hence careful documentation is necessary. The document should be endorsed by the BMC and later publicised in the respective panchayat/gram panchayat/Panchayat Samiti. Despite its substantial domestic trade and its long experience with herbal medicines, India has not been able to capitalise on this by promoting use in developed country markets. Historically, the bioresources, which include different genetic materials, are extracted by local communities with the help of their unique traditional knowledge on their use and sold to prospectors at low or negligible prices. Since there are no proper markets for such resources at its collection point, the existing price for the product is not revealing its actual value.

According to the *Report of the Task Force on Conservation and Sustainable Use of Medicinal Plants*, a critical factor in wild harvesting is the availability of cheap labour to undertake the very labour-intensive work of gathering. Because in many cases income from such sources represents the only form of paid employment for inhabitants of remote rural areas, there is a ready availability of workers. Further, contractors who employ the collectors often act as middlemen and traders as well. Collectors are often dependent on contractors as they are poor and often owe money to the contractors. Besides, the supply chain is often very long with as many as six or seven marketing stages involving primary collectors and producers, local contractors, regional wholesale markets, large wholesale markets and specialised suppliers. The long supply chain contributes to the low prices for the primary collectors and farmers for their products. It is for this reason to reduce the number of intermediaries involved in the distribution and marketing chain and increase the negotiating power of the producers and collectors. This would enhance the profit of primary farmers and collectors, many of whom are among the poorest of the population. To ensure the continued use and long-term survival of medicinal and aromatic plant species and populations in their habitats, while respecting the traditions, culture and livelihood of all stakeholders, value chain analysis, key actors, roles and responsibilities, points of value addition, regulatory landscape and market barriers and end-market customers, is of prime importance.

As collection is still more common than cultivation, huge differences in the quality of raw materials occur. The differences concern the amount of active ingredients based on where the plants were grown, what parts of the plants are being used, how the plants were harvested and how they were stored. Raw material is often also adulterated as collection from the wild cannot guarantee the uniformity of raw material.

The other challenge the industry encounters is of tapping the substantial potential for utilising medicinal, aromatic and natural dyes plants (MADPs) nationally in India as well as in export markets. At the forefront of these problems is ensuring consistent and acceptable quality. Traditionally, because the usage of plants was a part of a local community's culture and health practices, the quality was more manageable. However, this tradition is being rapidly eroded as control of medicinal development and usage moves to the industry. Certification of sustainable harvesting/collection methods can provide incentives for conservation of important habitats and strengthen local economies. A growing number of companies are realising that sustainable management of wild harvests and associated supply chains makes good business sense. As well as avoiding the need to discontinue or reformulate products, investment in sustainable sourcing, particularly when coupled with 'fair trade', can enhance the competitive advantage of a product. This is reinforced by growing consumer awareness of and demand for 'ethical' products.

Groups promoting 'alternate livelihoods' based on commercialisation of non-timber forest products have also come to realise that success relies on stable supplies, as well as stable or growing markets (Kathe et al. 2010). Sustainable wild harvests are devised to ensure that the wild production comes from a clearly defined area and using methods that meet international standards (Duerbeck 2008).

In recent years, efforts have been made to accurately identify medicinal plants used in raw drug trade to ensure the purity, quality and safety of drugs (Jayasinghe et al. 2009). Besides conventional methods including examination of wood anatomy and morpho-taxonomical keys, several DNA-based methods have been developed for the identification of medicinal plants (Sucher and Carles 2008). For example, a rapid detection method based on DNA sequences has been developed for identifying three *Bupleurum* species, *Bupleurum kaoi* Liu (Chao et Chuang), *Bupleurum falcatum* L. and *Bupleurum chinense* DC., in the processed herbal material using ITS regions (Lin et al. 2008). A sequence-specific oligonucleotide probe (SSOP) array has been developed using the sequence differences between these three species for identification (Lin et al. 2008). Misra et al. (2006) developed an AFLP-based detection of adulterants in crude drug preparations of the *safed musli* (*Chlorophytum*) complex. Jain et al. (2008) developed SCAR markers to identify three species of *Phyllanthus* used in dry leaf bulk herb trade (Jain et al. 2008). With the advent of DNA barcode tools, attempts are being made to use several candidate barcode regions to identify species. For example, the chloroplast psbA-trnH spacer region has been used to identify *Ephedra* species in dietary supplements (Techen et al. 2006).

Herbal medicines are generally considered comparably safer than synthetic drugs. However, recent reports challenge such assumptions. *Ephedra* marketed as a dietary aid in the USA led to at least a dozen deaths, heart attacks and strokes. Other well-known safety issues have been hepatotoxicity of kava and renal effects of aristolochic acid. Besides, drug interactions of herbal drugs are of a serious concern. Serious adverse effects have been reported when the addition of St. John's wort caused serum levels of cyclosporine and antiretroviral agents to fall to subtherapeutic levels. Garlic is reported to increase clotting time in patients taking warfarin. The wild varieties are more acceptable to consumers because of its efficacy over the cultivated ones. Standardisation of the plants becomes difficult due to this; as unlike that of the allopathic drugs, medicinal plants have a plethora of phyto-constituents that contribute to their bioactivity. The bioactivity further varies according to time (day, season, constellar position) and to region (arid, marshy), and there are differences in the bioactivity depending on the way the plant has been collected, processed and stored.

The quality of herbs has become a major concern following reports of heavy metals in Indian herbs. Adulteration of plants is a serious problem. Some of the common adulterants are botanicals, toxic metals, microorganisms, microbial toxins, pesticides and fumigation agents. One study showed that 64 % of samples collected in India contained significant amounts of lead (64 % mercury, 41 % arsenic and 9 % cadmium). However, this problem is not unique to Ayurvedic medicine alone. Other traditional medicines – Chinese, the Middle East and South American – have also been implicated. Such contamination can lead to serious harm to patients taking such remedies and could also interfere with the assessment of safety in a clinical trial. The quality has to be assured at all stages – herbal raw materials, processing of herbals and finished herbal medicines. Some of the Indian medicinal plants – *Phyllanthus amarus*, *Picrorhiza kurroa*, *Tinospora cordifolia*, *Commiphora mukul*, *Mucuna pruriens* and *Boswellia serrata* – have been tested in clinical trials. However, a recent review concluded that evidence-based studies on the efficacy and safety of traditional Indian medicines are limited.

Of particular importance is not only the intrinsic plant's toxicity but also adulterations, provoking multi-organ toxicity. As a result, the Food and Drug Administration (FDA) has pointed out some of the commonly used botanicals for lethal unwanted effects. Consistency in composition is primarily important for the efficacy and safety of phytomedicine that is also related to the overall therapeutic response. Since botanicals are the mixture of different/numerous biological active components, their standardisation could rarely be possible because of multiple known reasons. However, different models for the standardisation of phytomedicine are available that need further polishing. In a study of ginseng preparations, the amount of ginsenosides varied from 11.9 % to 327.7 % of the amount on the label.

Sustainable collection of wild MAP; uncertainty about annual sustained yield; large number of products, uses and markets; proliferation of labels and claims regarding sustainability without means for validation; and long and complex supply chains of products difficult to trace back to its source are utmost important.

Support of and collaboration with strong partners from industry, certification bodies, authorities and development cooperation agencies will be crucial for effective global distribution, acceptance and implementation of the standard.

3.11.1 Conservation and Recovery of Threatened Species

Nearly 3000 species of medicinal and aromatic plants are traded internationally. The resource is under pressure as about 15,000 medicinal plant species are threatened to some degree due to unique circumstances of ecology, habitat and pressures on resource for each species worldwide (IUCN).

India has banned the export of several wild species in their raw material form, although the export of finished products containing the material is allowed. A major part of the high-range Himalayan plants are wild harvested, and many of these are close to extinction from overharvesting or unskilful harvesting, e.g. *Nardostachys jatamansi* and *Aconitum* spp. A threatened species is any plant or animal species that is at risk of extinction. Different categories are allocated to threatened species (critically endangered, endangered and vulnerable) depending on the degree of risk. These categories are based on a number of criteria including trends in population size, health and distribution.

3.11.2 Biopiracy

One of the biggest threats to biodiversity and related traditional knowledge is ever-increasing bioprospecting activities. The indigenous and tribal people who conserve biodiversity by adopting sustainable method deserve to be recognised and compensated. Curbing biopiracy is about ensuring that indigenous populations receive justice and fair compensation for the use of their knowledge and genetic materials.

3.11.3 Bioprospecting

A systematic research is of prime importance for the development of new sources of chemical compounds, genes, microorganisms, macro-organisms or even the value-added products from nature for the purpose of research, bio-utilisation, conservation, industrial application or commercial utilisation. Benefits can be tangible or intangible and should be fairly shared among the parties involved. For the sustenance of the industry as well as the sustainable utilisation of resources, the need of the hour is to have strong partners, public-private partnership and development of cooperative agencies, certifiers, resource managers, communities and the authorities who can take decisions in the best possible manner for conservation and benefit sharing with the local communities with the active cooperation of the industry.

Investment in biotechnology is a high-risk activity. Sampling at sea costs a minimum of US $30,000 per day or US $1 million for a month. It typically takes 15 years overall, and an investment of up to US $1 billion, to go from research to commercial product, due to the fact that many products fail to deliver on early promises.

In respect of Areas Beyond National Jurisdiction (ABNJ), sharing of nonmonetary benefits is often perceived as the most practical and immediately valuable consequences of ABS, as the chances of R&D leading to a commercial product and generating monetary benefits are relatively small. Such ABS procedures include facilitated access to ex situ resources, including analysis and technology; collaboration and cooperation in R&D programmes; and different types of capacity building, from general education and institutional capacity building to more specific training related to genetic resources. This is mainly due to the fact that the costs for collecting marine organisms in coastal areas can be rather moderate. However, expenditures substantially increase when oceanographic means, such as special research vessels or even submersibles, are required to access marine genetic resources from interesting ecosystems on the high seas or in the deep seas. Furthermore, the benefit-sharing obligations are inherent in UNCLOS. However, the extent to which these obligations are applied with regard to marine genetic resources from ABNJ is currently not clear.

3.12 Conclusion

The institutional policy of Government of India through the National Biodiversity Authority encourages the corporate sectors to enter into the ABS mechanism by fine-tuning the procedures for transfer of technology, royalties, limiting quantity and time of access, direct payment for conservation, negotiations and access to bioresources. This is further achieved through the development of important human, technical and infrastructure capacities and laboratories permitting better negotiation conditions.

With the emergence of the National Biodiversity Authority and State Biodiversity Boards, the uncertainty of the business community for negotiations to secure prior informed consent on the bioresource is well addressed. Biotrade verification framework for native natural ingredients includes important principles relating to ABS, such as the need to ensure the prior informed consent of those providing access, the recognition and promotion of traditional knowledge and fair compensation for its use, the fair and equitable sharing of benefits derived from biodiversity use and the introduction of systems of traceability. Such initiatives reflect an increased convergence around ABS among sectors using genetic resources and those using raw materials as commodities.

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Chapter 4
Biodiversity, Access and Benefit Sharing in India: A Critical Analysis

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Abstract Traditionally, the focus on valuation of biodiversity has largely been on the forest ecosystem – both in terms of goods and services. But development demands across India are changing both agricultural lands and wetlands, especially in peri-urban areas. The current practice of Environmental Impact Assessment (EIA) lacks any stipulation for assessing net present value (NPV) of these two vital ecosystems. The financial strength of the Biodiversity Management Committee (BMC) and the sustainable livelihood of local communities could only be established through the realization of fees for accessing genetic resources within its jurisdiction, based on true economic valuation of the bio-resources. The chapter provides an analysis of the current situation in India regarding Access and Benefit Sharing indicating the extent of initiative taken up by the country and also reveals some gap areas calling for immediate attention.

Keywords Economic valuation • Biodiversity Management Committee • Wildlife tourism • Biosurvey • Bioprospecting

4.1 Introduction

The Convention on Biological Diversity (CBD), while declaring 'sovereign rights' of a nation over the bio-resources, emphasized the need for 'prior informed consent' for the 'access and transfer of material and knowledge' and 'benefit sharing' on 'mutually agreed terms' between the providers and receivers of traditional knowledge. This historic convention led to the enactment of the 'Biological Diversity Act' in India in 2002, after a protracted debate during 1993–2000. The Act based on the

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principles of CBD (Act No. 18, of 2003) authorized a three-tier framework for resource management, in consonance with the democratic principles. The National Biodiversity Authority (NBA), State Biodiversity Board (SBB) and local Biodiversity Management Committee (BMC) have been variably empowered to implement the Act in letter and spirit. Within a decade of its enactment, India has effectively constituted a functional NBA and SBBs across the Union Republic, but the crux of the problem can be traced to the local Biodiversity Management Committee. The BMCs are yet to show any effective and positive impact on the system of governance – largely due to the lack of resources, understanding and guidance.

4.2 The Biological Diversity Act and the Rules: Role of United Nations Environment Programme-Global Environment Facility (UNEP-GEF) Project

The Biodiversity (BD) Act, 2002, provided detailed guidance/procedure, for access to bio-resources under Rule 14, for revocation under Rule 15 and for restriction on activities to access under Rule 16. However, there were no guidelines on the modus operandi for benefit sharing, considering the necessity for effective implementation of the national law in India. Subsequently, a UNEP-GEF project has been launched in recent years across Andhra Pradesh (for Deccan Plateau and Eastern Ghats), Gujarat (for arid and semiarid zones), Himachal Pradesh (Western Himalayan ecosystem), Sikkim (Eastern Himalayan ecosystem) and West Bengal (Gangetic plain and coastal ecosystem). The project has five major components and plan of work. It includes (i) assessing of bio-resources under varied ecosystems and their economic valuation; (ii) providing tools, methodologies, guidelines and frameworks for effective implementation of rules under the Act; (iii) undertaking Access and Benefit Sharing (ABS) agreements on an experimental basis; (iv) implementing ABS principle at local, state and national level; and (v) enhancing capacity through training for effective implementation.

4.3 Economic Valuation

The economic valuation of the bio-resources and the ecosystem services provided by different ecosystems has gained much attention during the last two decades. Malhotra et al. (1991) had earlier pointed out the role of non-timber forest produce (NTFP) in village economy. The report of the Indian Statistical Institute Economic Research Unit (ERU 2000) focuses on the valuation of East Kolkata Wetlands from 1999 to 2000. Haripriya et al. (2006a) studied the value of biodiversity in India's forests under the 'Green Accounting for Indian States Project'; the same authors under the project had earlier published 'Valuation of Agricultural Cropland and

Protected Land in India' (2005a), 'Value of Timber, Carbon, Fuelwood and NTFP in Indian Forests' (2005b) and 'Ecological Services of India's Forests' (2006b). Guha and Ghosh (2007) pointed out the ecotourism valuation in the Indian Sundarbans.

These publications provided an index of economic valuation both for bio-resources and ecosystem services. Unfortunately, valuation of aquatic bio-resources in inland freshwater ecosystem or valuation of biodiversity in the agricultural crop-lands did not feature in the series. Traditionally, the focus on valuation of biodiversity has largely been on the forest ecosystem – both in terms of goods and services. But the development demands across India are changing both agricultural lands and wetlands, especially in peri-urban areas. The present author, acting as the expert consultant to the UNEP-GEF project, had pointed this out in his report in 2009. The current practice of Environmental Impact Assessment (EIA) also lacks any stipulation for assessing net present value (NPV) of these two vital ecosystems (Ghosh 2009). The agro-biodiversity of India is now globally recognized; recent research in West Bengal over the last 20 years or more indicates that 90 % of traditional farmer's varieties have been lost between 1947 and 2000. The factors for such enormous loss, one can argue, are not due to land-use changes but is largely related to the preference for high-yielding varieties (HYV) after the advent of the Green Revolution in the mid-1960s. But small farmers across India, one can presume, tried to save such traditional varieties but have to give away their farmlands during the acquisition for the development projects, viz. mining; multipurpose river valley projects; setting up iron, steel, chemical and fertilizer industries; oil refinery; exclusive economic zone; etc. The conversion of peri-urban and urban wetlands has also led to unaccounted loss of biodiversity; one classical example could be given from the case study of a 200-year-old wetland in the heart of Kolkata in West Bengal, India. The said wetland had lost 50 % of its area in 1964 due to the construction of a new six-storied building. It is recorded as a type locality for eight species of freshwater sponges, one species of rotifer and one species of copepod crustacean; it is the habitat of at least 96 aquatic species of invertebrates (ZSI 2012). The attempt to construct another ten-storied building was foiled by a public interest litigation case in the honourable High Court of Kolkata, pointing out the irreplaceable loss of biodiversity if the building comes up. The wetland has recorded 178 species with 28 new records, but 31 species have been lost in the past 100 years. Kumar (2012) has given an estimate of economic loss due to the conversion of wetlands in six states of India.

4.4 Nagoya Protocol and India

The Convention on Biological Diversity was opened for signature on 5 June 1992 at Rio de Janeiro and entered into force on 29th December 1993. While Article 8 (I) (dealing with access to genetic resources) is an integral part of CBD, the details to achieve the goal could only be arrived at the tenth meeting of the Conference of the Parties at Nagoya, Japan, on October 2010, after 6 years of negotiation. The said protocol has a total of 36 articles besides an annexure listing monetary and nonmonetary benefits. The protocol mentioned (u/s6) that ‘in accordance with domestic law, each party shall take measures to appropriate, with the aim of ensuring that prior informed consent or approval and involvement of indigenous and local communities is obtained for access to genetic resources where they have the established rights to grant access to such resources’ (CBD 2011). India has long back given ‘the established right to grant access’ in the Biological Diversity Act, 2002, through the Local Biodiversity Management Committee (BMC), representing indigenous and local communities (vide Article 41 of BD Act and Rule 22 of the said Act).

As of July, 2015, India has State Biodiversity Boards in all its 29 states, and the Indian Act advocates a three-tier system of controlling and managing biological/ genetic resources. The weakest link in the Act appears to be the local Biodiversity Management Committee, whose primary task seems to be revolving around the preparation of the ‘People’s Biodiversity Register’. The financial strength of local BMC could only be established through the realization of fees for accessing genetic resources within its jurisdiction from the commercial users.

The National Biodiversity Authority (NBA), the apex body constituted under Biological Diversity Act, 2002, on the occasion of the 11^{th} Conference of the Parties meet in October 2012 at Hyderabad, India, produced a document with ten case studies based on ‘community-based experiences of access and benefit sharing’ from Odessa (3), Tamil Nadu (2), Meghalaya, Madhya Pradesh, Uttaranchal, Karnataka and Kerala (1 each); this number as such may appear disappointing after 10 years of promulgation of BD Act in 2002.

On the other hand, India as a country has dealt with hundreds of cases during the same period at NBA level, granting permission to the applicant companies/individuals, prescribing fees for bioprospecting, access to resources and commercial utilization. A specially constituted ABS Expert Group has been providing support to NBA to deal with all the applications.

On 21 November 2014, the ‘Guidelines to Access to Bio-resources and Associated Knowledge and Benefit Sharing Regulations’ has been notified (GSR S27) in the Gazette of India. The said notification has prescribed three different slabs for payment based on ex-factory sale of product ranging from 0.1 to 0.5 %; benefit sharing obligation of the trader shall be 1.0–3.0 % of the purchase price of bio-resources and that of manufacturers shall range between 3.0 and 5.0 % of the purchase price; so u/s (3), percentage of benefit sharing of the trader, manufacturer and seller of the product, is given, while u/s (4), benefit sharing on annual gross ex-factory sale, is prescribed. This is expected to establish a definite guideline for ABS not only at the central level but across all states.

4.5 Bioprospecting

The word ‘biosurvey’ and ‘bio-utilization’ have been featured under Section 2 and u/s 3, but surprisingly, no fees have been fixed for biosurvey in any prospective area based on per acre of area surveyed. One can equate ‘biosurvey’ with ‘bioprospecting’, i.e. to explore and undertake survey of bio-resources to identify the material for prospective commercial utilization; such survey or prospecting may be undertaken in any ecosystem, viz. mountain, desert, freshwater, marine, agriculture, forest, etc. Bioprospecting value in different states of India (per ha basis) has been put at Rs. 6.16 (US $0.09) for Goa (lowest) and Rs. 1,06,876 (US $1609.21) for Sikkim (highest); one may always differ in the value assigned but such an index arrived at a mean value of Rs. 22, 646 per ha (US $340.98) at all Indian levels. In the report of the Central Empowered Committee (CEC 2007), the value of bioprospecting has been put as Rs. 25,553 per ha (US $384.75) at all Indian levels. Strangely enough, commercial enterprises and academic research institute applying for survey for bioprospecting, whether in forest ecosystem or in any other areas, have never been guided by the authority, till date.

4.6 Biodiversity Valuation in Forest Ecosystem and Others

The average net present value (NPV) of per ha of Indian forests, if allowed for conversion to non-forestry purposes, has now been fixed at Rs. 8.0 lakh[1] (US $12,045.47). The entire amount is deposited by the applicant company (public/private/joint sector) with the Principal Chief Conservator of Forests. In other words, the loss of forests per se is only collected by the state's Forest Department. Even if one goes by CEC assessment, at least 3 % of NPV collected should be logically deposited with the local Biodiversity Fund (in case BMC has been formed) or state Biodiversity Fund (in case no BMC exists). The value of biodiversity is generally linked with provisioning services (food, fibre, fuel, etc.) but hardly calculated at regulating services (process that regulates climate, disease, water) or cultural services (recreation, tourism) or production services (soil formation, photosynthesis). Enough thought must be given, and serious field-based research must be carried out to determine the value, so as to empower the local BMC and state boards to claim legitimate charges for any land-use changes.

4.7 Benefit Sharing: Challenges

Bishop et al. (2008), in their publication entitled 'Building Biodiversity Business', provided an idea how economic benefit can be derived by using biodiversity as the capital; the sectors of agriculture, forestry, non-timber forest products, fisheries and aquaculture, biocarbon, payments for watershed protection, bioprospecting, biodiversity offsets, ecotourism, recreational hunting and sports, fishing and finally

[1] 10 Lakh =100,000,0 = 1 million
1 Crore =100 Lakh
1 US $ = Rs.66.61

biodiversity management services have been featured in the same document. It has repeatedly focused on enabling the environment to undertake any of the above activities, keeping the issue of sustainability at the centre.

Most of the states do not have an inventory of tradable bio-resources or the users of such resources in a large commercial network. The Biological Diversity Act, 2002, has put the onus of registering such enterprise on the concerned companies, but a large number of companies/organizations across India are yet to register with the respective state boards. The Act has not yet been adequately advertised both in print and electronic media, which is an urgent necessity, further, while advertising compulsory provisions of the Act must be accompanied by the penalties prescribed for violation, as per the Act. The state of Madhya Pradesh has filed a number of cases against offending companies in the Green Tribunal; while legal notice may be the last recourse, repetitive awareness campaign may bring some desired results.

The government of India has published a list of 190 bio-resources as commonly traded material [vide S.O.2726 (E)]; all the materials listed are plant species, and none of the animal species have found place in the list. As such, freshwater fishes and crustaceans which are cultured and marketed should come within the purview of the Biological Diversity Act. On the other hand, there is no protection for trading varieties of seeds say ‘rice’ – which is being exported under the generic name only. India has a wealth of farmers’ varieties of rice and seeds of other crops including vegetable and horticulture crops, which have become rare and can provide extremely important genetic material for companies. The case of flavour of Basmati rice in US-grown ‘Texmati’ is now well known. One has to look critically at the EXIM policy to prevent future biopiracy from a megadiverse country like India.

The Biological Diversity Act 2002 and Rules 2004 paved the way for an effective ABS mechanism, but the process of implementation still remains slow; at the end of the UNDP-GEF project, lessons learned from selected states may provide valuable guidelines for the other states to follow.

In the meanwhile, adequate publicity of the provisions of the Act across the country and providing real benefit to the conservers and providers of traditional knowledge and material may be an agenda of top priority. Training of BMC members in local language may be taken up as a time-bound program by all State Biodiversity Boards, especially focusing on the need and opportunities for conservation.

Very often, ‘wildlife’ and ‘biodiversity’ are treated separately especially in the Indian context. Wildlife is unquestionably a part of ‘biodiversity’, and the conservation of wildlife, even a targeted keystone species like tiger, elephant or lion in land or whale and dolphin in water, will invariably lead to the conservation of habitats thereby offering an enormous opportunity for associated biota to survive under a protected environment. This in turn opens up opportunity to ‘wildlife tourism’, ‘nature tourism’ or ‘ecotourism’. How the benefits from such enterprises can reach the local community, who for generations helped to protect nature and biota, and thereby promote sustainable livelihood is worth exploring. Till date, there is no system of sharing benefit of wildlife tourism or ecotourism, with the local Biodiversity Management Committee. An opportunity exists for negotiation between the Forest Department or other park authorities and the BMCs, but it has hardly been explored.

The other aspect of benefit sharing that remained largely neglected is the microbial bioprospecting. India, a megadiverse country, has enormous potential for the use of microbial resources from major ecosystems as well as from different agro-climatic zones. Such resources once commercially utilized by national/multinational companies can provide significant financial benefit to the BMCs from whose jurisdictional areas soil or water samples have been collected and microbes isolated. India had a ‘Drugs from the Ocean’ project before the onset of the CBD regime; even in recent time, Department of Bio-Technology (DBT) had launched a program on screening biomolecules from microbial organisms collected from different ecological niches with a private company (NRDL) as an industrial partner and DBT as the government partner for an investment of Rs. 25 crores (US $3,764,210.00).

4.8 Conclusions

The Biological Diversity Act 2002 and Rules 2004 paved the way for an effective ABS mechanism, but the process of implementation in India still remains slow. The BMCs are yet to show an effective and positive impact on the system of governance – largely due to the lack of resources, understanding and guidance. Much opportunity exists for sharing of benefits of enterprises as wildlife tourism or eco-tourism, with the local Biodiversity Management Committee. India, a megadiverse country, has an enormous potential for the use of microbial resources from major ecosystems as well as from different agro-climatic zones. Such resources once commercially utilized by the national/multinational companies can provide significant financial benefit to the BMCs and provide sustainable livelihood options to the providers of bio-resources.

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Chapter 5
Access and Benefit Sharing in India: Challenges Ahead

R.V. Varma

Abstract The essence of the Nagoya Protocol is to regulate the utilisation of genetic resources and associated TK for commercial and research purposes by requiring the users of these resources to share the benefits with the country/community as the case may be. In pursuance of the Nagoya Protocol, the government of India's National Biodiversity Authority (NBA) brought out ABS regulations in 2014. Awareness at various levels supported by sufficient legal experts is essential to achieve the objectives of ABS. The monetary gains achieved through ABS have to be distributed in a flawless manner, and the benefit sharing at the local level is to be ensured to achieve sustainable livelihood. The decentralised governance in Kerala is a model for other states in India, as it is built on a strong foundation with people's participation. This chapter deals with the provisions of the Biodiversity Act, 2002, and Rules, 2004, and salient features of the ABS regulations in India. Case studies on benefit sharing in India are brought out along with the key challenges in implementing ABS at national level, at state level and at local level through a decentralised system.

Keywords ABS • Case studies • Kani tribes • Decentralised system • ABS regulations

5.1 Introduction

In India, many policies and legislations have been made since 1865 to protect the environment. In the post-independence era, the two important acts enacted are the Wildlife Protection Act, 1972, and the Forest Conservation Act, 1980. However, these two acts do not deal with issues of protection of Traditional Knowledge (TK), Access and Benefit Sharing (ABS) and equitable sharing of benefits. One of the main agenda of the Convention on Biological Diversity (CBD), 1992, was the fair

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and equitable sharing of benefits, arising out of the utilisation of genetic resources. Thus the Biodiversity Act (BD) in 2002 was enacted and subsequently the BD Rules in 2004. The three tenets of the BD Act are as follows:

– Conservation of biological diversity
– Sustainable use of biological resources
– Equitable sharing of benefits arising out of the utilisation of the genetic resources

The CBD has clearly set out principles and obligations of parties, under Article 15, on the access to genetic resources and fair and equitable sharing of benefits, when utilised on the basis of prior informed consent (PIC) and mutually agreed terms (MAT) and conditions. A few countries have started working on the implementation of ABS, and India too is a forerunner in the effective implementation of the ABS principle in accordance with the Nagoya Protocol, 2010.

5.2 Importance of the Nagoya Protocol

The Nagoya Protocol on ABS was adopted on 29 October 2010, by the Conference of the Parties at the tenth meeting in Nagoya, Japan. The essence of the Nagoya Protocol is to regulate the utilisation of the genetic resources and associated TK for commercial and research purposes by requiring the users of these resources to share the benefits with the country/community as the case may be. This protocol provides a strong basis for legal certainty and also transparency to both custodians and users of the genetic resources. It is also significant to note that there is also provision to support the TK holders, whose knowledge, if utilised for commercial purposes, will be suitably rewarded. In pursuance of the Nagoya Protocol, the government of India's National Biodiversity Authority (NBA) brought out the ABS regulations in 2014.

5.3 ABS, as per the BD Act, 2002

The BD Act stipulates that a foreigner cannot access the bioresources and associated TK or claim any intellectual property rights (IPR) based on Indian bioresources, without the prior approval of NBA. However, Indian institutions/individuals of Indian origin can access bioresources for the above purposes by getting an approval from the concerned State Biodiversity Boards (SBBs) from where the bioresources are accessed. Though in the act it says 'with prior intimation to SBB', for all practical purposes, an approval from the SBB is needed. This and many other similar ambiguities will get clarified in the course of time by legal experts, when we actually get into the business of ABS. It is certain that when ABS is implemented at state level, many issues will be referred to the court of law and further clarifications on specific issues will emerge. Same will be the case with matters related to IPR and

TK. There is also a feeling among the traders and multinational companies that the BD Act is mainly used as a weapon to block trade and commerce. This contention is not true, and what the NBA and most of the SBBs are trying is to play the role of a facilitator, within the purview of the act and rules, and see that the bioresources are utilised in a sustainable manner.

5.3.1 *Expert Committee on ABS*

Expert committees are constituted by the NBA to get advice on technical, techno-legal, administrative and scientific matters. The expert committee on ABS is constituted to examine the ABS applications as per the ABS regulations of 2014 and also based on the provisions of the BD Act, 2002, and Rules, 2004. Most of the applications are for access of bioresources by foreigners and for IPR (Form 3) which has to be filed by all, irrespective of foreign or Indian origin. The committee examines all applications, case by case, and decides on monetary and/or nonmonetary benefit-sharing options, including upfront payment. Closure or rejection of applications is also being done, depending on the merit of the case. On doubtful cases, the concerned party is also invited for presenting their case and heard by the EC, before taking a final decision. Most of the applications filed by foreign companies/researchers are for access of medicinal plants or microbes, which are utilised in drug development and fashion products. In many cases, the use of TK would also be involved. The committee scrutinises each one on the merit of it with due diligence to the existing regulations and rules. The task is much like a collective wisdom, and the 2014 ABS regulations have helped a lot in arriving at the benefit-sharing part.

Since 2007, NBA has initiated action to bring out the guidelines for ABS. The meetings/discussions continued at different levels and also in the expert group meetings, and the final set of regulations were published in the *Gazette of the Government of India* in November 2014.

5.3.2 *Salient Features of ABS Regulations, 2014*

As per BD Act, 2002, and Rules, 2004, four forms are available for obtaining approval from the NBA for various purposes. These applications are to be submitted to the NBA or SBB, as the case may be, depending on the status of the applicant, foreigner or Indian. Form 1 is for access to bioresources for commercial utilisation, biosurvey and bioutilisation. Form 2 is for transfer of research results relating to bioresources to non-Indians. Form 3 is applicable to both foreigners and Indians for obtaining IPR rights, and Form 4 is for the transfer of biological materials for non-commercial research or for research for emergency purposes outside India by Indian researchers/government institutions.

In the case of Form 1, the benefit-sharing obligation on the part of the trader shall be in the range of 1–3% of the purchase price of the biological resource. For the manufacturer, it shall be in the range of 3–5% of the purchase price of the biological resources. When it is accessed for commercial utilisation, the applicant shall have the option to pay the benefit sharing, ranging from 0.1 to 0.2 to 0.5 % on annual ex-factory gross sale of the product, depending on if the sales are up to Rs.1 crore[1] (US $150,568.40), between Rs.1 and 3 crores (US $150,568.40–US $ 451,705.20) and above Rs.3 crores (US $451,705.20), respectively. In the case of IPR, when the applicant himself commercialises a product, the benefit sharing shall be in the range of 0.2–0.1 %, which shall be worked out on the annual gross ex-factory sale minus government taxes. As per Clause 15(1) of the ABS regulation, when approval has been granted by the NBA for research or for commercial utilisation or for IPR, the mode of benefit sharing shall be as follows: (a) 5 % of the accrued benefits to the NBA, out of which half of the amount shall be retained by NBA and the other half to the concerned SBB for administrative charges, and (b) 95 % of the accrued benefits shall go to the concerned Biodiversity Management Committee (BMC) and/or benefit claimers.

5.3.3 Benefit-Sharing Options

Benefit-sharing provisions under the ABS regulations of 2014 include both monetary and nonmonetary modes. Under monetary, the important provisions are upfront payment, one-time payment, milestone payments, share of licence fee, contribution to national/state/local biodiversity funds, funding R&D activities in India, etc. Guidelines have also been brought out by the ABS expert committee on upfront payment, considering the extensiveness of the quantity and nature of bioresources proposed to be accessed. This is arrived at by considering various parameters such as quantity, frequency of collection, rarity, purpose of research, etc.

Under nonmonetary, the major provisions are providing institutional capacity building, training, infrastructure, transfer of technologies, education and training on conservation and sustainable use of biological resources and taxonomic research.

5.3.4 Importance of BMCs

While scrutinising the applications on ABS, very often the column wherein the comments from BMC have to be obtained is either put as blank or not applicable, because of lack of a functional BMC. Further, when the required information from the concerned SBB is not obtained within the stipulated period of 30 days, the NBA

[1] 10 Lakh = 100,000,0 = 1 million
1 Crore = 100 Lakh
1 US $ = Rs.66.61/-

takes it for granted that there is no objection and processes the application. The biggest drawback of the system is the procedural delays in processing the application, and in many cases, the application is processed without getting the consent of the BMC, the local custodians of the bioresources. Taking years to process the applications will definitely defeat the purpose for which the act, rules and regulations have been formulated.

Although SBBs have been established in all the 29 states, how many of them are well equipped or empowered to implement the various tasks envisaged under the BD Act is something to be evaluated by an expert committee. This can be easily understood by the fact that India has a total of over 638,000 villages, out of which BMCs have been constituted only in about 32,000. It is relevant to note that Kerala is the only state in the country to have achieved the target of constituting BMCs in all the local self-governments (LSGs) by 2012 itself. Even if the BMCs have been constituted, unless these local institutions are suitably empowered, ABS and other activities as envisaged in the act and rules will not be achieved. In Kerala, the BMCs are empowered to address and resolve local environmental issues. But how far such efforts have empowered these local bodies is to be assessed. Even in states where a few BMCs have been established, these are not functional or not being consulted on matters related to access and benefit-sharing issues. Section 41 of the BD Act signifies the importance of BMC in the three-tier system, and BMCs have a pivotal role in the ABS system, which is very weak now.

It is held that the royalty, in terms of monetary gains obtained by NBA on ABS, shall be made available to the BMCs or benefit claimers at the local level for conservation and livelihood improvement. As long as BMCs are not established in all the villages and also the provision of local biodiversity funds is not put to practice, the process will not work effectively.

5.3.5 Status of ABS Applications at the NBA

The recent statistics as of August 2015 on the number of applications received on all the four categories together (under Forms 1, 2, 3 and 4) is 1050, out of which more than half the applications were for IPR rights. In total, over 900 applications have been processed by the NBA and 190 agreements have been signed for. There is a time lag in processing the applications due to various reasons, and the administrative and decision-making process has to be simplified and decisions taken at a faster pace and communicated.

The total royalty collected by NBA would be about Rs.17 crores (US $2,559,662.80) as of now, out of which Rs.15 crores (US $2,258,526.00) is obtained through the recent auction on red sanders. Part of this money will be ploughed back to SBBs/BMCs as the case may be, and the mode of distribution of the same is yet to be worked out.

When we look at the various kinds of applications, it becomes clear that even the 2014 regulations will have to be modified at some point of time, based on practical situations. No system is perfect, and as time passes, newer challenges will emerge and the process of ABS would evolve to perfection.

5.4 Benefit Sharing: Case Studies

In India, the first example of sharing of benefits with a tribal community for sharing traditional knowledge (TK) was developed during 1987–1999, much before the BD Act came into existence. This happened during an ethnobotanic study by the Tropical Botanic Gardens and Research Institute (TBGRI) (now renamed as Jawaharlal Nehru Tropical Botanic Garden and Research Institute) in the southern part of the Western Ghats in Kerala, where they met with the Kani tribe and came to know about the medicinal properties of the plant Arogya pacha (*Trichopus zeylanicus*). The Kani tribe used this plant for its antifatigue properties and the knowledge was shared. The drug called *Jeevani* was developed by TBGRI, and later the technology was transferred to a pharmaceutical firm for its commercial production. The licence fee was shared between TBGRI and the Kani tribe. In addition, 2 % of royalties from the sales would also go to the tribal community. This model is a pre-CBD case study and cannot be compared with the post-CBD examples of ABS. The Kani tribe also formed a community trust initially, but it did not sustain in the long run due to various reasons.

After the BD Act came into force, there are a few examples which are worth mentioning:

The seaweed (*Kappaphycus alvarezii*/*Eucheuma cottonii*) is grown by the fishermen community in the coastal districts of Ramanathapuram, Tuticorin, Pudukkottai and Tanjore in Tamil Nadu and exported to the tune of 2000 mt to countries like Malaysia, the Philippines and Indonesia by M/S PepsiCo India Holdings Pvt. Ltd. A royalty of Rs.39.09 lakh (US $58,721.68) was paid to the NBA by the exporter. The Tamil Nadu Biodiversity Board is planning to distribute its share from the NBA under benefit sharing to about 754 families in the coastal districts.

From Andhra Pradesh, neem leaves (*Azadirachta indica*) are being collected by the villagers in the Amar Chitra Village BMC, and over 2000 kg are exported to Japan by Bio-India Biologicals Corporation. In this case also, the NBA was paid a royalty of Rs. 55,035 (US$ 828.65), and part of the money was transferred to Amar Chitra Village BMC for planting new saplings of neem and also for awareness creation.

Very recently, the red sandalwood auction had taken place in Andhra Pradesh. Red sanders or red sandalwood has high economic value and huge demand in countries like China, Japan and East Asia on account of its multifarious uses. Each tonne of red sanders fetches about Rs.25 lakh (US $37,642.10) in the international market. During the first phase of global auction of seized red sanders, the Andhra Pradesh government received nearly Rs.860 crores (US $129,488,824.00) during December 2014, and during the recent auction in 2015, the income was over Rs.1000 crores

(US $150,568,400.00). From the red sanders auction, a royalty of Rs.15 crores (US $2,258,526.00) was given to the NBA by the successful bidder. This is a classical example and similar instances in the future would generate enough monetary gains which have to be distributed appropriately and the benefit should reach the deserving. A similar approach can be taken while auctioning the sandalwood in states like Karnataka and Kerala.

It is reiterated that unless BMCs are constituted in all the villages in India, the sharing of benefits will not reach the people at the local level.

One more example to be mentioned, though yet to take off, is from the Ayurvedic Drug Manufacturers Association (ADMA) in India, which has volunteered to contribute to ABS fund. ADMA wanted this money to be utilised for conservation of medicinal plants. This offer from the ADMA can also emulate other sectors engaged in commercial ventures using bioresources to contribute towards the cause of conservation. It is difficult to resolve many issues through legal procedures, but this can be resolved through discussions and mutual understanding between the industries and NBA or SBB, as the case may be.

5.5 ABS System at State Level

All the State Biodiversity Boards can chalk out their own ABS policies, and a few states in India have already started the process of implementing the same at the state level. Kerala state is a forerunner, and the ABS policies and guidelines have already been prepared and will be implemented soon. Since Kerala state has BMCs in all the LSGs, the implementation of ABS would be more effective and meaningful. The State Biodiversity Board has already made the State Biodiversity Fund rules, and on similar terms, the local biodiversity funds at BMC level will also have to be made. Only when some of these basic formalities have been completed as per the act will the money accrued through ABS mechanism be channelled at a state/local level for various purposes. As far as the state of Kerala is concerned, the two major sectors like the Ayurvedic manufacturers and marine food exporters have to willingly contribute towards this effort for flourishing their business on a continuous basis and sustainable manner. In Madhya Pradesh, litigation in the High Court is pending against the ABS proposed by the MP Biodiversity Board on soybean extracting industries. This is questioned in the court on the grounds that soybean is a traditional crop and listed under the normally traded commodities (NTCs) for which there is an exemption as per Section 40 of the BD Act. Many technical/legal loopholes can be brought out by various industries to evade payment under the ABS. But if they understand the spirit and philosophy of ABS, a change in the mindset will happen and more and more players would contribute towards ABS at state level. The concerned authorities may also look at the possibilities of bringing the industries under ABS through a process of negotiations and try to avoid embarking on a legal battle.

It is pertinent to mention that both the NBA and SBBs are looking at the plant resources or plant-based industries, and there is an urgent need to look at critically as to what is happening in the animal and fish sectors in terms of ABS.

Another point worth considering is that when many SBBs are coming up with ABS policies and guidelines, there is a need to have uniformity in the approach, and if each state takes its own stand, the industries may not cooperate and implementation would be difficult. The NBA shall take a lead in bringing all the SBBs together and make a uniform approach in the implementation of the ABS regulations. A little bit of flexibility is possible, but it shall be within the purview of the existing act and rules.

There are instances wherein the industry is situated in a particular state and the industry would claim that the bioresources are procured from other states (localities are also often not mentioned), and there would be difficulty in arriving at the ABS. Till the whole process of ABS system is evolved to perfection in the SBBs, the NBA shall take corrective measures wherever needed. At a later stage, even regional groups, e.g. the southern region comprising the states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, can meet once in 3 months or so and collectively thrash out issues as mentioned above.

5.6 Capacity Building and Awareness

ABS requires capacity building and awareness at various levels. There are many stakeholders, and only a small percentage of them are aware of the various intricacies of the ABS system. Initially, the negative feeling of many sectors towards the ABS has to be changed, and the message to be popularised is that sustainable utilisation of bioresources is necessary for the industry. Scientists, legal professionals, university teachers and students, LSG representatives, media people, etc., must be made aware of the various clauses under the BD Act and ABS regulations. Several years back, the Department of Biotechnology (DBT), government of India, had a programme on creating awareness on IPR and related issues through the National Law University/other reputed universities for scientists which was quite effective. Similar programmes have to be chalked out at a national level by NBA and at a state level by the concerned SBBs which will ease out the difficulties in implementation of ABS in the country.

Local self-governments, especially the panchayat presidents/secretaries, have a major role to play in the implementation of ABS. It may be mentioned that the decentralised governance in Kerala is a model for other states in India, because it is built on a strong foundation with people's participation. The Kerala Institute of Local Administration (KILA) is a reputed institute in Asia to impart training/awareness for LSG representatives at different levels. This institute is a venue for imparting training to LSGs on the BD Act with technical support from Kerala State Biodiversity Board (KSBB). It is worthwhile considering imparting training on

ABS to the representatives of LSGs from all the southern states of India in this institute.

Another major sector is the judiciary whose competence and awareness have to be enhanced. We need a large number of expert lawyers to understand and interpret complicated issues connected with environmental issues/IPR and patent issues and on ABS. We have almost 20 litigations pending with the Green Tribunal connected with the BD Act. As we go along, newer challenges will emerge which will require careful legal examination for which the services of experts are essential.

5.7 Other Challenges

- Based on the applications that are being processed at NBA, many new issues are likely to crop up which will require redefining/modifying or amending some of the clauses in the BD Act and ABS regulations.
- As of now, importance is given for plant bioresources for ABS, and a similar focus is needed for animal/fish resources also.
- The number of legal experts in the country is meagre, and this has to be strengthened to resolve several upcoming issues.
- Development of new knowledge/products/commercialisation based on TK and traditional cultural expressions (TCE) is to be promoted at the same time with stringent measures to prevent misappropriation of traditional rights.
- Promote interaction of modern science and technology with TK and TCE in a mutually beneficial manner to the holders and users.
- Smuggling of bioresources, both plants and animals, is still prevalent in spite of the act and rules. Seaport/airport authorities are to be alerted and provided with technical support to overcome such events.
- The herbal drug sector is likely to gain much more momentum in the coming years with maximum export potential, and one fallout of the commercialisation of herbal products would be the challenge to conserve them.

5.8 Conclusions

Compared to many countries, the current scenario on ABS in India is somewhat satisfactory. However, there are areas for improvement and the system would evolve to perfection in course of time. Both the NBA and SBB have to play the role of a facilitator, and at the same time, the act and rules and the ABS regulations have to be implemented strictly. Processing of the applications can be speeded up and the procedural hurdles reduced to the minimum. Like the plant bioresources, both animal and fish resources have to come under the ABS system. It is a sad reality that the benefit sharing is yet to reach the communities at the village level. Unless this is achieved, the people will not realise the importance and get involved in the conservation of genetic resources. Awareness at various levels supported by sufficient legal experts is essential to achieve the objectives of ABS. The monetary gains achieved through ABS have to be distributed in a flawless manner, and the benefit sharing at the local level is to be ensured. There should be a monitoring mechanism to oversee the effectiveness of the distribution process and corrective measures taken wherever needed. There is also a need to develop innovative models of ABS, which can be replicated. Some of the existing lacunae in the ABS regulations will have to be thrashed out in course of time.

Chapter 6
Ethnopharmacology, Traditional Knowledge and Intellectual Property Rights

P. Pushpangadan, V. George, T.P. Ijinu, and S. Rajasekharan

Abstract Over the last three decades, a great awakening on the link between sustainable livelihood and ecological health has emerged. Access and Benefit Sharing (ABS) was conceived as a tool for equity and as an opportunity for sustainable development. In India, the authors have developed the first model of benefit sharing that implemented in letter and spirit Article 8 (j) and Article 15.7 of the Convention on Biological Diversity (CBD). The authors, while at the Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), demonstrated that indigenous knowledge systems merit support, recognition and fair and adequate compensation. The prerequisite for developing an effective ABS regime is building up a comprehensive information system on all pertinent aspects of availability, diversity, distribution, economic uses and potentials, conservation status of biogenetic resources and associated traditional knowledge. The major challenge is to develop appropriate national policies and legal framework to provide a conducive and enabling environment to undertake bioprospecting and biotechnological innovations, giving adequate attention to the administrative as well as the legal aspects of IPR protection, benefit-sharing procedures and conservation and sustainable use of biodiversity and the associated traditional knowledge. The chapter details the development of ethnobiology in India, bioprospecting and national legislations for the protection of traditional knowledge and sustainable utilization of bioresources.

Keywords Ethnobiology • Sustainable use • IPR • Bioprospecting • *Sui generis system* • Ayurveda

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6.1 Introduction

Traditional knowledge (TK) and ethnobiology are community-based knowledge systems that have been developed, preserved and maintained over many generations by the local and indigenous communities through their continuous interactions with plants and animals. Ethnobiology is the information on plants and animals and their relationship with human society. It is associated with traditional communities, and therefore, it is unique to a given culture or society and is developed as a result of the coevolution and coexistence of both the indigenous culture and their traditional practices of resource use and ecosystem management. TK is a general term, which refers to the collective knowledge, beliefs and practices of indigenous/local people on the sustainable use and management of their ambient resources. Through years of observations and analysis, trial and error or experimentations, the traditional communities have been able to identify useful as well as harmful elements of their ambient flora and fauna. Such knowledge (acquired through ages) has always remained as part of their life, culture, traditions, beliefs, folklores, arts, music, dance, etc. TK covers a broad spectrum of the local and indigenous people's traditional life and culture, art, music, architecture, agriculture, medicine, engineering and a host of other spheres of human activity. TK thus can be of direct or indirect benefit to the society as it is often developed, in part, as an intellectual response, to the necessities of the day-to-day challenges of the indigenous societies. Protection and maintenance of TK of local and indigenous communities are vital for their well-being and sustainable development and for their intellectual and cultural vitality.

6.2 Genesis of the Subject Ethnopharmacology

Ethnopharmacology as a scientific term was first introduced at an international symposium held at San Francisco in 1967 (Efron et al. 1967) while discussing the theme 'Traditional Psychoactive Drugs'. But later Rivier and Bruhn (1979) made an attempt to define ethnopharmacology as a 'multidisciplinary area of research concerned' with observation, description and experimental investigation of indigenous drugs and their biological activities. It was later redefined by Bruhn and Helmstead (1981) as 'the interdisciplinary scientific exploration of biologically active agents traditionally employed or observed by man'. In its entirety, pharmacology embraces the knowledge of the history; source; chemical and physical properties; compounding; biochemical and physiological effects; mechanism of action, absorption, distribution, biotransformation and excretion; and therapeutic and other uses of drugs. A drug is broadly defined as any substance (chemical agent) that affects life processes. Therefore, briefly, the main component of ethnopharmacology may be defined as pharmacology of drugs used in ethnomedicine. However, none of the above-said definitions captures the true spirit of this interdisciplinary subject. Ethno- (Gr., culture or people) pharmacology (Gr., drug) is about the intersection of medical ethnography and the biology of therapeutic action, i.e. a transdisciplinary exploration that spans the biological and social sciences. This suggests that ethnopharmacologists are professionally cross-trained – for example, in pharmacology and anthropology – or that ethnopharmacological research is the product of collaborations among individuals whose formal training includes two or more traditional disciplines. In fact, very little of what is published as ethnopharmacology meets these criteria.

Hansen et al. (1995) suggested that the objectives of ethnopharmacology should focus on:

1. The basic research aiming at giving rational explanation as to how traditional medicine works
2. The applied research aiming at developing traditional medicine into modern medicine (pharmacotherapy) or to develop its original usage by modern methods (phytotherapy)

The scientific evaluation and standardization of traditional remedies using exclusively the parameters of the modern medicine are both conceptually wrong and unethical. The evaluation of traditional remedies particularly those of the classical traditions has to be based on the theoretical and conceptual foundation of these classical systems of medicine but may utilize the advancements made in modern scientific knowledge, tools and technology. In fact, it is important to combine the best of the elements of concept and practice from traditional medicines and modern medicines with the objective to improve the healthcare system of humankind. Such an integrated approach to study and develop the holistic healthcare system is termed as the ethnopharmacological approach. The concept of ethnopharmacology research in India evolved in the 1980s independent of this international initiative.

Ethnopharmacology research in India was initiated at the Regional Research Laboratory (RRL), Jammu, in 1985, and it was observed that subjecting the traditional herbal remedies including the remedies of the classical systems like Ayurveda, Siddha and Unani to the parameters of modern medicine is not only foolish but suicidal. Both these systems are conceptually quite different. The concept of disease, its etiology, manifestation and approach to treatment, etc., are all viewed on a holistic basis contrary to the reductionistic approach of modern medicine. Only an integrated approach that combines the best of theory, concepts and methods of the classical systems of medicine such as Ayurveda, Siddha and Unani with the modern scientific knowledge (phytochemistry and pharmacology) can bring in the desired results.

The concept and methods of ethnopharmacology research thus developed by the authors involved experts from diverse disciplines, like Ayurveda and Siddha, and scholars of Sanskrit and Tamil languages (who can correctly interpret the classical texts of Ayurveda and also its theoretical basis like 'Sankhya' and 'Vaiseshika' philosophy), ethnobotany/ethnomedicine, chemistry, pharmacognosy, pharmacology, biochemistry, molecular biology, pharmacy, etc. The main objective of this approach was to develop appropriate techniques to evaluate the traditional remedies in line with the classical concepts of Ayurvedic pharmacy and pharmacology such as the 'rasa', 'guna', 'veerya', 'vipaka' and 'prabhava', in other words 'Samagra Guna' of the 'Draya Guna' concept of Ayurveda.

However, the first fully fledged ethnopharmacology division was started in 1992 at JNTBGRI, and the team could successfully demonstrate the integrated approach and could develop novel scientifically verified standardized herbal drugs. Some herbal drugs developed at JNTBGRI after filing patents were released for commercial production. Ethnopharmacological impulse to modern medicine can lead to many novel useful drugs. Traditional medicine in general is a powerful source of biologically active compounds. Ethnopharmacology has become a scientific backbone in the development of active therapeutics based upon the traditional medicine of various ethnic groups. The ultimate aim of ethnopharmacology is the validation of these traditional preparations, either through pharmacological findings or through the isolation of active substances. Harmful practices can be discouraged such as the use of plants containing tumour-producing pyrrolizidine alkaloids. The selection of plants for serious study depends basically on two approaches. One approach is the random screening of plants for their medicinal value. Another approach is the ethnopharmacological survey of plants of a particular region or cultural group based on their use in the traditional system by choosing a specific therapeutic target. The screening programme based on ethnoparmacological information has more success rate than the random screening (George and John 2008). The first and most important stage in a drug development programme using plants is the collection and analysis of information on the use(s) of the plant(s) by various indigenous cultures. Ethnobotany, ethnomedicine, folk medicine and traditional medicine can provide information that is useful as a prescreen to select plants for experimental pharmacological studies (Bigoniya 2008).

6.3 The Tribal Scenario in India

After independence, the national government inherited a tribal scenario evolved out of conflicting policies of the development. There was hardly any useful data to comprehend the 'felt needs' or the real needs of the varied tribal groups numbering well over 250, spreading over a large spectrum, ranging from the preliterate *Andamanese* and the *Abujhmadias* to the acculturated *Bhilalas* and the *Khasis*. They followed varied vocations, depending upon their level of cultural development, from hunting and food gathering to slash-and-burn cultivation, settled agriculture or even iron smelting. Rich in cultural heritages, they spoke various dialects and practised different customs and rituals during marriage, childbirth and death ceremonies. From animism to monotheism, they followed an array of religious beliefs, rituals and practices. Land tenure systems were different and so were the personal laws.

On the basis of historical, ethnic and sociocultural affinities, the tribal communities living in different regions can be divided as follows:

1. Northeast India comprising the states of Assam, Arunachal Pradesh, Nagaland, Manipur, Tripura, Mizoram, Meghalaya and Sikkim
2. Sub-Himalayan region of the North and Northwest India comprising the northern sub-mountainous districts of Uttar Pradesh and Himachal Pradesh
3. Central and Eastern India constituting West Bengal, Bihar, Orissa, Madhya Pradesh, Andhra Pradesh and the Andaman and Nicobar Islands
4. Southern India covering Tamil Nadu, Karnataka, Kerala, Pondicherry and Lakshadweep
5. Western India including Rajasthan, Maharashtra, Gujarat, Daman and Diu and Dadra and Nagar Haveli

6.4 All India Coordinated Research Project on Ethnobiology (AICRPE), Ministry of Environment and Forest, Government of India

The All India Coordinated Research Project on Ethnobiology (AICRPE) launched by the Union Ministry of Environment and Forests (MoEF) from 1980 to 1998, under the initiative of eminent scientists of the country like Dr. M.S. Swaminathan, Dr. T. N. Khoshoo and Dr. E. K. Janaki Ammal, was perhaps the first ever comprehensive study about the tribal population of India with a focus on their traditional knowledge. The study was conducted through 27 premier national institutes to gather and document the fast-disappearing traditional knowledge of tribal communities.

The traditional knowledge to be tapped with the appropriate benefit-sharing mechanism could mean wealth for the tribes in particular and the country in general. Forests have been the home of many of these tribes, and they have a deep-rooted association with the forest and nature around. Their relationship with the forests has always been harmonious with their whole life revolving around the forests and forest resources. They have acquired unique knowledge about the use of the wild flora and fauna through generations, most of which is either lesser known or hitherto unknown to the outside world; this treasure of traditional knowledge (TK) system, if subjected to scientific scrutiny, could benefit them, the country and the humankind in many ways. The inroads of modernization are presently posing a threat to the TK system, and this age-old wisdom is in the imminent danger of being lost (AICRPE 1992–1998).

6.4.1 Workshop on Ethnobiology and Tribal Welfare

A national workshop on ethnobiology and tribal welfare was organized on behalf of the Ministry of Environment and Forests, Government of India, in association with the International Institute of Ayurveda (IAA), Coimbatore, Tamil Nadu, by the AICRPE Coordination Unit. The aim of this workshop was to bring together the senior administrators, planners, scientists and voluntary agencies associated with tribal welfare programmes as well as the tribal representatives in order to interact and evolve ways and means by which the information generated from AICRPE could immediately be translated into action. The 3-day deliberation emerged in the context of the fact that the destruction of the material resource base due to deforestation has caused great hardship and economic loss to tribals. After the discussions on the various issues and problems of the tribals and also keeping in view the AICRPE project findings, specific recommendations were made for improving the socioeconomic status and quality of life of the tribal people, and the same was submitted to the Ministry of Environment and Forests, Government of India (Pushpangadan 1993).

Another national conference, as part of the AICRPE, to streamline the traditional knowledge towards a sui generis regime in the post-World Trade Organization (WTO) scenario named 'Dhishana 2008' was organized in association with the Ministry of Environment and Forests, Government of India, during 23–25 May 2008, at Thiruvananthapuram, Kerala. This was also supported by the other ministries and agencies of the Government of India. The major objective of the conference was to evolve appropriate sui generis mechanisms in the context of CBD, WTO and Trade-Related Aspects of Intellectual Property Rights (TRIPS) requirements. Scientists, legal luminaries, policymakers and activists together with the representatives of TK holders from tribal and nontribal backgrounds came together for the purpose. The conference came out with the Thiruvananthapuram Declaration on Traditional Knowledge (TDTK), a landmark document on TK and biodiversity, with focus on tribal communities of Kerala (Pushpangadan and Pradeep 2008).

6.4.2 Appropriate Policy Guidelines Derived in the National Seminar: Dhishana

Appropriate national policy guidelines on biodiversity and access and benefit sharing on biogenetic resources and traditional knowledge are in place in many like-minded countries. One of the priority actions for these countries would be to evolve effective mechanisms for developing as well as implementing relevant legal instruments that could facilitate regulated access and benefit-sharing regime with stringent provisions to prevent any illegal and inappropriate access and transfer of genetic resources and associated knowledge by any individual or corporate bodies with vested interests. The second important priority of these countries would be to concentrate their efforts in developing national and regional science and technology (S&T) capacity building and human resource development programmes for harnessing the wealth of biogenetic resources and traditional knowledge shared by these countries. Building up equitable bioprospecting partnership among the countries based on mutually agreed terms and transparent legal and policy support will be a promising area that will help multilateral exchange or transfer of biological resources, associated information and knowledge and relevant technologies, besides helping to build up human resources in the most advanced areas of biotechnology, herbal technology and information technology. Mutual trust and cooperation built through multilateral stakeholder consultations between the countries and other groups of developing countries or countries with economies in transition can go a long way in bringing a new era of bio-partnership. Since the like-minded countries have shared concerns and interests to protect their biodiversity and traditional knowledge systems, any collective efforts of the group will help them challenge the threats of increasing incidences of biopiracy and misappropriation of intellectual property rights (IPR) of their biodiversity and traditional knowledge systems by the powerful lobbies of biotechnologists. What is more important at the national level for all like-minded countries is to reaffirm their commitment in evolving a transparent and viable mechanism for regulated access and benefit sharing of genetic resources and associated traditional knowledge. The prerequisite for developing an effective ABS regime is building up a comprehensive information system on all pertinent aspects of availability, diversity, distribution, economic uses and potentials, conservation status of biogenetic resources and associated traditional knowledge. This should be integrated with the information on the existing S&T infrastructure and capabilities, including human resource wealth, national and international legal and policy frameworks, current achievements and future plans and priorities for capacity building for conservation, the sustainable use, bioprospecting and economic valuation of bioresources and traditional knowledge.

Fundamental issues of the Indian policy like the present modalities in signing the international protocols and treaties were addressed as also the basic problems of the tribal areas and conservation of biodiversity. Prof. M.S. Swaminathan in one of his addresses said that the path towards sustainable food security is ‘evergreen revolution’ which will help increase productivity in perpetuity without the associated ecological harm. He stressed the need for blending traditional knowledge with modern science. He added that it is only such a blend that would empower us in the area of meeting the challenges posed by climate change and transboundary pests, as well as the shrinking per capita water availability and the expanding biotic and abiotic stresses.

The majority of the tribal representatives were critical of the trade motive in tribal medicine and did not want to have direct deals with any company. ‘Our knowledge is divine and we honour it, selling it to foreign companies is ruled out’, said K. K. Suresh, a tribal healer and leader from the Kurichia community in Wayanad. Prathapi Guni, from the Guni tribal community in Udaipur, Rajasthan, told about an instance where the Gunis refused to share the knowledge of a formulation when asked by an Indian company for making a drug as they did not trust them. According to the tribal healers, there has to be a mechanism of the government that will be an intermediary between the tribes and the companies if at all some drugs are produced. They are willing to share the knowledge with a government agency but not with a private company.

The conference was attended by more than 350 delegates and invitees from the different parts of the country including the representatives from tribal communities of Arunachal Pradesh to Kerala. The 3-day national conference came to an end with very meaningful deliberations, and there was an immense cross flow of information. Broadly, the following major conclusions were arrived at:

1. The TK, mainly the tribal knowledge, is undergoing erosion and needs to be protected.
2. There is a hesitation among the tribal people about allowing access to their knowledge to private companies for trade; trade is not their objective.
3. They expect the government to build a mechanism with their representation, and this should deal with all matters of TK.
4. The need for a case-specific legal system, what is called sui generis, but not aimed at catering to international pressure, is needed for safeguarding and promoting the knowledge and getting returns from the same.
5. There has to be revalidation of TK, wherever these are made use of outside the locale, say when healing techniques of one tribal group are used by others.

The Indian TK, including Ayurveda, is self-contained and they have their own scientific explanation; these need not be explained by modern science and its methodology.

6.5 Protection of Traditional Knowledge

Over the last three decades, a great awakening on the link between sustainable livelihood and ecological health has emerged. This understanding has led to various international, regional and local dialogues, development of laws and regulations in conservation and sustainable use of trade and commerce of bioresources. Side by side, research and development in science and technology led to enhanced value addition in primary biological products thereby creating wealth from the bioresources. The developmental strategy of the world in general is now focused on achieving a new world order marketed by equity and human welfare. The whole gamut of sustainable development of biodiversity is expressed in terms of conservation and sustainable utilization. The UN regulations like the Convention on Biological Diversity (CBD) have provided a basic framework for countries to evolve appropriate regulatory mechanism for achieving the above goals. Immediately after the adoption of CBD in December 1993, in June 1994 another international agenda of the World Trade Organization (WTO) emerged to control the economic order of the world. Throughout history, biodiversity has been the common asset of the local communities, with both resources and knowledge being freely exchanged, and the concept of sovereign rights or property rights of genetic resource was alien to the traditional communities of the third world countries. CBD has honoured these traditional practices and offered protection under Article 3, Article 8(j), Article 10(c), Article 15.7, etc. The Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement of WTO brought in 1995, however, had a different agenda. CBD is founded on the principle that the local communities are dependent on biodiversity and should continue to benefit from it. The WTO administers a global trading system, much of which is founded on the private monopoly rights of traditional corporations over biodiversity.

CBD, on the other hand, is based on the principles of equity and ethics and, therefore, has far more flexible provisions concerning protection of the rights of traditional communities over their intellectual property and traditional resources. Article 8(j) and Article 15.7 of CBD explicitly express the need for recognition and rewards for indigenous people's contributions to conservation and sustainable use of biodiversity. It reads as: 'Respect, preserve and maintain knowledge, innovations, and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of benefits arising from the utilization of such knowledge, innovations and practices'. The other important provisions of CBD that call for support and recognition of indigenous and traditional technologies are contained in Articles 10(c), 11, 12, 13 and 16. However, Article 16 is the one that is unequivocal about the protection of IPR of the traditional communities. More detailed discussions and critical analysis on CBD and TRIPS, particularly on those provisions relating to informal innovations of IPR protection for traditional communities, are available in Gadgil and Devasia (1995), Dutfield (2005), Gupta (2001) and Mashelkar (2001).

The Biodiversity Act is an important national legislation that provides provision for the protection of the traditional knowledge of the local and indigenous communities. The current IPR regime does not allow any of such provisions for recognition and reward for IPR based on knowledge of traditional communities. India's Biodiversity Act is in line with the CBD which essentially aims at conservation of biological diversity, sustainable use of its components and a fair and equitable sharing of the benefits arising out of the utilization of genetic resources and associated knowledge. TRIPS stipulates that 'the protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology to the mutual advantage of producers and users of the technological knowledge in a manner conducive to social and economic welfare and to a balance of rights and obligations' (Article 7, TRIPS).

Article 27 (3b) of the TRIPS requires the members to provide for the protection of plant varieties either by patents or by an effective sui generis system or by any combination thereof. These are the two rather contentious provisions in TRIPS which the developing country members like India need to address carefully. The main pitfalls in the TRIPS provisions are the failure to recognize the informal innovations emanating from traditional societies and imposing developing countries to develop sui generis system for plant variety protection based on the 1991 International union for the Protection of New Varieties of Plants (UPOV) model (Shiva 1994). The UPOV model is designed to provide protection for the rights of plant breeders and other formal types of innovations. It excludes the rights of farmers who produce, select, improve and breed a plethora of diverse plant varieties (Shiva 1994). However, the commitment to TRIPS makes it obligatory for the members, especially the developing countries, to bring their national legislations pertaining to the protection of patents and other intellectual property rights in harmony with the provisions of TRIPS, besides developing appropriate sui generis models for the protection of plant varieties.

6.5.1 Intellectual Property Rights, Patenting and Sui Generis System

The CBD acknowledges the IPR of the collective wisdom and common resources of the communities as a sovereign property, whereas TRIPS recognizes IPR as the monopolistic rights of individual or corporate innovators. This disparity provides the developing countries like India with enormous challenges and opportunities. Several countries are now working towards amending their existing laws or enacting few national legislations including sui generis model to make them compatible with the CBD and TRIPS provisions. The Government of India is quite sensitive to the fast changes that are taking place and has displayed strong commitment for the conservation and sustainable utilization of the bioresources and traditional knowledge systems of our country. The conservation of the country's rich biodiversity to ensure the livelihood security and improvement in the quality of life of the traditional communities is given a predominant position in the policies and programmes now being evolved by the various acts executed by the government. The major challenge is to develop appropriate national policies and a legal framework to provide a conducive and enabling environment to undertake bioprospecting and biotechnological innovations, giving adequate attention to the administrative as well as the legal aspects of IPR protection, benefit-sharing procedures and conservation and the sustainable use of biodiversity and the associated traditional knowledge. The Government of India has already enacted three major national legislations, viz. (i) Patent Second and Third Amendment Acts, (ii) Bio Diversity Act and Biodiversity Rules and (iii) Plant Variety Protection and Farmers' Rights Act (PVPFR Act) and PVPFR rules. These legislations contain adequate provisions that would help safeguard the sovereign rights of the country over its biological resources, protect the indigenous knowledge systems associated with biological diversity and recognize the farmers' rights to save, use, exchange, share or sell the plant varieties which they have developed, improved and maintained over many generations. The PVPFR Act also has a similar clause for opposition for revocation of a plant variety, if there is a valid claim attributable to the contribution of the people of a village or local community in the evolution of that registered variety.

The Biodiversity Act, 2002, and the Biodiversity Rule, 2004, and the Plant Varieties Protection and Farmers Right Act, 2001, are examples of the same. The Bio Diversity Act has an enabling provision in Section 36.5 empowering the central government for protecting the knowledge of local people relating to biodiversity, inter alia through the registration of such knowledge at the community/panchayat level and developing a sui generis system of IPR protection. The Plant Variety Protection and Farmers Right Act, 2001, and Rules, 2003, deal primarily with the protection of plant breeders rights over the new variety developed by them and allow entitlement of farmers to register new varieties and also to save, breed, use, exchange, share or sell the plant varieties which the latter have developed, improved and maintained over many generations. There are important provisions in this Act that stipulate the need of the breeder or any applicant for registration of a new plant variety to disclose any information regarding the use of genetic material conserved by any tribal or rural farmers in the breeding for the development of the new variety. The Act also ensures compensation to the contributions of any village or local communities to the development of a variety registered under this Act. Such compensations will be deposited to the National Gene Fund. The Patent Second Amendment Act 2002 and Third Amendment Act 2005 also make it mandatory to disclose the source and geographical origin of the biological material in the specification when used in an invention (Sec 8D). It also stipulates that nondisclosure or wrongful disclosure of the source of biological material and any associated knowledge will result in opposition to the grant of patent or revocation of patent (Sec 18(j); Sec 25(1), (j) and (k); Sec 25 (2) (j) and (k)).

The Biodiversity Act in 2002 and Rules in 2004 are based broadly on the objectives of CBD with special focus on the aspects of equitable sharing of benefits arising out of the sustainable use of biodiversity and traditional knowledge. The salient features of the Act are to:

(i) Regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resources and associated knowledge relating to biological resources
(ii) Conserve and sustainably use biological diversity
(iii) Respect and protect the knowledge of local and indigenous communities related to biodiversity
(iv) Secure sharing of benefits with local people as conservers of biological resources
(v) Conserve and develop areas important from the standpoint of biological diversity as biological diversity heritage sites
(vi) Protect and rehabilitate threatened species
(vii) Involve institutions of self-government in the broad scheme of the implementation of the Act through constitution of committees

The Act in general is more of regulatory in nature but contains the following important clauses pertaining to the protection of IPRs of traditional communities and benefit sharing:

(a) People's knowledge shall be protected through registration of local, state and national level by a sui generis system of IPRs (Clause 36(4) and 41).
(b) Any person applying for IPR in India and abroad relating to biological resources occurring in and accessed from India shall obtain prior permission of national authority and abide by the benefit-sharing conditions imposed by the authority (Clause 6).
(c) The national authority shall oppose the grant of IPRs worldwide relating to biological resources or knowledge derived from India (Clause 18(4)).
(d) No foreign agency can access biological resources occurring in India and related knowledge without prior informed consent of the national authority (Clause 3).
(e) The National Biodiversity Authority (NBA) in consultation with local bodies shall impose terms and conditions for securing equitable sharing of benefits. Monetary benefits shall be deposited to the National Biodiversity Fund, except in cases where the biological resources and knowledge are accessed from a specific individual or group of individuals; in which case the monetary benefits shall be directly made to the providers (Clause 21). The national fund would be used to reward people for their conservation efforts and knowledge as claimed by the village-level management council (Clause 41).

The Bio Diversity Act is to be viewed as an important national legislation as it provides provisions for the protection of the traditional knowledge of local and indigenous people and secures the IPRs arising out of the use of such traditional knowledge and traditional biogenetic resources. The current IPR regime does not allow any such provision for the recognition of the role of traditional communities in IPR.

With the changing global scenario on conservation of biodiversity leading to the UN Convention on Biological Diversity (CBD) at Rio de Janeiro in 1992 and its adoption in December, 1993, the trade sector also underwent changes. The General Agreement of Trade and Tariff (GATT) Uruguay Round particularly through the Trade-Related Intellectual Property Rights (TRIPS), World Trade Organizations (WTOs) and TRIPS agreement obliges all members to provide intellectual property protection for plant varieties at the national level, either through patents or 'an effective sui generis system' or both. Many developing countries including India have signed both in the CBD and WTO. India has now initiated legal procedures and evolved other management strategies during the past one decade.

6.6 Bioprospecting of Traditional Knowledge

Biodiversity represents (1) a priceless resource with many actual uses and potential values to humanity and (2) a complex self-sustaining ecological system that helps maintain the integrity and resilience of the biosphere. These two complementary perceptions would lead to the surmise that biodiversity is an invaluable natural resource, which needs to be conserved and sustainably utilized for the benefit of the present as well as the future generations of humankind. Humankind has tapped only a fraction of this great nature's genetic library. Bioprospecting is the systematic search for genes, natural compounds, designs and whole organisms of forest/wildlife with potential for product development.

Modern prospecting involves well-organized research and methodologies. Bioprospecting in essence means an activity involving survey, exploration, documentation and evaluation of biological resources and their derivatives and/or associated TK, leading to the identification and/or isolation of commercially valuable products (genes, biochemicals), compounds, derivatives and/or any other tangible and intangible components including IPR-covered processes, technologies and services derived from wild or domesticated biodiversity. With the advent of new tools and techniques, the power of bioprospecting has been incredibly increased. Modern bioprospecting now includes systematic search for genes, natural compounds, designs and whole organisms of either domesticated or wild source with a potential for product development. Bioprospecting is essentially an action-oriented multidisciplinary programme with the end in view of generating both knowledge and avenues for the development of a diverse array of IPR-covered, value-added products and their commercialization with appropriate benefit-sharing arrangements.

The prospects of exploring biodiversity for new medicines, foods, crops, insecticides, pesticides and other commercially valuable genetic and biological products and processes are booming, thanks to the rapid development in biotechnology (particularly genomics, proteomics, enzymatic and transgenic technologies), herbal technology and information technology, and this exploration of biodiversity for commercially valuable genetic and biochemical resources is termed as 'bioprospecting' (Eisner 1989; Reid et al. 1993). In short, bioprospecting involves investigation of genetic resources or biochemicals for new commercial leads (Laird and ten Kate 2002) and includes three major areas such as 'chemical prospecting, gene prospecting and bionic prospecting' (Mateo et al. 2000). The major bioprospecting areas are depicted in Fig. 6.1.

The major players of bioprospecting include multinational companies (in private and public sectors), R&D institutions, universities, botanic gardens, etc. Genetic resources and associated traditional knowledge provide the key resources, and biotechnology offers the key tools relevant for these bioprospecting sectors. The ways in which they use genetic resources would vary among and between these sectors depending upon the ultimate aim and targets of each bioprospecting activity. The quantum of genetic resources or their derivatives used, the leads from associated traditional knowledge accessed or utilized and the methodological framework of

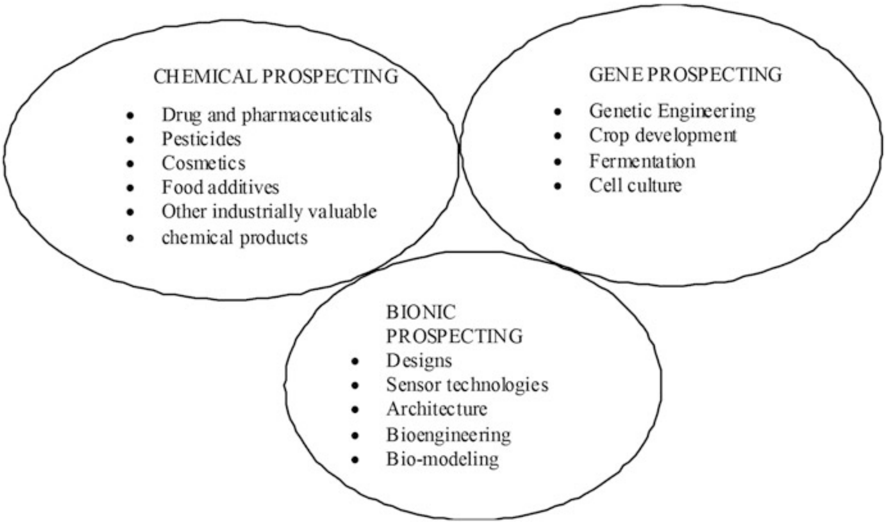

Fig. 6.1 Major bioprospecting areas

various techniques and tools employed would differ significantly in each bioprospecting activity. These are guided by a number of requisite factors such as the capability of the bioprospecting companies or institutions in terms of infrastructure, human resources and technological capabilities, as well as the existing national and international policies and legal frameworks that facilitate free and regulated access to genetic resources or their derivatives and/or the associated traditional knowledge, and more importantly, the ultimate objectives of the bioprospecting mission envisaged. For example, among the above-mentioned major players in bioprospecting programmes, the pharmaceutical and agrobiotechnology industries are the prominent ones and have a major stake in the global bioindustrial regimes. They use genetic resources in significantly different ways. There is diversity of genetic resources used and biotechnological interventions within and between the bioprospecting sectors which are influenced greatly by the following factors: (1) the size of industries and markets for the products, (2) the role of natural products in these markets and percentage of sales contributed by genetic resources and (3) the relationship between commercial products and the genetic resources from which they are developed (Laird and ten Kate 2002). The annual global sale values of various bioprospecting sectors are presented in Table 6.1.

6.7 International Regime on Access and Benefit Sharing

Developing the international law and policies to put ABS into practice is, however, far from simple. In addition, the role of traditional knowledge in bioprospecting further complicates matters. On many occasions, it is the traditional knowledge held

Table 6.1 Annual global sale values of various bioprospecting sectors

Sectors	Annual sale values
Pharmaceuticals	US $ 300 billion (1998 figures)
Crop protection	US $ 30 billion (1997 figures)
Agricultural seed	US $ 30 billion (1997 figures)
Horticulture	US $ 16–19 billion (1998 figures)
Botanical medicines	US $ 20 billion (1999 January–November figures)
Cosmetic and personal care	US $ 75 billion (1998 figures)
Total	**US $ 471–474 billion**

Laird and ten Kate 2002

by indigenous peoples and local communities that provides clues as to the potentially useful properties of a genetic resource. The ABS was conceived as a tool to promote fairness and equity at the interstate level; however, traditional knowledge demands regulatory action at the intrastate level. Indigenous peoples and local communities reside within state boundaries, and their rights, subject to international human rights norms, are regulated by national law. Furthermore, the use of the intellectual property rights system has resulted in a series of famous biopiracy cases involving the misappropriation of traditional knowledge, including those related to turmeric, neem, ayahuasca and hoodia. The international law on ABS thus needs both to address the practical aspects of ABS transactions and to serve broader aims related to fairness, equity and justice (Tsioumani 2015). In addition, the international law needs to guide the development of domestic legislation on ABS and ensure fairness in transnational ABS transactions in order to reduce asymmetries both among parties in each individual transaction and among developed and developing states (Morgera et al. 2014).

The growing concern over monopolization of benefits led genetic resource-providing countries to restrict access to genetic resources and associated traditional knowledge. The CBD, ITPGR (2001) and the Bonn Guidelines (2002) provide a broad framework for ABS procedures. In light of the asymmetries between states providing and using genetic resources, as well as the growing expectations concerning the commercial value of biodiversity, ABS was conceived as a tool for equity and as an opportunity for sustainable development. The idea behind it was developing countries host most of the world's biodiversity, and thus commercial products developed on the basis of these genetic resources benefit mostly the companies and consumers in developed countries, and part of these benefits should flow back to the countries of origin of genetic resources.

Many countries from the South felt that while the Bonn Guidelines elaborated on access, they have left the benefit-sharing aspect relatively unspecific. The voluntary nature of the guidelines has been judged as insufficient for implementing the ABS provisions of the CBD. In order to further implement the third objective of the Convention and its ABS-related provisions, the World Summit on Sustainable Development, held in Johannesburg, called for an action (IISD 2009) to negotiate within the framework of the Convention on Biological Diversity an international regime to promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources. In 2004, in response to this call for action, the Conference of the Parties (COP) mandated the Ad Hoc Open-Ended Working Group on ABS (COP 5 decision V/26) to elaborate and negotiate an international regime on access to genetic resources and benefit sharing with the aim of adopting instrument(s) to effectively implement the provisions in Article 15 and 8(j) of the Convention and the three objectives of the Convention, and at its ninth meeting, in 2008, in Bonn, Germany, the COP agreed on a schedule of meetings to complete the negotiations before its tenth meeting in 2010 at Nagoya, Japan. The objective of the Nagoya Protocol is the fair and equitable sharing of benefits arising from the utilization of genetic resources, with a view to contributing to the conservation of biodiversity and the sustainable use of its components. Benefit sharing is envisaged through appropriate access to genetic resources, the transfer of relevant technologies and funding. Benefit-sharing obligations also arise from the use of traditional knowledge associated with such genetic resources and genetic resources held by indigenous and local communities. In this regard, the Nagoya Protocol is particularly innovative; it is the first time that such obligations are triggered by the use of traditional knowledge for research and development purposes in an international legally binding instrument. The Protocol is also innovative in detailing measures to ensure compliance with ABS-related obligations – an aspect that was neglected under the CBD (Tsioumani 2015).

The Nagoya Protocol entered into force on 12 October 2014 having been ratified by 54 countries at that time. The first meeting of its parties (COP/MOP 1) was held from 13 to 17 October 2014, during the second week of the 12th meeting of the Conference of the Parties (COP 12) to the CBD. The major achievement of the first meeting of the Parties to the Protocol was the establishment of a compliance committee and agreement on procedures and mechanisms to promote compliance and address cases of noncompliance. The second meeting of the Conference of the Parties, serving as the meeting of the Parties to the Nagoya Protocol, will be held in Los Cabos, Mexico, in November 2016 (COP 12 Decision).

There are three key remaining areas to address to help make the ABS regime more functional: contractual mechanisms for access and for benefit sharing; domestic legislative, policy and administrative measures in both user countries and provider countries; and clarifying questions at the international level including the possibility of unregulated genetic resources in certain areas (Tvedt and Schei 2014). It is therefore increasingly urgent for the CBD to make ABS work as was intended. The entry into force of the Nagoya Protocol represents a step in this direction. The new instrument, however, cannot reach these goals alone and so much will rely on functional implementation for moving forward.

India has been a regular victim of misappropriation of genetic resources and associated traditional knowledge, which have been patented in other countries (well-known examples include *haldi* and neem). It is expected that the Access Sharing and Benefit (ABS) Protocol, which is a key missing pillar of the CBD, would rectify this problem (Mehta 2014).

As the genetic resources and traditional knowledge are transferred from the provider country to the user (industry), property rights including intellectual property rights (IPR) are the most relevant critical factors in the access and benefit sharing of genetic resources concept. There are two possibilities that exist for strengthening the property rights of resource managers. On the one hand, national governments can ensure that the local level participates in the property rights over biodiversity and the benefits that arise from their use. On the other hand, international and national patent law requires the disclosure of the origin of genetic resources when IPRs are granted (Mehta 2014). It is hoped that the Nagoya Protocol would address the imbalance arising from property rights distribution. The Protocol has strengthened the local level by asking the parties to take legislative, administrative or policy measures to ensure that benefits arising from the utilization of genetic resources that are held by indigenous and local communities are shared in a fair and equitable way with the communities concerned.

6.7.1 The First Indian Model of Benefit Sharing

Based on a lead obtained from a Kani tribe of Kerala, the authors have developed an antifatigue, immuno-enhancing herbal formulation named 'Jeevani'. With the technology of production of this drug being transferred to a pharmaceutical company on payment of a license fee and a royalty of 2 % on the ex-factory sale of product, TBGRI resolved to share 1:1 of the license fee and royalty with the Kani tribe. Currently this model is acclaimed as the model to be emulated in similar situations elsewhere in the world. Although this model was worked out in early 1994 in full consultation with the Kani tribe, it took almost 3–4 years to effect this model mainly because of the inherent inability of the 'Kani' people to receive the benefit. Finally the majority of the members of the Kani tribe resolved to form a trust which was then registered, and in February 1999, the license fee and royalty due to them was transferred to the trust. The trust continued to receive the royalty accrued from the drug developed from their knowledge of a lesser-known wild plant during the entire period the patent was in effect.

This model is perhaps a unique experiment ever done, wherein the benefits accrued from the development of a product based on an ethnobotanical lead were shared with the holders of that traditional knowledge. Considering the significant outcome of this model in community empowerment, income generation and poverty eradication of a tribal community, Pushpangadan was awarded with the UN-Equator Initiative Prize (under individual category) at the World Summit on Sustainable Development held in Johannesburg in August 2002. Now with the CBD, Bonn and World Intellectual Property Organisation (WIPO) guidelines and our national legislation on biodiversity in position, the JNTBGRI or Kani case study could be taken as an ideal model of equitable benefit sharing involving genetic resources and associated traditional knowledge.

Recently, the Ministry of Environment, Forest and Climate Change (MoEF 2014) brought out a regulation called Guidelines on Access to Biological Resources

Table 6.2 Benefit sharing as per ABS regulations, India

Annual gross ex-factory sale of product	Benefit-sharing component
Up to 1,00,00,000 rupees	0.1 %
1,00,00,001–3,00,00,000 rupees	0.2 %
Above 3,00,00,000 rupees	0.5 %

and Associated Knowledge and Benefits Sharing Regulations, 2014. They have written about the procedure for access to biological resources, for commercial utilization or for biosurvey and bio-utilization for commercial utilization. When the biological resources are accessed for commercial utilization or the biosurvey and bio-utilization leads to commercial utilization, the applicant shall have the option to pay the benefit sharing ranging from 0.1 to 0.5 % at the following graded percentages of the annual gross ex-factory sale of the product which shall be worked out based on the annual gross ex-factory sale minus government taxes as given in Table 6.2.

The collection of fees, procedure for the transfer of results of research relating to biological resources, mode of benefit sharing for the transfer of results of research, procedure for obtaining intellectual property rights (IPR), mode of benefit sharing in IPR, obligations of applicant in the event of the commercialization of IPR, procedure for the transfer of accessed biological resource and/or associated knowledge to third party for research/commercial utilization, mode of benefit sharing for the transfer of accessed biological resource and/or associated knowledge to the third party for research/commercial utilization, conducting of noncommercial research or research for emergency purposes outside India by Indian researchers/government institutions, determination of benefit sharing, sharing of benefits, processing of applications received by NBA, etc., have been described in detail.

6.8 The Key Issues Between Genetic Resources, Traditional Knowledge and IPR

The key issues are the relationship between the genetic resource and traditional knowledge on the one hand and the claimed invention on the other. This includes clarification of the range and duration of obligations that may attach to such resources and knowledge, within the source country and in foreign jurisdictions, and how far these obligations 'reach through' subsequent inventive activities and ensuing patent applications. The degree of clarity and predictability of impact of any disclosure requirement, and thus its practical impact, is likely to depend on whether the requirement can be analysed or expressed in terms of patent law.

Another key issue is the legal basis of the disclosure requirement in question and its relationship with the processing of patent applications, the grant of patent and the exercise of patent rights. This raises also the legal and practical interaction of the disclosure requirement with other areas of law beyond the patent system, including the law of other jurisdictions. Some of the legal and policy questions that arise are as follows:

– The potential role of the patent system in one country in monitoring and giving effect to contracts, licenses and regulations in other areas of law and in other jurisdictions and the resolution of private international law or 'choice of law' issues that arise in interpreting and applying across jurisdictions contract obligations and laws determining legitimacy of access and downstream use of GR/TK
– The nature of the disclosure obligation, in particular, whether it is essentially a mechanism to assist with the monitoring of compliance with non-patent laws and regulations or whether it incorporates compliance

6.9 Sharing of Benefits According to the Biodiversity Act

1. Where approval has been granted by the NBA for research or for commercial utilization or for transfer of results of research or for intellectual property rights or for third party transfer, the mode of benefit sharing shall be as follows:

    (a) 5.0 % of the accrued benefits shall go to the NBA, out of which half of the amount shall be retained by the NBA and the other half may be passed on to the concerned State Biodiversity Board (SBB) for administrative charges.
    (b) 95 % of the accrued benefits shall go to the concerned BMC(s) and/or benefit claimers:

Provided that where the biological resource or knowledge is sourced from an individual or group of individuals or organizations, the amount received under this clause shall directly go to such individual or group of individuals or organizations, in accordance with the terms of any agreement and in such manner as may be deemed fit.

Provided further that where benefit claimers are not identified, such funds shall be used to support conservation and sustainable use of biological resources and to promote livelihoods of the local people from where the biological resources are accessed.

2. Where approval has been granted by the State Biodiversity Board under these regulations:

The sharing of accrued benefits shall be as follows – the SBB may retain a share, not exceeding 5 % of the benefits accrued towards their administrative charges, and the remaining share shall be passed on to the BMC concerned or to benefit claimers, where identified.

Provided that where any individual or group of individuals or organizations cannot be identified, such funds shall be used to support conservation and the sustainable use of biological resources and to promote livelihoods of the local people from where the biological resources are accessed.

6.10 Certain Activities or Persons Exempted from the Approval of NBA or SBB According to the Biodiversity Act

The following activities or persons shall not require approval of the NBA or SBB, namely:

(a) Indian citizens or entities accessing biological resources and/or associated knowledge, occurring in or obtained from India, for the purposes of research or biosurvey and bio-utilization for research in India
(b) Collaborative research projects, involving the transfer or exchange of biological resources or related information, if such collaborative research projects have been approved by the concerned ministry or department of the state or central government and conform to the policy guidelines issued by the central government for such collaborative research projects
(c) Local people and communities of the area, including growers and cultivators of biological resources, and Vaids and Hakims, practising indigenous medicine, except for obtaining intellectual property rights
(d) Accessing biological resources for conventional breeding or traditional practices in use in any agriculture, horticulture, poultry, dairy farming, animal husbandry or beekeeping in India
(e) Publication of research papers or dissemination of knowledge, in any seminar or workshop, if such publication is in conformity with the guidelines issued by the central government from time to time
(f) Accessing value-added products which are products containing portions or extracts of plants and animals in unrecognizable and physically inseparable form
(g) Biological resources, normally traded as commodities notified by the central government under Section 40 of the Act

6.11 National Innovation Foundation

The National Innovation Foundation (NIF) conceived by Prof. Anil Gupta of IIM, Ahmedabad, was established as an autonomous society by the Government of India in 2000. NIF works for recognizing, respecting and rewarding grassroots-level innovations and outstanding TK. NIF and the Honey Bee Network under the Society for Research and Initiative for Sustainable Technologies and Institutions (SRISTI), an NGO based at Ahmedabad, have been scouting for documenting local innovations and linking their innovations for further valorization with science and technology experts. NIF maintains a separate national register for Green Grassroots Technological Innovations and Traditional Knowledge and so far has screened over 70,000 innovations and TK. The NIF scouting and documentations involve several steps such as:

(a) To coordinate with various governmental and nongovernmental agencies to mount a national campaign to scout innovations with the help of grassroots-level functionaries of education, agriculture, rural development, small-scale industry, Panchayat Raj institutions, etc., or through students during summer vacation, Shodh Yatras (walks through the villages every 6 months for a week or more), advertisements in regional language newspapers, innovators looking for others of their kind, etc.
(b) To screen, document and verify the claims about these innovations and traditional knowledge through various networks of scientific and other institutional initiatives as well as through Honey Bee collaborators, study of existing databases and field visits
(c) To generate and experiment with material and nonmaterial incentive mechanisms for innovators and traditional knowledge holders
(d) To provide assistance in forging decentralized networks of inventors/knowledge experts to strengthen the Honey Bee Network
(e) To obtain prior informed consent (PIC) of the providers of knowledge
(f) To share the innovations permitted by the knowledge providers to be put in public domain through Honey Bee newsletter and other media to enrich the repertoire of the local communities and informal knowledge experts and to support Shodh Yatras in different parts of the country

NIF has so far scouted over 200,000 innovations and TK. NIF maintains confidentiality of the TK recorded until a proper system of safeguarding the knowledge is put in place. But to answer such questions, formalization and legal protection of the national register should be the priority. We, of course, are bound by PIC, which is covered under the contract law.

6.12 Conclusion

Ethnobiological research can provide a wealth of information regarding relationships between plants and the traditional societies. Investigations into the traditional use and management of local flora have demonstrated the existence of extensive local knowledge of not only about the physical and chemical properties of many plant species but also the phenological and ecological features in the case of domesticated species. In addition to its traditional roles in economic botany and exploration of human cognition, ethnobotanical research has been applied to current areas of study such as bioprospecting and vegetation management.

The issues of community rights/TK, ABS transfers and intellectual property rights protection related to genetic resources and traditional knowledge are the most contentious ones that keep the developed and developing countries divided in their attitude and approaches. The intricate imbalance in the core objectives and directives of CBD and TRIPS is a major concern for the parties or members of these international laws. Among all the issues being debated between CBD Secretariat and TRIPS Council, the question of providing legal protection to genetic resources and associated traditional knowledge continues to crop up at the intersessional meetings of CBD, TRIPS and WIPO. It is a matter of grave concern that certain countries with advanced technologies are still reluctant to become a party to CBD, but continue to oppose the plea of the developing or the least-developed countries for evolving an enabling and equitable legal mechanism for implementing the international trade and intellectual property laws in relation to biodiversity, genetic resources and traditional knowledge systems.

What is more important at the national level is to reaffirm their commitment in evolving a transparent and viable mechanism for regulated access and benefit sharing of genetic resources and associated traditional knowledge. The prerequisite for developing an effective ABS regime is building up a comprehensive information system on all pertinent aspects of availability, diversity, distribution, economic uses and potentials, conservation status of biogenetic resources and associated traditional knowledge along with the information on the existing S&T infrastructure and capabilities, including human resource wealth, national and international legal and policy frameworks, current achievements and future plans and priorities for capacity building for conservation, sustainable use, bioprospecting and economic valuation of their great wealth of bioresources and traditional knowledge. The entry into force of the Nagoya Protocol represents a step in this direction. The new instrument, however, cannot reach these goals alone and so much will rely on functional implementation for moving forward.

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Chapter 7
Can Benefits Be Shared? Three Tangles for Access and Benefit Sharing

Kanchi Kohli and Shalini Bhutani

Abstract Resource-dependent communities living in different regions are dependent on either wild or cultivated ecosystems for livelihoods. Access to bioresources for local trade and exchange of biological products has generated sustainable livelihoods for generations. The international and national legal framework for Access and Benefit Sharing (ABS) has been put in place, to ensure that access to biological resources is legal and benefit sharing equitable, but there are many challenges which come into play. The challenges are mainly (a) the dynamism of biodiversity and knowledge which makes it difficult to identify owners and create ABS contracts, (b) defining what the bioresource which is being accessed is and (c) the challenges related to enforcement and compliance of both the provisions of the Biological Diversity Act as well as conditions of access. For local communities to have a stake in the law and its implementation, they would need to establish themselves as the benefit claimers. The chapter deals in detail with the three main challenges for implementation of ABS framework in India with specific case studies.

Keywords Benefit claimers • Traditional knowledge • Biopiracy • ABS

7.1 Introduction: Conceptual and Legal Framework for ABS

By simple non-legal definitions, the word *access* means approaching or entering a place or actually obtaining or retrieving a material object. The term has acquired very specific meaning in the context of biological resources and people's knowledge. For generations, human societies have survived, and human enterprises have been built by accessing biological materials for food, fuel, fibre and fodder.

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Other than for subsistence needs, access for local trade and exchange of biological products has generated livelihoods. This dependence has established a range of economic relationships, locally relevant know-how and cultural practices intertwined with specific ecological contexts. Thus, access with respect to bioprospecting implies gathering something from a locale not yours.

Over the years, the political economy of the access to biological diversity (or biodiversity) and the related people's knowledge began to be a matter of concern. As world economies grew, so did the cross-border trade in biological materials, for pharmaceuticals, agribusiness and other related life-science industries. At the same time, the public sector research and development (R&D) institutions began responding more to the market opportunities or needs of industry rather than public good and welfare for which they were set up. For instance, the Indian Council of Agricultural Research (ICAR) has set up its own registered company – AgrInnovate India Limited – for commercial activities.[1] There existed no overarching policy framework delving deeper into restricting unethical and exploitative access and neither was there any regulatory framework, which would prescribe processes by which such access could be minimised, impacts mitigated or profits shared.

7.2 The International Framework for Access

The multilateral international treaty, which is the centre point for global discussions on access to biological material and related knowledge, is the Convention on Biological Diversity (CBD). The CBD emanated from the growing concern to protect biodiversity loss and check 'biopiracy'. Even though the process to formulate such global measures had started in 1988 (see *History of the Convention*),[2] it was at the Rio Earth Summit in 1992 that the CBD was opened for signature. It finally entered into force on 29 December 1993. This history is important to trace the progression of the terminologies of 'access and benefit sharing' (ABS) and how they came to be used within this international framework.

Access under the CBD is applicable to genetic resources from countries of origin or those countries that have acquired the resources as per CBD-compliant rules. The convention (1993) and its Bonn Guidelines (2002) preceding an international regime on ABS (2010) explicitly set fair and equitable access to genetic resources and sharing of benefits arising out of that access as one of the main objectives of the convention.

With this, the CBD also sought to settle the debate that access for commercial use or research is inevitable and needs to be legally facilitated. Provider countries now could not refuse physical access to or a claim for intellectual property over bioresources, unless there is procedural justification. The default assumption is a

[1] http://www.icar.org.in/en/AgrInnovate-India-Limited.htm

[2] http://www.cbd.int/history/

national-level authority in each country (as and when it would be set up) which will grant access, and hence every refusal will have to be grounded and can be appealed against.

The convention insists that access to genetic resources and reciprocal transfer of technologies must be relevant to the purposes of conservation and sustainable use of biodiversity. This is clearly laid out in Articles 15 and 16 of the CBD and has a bearing on how ABS is located within India's Biological Diversity Act, 2002. The CBD Articles made a crucial change in the manner in which elements of biodiversity would be owned, protected and governed, thereby establishing who would need to be spoken to when access does take place by a third party. It was agreed upon by governments that through the CBD (Article 3) the sovereign rights of states (*nation-states or countries*) over their natural resources would be recognised. CBD vests the authority to determine access to genetic resources with national governments subject to national legislation (Article 15.1). Any contractual agreement in the remotest part of a country, even with the existing custodians of biodiversity and knowledge, would then be governed by the frameworks devised by country governments. Prior informed consent (PIC) was envisaged with the 'contracting party' (Article 15.5), recognisably the national governments.

What is also important to note is the primary manner in which the CBD approaches the issue of access to biodiversity through an understanding of 'genetic material'.[3] In simple biological interpretation, this means the smallest part of living matter, which can become the basis of experimentation, scientific research and industrial production. For instance, it is the basic genes of a rice variety, which will be required when it comes to accessing it for laboratory research purposes. Local communities even with their knowledge of socio-economic use of biodiversity did not take genetic material very much afar from its natural habitat to develop new products. Controversial as it may seem, it could be that when the CBD laid out frameworks for access and defined benefit sharing, it could have been with the purpose of keeping the interest of the scientific community and business interests in mind.

Once the nature of access was established, its owners were recognised and sustainable use was emphasised, the CBD text (Article 1) made its stated objective of 'fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding'.

The Nagoya Protocol under the CBD, also called the international regime (IR) on ABS, entered into force on 12 October 2014.[4] The IR was the main outcome of the

[3] The CBD in Article 2 defines 'genetic material' as 'any material of plant, animal, microbial or other origin, containing functional units of heredity'.

[4] The full text of the *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization* can be accessed at https://www.cbd.int/abs/about/

CBD's Tenth Conference of Parties held in Nagoya, Japan. The IR forms the essential backdrop for the 'new' ABS guidelines in India, which were notified in 2014. The protocol lays down a text by which 'benefits' arising out of any kind of use of biological material and associated traditional knowledge (TK) when accessed need to be shared. Ever since, countries like India have been under much pressure to design legally binding mechanisms in line with the IR to facilitate access to bioresources and knowledge. They are also under pressure to have laws and policies in place through which benefit sharing can be done once access is permitted. The absence of a working system for ABS puts governments of biodiversity-rich countries at risk of not being able to harness back 'benefits'; that is also how ABS rules and regulations are justified by states to their domestic constituencies.

7.3 The Framing of Access and Benefits

7.3.1 Establishing Access with Benefit Sharing

The CBD framework considers access and benefit sharing as two sides of the same coin. ABS at the level of implementation is now locked into a single frame. The aspect of access to genetic resources and that of sharing legally recognised 'benefits' once relevant national authorities grant access are treated as inseparable. It completely puts aside the question that oftentimes access itself can be disenfranchising for both local communities and weaker governments. Access may also go against the tenets of conservation and sustainable use, and in such instances sharing of benefits might be deceiving (Bavikatte and Robinson 2011; Kohli and Bhutani 2013b). There is no scope to challenge the idea of access within the CBD framework itself.

The politics of global conventions and representative decision-making has brought us to a point when genetic material and people's knowledge are controlled by national governments. It is through their offices and functionaries that any proposals of ABS are to be processed. Bringing on board, in the process of decision-making, the local people who have evolved socio-economic and cultural practice with different biological resources becomes a piecemeal and administrative exercise.

Both the nature of access and how benefit sharing will actually take place have become very critical policy discourses today. This in part has been due to the increased interest of the life sciences and other trade sectors in accessing biodiversity and the push from conservationists, rights activists and governments to ensure that the benefits accruing out of this access are pushed back to countries or communities from where the material or knowledge has been procured.

7.3.2 ABS in Indian Law

The ABS framework for India is elaborated in the country's Biological Diversity (BD) Act, 2002, and its implementing Rules, 2004. Sections 3, 4 and 6 of the BD Act together with Rules 14–19 of the BD Rules lay down the procedure to be followed for access to Indian biological resources and/or associated traditional knowledge. The law, in line with the CBD, makes clear that the main focus is to regulate the use by what it defines as non-Indian persons.

While the CBD is also about conservation and sustainable use, ABS continues to dominate both the CBD landscape globally and the implementation of the BD Act domestically. As of 29 April 2015, a total of 172 approvals for access have been granted by the Chennai-based National Biodiversity Authority (NBA), which began to process access applications in 2005.[5] On the other hand, in many cases, permissions for access are simply not being sought (Sood 2013). And the law itself exempts a list of Normally Traded Commodities (NTCs) from access rules and benefit-sharing obligations.[6]

The NBA set up under the BD Act is central to the process of screening and approving access applications. The NBA has set up an expert committee for ABS, which meets periodically to take decisions on the access applications received. The NBA has to ensure that there is meaningful participation of the local communities from where both genetic material and people's knowledge are accessed. For that it has to redirect every access application to the relevant State Biodiversity Boards (SBBs). So it depends very much on the strength, interest and capacity of SBBs to carry through the consultation with the local-level Biodiversity Management Committees (BMCs) and people in that area, where such BMCs have not yet been formed in India. In 2014–2015, the NBA disbursed an amount of INR 3.81 crores ($575,268.47) for the formation of BMCs in 20 states.[7]

The act, in line with the CBD, has focused on regulating access by foreign persons. The procedure for access to bioresources by Indian persons is less regulated, with neither local people nor traditional healers coming under its purview. Foreign persons – natural and legal – have to mandatorily take permissions prior to any sort of access including research, biosurvey and commercial utilisation; the law requires Indian enterprises to merely inform the relevant State Biodiversity Boards (SBBs). When it comes to seeking intellectual property (except plant variety protection), both Indians and foreign entities have to mandatorily take permission from the NBA. In all these instances, the NBA and the SBBs are required to consult a BMC, whether in rural or urban areas.

The BD Act lists six broad types of benefit sharing that can be realised when either access takes place or approval for IPR is granted. This includes joint ownership

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[5] Statistics from the NBA website as accessed on 16 May 2015 http://nbaindia.org/content/683/61/1/approvals.html

[6] Section 40 of the BD Act.

[7] NBA's data for 2014–2015.

of IPR to either NBA or an identified benefit claimer, transfer of technology, involvement in research and development endeavours, setting up venture capital funds or payment of compensation. But simply having prescribed forms and a detailed 15-step procedure from application to approval[8] did neither settle the procedural uncertainties nor guarantee benefits. The set of 'new' guidelines on ABS are meant to fill those gaps. They also combine the two ideas of 'access' and 'benefit sharing', while previously the NBA had issued two separate draft guidelines on them each.[9]

7.3.3 Access and the 2014 ABS Guidelines

The NBA and the Ministry of Environment, Forests and Climate Change (MoEFCC) notified the *Guidelines on Access to Biological Resources and Associated Knowledge and Benefits Sharing Regulations* on 21 November 2014. These guidelines reiterate how the government views ABS as a 'large-scale financing mechanism' (NBA 2012a) which it anticipates would generate the necessary funds for the twin purposes of conservation and poverty reduction. But the ABS system will churn out the anticipated money only upon commercial utilisation.

The new guidelines only marginally add to what the existing BD Act and Rules lay down on the ABS issue. The only area where the guidelines introduce something new is a category of access that allows an Indian researcher or government institution to carry or send Indian biological resources for basic research. This is only possible in emergency situations, for example, during pandemics. In such circumstances, like in collaborative research agreements, the access granted is exempt from the legal duty of the accessor to do benefit sharing. The guidelines have prescribed a special Form B for the purpose, which will have to be submitted to the NBA.

Unfortunately, the guidelines issued don't explain the logic on how the various figures for payment (of benefits) have been arrived at. They also don't explain why in some instances there are direct payments to local-level committees and in others it is not envisaged. Unfortunately, the intended benefactors or the readers of the document don't have any way to understand the thought process. A supplementary note to the notification, indicating the reasoning, would have helped to better understand the guidelines and allow for constructive critiques (Kohli and Bhutani 2015).

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[8] ABS application process on the NBA web site as accessed on 16 May 2015 http://nbaindia.org/content/684/62/1/applicationprocess.html

[9] http://nbaindia.org/blog/602/47//CommentsSolicitedo.html The NBA had sought public comments on the *Draft Access Guidelines* and *Draft Benefit Sharing Guidelines* in May 2013.

7.3.4 Benefit Sharing and 2014 ABS Guidelines

The guidelines prescribe that when India's biological resources are accessed and commercially utilised, the applicant shall have the option to pay the benefit sharing ranging from 0.1 % to 0.5 % at graded percentages of the annual gross ex-factory sale of the product, which shall be worked out on the basis of annual gross ex-factory sale minus government taxes.

The 2014 guidelines broadly convey that sharing of benefits may be done either through a monetary or nonmonetary mode. A list of options is contained in an Annexure I to the notified guidelines. These are in line with the IR on ABS. However, there is still no step-by-step process on how benefit sharing should be realised in a fair, equitable and ethical manner. There is also nothing to indicate what would be 'good practice' for benefit sharing. With no prioritisation, all kinds of benefit-sharing mechanisms receive equal weightage, be it a one-time compensation or carrying out joint product research or development. This is significant because the 10-year practice pre-guidelines have shown a preference for monetary benefits in ABS arrangements. The collection in the National Biodiversity Fund has been far less than anticipated. For instance, during 2011–2012, the NBA had received only Rs.198,603 – in the form of royalty from access applicants (NBA 2012b).

7.4 Three Tangles for ABS

While both the international and national legal frameworks have been set into motion to ensure that access is legal and benefit sharing equitable, there are many challenges which come into play. The challenges are mainly (a) the dynamism of biodiversity and knowledge which makes it difficult to identify owners and create ABS contracts, (b) defining what the bioresource which is being accessed and (c) the challenges related to enforcement and compliance of both the provisions of the BD Act as well as conditions of access.

7.4.1 Binding the Dynamism of Biodiversity and Knowledge

Biological diversity (or biodiversity) as understood in simple terms is the diversity of life and life forms including plants, animals and microorganisms. The complex web of flora and fauna manifests itself in a variety of interactions and ecological configurations when they come together in one or another habitat type, be it forests, marine, desert, grassland and so on. While part of this interplay of species is devoid of human factors, there may be other ecological habitats that have evolved over time with the interference and interdependence of human beings. When such interactions take place, most often than not human beings have adapted and created knowledge systems to deal with the use and coexistence on one hand and adaptation and modification on the other hand.

Over the years, the relationship between human beings and biodiversity has evolved both at individual level and through application of collective wisdoms. For instance, resource-dependent communities living in different regions are dependent on either wild or cultivated ecosystems for livelihoods. This could be both at individual and family level for food security, sale in local markets or conservation of common spaces which are to be used by one or many community formations residing in a geographical region.

It is within these vibrant associations of human beings with biodiversity and its cultural expression that larger visions of using and modifying biological resources need to be understood. This is especially important when understanding the political economy of trade related to research and development, commercial utilisation[10] as well as grant of intellectual property. At the same time, it needs to be borne in mind that policy responses are continuously also responding to the growing concern around loss of biodiversity and knowledge systems associated with it. Climate-resilient crops, medicinal plants and forest foods are fast disappearing. At the same time, the vast cultural diversity, which has evolved around this biodiversity, is also being lost rapidly. With this the related ancestral knowledge, as well as the scope for its future evolution, is also lost (IIED 2012).

There have been debates in India and across the world about whether knowledge should be termed as 'traditional' or not or whether biodiversity can be contained within a single geographical region. One specific concern is with respect to the use of the word 'traditional'. Traditional knowledge refers to the long-standing wisdom, knowledge, teachings and its practice, which is linked to specific indigenous and local communities.[11] It is also acknowledged as being the intellectual heritage of these communities, and therefore debates has been generated around the requirement of consents for accessing the knowledge.

Knowledge is both contextual and dynamic in nature. Indigenous communities, local healers, farmers, fisherfolk, forest dwellers and others who have been using and applying these knowledge forms are themselves constantly innovating and

[10] The BD Act defines commercial utilisation as 'end uses of biological resources for commercial utilization such as drugs, industrial enzymes, food flavours, fragrance, cosmetics, emulsifiers, oleoresins, colours, extracts and genes used for improving crops and livestock through genetic intervention, but does not include conventional breeding or traditional practices in use in any agriculture, horticulture, poultry, dairy farming, animal husbandry or bee keeping'.

[11] The CBD defines traditional knowledge as 'the knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation. It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds. Sometimes it is referred to as an oral traditional for it is practiced, sung, danced, painted, carved, chanted and performed down through millennia. Traditional knowledge is mainly of a practical nature, particularly in such fields as agriculture, fisheries, health, horticulture, forestry and environmental management in general'.

thereby becoming part of the overall evolution of this knowledge. This is why there have been some critiques around the use of the term *traditional* knowledge. It is argued that by referring to knowledge as traditional, it does not do justice to its dynamism and also tends to freeze it in a particular time frame.

India's BD Act has clear definitions of who are legitimate 'benefit claimers', once access to biological material or people's knowledge takes place. They are 'conservers of biological resources, their by-products, creators and holders of knowledge and information relating to the use of such biological resources, innovations and practices associated with such use and application'.[12]

Through the years 2006–2007 to 2015–2016, the NBA has granted approval for access in 193 cases.[13] The NBA executed 41 ABS agreements during the year 2014–2015.[14] The challenge with respect to many of these agreements is to reach out to the legitimate local 'benefit claimers' who are yet to be fully identified in most cases. Moreover, it raises the larger question around whether or not knowledge itself should or can be attributed to one or multiple sets of individuals in India's diverse biocultural context. Ironically this will be important to create the necessary contractual arrangements, which can be fitted within the global access and benefit-sharing (ABS) framework that India has ratified.[15]

7.4.2 Definitional Challenges: What Is the 'Bioresource' to Be Accessed?

It is in the nature of law to be interpreted diversely, and such has been the case with the applicability of ABS and issue of levying of charges in India. Once the directions to expedite the implementation of ABS mechanism is in place, the responsible institutions are faced with a variety of challenges, one being that of defining 'biological resource' itself. Not all the interpretations of those implementing the law seem to coherently fit into a common understanding. For instance, in 2013 the Madhya Pradesh (MP) State Biodiversity Board (SBB) chose to take a substantially expanded meaning of the words 'biological resources' and 'commercial utilisation' used in the BD Act.

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[12] Article 2(a) of the BD Act.

[13] NBA statistics updated as on 31/08/2015 http://nbaindia.org/content/683/61/1/approvals.html

[14] NBA brochure http://nbaindia.org/uploaded/pdf/NBA_Brochure_2014.pdf

[15] The main outcome of the CBD COP10 in the city of Nagoya, Japan, is the Nagoya ABS Protocol. It is here that CBD countries agreed upon an IR on ABS. The IR contained in the protocol lays down a text by which 'benefits' arising out of any kind of use of biological material and associated traditional knowledge when accessed need to be followed through. But the question is whether it makes things any better for provider countries, and in doing so does it guarantee 'benefits' to local communities or further conservation? India has ratified the Nagoya Protocol in October 2012 during the COP 11 deliberations in Hyderabad where India was the host country. However, the protocol is yet to be operationalised.

This action by the MP SBB sparked off a debate in the interpretation of the BD Act in India, 11 years after it was gazetted. It came at a time when the ABS guidelines were yet to be given final shape by the NBA. There were two things the MP SBB was trying to achieve through this process. *First* is to expand the meaning of bioresources, to include elements like coal, soya and molasses used for alcohol production, which are of high royalty value. By doing so, the SBB would be able to levy access fees on companies using these bioresources and channel funds into the State Biodiversity Fund. Where a BMC is involved, the local biodiversity fund would benefit too.

From December 2012 onwards, the MP SBB issued notices to several private companies, whether producing pharmaceuticals, mining coal, processing food, brewing liquor, milling sugar, extracting oil and other industrial processes, which according to MP SBB's interpretation are tantamount to (commercially) utilising biological resources. The SBB also likewise wrote to the State Forest Department, Forest Development Corporation, Minor Forest Produce Federation and Fisheries Department.

In their letters, the SBB has invoked Section 2 (c) of the 2002 legislation which defines biological resources as 'plants, animals and micro-organisms or parts thereof, their genetic material and by products (excluding value added products) with actual or potential use or value, but does not include human genetic material'. In their two letters of April 2013 to the NBA, the member secretary of the board has stressed how 'it is very necessary that it should be clarified what the bio-resources are which comes under the purview of the Act and broader classification of industries that are using biological resources for commercial utilisation'.

Even as this was awaited, the notices were issued to the industries to fill the requisite form and pay a fee using a benchmark of 2 % of their gross sales or gross revenue on financial year basis. The logic of the MP SBB as stated in their communication to the NBA in April 2013 is that 'coal is a plant fossil and it has a genetic material of a plant', and therefore it needs to be treated as a biological resource under the BD Act. Similarly, 'limestone is a genetic material of marine organisms and is made after calcification of marine organisms'. Further, not only coal mining but also thermal and other industrial operations need to come into the purview of ABS as they commercially use coal (Kohli and Bhutani 2013a).

This step of the MP SBB not surprisingly triggered some legal battles. The recipient of the notices challenged the order before the National Green Tribunal (NGT). The Central Zone Bench of the NGT at Bhopal has admitted cases filed by several private companies such as Agro Solvent and Lilason Breweries Ltd. At the same time, pursuing the understanding adopted by the SBB, the Eklehra Panchayat in Chhindwara District of Madhya Pradesh has filed a case against Coal India Limited to share profits from coal extraction with the panchayat. According to the contention of the panchayat, while coal is being extracted from coal mines under their panchayat, the company is not sharing its benefit with them (Kohli and Bhutani 2014; Jha 2013).

The matters were to be heard in the NGT on a regular basis. The counter argument by those served notices by the MP SBB was that aspects of ABS in the BD Act are applicable only to genetic material and not biological resources in general. Therefore the Act does not apply to them. There were reports that MPSBB has formed a state level committee to resolve issues related to non-compliance of the BD Act and implement the recently notified access to bioresources and benefit sharing (ABS) guidelines effective from November 21 last year (Vijay 2015). Over dozen cases pending in the NGT were dismissed in February 2015 once the ABS Guidelines were issued in November 2014. Another judgment of in May 2016 decided that coal is not a bioresource and therefore the BD Act does not apply to it (Nautiyal 2015).

7.4.3 The Questions Around Enforcement

Even as and when ABS is insisted upon nationally and internationally, there is absolutely no mechanism to ensure that either enforcement of processes of access or post facto monitoring will take place. There are clear examples like that of accessing germplasm for the creation of genetically modified Bt brinjal or collecting the blood sample of the Garole sheep (Kohli and Bhutani 2013b) where agreements have been signed with accessors based on the belief that they will revert back to the NBA in case of any future commercial application or use of the material or knowledge accessed. There aren't many examples within these ABS agreements that engender faith in the possibility of this happening. Moreover, neither the law nor the international legal framework has provisions to help national governments (let alone local bodies) to go after accessors once the material has moved borders. Once such material and knowledge are funnelled into laboratory experiments, then tracing it back to the source of access is close to impossible. Therefore, in the current scenario, big corporations and private researchers are getting away by demonstrating their benevolence through upfront payments of royalty to the NBA.

The NBA is the key government body for the purposes of benefit sharing. (The MoEFCC in August 2014 had designated the NBA as the 'competent national authority' for the purposes of the Nagoya Protocol.) It is the entity that determines what will be equitable benefit sharing in each case of access (read Section 21 along with BD Rule 20). This determination is regarded by the act as equivalent to a decree of a civil court (Section 53 of the BD Act). The process for access to Genetic or Biological Materials or Resources (GBMR) and associated TK also reiterates the independent enforceability of individual clauses. This means that even if the entire agreement is not enforced, the particular individual clause in the contract for ABS will be asked to be performed. The BD Rules insist that a provision be made part of all the ABS agreements to ensure that obligations in benefit-sharing clauses will survive the termination of the agreement (BD Rule 14).

Further, while non-compliance of the BS requirements is a punishable offence that can attract the penal provisions of the BD Act, there is no infrastructure or wherewithal to monitor all the ABS agreements. Rule 20 (10) of the BD Act clearly states that 'the Authority shall monitor the flow of benefits…in a manner determined by it'. But what is the enforcement mechanism to monitor that the terms of the ABS contract are met and that violations did not take place? Both the framework and the implementation of the act have and continued to be challenged by this lacuna.

Other than the above points, there has also been a concern that despite the CBD being in place for two decades and countries like India having a BD Act, for several years, it has not been possible to check the rampant instances of what is termed as 'biopiracy' or theft of biological material and knowledge (a word that does not occur in the CBD text).

While the issues of biopiracy and conditions for approval continue to be unresolved, more recently, a critical issue has emerged. A recent news article reported that 'the Ayurveda Drug Manufacturers Association (ADMA), which sought legal opinion from three different law firms, has been advised that while the BD Act is applicable to all companies, the clause on access and benefit-sharing (ABS) fees is relevant only to non-Indian companies'. Based on this, the ADMA has circulated an advisory to its members suggesting to defer the ABS payment, if possible. If not, they pay it only under protest (Vijay 2015).

7.5 Conclusion: Entangled in Contracts

One of the first things that the national ABS law – the BD Act – did was that it has made bioresources legally accessible to industries and prescribed the capture of knowledge through documentation in such a way that they can be made relevant to scientific research and commercial use. Through the processes such as registration and databasing, attempts are made to document the uses of bioresources and to identify the knowledge holder. It is this entity who is to be consulted prior to any access and with whom a benefit-sharing arrangement has to be worked out. This boils down to the drafting of contracts. In order for information or data to be made relevant to either IPR or material transfer agreements, they need to be legible and understandable in globally accepted formats. The dynamic, evolving, fluid and widespread nature of biodiversity or knowledge will not be relevant to biotrade sans doing that. As James C. Scott points out, the state often tries to make a society legible and to arrange population in ways that simplified the classic state functions of taxation, conscription and prevention of rebellion (Scott 1998).

The biodiversity regime also views custodians of local bioresources and knowledge holders through the narrow lens of being potential 'benefit claimers'. Knowledge related to the use of bioresources most often does not lie with one individual or village; it cuts across local, national and sometimes even international territorial boundaries. One or each set of people with whom benefit-sharing agreements are arrived at would need to establish exclusive ownership of that knowledge or resource which is antithetical to the biocultural relationship-based sharing which have and continue to exist even today. The BD Act and IR on ABS would need to change this, if it has to be implemented. The ABS framework requires two clear sides – the user/accessor and the benefit claimer – to be in a contract. The BD Act prescribes the legal procedure to arrive at that contract and further protects that contract. Yet the resources themselves, local rights and relationships over them, the documented biodiversity registers and the de facto biodiversity keepers on the ground are yet to get equal legal protection.

Finally, for the biodiversity regime to work, it would require filtering out the non-tangible from policy and law. Ethical arguments and cultural associations would have little space as they cannot be measured. The ex-minister of state for environment Jairam Ramesh has remarked during a lecture in May 2011 that ‘what we cannot measure we cannot monitor and what we cannot monitor we cannot manage’ (Ramesh 2011; Kohli and Menon 2011). The NBA and SBBs are convinced that the only way to make the IR on ABS through the BD Act relevant to people today is to convince them of the ‘benefits’ (mostly monetary) that would accrue to them (Bhutani and Kohli 2012) and financial resources that would be made available so to ensure conservation.

The purpose of ABS even by its broadest definition and not by the minimalistic view of cash compensation will fail if it deviates from the prime objective of conservation. That is what needs to be constantly reinterpreted no matter what the case may be. Till then the CBD objectives will remain entangled in contracts.

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Chapter 8
Bio-resources Valuation for Ensuring Equity in Access and Benefit Sharing: Issues and Challenges

Prakash Nelliyat

Abstract Loss of biodiversity constitutes a concern for human welfare, especially for the well-being of the poorest, since it acts as a major livelihood option for them. The Nagoya protocol made a platform for compliance provisions as well as the more predictable conditions for access to genetic resources and sharing their benefits. In addition, the protocol emphasises on the provisions of access to traditional knowledge (associated with genetic resources) owned by indigenous and local communities as well as benefit sharing to the community, when a company makes use of their knowledge, innovations and practices. Bioprospectors are making huge residual rents which are confined with the company as an abnormal profit/benefit. The ABS challenge is to frame a legal strategy to bounce back this abnormal profit from the bioprospectors to the bio-resources providers (communities), through the introduction of appropriate economic instruments such as royalty. The fair distribution of benefits acts as a financial incentive and source towards the conservation and sustainable use of biodiversity. One of the major constraints in bio-resources exchange at its collection point is market imperfection. Hence, users of bio-resources may benefit more than the providers, and this creates an unequal benefit-sharing scenario. This paper attempts to examine the significance, challenge and management options on biodiversity, various issues of biodiversity/bio-resources valuation with respect to ABS and the possible approaches for deriving the real value of bio-resources for operationalising the ABS.

Keywords Economic valuation • Exchange value • Use value • Equity • Market

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8.1 Introduction

Fair and equitable sharing of benefits arising from the commercial utilisation of genetic or bio-resources is one of the objectives of the Convention of Biological Diversity (CBD). For operationalising this objective, the key element is to estimate the contribution that the bio-resources have made to the creation of the benefits. Without proper and scientific assessment of the benefits, the user countries of bio-resources cannot ensure fairness in sharing the benefit with the provider countries. Further, it is assumed that the fair distribution of benefits acts as a financial incentive and source towards the conservation and sustainable use of biodiversity. Hence, through a successful ABS mechanism, one can maintain the global biodiversity stock for enhancing human welfare without compromising its ecological functions and services.

In a broader sense, one can argue that the valuation of bio-resources is a prerequisite for fulfilling all the three objectives of the CBD. Morte and Tomme (2007) rightly indicated that 'issue of valuation and equity forms a critical link to the other objectives of CBD (conservation and sustainable use) without which there is no justification for the ABS system'. Ideally, the estimation of the benefits arising from the utilisation of bio-resources is nothing but assigning the real value of the bio-resources.

The ABS issues are closely linked with equity. In the bio-resources case, the equity questions emerge, when they are extracted for commercial purposes by bio-prospecting industries. In a normal condition, the providers and users of biological resources are two different parties or countries. One of the major constraints in bio-resources exchange at its collection point is market imperfection. Hence, users of bio-resources may benefit more than the providers and create an unequal benefit-sharing scenario. This lesson envisages the CBD to insist on their parties that the bio-resources-related commercial process should be regulated through legal actions, for ensuring equity.

As an outcome of CBD initiatives, countries like India enacted the Biological Diversity Act (2002) and Rules (2004) and made decentralised institutional arrangements such as National Biodiversity Authority, State Biodiversity Boards and Biological Management Committees at the national, state and regional levels, respectively, for their effective implementation. However, fixing the benefit-sharing criteria is under the domain of economics. In this regard, one should estimate the bio-resources-induced benefits in bioprospecting and the ratio of the benefit to be transferred to the provider (local community or the state).

8.2 Biodiversity: Economic Significance and Management Challenges

Biological diversity (biodiversity) represents the variety of life on Earth, which include species diversity (the numbers and kinds of living organisms), genetic diversity (genetic variations within species) and ecosystem diversity (the variety of habitats, biological communities and ecological processes). The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet (Costanza et al. 1997). Biodiverse ecosystems provide vital services such as the regulation of water flows and levels, protection against extreme weather conditions, the purification of air and water, the prevention of soil erosion and opportunities for recreation and spiritual reflection. Besides, biodiversity offers essential resources and goods, such as food, fibre and medicines (CBD 2011). In brief, biodiversity is a global asset with tremendous value to the present and future generations. However, the loss of biodiversity constitutes a concern for human welfare, especially for the well-being of the poorest, since it acts as a major livelihood option for them. Hence, biodiversity loss presents significant economic challenges. Historically biodiversity has been considered as a 'global public good', and its conservation and management are recognised as a global responsibility.

A great deal of economics is required to understand the emerging biodiversity issues, but a simple and important observation is that most species and ecosystems are not traded in markets, so prices are often absent and biodiversity is underprovided. One of the reasons biodiversity has been relegated to the margins of economics is that there are formidable obstacles in the way of high-quality economic analysis. Biodiversity is a particularly intractable economic problem (Helm and Cameron 2012).

In the absence of a market and price on biodiversity goods and services, informed choices about their conservation and sustainable use are difficult. Hence, understanding the value of the biodiversity, particularly the non-marketed services, is an apprehension, to the environmental economist from academic as well as policy perspectives. The absence of a price does not mean the absence of economic value. Revealing the hidden value of the ecosystem/biodiversity services through valuation techniques is an important mechanism for integrating biodiversity considerations in economic decision-making (CBD 2007). The work done by MEA (2003), Jin et al. (2003), Pearce and Dominic (1994) and the TEEB (2010) demonstrated (a) the significance of economic valuation of biodiversity for framing environmentally sustainable economic policies at regional, national and global level, (b) various methodologies for valuing the goods and services derived from the biodiversity and (c) the complexities and challenges in the valuation of biodiversity.

From the ABS perspective, we should re-examine the public good nature of biodiversity. Biodiversity services, which are not tangible and visible, have public good character. But in the biodiversity goods (which are tangible and visible) case, the state or people have an ownership rights based on the geographical location where a particular fauna or flora (bio-resources) flourish. Since bio-resources are the source for consumer products such as biopharmaceuticals (modern drugs), botanicals (AYUSH), food and nutraceuticals, personal care and cosmetics, crop protection products, etc., many business entrepreneurs historically demand the resources and the trend keeps on escalating with the advent of modern biotechnology.

Since biodiversity or bio-resources are unequally distributed in the world, their supply is restricted. On the other hand, their demand is escalating universally in the globalised world. This bio-resources business (collection, transfer and exchange) is progressing at an alarming rate in different parts of the world. This business trend has led to the transformation of biodiversity more from a global public good to a local public good or as state property and is to be viewed as a national sovereignty. In this context, the CBD insisted on their parties to follow ABS through legal and institutional arrangements for the conservation and sustainable use of their biodiversity.

8.3 Nagoya Protocol on Access and Benefit Sharing

Genetic/bio-resources and associated traditional knowledge have great commercial potential, and their contribution to global economy and global intellectual property regimes is enormous. They are the key resources for sustainable bioprospective and value addition processes. Further, biogenetic resources are the primary source of valuable genes, chemicals, drugs, pharmaceuticals, natural dyes, gums, resins, enzymes or proteins of great health, nutritional and economic importance (Pushpangadan and Nair 2005). The combined world market for products manufactured through bio-resources is estimated to be over US $500 billion (Laird and Kate 2002).

With the advent of new tools and techniques, the power of bioprospectives has increased considerably in recent decades. According to Pushpangadan and Nair (2005), modern bioprospectives include systematic search for genes, natural components, designs and whole organisms of either domesticated or wild sources with a potential for product development. Thus, bioprospective has three facets: chemical prospective, gene prospective and bionic prospective.

Even if biological diversity is a global asset, with tremendous value to the present and future generations, the species and ecosystem are under greater threat in recent years than ever before. Some estimates indicate the loss of 45–250 species per day and biodiversity losses have become a global concern. But biodiversity once lost is lost forever and likely to cause serious consequences to the ecosystem and human life. Considering this fact, arresting the decline of biodiversity (species and ecosystems) is a major objective of environmental policy at the global level, and needs to take initiatives at national and local levels.

With this perspective, the Convention of Biological Diversity (CBD) was initiated on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio ‘Earth Summit’) and came into force on December 1993 as an international instrument for comprehensively addressing biological diversity. The convention’s three objectives include (1) the conservation of biological diversity, (2) the sustainable use of its components and (3) the fair and equitable sharing of benefits arising from the utilisation of genetic resources. These objectives need to operate in a continuous and cyclical manner towards the successful running of the ecological/biodiversity functions for enhancing human welfare.

In a realistic sense, the third objective is more instrumental for achieving the first and second objectives of CBD. Therefore, further advance of the implementation of the third objective was essential. The World Summit on Sustainable Development at

Johannesburg (September 2002) called for the negotiation of an international regime, within the framework of the convention, to promote and safeguard the fair and equitable sharing of benefits arising from the utilisation of genetic resources. The convention's Conference of the Parties (COP) responded at its seventh meeting, in 2004, by mandating its Ad Hoc Open-ended Working Group. After 6 years of negotiation, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the CBD was adopted at the tenth meeting of the COP on 29 October 2010, in Nagoya, Japan (CBD 2011).

The protocol significantly advances the convention's third objective by providing a strong basis for greater legal certainty and transparency for both providers and users of genetic resources. Specific obligations to support compliance with domestic legislation or regulatory requirements of the party providing genetic resources and contractual obligations reflected in mutually agreed terms are a significant innovation of the protocol. In other words, the protocol made a platform for compliance provisions as well as the more predictable conditions for access to genetic resources and sharing their benefits. In addition, the protocol emphasises on the provisions of access to traditional knowledge (associated with genetic resources) owned by indigenous and local communities as well as benefit sharing to the community, when a company makes use of their knowledge, innovations and practices.

The protocol has 36 articles containing divergent aspects including objectives, use and scope, access of biological resources and traditional knowledge, fair and equitable benefit sharing, contribution to conservation and sustainable use, global multilateral benefit-sharing mechanism, compliance with domestic legislation, monitoring the utilisation of genetic resources, capacity and awareness raising, technology transfer, monitoring and reporting by parties, etc.

By promoting the use of genetic resources and associated traditional knowledge, and by strengthening the opportunities for fair and equitable sharing of benefits from their use, the protocol will create incentives to conserve biological diversity, sustainably use its components and further enhance the contribution of biological diversity to sustainable development and human well-being (CBD 2011). The protocol clearly demarcated various monetary and nonmonetary benefit-sharing strategies (Appendix 1). However, monetary benefit sharing is more transparent and requires a rigorous economic analysis.

8.4 Economic Principles in ABS: Valuation and Incentive

From the ABS perspective, the distinction between the 'exchange value' and 'use value' and their integration is the concern. Exchange value is the relative price of a good or service in the market. But the use value or utility of a good or service can be very different from the market price. For example, the market price of water may be very low, but their use value is extremely high. The reverse is the case for diamonds, where market price is extremely high but the use value may be low. Similarly, the market value of genetic/bio-resources is generally insignificant, but its use value to the bioprospecting industries is significant. Unfortunately, this fact is not rightly understood by the owners/providers of the resources but is restricted within the domain of science and technology or bioprospectors (users of the bio-resources).

Generally, different disciplines define and use value in different ways. In economics, value or utility is unambiguously anthropogenic and a subjective phenomenon. For marketed goods and services, it is humans who reveal value, in terms of their so-called willingness to pay, by the process of exchange. Similarly, utility is derived by humans. But other disciplines may assign different interpretations to value or importance, which may or may not be linked to values ascribed by human beings. For example, anthropology may infer value for biodiversity from cultural norms and practices that are in some sense non-negotiable (sacred groves). Theologians and ethicists may base importance on moral or spiritual criteria that are neither observable nor measurable (but nevertheless strong motives) and may also point out that the predominant role of humans in utilitarian thinking displaces intrinsic value and the right of other species to exist. Ecologists will be interested in the importance of attributes or functions of a system to maintain ecosystem resilience. This is an objective criterion, that is, irrespective of its relevance to humans (CBD 2007).

In brief, biodiversity has been viewed by the public from different perspectives; hence, its value may arrive at different disciplinary angles, which makes valuation more complex. However, for ABS purposes one should look at the value of biodiversity/bio-resources from realistic perspectives in an objective manner, considering their commercial potential and significance. But, practically a pure objective approach in bio-resources valuation is difficult. The present trend of indiscriminate extraction of bio-resources in huge volumes may affect their renewability and stock, which has vast ecological, social, spiritual and religious implications.

Environmental economics has extended the demand theory to the ecosystem/biodiversity goods and services that are not traded in markets. As they are not traded in markets, their value is not captured in the form of market prices. The reason is that many ecosystem goods and services bear characteristics of 'public goods', where nobody can be excluded from their use. For this reason, markets cannot spontaneously develop for public goods, and the value of these public goods will therefore be not reflected in a market price (CBD 2007).

Hence, the development of valuation methods that can elicit the 'hidden' value of non-marketed natural resources such as biodiversity goods and services is the primary responsibility of environmental economists. For ABS, the emphasis is not directly on the biodiversity services, but only on the goods coming out of the ecosystem/biodiversity. For example, the ABS negotiation is not with square kilometres of the forest and its services (such as climatic control, nutrient cycle, hydrological functions, etc.), but with the goods (like medicinal plants, fruits, grains, etc.) coming out from the forests. Here, the ABS philosophy propagates that among the benefits derived from the commercial use of medicinal plants, a portion has to be shared to the local community; it acts as an incentive to them in the conservation and sustainable use of the medicinal plants.

According to Morten and Tomme (2007), the uncertainty of valuation in the ABS process has generally caused CBD parties to avoid the valuation discussion, possibly to protect their position in future negotiations of individual ABS arrangements. At the same time, however, the lack of transparency regarding the valuation of genetic resources, in general and in specific contracts, has been a major factor contributing to the complexity and difficulty of ABS negotiations and documentation in developing countries. Joseph et al. (2011) also stated that economic thinking has been absent in all ten COP to the CBD despite its presence in academic literature. Perhaps as a consequence of faithful reporting, economics is also absent in the otherwise excellent overview by Evanson et al. (2010) of the Nagoya Protocol on Access to Genetic Resources and Benefit Sharing. By ignoring the abstraction that economics affords, ABS has become needlessly complex and contentious.

Another crucial economic aspect, which is scarcely understood, is ABS as an innovative financial mechanism, through which one can find out the finance required for the conservation and the management of biodiversity. Pisupati and Bavikatte (2014) stated that the time has come for parties to the CBD to review this situation and move forward progressively in the manner the ABS framework is developed, not as a legal centred approach making the process heavy administratively and legally but as a resource-centred approach that offers streamlined opportunities to raise local resources for implementing the Nagoya Protocol.

Hence, developing countries should aim towards mobilising adequate finance from biodiversity management through ABS. If they succeed in these tasks, they should not depend on other sources (public finance), which may be extremely cumbersome for developing countries for biodiversity conservation. In this context, the need of the hour in a post-Nagoya process is a paradigm shift in the way perceptions about ABS systems are placed. We need to stop looking at ABS through the lenses of the Nagoya Protocol negotiations, where the focus is to prevent biopiracy at all costs. Instead we now have to start viewing ABS as an innovative financing mechanism than as a regulatory burden (Pisupati and Bavikatte 2014).

8.4.1 Trajectory in ABS: Valuation Options and Challenges

It is clear that biodiversity is a series of overlapping public goods, from the local to the global scale. The biodiversity literature is much more heterogeneous. The economic tools available are not yet 'fit for the purpose' of the analysis of biodiversity, though they are a helpful starting point (Helm and Cameron 2012), and this is true in the case of ABS. Suneetha and Pisupati (2009) proposed that resorting to a periodical valuation of their economic value will help in determining and realising the realistic estimates of the benefits derivable from the accessed resources and thereby the benefits accruable to the country and communities of the origin of the resource or knowledge.

From a practical sense, the value of the benefits addressed in ABS contracts and legislation needs to be either pre-estimating (where leading to an agreed amount for benefit sharing which can be paid early in the ABS relationship) as upfront payment or by waiting and valuing each benefit (through a detailed value chain), as it is received. In general, the pre-estimation and upfront payment process can happen only where there is an ABS contract or other agreement. According to Morten and Tomme (2007), 'currently, there is no basis in the CBD or elsewhere for unilaterally choosing and imposing a set value on either Party'. Consent to a specified payment as full or partial satisfaction of the benefit-sharing obligations must be reflected in MAT. But a lot of constraints and complexities exist, when practically viewing this negotiation process. This is primarily due to the uncertainties in bioprospecting and the generation of benefit acquisition.

Bavikatte and Morten (2015) indicated that determining the value of a resource for a particular industry based on the exploratory phase of the research and insufficient information regarding market potential and various other imponderables in ABS process is the practice. However, this is considered as a major valuation challenge pertaining to ABS. The valuation process in ABS is very complex and needs to realise that 'genetic resources' are something more than simply the raw materials of biotechnology (Morten and Tomme (2007). In this context only, within the CBD, the specialised legal right to utilise genetic resources was created as a mechanism for integrating a variety of linked objectives and rights, through a legislative and contractual system.

Here, the question arises how genetic resource valuation differs from the traditional kinds of ecosystem/biodiversity goods valuation or physical valuation of bioresources. Traditionally, variations in the 'genetic value' from the bio-resources value were not distinguished, and the genetic resources value depended primarily on the physical 'quality' of the particular material (bio-resources) being exchanged. For example, the value of 1 kl of grapes is much higher when the grapes are of the type, quality and condition that enable them to be used to produce champagne and much lower when they can only be sold for consumption as 'table grapes'. However, this distinct value will not reflect in the market, if the above information asymmetry exists, and it is the real fact in most of the genetic or biological resources exchange.

But in recent years, with the help of advanced science, we can identify the commercially significant bio-resources and enhance their production through scientific farming methods. A particular genetic or biochemical data or material may be valuable as a 'genetic resource' where it is linked to properties that can be used or replicated in other ways. Their value may depend on either or both the microphysical genetic material and the genetic information it contains. Whether these components are utilised individually or together, the utilisation of genetic material is recognised to confer a different or additional value beyond the bulk value of the particular biological resources.

The above statement reveals that the value of 'genetic resources' for ABS must be discussed from the perspective of drawing benefits from using the microphysical material and utilisation of the genetic information that they contain. Valuation must target the new resources value, separating the bulk value of the biological resource from the value of its tangible and intangible genetic resources. This would include, for example, DNA sequences and biochemical formulas, whether contained in whole specimens, prepared samples, extracts or written scientific notation or descriptions (Morten and Tomme 2007).

For operationalising the ABS mechanism as per the CBD norms, it is necessary to assess the genetic resources value. However, most of these genetic resources are non-excludable ones. The task of the ABS system is to assess the true value of the genetic resource and share it appropriately, so that the source countries do not feel the need to block the access or limit the exchange of genetic resources. A clear standard for valuation and sharing would serve two primary purposes: (a) to alleviate misunderstandings and unrealistic expectations of both providers and users and (b) to provide a concrete basis for the implementation of user-side measures, including especially in determining the obligations of a user who has not obtained an ABS contract with the source country. In this manner the equity principle will be ensured in the process between the provider and users of genetic or biological resources. However, the valuation of genetic resources which considers its divergent potential to different bioprospectors is a mammoth task.

In most countries, biodiversity and genetic resources and associated traditional knowledge are considered to be public goods, managed under the oversight of the national government as the sovereign right of the nation. However, historically communities are collecting the resources with their users' rights and providing to the users (bioprospectors) without understanding their potential. Here, the government as a legal custodian of their resources needs to play a significant role, particularly the resources coming out from common area such as the forests and oceans. Consequently, some mechanism is necessary to assure the negotiating government official that he is getting a fair value for a public resource which he is sworn to preserve and use in the best interests of the country and its citizens.

In the absence of the valuation of genetic resources, parties in ABS transactions may be compelled to accept inappropriate (too high or too low) payment as the user's benefit-sharing obligation. However, transparency about prices and financial terms will enable the development of professional appraisal standards, which can ease contractual negotiations. It has been noted that the 'current form of contractual approach is leading to a low value of individual transactions and not to the full valuation of environmental services provided by biodiversity' (Morten and Tomme 2007). Perhaps the most important dilemma in genetic resources is that public goods are disposed of through private contracts, where equity and CBD objectives will not be supported by commercial practices. Private negotiations (for public good) rarely, if ever, reflect the interests, needs and values of the society or community. In this respect, it is important to examine the lacuna in the existing valuation procedures of the bio-resources and a paradigm shift in the bio-resources valuation for ABS is necessary.

8.4.2 Lacuna in Classical Valuation Approach in ABS Perspectives

According to Pisupati (2013), lack of valuation is the underlying cause for the observed degradation of ecosystems and loss of biodiversity. Ecosystems, their goods and services and biodiversity are often systematically undervalued. The reason for this is their site-specific nature and perceived short-term gains as against private goods that are valued due to ownership rights, potential future value and integration into formal economic equations. Sectoral policies, lack of methods to value public goods and/or understanding of how to protect such goods often pose serious challenges to policymakers to recognise public goods and integrate their preservation into policymaking. This is the fundamental challenge in operationalising the ABS mechanism in biodiversity goods, since they are predominantly public goods.

Conceptually, the total economic value (TEV) of an ecosystem/biodiversity resource consists of its use value (UV) and non-use value (NUV). A use value is a value (in the form of commodities and services) arising from an actual use made of a given resource. This might be the use of a biodiversity hot spot, like the forest for timber and non-timber products, or of a wetland for recreation or fishing and so on. Use values are further divided into direct use values (DUV), which refer to actual uses such as fishing, timber extraction and others; indirect use values (IUV), which refer to the benefits deriving from ecosystem functions, such as a forest's function in protecting the watershed, carbon sequestration, nutrient cycle, etc.; and option values (OV), which is a value approximating an individual's willingness to pay to safeguard an asset for the option of using it at a future date, like an insurance value.

NUVs are more problematic in definition and estimation since these are non-marketed services of biodiversity or an ecosystem. NUVs are usually divided as a bequest value (BV) and an existence or 'passive' use value (EV). The former measures the benefit accruing to any individual from the knowledge that others might benefit from a resource in future. The latter are unrelated to current use or option values, deriving simply from the existence of any particular asset (Pearce and Dominic 1994). Thus, the total economic value is generally calculated using the formula:

$$\mathrm{TEV} = \mathrm{UV} + \mathrm{NUV} = \left(\mathrm{DUV} + \mathrm{IUV} + \mathrm{OV}\right) + \left(\mathrm{EV} + \mathrm{BV}\right)$$

Generally, the valuation of the non-marketed services of ecosystem is a challenge. However, environmental economists widely attempted to value the ecosystem services through the generation of the hypothetical markets; and as per the estimation done by Costanza et al. (1997), the current economic value of 17 ecosystem services for 16 biomes for the entire biosphere was in the range of US \$16–54 trillion (10^{12}) per year, with an average of US \$33 trillion per year. However, the global gross national product is around US \$18 trillion per year.

Ecosystem valuation methods consider market prices, replacement costs, damage cost avoided, production function, hedonic price method, travel cost method, contingent valuation method, choice experiments, participatory environmental valuation and benefits transfer (mean value, adjusted mean value, benefit function) (TEEB 2010).

Here, we need to re-examine the valuation process adopted for goods derived from the ecosystem, which is the major concern for ABS. At present, environmental economists are assigning the values of ecosystem goods (genetic or bio-resources), based on their current exchange rate or price (multiplying the quantity of goods with the price) at their collection point, such as the forest gate or the nearby local market.

On the other hand, the non-marketed services of ecosystems are estimated based on the standard valuation tools and methods.

However, the paradox is that when the ecosystem/biodiversity services are valued with the help of appropriate methodologies, the ecosystem/biodiversity goods value is determined with the help of the existing market prices that are completely arbitrary, in the absence of well-functioning markets (Nelliyet and Pisupati 2014). Such prices do not consider the true or actual value of these biodiversity goods (bio-resources). A considerable volume of bio-resources is in public land, like forests, wetlands and ocean, where the local communities are entitled to the users' rights.

In the ABS perspective, we are not doing the TEV estimation of a particular ecosystem but only the direct use value of the ecosystem/biodiversity goods, in the form of bio-resources/genetic resources, that have market potential and business scope.

Nelliyet and Pisupati (2013) did a detailed review on the literature pertaining to different bio-resources valuations. These studies attempted to (a) understand and disseminate the bioprospecting values of bio-resources/biodiversity; (b) assess the value of biodiversity spots such as cultivable (agriculture) land, forests and wetlands, where the bio-resources are growing; and (c) understand the significance of bioprospecting values in biodiversity conservation as a source of revenue. These studies argued that through estimating and assigning a value to biodiversity hot spots like forests, considering their resources (such as medicinal plants) may help in conserving the land/resources and overcome the threats of different land-use changes. Here, the final figure (value) arrived at by each study is not of great concern, since it is not directly used for any policy decisions. However, some of the methods/approaches used are very promising and can be considered for the valuation we are seeking for ABS, with the required modifications.

According to Beattie (n. a.), three underlying principles are the bioprospecting values of different bio-resources:

1. Economic values are determined on the margin. This means that values must be placed in the context of particular magnitudes of change. If a great majority of the Earth's biodiversity were to be lost, the value of the lost opportunities for inventing and improving products would be astronomical. Less value would be foregone if fewer components of biodiversity were at risk.
2. Research and development is an inherently random process, and the outcomes are uncertain. The value to be assigned to a change in the biodiversity available for conducting research is related to the increase in the expectation of the outcome it affords.
3. Value is determined by scarcity. If there is a lot of something, a little more or less of it does not make much difference. Conversely, unique resources command large values because there are no substitutes for them.

In a developing country like India, generally bio-resources are collected or cultivated by the communities and transferred to the prospecting industries through traders. In reality, the provider (community) and trader of the resources are not aware about the bioprospecting scope and the overall economic potential of the resources, which they supply to the user (industries). Since there are no proper markets for such resources at their collection point, along with a huge information asymmetry, the existing price for the bio-resources does not reveal its actual value. The actual value may be more than the existing market price (Nelliyet and Pisupati 2014).

8.4.3 Approach and Methods of Valuation for ABS

According to Markandya and Nunes (2012), in order to regulate the proliferation of bioprospecting and protect biological diversity in the source countries, the CBD established a legal framework for the reciprocal transfer of biological materials between the interested parties in bioprospecting activities, subject to the Prior Informed Content (PIC) principles, and a set of mutually agreed items on equitable sharing of benefits. However, there is a feeling that the 'price' being paid under these arrangements is too low; particularly, the resource is largely open to access.

Bio-resources are not like other natural resources such as, air, water, minerals and soil qualities. Generally, in these resources there is no demarcation between the provider and the users. Further, the benefits arising from the use of these resources are more region oriented and confined to the local communities. However, the benefits accrued from the bio-resources (genetic resources) through bioprospecting differ, as they are widespread and universal in nature. In the case of biodiversity/ bio-resources, the providers and users may be in different locations or countries.

The economic valuation or estimation of the true value of bio-resources at their collection point is an important aspect and a prerequisite in operationalising the ABS mechanism. Here the nature of demand on bio-resources by the bioprospecting industries is critical. For example, bioprospecting industries like pharmaceuticals (modern drug), biotechnology (seed and agriculture related) and bio-fertiliser and pesticides need microorganisms (bio-resources) from nature in limited quantities and multiply them through their in-house R&D as per their requirements.

But industries like botanicals (AYUSH), food and nutraceuticals required the bio-resources as a raw material on a regular basis, in bulk quantities. Therefore, just arriving at the value based on the volume or quantity for benefit sharing is inappropriate. Sometimes one drop of inoculum or unit of enzyme or strain used by a modern drug manufacturing company may be more valuable than one ton of *Andrographis paniculata* (a medicinal plant) generally used in the preparation of Ayurvedic medicine. However, the providers (local community) are unaware of this fact and exchanging the resources for a negligible price.

The above-mentioned scenarios may be common in the bio-resources business, which makes valuation much more complex. Hence, rather than a unilateral valuation approach, divergent approaches, which consider the nature of collection (one time, occasionally or regularly) of bio-resources, should be followed. Broadly, what is needed here is a thorough understanding of the value addition on bio-resources-based production activity.

In brief, for ABS valuation one should identify the proportion of bio-resources in the product *or* identify the value of bio-resources in the total value of the product or identify the share of bio-resources-induced profit (benefit) in the total profit (benefit). Since the existing literature on environmental economics has not debated much on the ABS kind of valuation, we do not have any standard methodology for valuation for operationalising the ABS. However, based on the rough insights from selected literature and the experts' opinion, the following thoughts for developing the methodology for valuing bio-resources for ABS are proposed.

- In bio-resources-based economic activities and exchange, the provider or community may not know the actual value, since they are not involved in or are not aware of the potential use and the production processes. But the buyers (industries and the prospectors) are fully aware of the value of the resources. Hence, the 'maximum willingness to pay' for bio-resources by the user at their collection point will be captured, and it will reveal the bio-resources 'real value'. Through this process, a mutually negotiable/agreeable price will derive, which is the emphasis of CBD's proposal of MAT for benefit sharing.
- The bio-resources which come under the purview of the ABS are predominantly the public-owned or common property resources. Bio-resources have multiple uses and diverse product manufacturing capacities and value generation (it is not a uniform resource like water). With this consideration one can fix a 'tax' or apply any other appropriate economic instrument (cess, charges and royalty, etc.) for the extraction of the particular resources.
- The authority concerned (at local and national levels) can fix a support price, with the consultation of experts, for the bio-resources prevailing in their jurisdiction. The nature of the availability of the resources, demand, parts of collection, usage in industries, value generation capacity, etc., may be considered as the criteria for fixing the support price.
- Generally, the local communities put in their hard work and unique knowledge in collecting the bio-resources from the wild. But in most cases, they are compelled to exchange the resources at negligible prices, due to market imperfection, lack of ownership rights of the resources and the least bargaining ability. Rather than this, the communities' 'minimum willingness to accept' for bio-resources price should be considered. Here, the price of a particular bio-resource collected by a community/collector should not be less than his or her minimum willingness to accept.
- A minimum or standard amount for rural livelihood or wage can be considered for bio-resources collectors ('minimum livelihood approach'). The time spent by communities for bio-resources' collection is the criterion for fixing the amount, and that amount can be considered as the value of the bio-resources that he/she collected per day.
- The bio-resources from the agriculture ecosystem which are cultivated can be valued, considering their cost of production or cultivation. This approach is more transparent and easy to estimate.

However, for fixing the tax, cess, charges, royalty and minimum support price for bio-resources, the government or the authority concerned required a scientific base or criterion. In this regard, assessing the 'value chain' of bio-resources-based production from the input to the final output is the promising strategy.

Generally, value addition for bio-resources (raw) and bio-resources-based products occurs either through transaction costs or/and processing or manufacturing costs (Nelliyet and Pisupati 2014). Transaction costs are the costs of a particular bio-resources' movement from their collection point to the company gate and occur through transportation charges and brokers' or traders' or dealers' profits. Normally, the bio-resources transaction may take place through different agencies such as federations, wholesalers and retailers at different locations before reaching the final consumer, and the price spread for the resources will occur. The ABS concern is whether the price spread is reasonable or not, and if not, what are the abnormalities and how will it bounce back to the communities or providers of the resources.

Further, bio-resources are basic raw materials for manufacturing the final consumer products. Besides, many other products (inputs) and knowledge/skill (research and development) also contribute to an output production. Hence, the processing or manufacturing costs at different stages are significant. Through an amortised (remunerated) pricing technique, one can estimate the real price of the bio-resources. The same approach is applicable in the case of bioprospecting-based research and development.

For a value chain analysis, a series of steps are proposed with reliable information and sources (Table 8.1). It is important to have the active participation of various bio-resources stakeholders (collectors, traders and industries) and a reliable database for the comprehensive value chain analysis of bio-resources.

Through a value chain analysis, one can derive the 'rent', the difference between that bio-resources value (to the users) and the costs of obtaining/exploiting the resources:

$$\text{Rent}(\text{R}) = \text{Value}(\text{V}) - \text{Cost}(\text{C})$$

In bioprospecting rent is a surplus value that remains with the industries after deducting all costs of production including the raw material costs, labour costs, building and machinery costs and costs for entrepreneurial skills as normal profits. This surplus value is the prime concern in ABS, and the argument is 'why can't this surplus value (abnormal benefits), or at least a reasonable share of it, should be shared with the original owners/providers of bio-resources, who are the local and indigenous communities or the state'.

Here, along with the general rent based on the nature of the bio-resources, one needs to take into account specific rent such as scarcity rent (SR), endemic rent (ER) and information rent (IR).

- SR is the value derived from the limited stock of resources compared to its demand. Here, those bio-resources are entitled for a special price (rent) due to

Table 8.1 Major steps in value chain analysis

Major steps in value chain analysis		
Steps	Tasks	Sources of information
1	Identification of the key bio-resources (having economic and ABS potential) extracted from a geographical area/ecosystem	Local communities, biodiversity data at local level, forest departments and others
2	Understand the status of the bio-resources (Rare Endangered and Threatened – RET, abundant, endemic). For providing a weightage in valuation process (rent)	Local communities, biodiversity data at local level, forest department and others including taxonomists and ecologists
3	Understand its potential/purpose/usage	Local communities, traders, research organisations, government departments, industries
4	Identify its leverage/movements: local → regional → state → national → international	Local communities, traders, industrial association, companies, exporters, customs department
5	Prioritise the promising uses of bio-resources based on value addition (ranking)	Industries, traders, research organisations
6	Select any manufacturing company, who use the bio-resources	Appropriate industry
7	Estimate the transaction cost of bio-resources: from forest gate to company gate. (Price at company gate – price at forest gate)	Forest dwellers, traders, industries
8	Identify the major production steps	Company management and production manager
9	Identify the different factors of production involved in each stage and its cost/remuneration (factor cost method)	Company management, production manager and labourers
10	Identify the abnormal benefits and rates (differences between company rate with general market rate)	Company management, production manager, labourers, industrial/govt. departments
11	Fix the optimum benefit and share the surplus to local communities who preserve the bio-resources (royalty; institutional mechanism for distribution)	Company management, production manager, labourers, industrial/govt. departments and local communities

Source: Nelliyat and Pisupati (2014)

their limited availability, with the assumption that if this resources stock is not available for a company, they cannot proceed with its production.

- ER is the special value derived from an endemic species; they are unique and region specific. If these scarce and endemic species or resources are just extracted like normal or plentiful resources, there are possibilities of a reduction in their stock and to extinction.
- IR is the value/profit acquired through relevant prior information (high-probability leads). Information is a valuable economic resource and plays a significant role in bioprospecting. Any bioprospecting research starts with prior information which makes the discovery easy and achieves huge time and cost saving. Generally, the traditional knowledge (TK) about bio-resources (such as

availability, season and location; collection, storage, packing and transportation procedures; sustainable extraction; different/promising users; harvesting practices; etc.) existing with local communities is the key for bioprospecting and information rent.

In brief, the value of bio-resources should be estimated considering the contribution to the total product value or profit plus the relevant rent of bio-resources such as SR, ER or IR.

8.5 Conclusion

Biodiversity is the fundamental source of bioprospecting, but it is rarely possible to predict which genes, species or ecosystems will become valuable for bioprospecting. However, well-regulated bioprospecting contributes to the joint goals of ecosystem conservation and socio-economic development through partnerships and benefit sharing. Market trends on genetic/bio-resources vary widely according to the industry and country involved, but many bioprospecting activities and revenues are expected to increase over the next decades. If proactive action is not taken in time, biodiversity is under huge pressure. Global threats to biodiversity, and especially species losses, may affect the development of valuable new products for humanity, including medicines, industrial processes and new crop varieties.

There is no doubt about the socio-ecological and ethical significance of the ABS doctrine. ABS is a revenue generation process and can ensure financial security for biodiversity management. Besides, it is an incentives mechanism for local bodies or communities for the conservation and sustainable use of biodiversity. However, ABS operationalisation faces huge hurdles at different levels, and the valuation of bio-resources and estimation of the benefits derived from bioprospecting are the major ones. These attempts are extremely important to determine the benefit-sharing criteria and ensure equity, which is under the domain of economics. However, economics is not a subject that fundamentally attempts equity, but it is more on efficiency at various levels, such as production, exchange, distribution and consumption. For equitable benefit sharing, an estimation of the ‘real value’ of the bio-resources is required, where economists would come up with the appropriate valuation techniques.

In the biodiversity/bio-resources case, ownership is a big concern. Generally, the ownership of the bio-resources from common land is with the state; the community enjoys its user rights. Since the property rights of bio-resources are not well defined and dispersed (not like the private resources), the market cannot function effectively and determine the real price for the resources derived from the biodiversity. Hence, the equity principles cannot reach automatically in the bio-resources business. In other words, unstable ownership rights induced unequal distribution of the benefit; this is the concern of ABS.

It is assumed that bioprospectors are making huge residual rents which are confined with the company as an abnormal profit/benefit. The ABS challenge is to frame a legal strategy to bounce back this abnormal profit from the bioprospectors to the bio-resources providers (communities), through the introduction of appropriate economic instruments such as royalty. In this manner, the owner of the resources should receive a fair share. Here, the political economy question is: what is the remunerative price for a particular genetic/bio-resource when it is exchanged? Normally, for a private good, the price is estimated based on the cost of production. But bio-resources from public lands are a gift of nature; hence, the costs of production do not emerge. These resources are exchanged for a meagre price, which represents only a part of the resources value.

Bio-resources scarcity is with respect to its demand or 'economic scarcity'. Here one should break the monopoly and try to understand the true demand (derived demand) of the bio-resources, which is a prerequisite for obtaining a reasonable price for them. In brief, the major valuation concern for ABS is to identify the marginal value of the bio-resources in the total value of the product and impose a simple tax (with a reliable rate) for bioprospectors. If we fail in justifying and convincing the stakeholders about the 'fairness of the bio-resources value', ABS itself will become a dandling challenge and a vague philosophy.

Appendix 1

Monetary and Nonmonetary Benefits

Monetary benefits may include, but not be limited to:

(a) Access fees/fee per sample collected or otherwise acquired
(b) Upfront payments
(c) Milestone payments
(d) Payment of royalties
(e) Licence fees in case of commercialisation
(f) Special fees to be paid to trust funds supporting conservation and sustainable use of biodiversity
(g) Salaries and preferential terms where mutually agreed
(h) Research funding
(i) Joint ventures
(j) Joint ownership of relevant intellectual property rights

Nonmonetary benefits may include, but not be limited to:

(a) Sharing of research and development results
(b) Collaboration, cooperation and contribution in scientific research and development programmes, particularly biotechnological research activities, where possible in the party providing genetic resources

(c) Participation in product development
(d) Collaboration, cooperation and contribution in education and training
(e) Admittance to ex situ facilities of genetic resources and to databases
(f) Transfer to the provider of the genetic resources of knowledge and technology under fair and most favourable terms, including on concessional and preferential terms where agreed, in particular, knowledge and technology that make use of genetic resources, including biotechnology, or that are relevant to the conservation and sustainable utilisation of biological diversity
(g) Strengthening capacities for technology transfer
(h) Institutional capacity building
(i) Human and material resources to strengthen the capacities for the administration and enforcement of access regulations
(j) Training related to genetic resources with the full participation of countries providing genetic resources, and where possible, in such countries
(k) Access to scientific information relevant to conservation and sustainable use of biological diversity, including biological inventories and taxonomic studies
(l) Contributions to the local economy
(m) Research directed towards priority needs, such as health and food security, taking into account domestic uses of genetic resources in the party providing genetic resources
(n) Institutional and professional relationships that can arise from an access and benefit-sharing agreement and subsequent collaborative activities
(o) Food and livelihood security benefits
(p) Social recognition
(q) Joint ownership of relevant intellectual property rights

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Chapter 9
Green GSDP for Sustainable Development

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Abstract Conventional measures of national income and wealth do not account for environmental and social costs of development. Therefore, they may mislead long-term economic forecasts for an economy. It is therefore necessary to develop a system of accounting of natural resources, which is likely to provide ample support to design the economic system, in such way that it is possible to attain economic growth without destroying natural resources. Hence, the concept of green accounting has increasingly been accepted and promoted by national and international organizations. This system of greening our accounts would provide an improved parameter of measuring development as compared to GDP growth alone. Green GDP shall measure sustainability of development and would be an appropriate and valuable decision-making aid in economic planning. The study discusses the accounting framework for forestry accounting in the context of SEEA and provides the framework and methodology for compilation of forestry accounts. It attempts on economic valuation of few ecosystem services, viz. carbon sequestration, soil conservation, water recharge, water purification and pollination and seed dispersal services from the forests of Karnataka, India. The study also highlights the 'glaring lack of data', 'standardized methodologies' and 'standardized accounting units' for ascribing an economic value to intangible services deriving from forest resource as the main reason for it not being included in the accounting part of conventional GDP.

Keywords GSDP • Economic valuation • Forest • Ecosystem services • Carbon sequestration • Soil conservation • Water recharge • Water purification • Pollination

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9.1 Introduction

Forests form a unique set of natural resource which sustains life on earth. Forests provide tangible marketable goods such as timber, fuel wood and non-timber forest produce. Forests also provide life-sustaining services like sequestration of atmospheric carbon, generate atmospheric oxygen, regulate temperature and rainfall, protect soil cover and recharge the groundwater. These services fall outside the domain of markets; hence, their services are not traded. Therefore, the services are unprized and unaccounted. As a result, the GDP underestimates the prosperity enjoyed by the society due to the contributions of natural wealth.

9.2 Classification of Forest Types in Karnataka

The SEEA methodology is adopted, and the population stratification technique is endorsed to divide a heterogeneous population into relatively homogeneous subpopulation based on certain stratification variables. Since forest ecosystem services largely depend on the forest type and canopy density, these two variables are considered as stratification variables. The canopy density-wise spatial information is available under the forest cover mapping project by the Forest Survey of India (FSI). Forest cover density has four canopy density classes, viz. very dense forests (VDF), moderately dense forests (MDF), open forests (OF), and scrub (S). In Karnataka, India, there are six forest-type groups, viz. tropical wet evergreen, tropical semievergreen, tropical moist deciduous, tropical dry deciduous, tropical thorn and subtropical broad-leaved hill forests. Thus there are four forest canopy density classes and six forest-type classes giving 24 classes or classification units in all. The spatial extent of each classification unit for forests in Karnataka is given in Table 9.1.

Table 9.1 Spatial extent of each classification unit for forests in Karnataka (in Hectares)

SL no	Forest-type groups	Very dense forest (VDF)	Moderately dense forest (MDF)	Open forest (OF)	Scrub (S)	Total
1	Tropical wet evergreen forests of Western Ghats	29,400	504,700	107,200	0	641,300
2	Tropical semievergreen forests of Western Ghats	8300	393,000	119,500	100	520,900
3	Tropical moist deciduous forests	7600	666,100	255,500	0	929,200
4	Tropical dry deciduous forests	600	340,100	441,300	152,700	934,700
5	Tropical thorn forests	0	48,100	247,900	162,300	458,300
6	Broad-leaved hill forests	400	26,700	12,300	0	39,400
Total forest area						3,523,800

The economic values for classes were multiplied by the area statistic of respective classes and added together to arrive at the economic value of the goods and services for the forests as a whole. The ecosystem services valued comprise of carbon sequestration, soil conservation, water recharge, water purification and pollination and seed dispersal service.

9.3 Economic Valuation

9.3.1 Economic Value of Carbon Sequestration Service

Forests permanently sequester carbon and mitigate the effects of GHG emissions. The valuation of carbon sequestration services from forest classification units is calculated from below-mentioned assumptions:

(i) Total biomass estimates (tonnes/ha) in forest classification units as per from the forest inventory of the Forest Survey of India (FSI 2013)
(ii) Mean annual increment in biomass (tonnes/ha) based on Von Mantel's formula
(iii) Calculating annual carbon sequestration based on default Intergovernmental Panel on Climate Change (IPCC) values of carbon ~50 % of biomass and 1 tC = 3.67tCO_2 (IPCC 2003)
(iv) The average social cost of CO_2 (US\$10/tCO_2) and exchange rate 1 US\$ = Rs 63.4

The total value of carbon sequestration service from the forests in Karnataka is computed by multiplying the value of carbon sequestration (Table 9.2) with the area of respective forest classification unit (Table 9.1) and taking arithmetic sum of it.

Table 9.2 Valuation of carbon sequestration service

SL no	Forest-type groups	Very dense forest	Moderately dense forest	Open forest	Scrub
1	Tropical wet evergreen forests of Western Ghats	11,666	7176	2281	498
2	Tropical semievergreen forests of Western Ghats	7015	4129	1736	485
3	Tropical moist deciduous forests	5828	3529	1553	356
4	Tropical dry deciduous forests	3946	2866	1350	573
5	Tropical thorn forests	2412	1241	1083	383
6	Subtropical pine/broad-leaved hill forests	4699	3391	1460	274

Thus, the economic value of carbon sequestration service is Rs. 11,05,04,56,300[1] (US $166,384,952.44).

9.3.2 Economic Value of Soil Conservation Service

The quantity of annual soil erosion prevented by forests is estimated for all forest-type groups and canopy cover density classes based on the weight of soil per ha (forest inventory of FSI), estimated annual soil erosion rates and relative weights of different canopy densities in their ability to prevent soil erosion.

Assumptions

- Concentration of nutrients in runoff (C_N)

Nitrogen	2.320 mg/g
Phosphorus	0.044 mg/g
Potassium	8.250 mg/g

- Price of fertilizers (P_F)

Urea (46 % N)	5.36/kg
DAP	20.10/kg
Muriate of potash (60 % K_2O)	20.00 kg

- Assuming 100 years for the entire soil to erode completely and relative weights of various canopy density classes as compared to VDF class in preventing erosion loss

Ratio of erosion loss prevented by MDF to VDF	0.647
Ratio of erosion loss prevented by OF to VDF	0.294
Ratio of erosion loss prevented by scrub to VDF	0.059

The nutrient loss that is prevented is then quantified, and its value is computed on the market price of fertilizers. The economic value of soil conservation service is shown in Table 9.3.

The total economic value of soil conservation services can be obtained by multiplying the estimated values of each classification unit (Table 9.3) with the areas of respective classification units (Table 9.1) and taking arithmetic sum of it. Therefore,

[1] 10 Lakh = 100,000 = 1 million
1 Crore = 100 Lakh
1 US $ = Rs.66.61/–

Table 9.3 Calculation of soil conservation service

SL no	Forest-type groups	Very dense forest	Moderately dense forest	Open forest	Scrub
1	Tropical wet evergreen forests of Western Ghats	19,436	12,575	5714	1147
2	Tropical semievergreen forests of Western Ghats	16,917	10,946	4974	998
3	Tropical moist deciduous forests	21,076	13,636	6196	1243
4	Tropical dry deciduous forests	13,947	9024	4101	823
5	Tropical thorn forests	12,807	8286	3765	756
6	Subtropical pine/broad-leaved hill forests	14,589	9439	4289	861

economic value of soil conservation service is Rs. 3017, 15, 23,300 (US $454,287,798.88).

9.3.3 Economic Value of Water Purification Service

The economic value of water purification services was computed based on value estimated in studies elsewhere in the world and adjusted for GDP per capita and currency exchange rate. As there is lack of information on estimates for different forest-type groups and canopy density classes, therefore a common value of Rs.2950 (US $44.42) per ha/year has been taken for all classification units. The economic value of water purification services in rupees

$$= 2950 * (\text{US}\,\$44.42)\,\text{total area of all classification unit} = 2950 * 3523800$$
$$= 1039{,}52{,}10{,}000\,(\text{Us}\,\$156519013.74)$$

9.3.4 Economic Value of Water Recharge Service

The economic value of water recharge has been estimated as per the calculation and assumptions and is shown in Table 9.4:

1. Runoff rates are assumed as below for different forest canopy cover densities.
2. Runoff rates for bare soil and VDF are from P. Kumar et al. (2006), and those for MDF and OF are estimated based on average canopy density assuming linear relationship.
3. Precipitation data taken from UNEP geo data portal.
4. Economic value of water taken as E_V = Rs 12.93 ($0.19) per cubic metre (Kumar et al. 2008).

Table 9.4 Economic value of water recharge service

Canopy density category	Average canopy density	Runoff as percentage of rainfall	Difference in runoff rates with respect to bare soil
Bare soil	0	19.60 %	0.00 %
Scrub	0.05	18.56 %	1.04 %
OF	0.25	14.42 %	5.18 %
MDF	0.55	8.21 %	11.39 %
VDF	0.85	2.00 %	17.60 %

Table 9.5 Calculations of water recharge service

SL no	Forest-type groups	Very dense forest	Moderately dense forest	Open forest	Scrub
1	Tropical wet evergreen forests of Western Ghats	4365	2643	1142	208
2	Tropical semievergreen forests of Western Ghats	3793	2357	978	217
3	Tropical moist deciduous forests	2878	2048	1115	193
4	Tropical dry deciduous forests	1951	1269	527	103
5	Tropical thorn forests	1578	1270	472	82
6	Subtropical pine/broad-leaved hill forests	2171	1340	796	181

The total economic value of water recharge services can be obtained by multiplying the estimated values given in Table 9.5 with the areas of respective classification units (Table 9.1) and adding the values for all the units. Thus, the economic value of water recharge service is computed as Rs. 524, 91, 71,500 (US $79,035,935.41).

9.3.5 Economic Value of Pollination and Seed Dispersal Service

The economic value of pollination and seed dispersal service has been estimated in the current study based on natural forest regeneration and its replacement cost if done artificially according to the model cost of Rs.17,100 (US $257.47) per hectare as recommended by the National Afforestation Programme Guidelines (NAP 2009). The estimates of natural forest regeneration in all forest-type groups classified are further adjusted according to the forest regeneration in plantations. The calculation of economic value per ha for each of the classification unit is as per the assumptions given below:

- Data for percentage ideal regeneration is taken from forest inventory, Forest Survey of India 2013.

- Regeneration percentage is adjusted according to the regeneration estimates of 62.6 % in plantations as per forest inventory, FSI 2013.
- Value is calculated assuming only 50 % of the regeneration can be attributed to pollination and seed dispersal services.
- Assuming costs for artificial regeneration on the basis of model costs of Rs 17,000 (US $255.97) per ha as per the National Afforestation Programme Guidelines 2009.

Calculations of pollination and seed dispersal service is given in Table 9.6. The total economic value of pollination and seed dispersal service is obtained by multiplying the estimated values given in Table 9.7 with area of respective forest classification unit (given in Table 9.1) and adding the values for all the units. Thus, the economic value of pollination and seed dispersal service is computed as Rs.3695, 95, 43,800 (US $556,493,937.47). Total economic value of ecosystem services from forests of Karnataka is calculated as US $ 1,412,721,638.00 (Table 9.8).

9.3.6 Environmentally Adjusted NSDP

The NSDP value of the forestry and logging sector for the year 2013–2014 is Rs 11,776 crores.

$$\begin{gathered}\text{The contribution of forestry and logging sector} = \text{Total economic value of all 5 forest}\\ + \text{NSDP ecosystem services} = 9382.5904900 + 11{,}776 = \text{Rs } 21{,}158.59049 \text{ crores}\end{gathered}$$

Table 9.6 Calculations of pollination and seed dispersal service

SL no	Forest-type groups	% to ideal regeneration	Regeneration after adjustment of regeneration in plantations	Value of pollination and seed dispersal services
1	Tropical wet evergreen forests of Western Ghats	87.2	139.2	11,907
2	Tropical semievergreen forests of Western Ghats	88.3	141.0	12,054
3	Tropical moist deciduous forests	77.2	123.3	10,548
4	Tropical dry deciduous forests	74.4	118.9	10,167
5	Tropical thorn forests	54.5	87.1	7448
6	Subtropical pine/ broad-leaved hill forests	60.8	97.0	8298

Table 9.7 Economic value of pollination and seed dispersal service

SL no	Forest-type groups	Very dense forest	Moderately dense forest	Open forest	Scrub
1	Tropical wet evergreen forests of Western Ghats	11,907	11,907	11,907	11,907
2	Tropical semievergreen forests of Western Ghats	12,054	12,054	12,054	12,054
3	Tropical moist deciduous forests	10,548	10,548	10,548	10,548
4	Tropical dry deciduous forests	10,167	10,167	10,167	10,167
5	Tropical thorn forests	7448	7448	7448	7448
6	Subtropical pine/broad-leaved hill forests	8298	8298	8298	8298

Table 9.8 Total economic value of ecosystem services from forests of Karnataka

Particulars	Value (US $)
Total economic value of carbon sequestration service	166,384,952.44
Total economic value of soil conservation services	454,287,798.88
Total economic value of water purification services	156,519,013.74
Total economic value of pollination and seed dispersal services	556,493,937.47
Total economic value of water recharge services	79,035,935.41
The total economic value of all the ecosystem services	1,412,721,638.00

9.4 Conclusion

It is necessary to provide weightage to ecosystem services in the calculation of GDPs so that the critical importance of natural resources is quantitatively measured and adequate funds are provided in state budgets for the maintenance and development of forest ecosystems. Any decision regarding conservation or diversion of forest resources is taken with a cost-to-benefit analysis incorporating the value of their ecological functions.

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Part II
Biodiversity Governance for Sustainable Development

Chapter 10
Decentralized Governance for Sustainable Development

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Abstract India has devolved considerable powers to local self-government institutions in rural areas, through Panchayati Raj Institutions (PRIs). PRIs have a three-tier structure with gram sabha and gram panchayat as the basic unit, which are usually at the level of a village. Biodiversity management is a multilayered process, and the involvement of local communities in conservation planning should be at the core of conservation initiatives. The Kerala State Biodiversity Board (KSBB) has taken the initiative to encourage and empower the local self-governments to effectively conserve biodiversity for a sustainable future. In Kerala, Biodiversity Management Committees (BMCs) have been authorized to function as "environmental watch groups." This chapter highlights the programs for biodiversity conservation implemented at local level in Kerala, India, by the BMCs. The chapter presents five different case studies and explores the process of BMC formulation and tries to analyze the factors that facilitate or hinder conservation actions at local level.

Keywords Decentralized governance • Biodiversity management committee • Environmental watch group • Case studies • Local biodiversity governance

10.1 Introduction

Radical changes are required for integrating biodiversity concerns into national policies and management framework. Habitat loss and forest fragmentation due to developmental activities are a major threat to biodiversity conservation. A large-scale approach to biodiversity conservation has been recognized as necessary to ensure that ecological processes and viable populations of species are preserved and to conserve areas large enough to withstand disturbance and environmental change

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(Miller et al. 2008). In recent years, numerous authors have called for greater integration of ecological principles in land-use planning to improve biodiversity conservation (Radeloff et al. 2005).

India has devolved considerable powers to local self-government institutions in rural areas, through Panchayati Raj Institutions (PRIs). PRIs have a three-tier structure with gram sabha and gram panchayat as the basic unit, which are usually at the level of a village. The Block level/Panchayat samithi is the second layer of the three tier system and usually consists of 20–60 villages. The District level/Zilla parishad is the apex body under the three tier structure of Panchayati Raj and co-ordinates the activities of the Panchayat samithi falling within its jurisdiction. Biodiversity management is a multilayered process, and the involvement of local communities in conservation planning should be at the core of biodiversity conservation initiatives.

The Biological Diversity Act 2002 and Rules 2004 by the Government of India is a landmark legislation which provides for regulated access to bioresources for commercial utilization or for bio-survey and bio-utilization. The Biological Diversity Act is being implemented through a three-tier decentralized system. The first tier is the National Biodiversity Authority (NBA) functioning at national level, which was established in 2003. The second tier is the State Biodiversity Boards (SBBs) at state level. The Biodiversity Management Committees (BMCs) constituted at local level, i.e., in all the gram panchayats, municipalities and corporations act as the third tier or basic unit. BMCs are statutory organizations at local bodies comprising of eight members constituted in accordance with the Section 41 of the Act 2002 and Section 22 of the Rules 2004.

10.2 Structure and Role of BMC

In Kerala, India, the BMC consists of a chairperson, secretary, and six members nominated by the local body. Of the six members, one third should be women, and not less than 18 % should belong to the Scheduled Castes/Scheduled Tribes. The BMC members should be selected from among the herbalists, agriculturists, collectors, traders of non-timber forest produce (NTFP), fisher folk, traditional knowledge holders, community workers, academicians, and any other person/representative of organization, on whom the local body trusts. All the members should be residents of the local body and be in the voters list. The tenure of the BMC will be 5 years from the date of its constitution.

BMCs are constituted for the purpose of promoting conservation, sustainable use, and documentation of biological diversity including preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals, microorganisms, and documentation of knowledge relating to biological diversity. The mandate of the BMCs is conservation, sustainable use, documentation of biodiversity, and chronicling of knowledge relating to biodiversity. Generally environmental policies and programs evolve in response to national government initiatives and international agreements, but the implementation of many initiatives aimed at promoting sustainable livelihoods and reducing the pressure on natural habitats can be addressed only at local level.

The KSBB has taken the initiative to encourage and empower the local self-governments to effectively conserve biodiversity for a sustainable future. In Kerala, BMC has been authorized to function as an "environmental watch group" and work for incorporating primary environmental protection programs in the schemes of the panchayat, present them in the gram sabha, and take actions to include them in the development schemes of the panchayat. At the grassroots level, primary environmental protection will be the responsibility of the BMC of the respective panchayat. The respective BMC will be responsible to inform the concerned authorities for taking immediate action against all activities violating environmental rules, acts, and notifications, as also environmental depletion, general public health problems, and circumstances which lead to or may lead to threat for human life. Formulation of directions for environmental conservation of the panchayat and their implementation through the panchayat committee are also entrusted to the BMC.

10.3 Best Practices in Biodiversity Governance

The Best BMC award was instituted by the Kerala State Biodiversity Board (KSBB) in 2013 to recognize outstanding models of biodiversity governance by local self-government. Development works best by example and it is contagious, and honoring the achievements of BMC sends a positive signal.

10.3.1 Cross-Sectoral Partnerships for Biodiversity Conservation

The BMC of the panchayat Eraviperoor Gram Panchayat, Pathanamthitta District, Kerala, has effectively built up cross-sectoral partnerships among line departments and ensured that the concerns of environmental conservation are duly met within the plans/schemes of different sectors. With the support of farm information center, training in modern techniques of organic farming was given for vegetable and banana cultivation in homesteads and terrace farming in grow bags. Efforts are underway to provide training to selected farmers in polyhouse technology and develop viable market for the produce. The programs were included in rural employment guarantee scheme, and additional 20 acres were brought under banana cultivation. The panchayat has been selected as model Haritha village (green village). With the support of Kudumbasree, upland rice cultivation has been taken up in 18 acres. Utilizing the labor force available in the panchayat, 60 acres of abandoned paddy fields have been reclaimed.

To increase fish stock, 50,000 fish fingerlings were released into canals and streams with the support of the Fisheries Department. With community participation in public areas, fodder crops were planted. Along roadside and highways with cooperation of Plantation Corporation, 200 avenue and shade trees were planted. Eco-clubs have been formulated in the schools in the panchayat, and training has been imparted for organic vegetable farming and paddy cultivation. More than 8000 saplings of different tree species were distributed to children, and through rural employment guarantee scheme, medicinal plant gardens were made in government school compounds. The river Poorva Pamba and its tributary Varattar, which are facing environmental degradation, are dying due to scarcity of water flow. The Varattar-Poorva Pamba rejuvenation program is being promoted for preventing encroachments and generating awareness through gram sabhas and seminars and by enlisting community support. Varattar Punarjani, a Facebook account, was opened with the express purpose of providing a platform for discussions.

As environmental watch groups, the BMC is taking action against felling of trees in public places and environmental pollution. The panchayat officials have taken initiative in cleaning ponds and canals for irrigation and drinking water purposes, through rural employment scheme. The panchayat has an ambitious plan to install 100,000 rainwater harvesting structures. By the initiative of environmental gram sabha, 35,000 rainwater harvesting pits of $1.5 \times 0.5 \times 1$ mt have been installed. Total waste management is being aimed at by installing Haritha plastic unit collection points at schools and anganwadis where plastic waste was collected at Rs 10/kg and given for tarring works. The panchayat has effectively utilized funds allocated by Suchitwa Mission by setting up of biogas plants (183 biogas plants) and 58 composting pits. Eraviperoor Gram Panchayat was awarded as the Best BMC (2013–2014) for their efforts in mainstreaming biodiversity issues at local level planning and prioritizing the issues within the panchayat which requires greater focus. The panchayat has also been honored with the Sanitation Award of the State Sanitation Mission. The Horticulture Department had selected Eraviperoor as a model hi-tech green village in recognition of the local body's green initiatives. In addition, Eraviperoor Gram Panchayat is also the recipient of the National Award for Public Administration.

10.3.2 Conservation of Local Landraces for Food Security

Edavaka Gram Panchayat, Wayanad District, Kerala, was once a hotspot of medicinal plants and home to several traditional healers. The BMC of Edavaka Gram Panchayat has the proud distinction of being the first to complete People's Biodiversity Register (a comprehensive data of bioresources of the panchayat) in Kerala which was prepared with the help of students, environmentalists, farmers, and people from different sectors of the society. The Edavaka Gram Panchayat in Wayanad District has set a model for other local bodies by implementing developmental activities under various projects of the state and union government.

The panchayat has been selected for the Best BMC Award, 2013–2014, of KSBB. It was also the recipient of the prestigious Bharat Ratna Rajeev Gandhi Award, 2013, instituted by the Academy of Grassroots Studies and Research of India (AGRASRI) – for the best all-round performance by a gram panchayat. It has also bagged awards such as Mahatma Puraskar in 2011–2012 and 2012–2013, Swaraj Trophy in 2010, and Nirmal Puraskar in 2008 for exemplary performance in the state. "Thanal," a project launched by the panchayat under the Mahatma Gandhi National Rural Employment Guarantee Act, has provided jobs for 600 senior citizens, including 250 tribal men and 10 physically challenged persons, in 19 plant nursery units. Each unit plants around 10,000–25,000 saplings of areca nut, coffee, pepper, and fruit trees, besides three species of bamboos in polythene bags.

The panchayat has taken up organic cultivation of tubers on 1.73 acres of public land on the slopes of a hill, with labor provided by workers under the Mahatma Gandhi National Rural Employment Guarantee Scheme. A massive awareness campaign has been launched with the help of the local community radio named *Maattoli* and a community newspaper *Naattuvettam*. A school-level campaign targeting students has also been taken up.

Various biodiversity conservation activities were planned and put into action by the Edavaka BMC. One hundred fifty thousand trees were planted, and 100,000 fish fingerlings were released in Kabini River in association with the Fisheries Department. They have addressed several local issues such as reclamation of paddy fields, sand mining, conversion of sacred groves, etc., and brought it to the attention of concerned officials. They set the pace for afforestation in the panchayat by supplying seedlings of medicinal plants and saplings of hardwood trees like teak and mahogany and promoted organic farming in schools. They have also conducted several awareness programs in schools and colleges and visits to sacred groves.

To conserve indigenous tuber crop varieties of Wayanad, the project "Conservation of tuber crop diversity in Wayanad and its popularization among the villagers of the district" is being implemented at Edavaka Gram Panchayat through the Biodiversity Management Committee (Figs. 10.1, 10.2, 10.3, and 10.4). The project aims to

Fig. 10.1 Conservation of tuber diversity by the BMC of Edavaka

Fig. 10.2 Harvesting of tubers by tribal communities of Wayanad

Fig. 10.3 Harvested tubers ready for marketing

Fig. 10.4 Harvesting of tubers at schools

conserve genetic diversity of neglected and underutilized root and tuber crops through germplasm conservation. The main highlights of the work were the following:

- Community-level germplasm center in 1 acre in Edavaka Gram Panchayat.
- Fifty-two varieties of different roots and tubers were collected and raised, of which seven are wild ones, procured from forests with the help of tribal people.
- Germplasm centers were established in two schools at Edavaka Gram Panchayat and one each at Mananthavady and Vellamunda Gram Panchayats.
- Germplasms of 13 varieties of greater yam, 11 varieties of tapioca, five varieties of sweet potato, three varieties each of arrowroot and elephant foot yam, seven varieties of wild tuber, and 11 varieties of *Colocasia* are conserved.

10.3.3 Ecorestoration of Degraded Land

Ambalapara quarry situated in the Thrikkakkara municipality of Ernakulam District, Kerala, lies close to the Edappally canal and is spread over an area of more than 12 ha with a depth of 200–300 ft. The mining activities at the quarry are abandoned, and the quarry with an approximate depth of 200–300 ft is a perennial source of water. The water analysis of quarry showed turbid foul-smelling water with *E. coli* and is unsuitable for human utilization. The area is subjected to unchecked pollution

Fig. 10.5 Cleaning of quarry by the BMC of Thrikkakkara Panchayat

due to urbanization, and the water bodies are choked with water hyacinth and weeds. The abandoned quarry was an accident-prone area and also posed health hazards due to stagnant water. The impact of quarrying on ecological niche is much more severe than other kinds of human disturbances due to disturbance of soil profile and compaction resulting in environmental degradation of the site. The landscape has been drastically altered and the ecosystem totally disrupted. The lack of conservation management and land-use change has led to scrub encroachment, and the area supports only small populations of species. The land has been left barren and exposed where waste materials are dumped.

The ecorestoration of the abandoned quarry by the Biodiversity Management Committee of Thrikkakkara municipality, utilizing the local biodiversity fund, provides a novel decentralized biodiversity governance model with equitable sharing of benefits to the communities affected by natural resource extraction (Figs. 10.5 and 10.6). Participation is critical to the community-based conservation concept, and in order to ensure that participation takes place at all stages, from planning to implementation, management, and monitoring, regular meetings were conducted. To strengthen awareness of ecosystem services provided by nature, workshops for the public involving experts from different fields were conducted. The polluted water was cleaned and plastics and other wastes were removed using country boats. The revitalization of the degraded area included sustainable and eco-friendly developmental activities such as planting vetiver (*Chrysopogon zizanioides*) along the quarry periphery, mangrove ferns along the Edappally canal, avenue trees in the open spaces, medicinal plants in the herbal gardens, birth star plants in the star garden, coconut trees along the roadside, and plants suitable for butterfly in butterfly garden. Ecorestoration of the site by planting recommended native species of

Fig. 10.6 Ecorestoration of quarry by the BMC

grasses, shrubs, and trees was undertaken. Around 2000 vetiver plantlets and 2000 saplings of 150 different species were planted at the site. Vetiver plants were planted along the quarry periphery which forms a permanent "bio-dam" that can effectively hold up runoff, sand, and litter. Biofencing along the Edappally canal was carried out by planting around 1200 plantlets of riparian mangrove plants like *Acrostichum aureum*. Five hundred saplings of various species procured from the Forest Department were distributed to public. In association with the Social Forestry Division of the Forest Department, a birth star garden was initiated. With the help of the Cochin Natural History Society, a bird watching survey was conducted and the team spotted and identified 30 different species of birds. The presence of the highest predator birds like kingfisher on the water body was taken as indicator of good health. A beautifully designed butterfly garden has been installed at the project site with a variety of plants that attract butterflies like *Ixora*, *Chrysanthemum*, *Duranta*, *Cordia*, *Mussaenda*, and *Zinnia*. Various boards designating different regions and posters depicting the importance of conservation of nature and natural resources were put up.

Ecorestoration of degraded ecosystems provides several tangible and intangible benefits to the community. The tangible benefits included enhanced livelihood options as the cleaning and desilting of the quarry were undertaken with the help of Local Self Government (LSG) and through Mahatma Gandhi Rural Employment Guarantee Scheme thus providing direct employment to local workers. The scheme also helped in recharging the underlying aquifer, raising the water table which will increase the vegetation in the surrounding area. The intangible benefits included the enhanced physical well-being provided by a green space in the urban environment.

The quarry used to pose health hazards to the inhabitants of the area and revitalization of the area has resulted in a better environmental quality leading to better air quality and improved hydrology. The sustainable reclamation measure has ensured the maintenance of land-use options for future generations. The biodiversity management model proposed has enhanced the ecosystem provisioning services, and the water body attracts many birds and butterflies and serves as an important habitat for a range of amphibians and other invertebrates.

10.3.4 Gramavanam: An Afforestation Program

The Biodiversity Management Committee of Mankara, Palakkad District, Kerala, was selected for the Best BMC Award in 2014–2015 and also received the Arogya Keralam award.

1. The project Gramavanam is being implemented by the BMC of Mankara whereby afforestation is being conducted in forest areas, on banks of canals, on roadsides, in public places, etc. The BMC effectively implemented various programs for environment/biodiversity conservation.
2. Protection of Bharathapuzha River: In order to avoid landslide along the banks of the river and to conserve endangered bamboo species in the region, the BMC planted bamboos along the riverbank.
3. Farmer's friendly activities: They have done various projects along with the local body to help farmers' community. Organic farming was supported and mass awareness campaigns to promote organic farming and use of organic fertilizers were taken up. They distributed 1000 pipe composts for giving wide publicity for the use of organic fertilizers.
4. Cleaning activities: Cleaning programs were conducted throughout the local body such as removal of wastes from public places, cleaning of public wells, avoiding stagnation of water in public places, and cleaning of water bodies.
5. Student programs: To develop environment/biodiversity awareness in children, biodiversity clubs were started in all schools with the support of KSBB. The BMC supported the students in various eco-friendly activities and encouraged them to develop medicinal plant gardens in schools.
6. Biodiversity documentary: Apart from having their own biodiversity register as per the Biodiversity Act and Rule, a 50-min-long documentary film titled "Grama Jeevan" was also made to familiarize the younger generation about the fauna, flora, landscapes, fields, etc.
7. For the welfare of the agricultural sector, an agricultural task force was constituted, the service of which is being deputed according to requirement.
9. Awareness on harmful effects of excessive pesticide and fertilizer use was generated among the public.

Fig. 10.7 Conservation of Sasthamkotta Lake by joint BMC

10.3.5 Joint Biodiversity Management: West Kallada BMC, Kollam District

Sasthamkotta Lake, a Ramsar site of Kerala, is geographically located in three panchayats: Sasthamkotta, West Kallada, and Mynagappally. The State Biodiversity Board took initiative to constitute a joint BMC for achieving the goal of biodiversity conservation of the lake. These three BMCs come under same block panchayat (Sasthamkotta Block); hence under the chairmanship of the block panchayat president, a joint BMC was constituted, and action is being undertaken to protect the watershed by massive afforestation and other measures. The committee has been active as an environmental watch group in the locality and has raised its voice against excessive withdrawal of water by the Kerala Water Authority (KWA). The committee is also actively working to regulate the extraction of water from the lake, to control sand mining, and to minimize the number of brick kilns in the locality (Fig. 10.7). This joint BMC demonstrates that biodiversity conservation cannot be constrained by geographical boundaries.

10.4 Conclusions

These five best practices demonstrate that community outreach is the most effective way to bring conservation into local planning. A great impediment to conservation projects seems to be lack of funding, and this can be best addressed by building cross-sectoral partnerships. It has been suggested that one way to foster greater support for conservation among the public is to emphasize the connections between biodiversity and quality of life. The conservation practices presented here have facilitated better quality of life through enhancing the ecosystem services whether it is provisioning, regulating, supporting, or cultural services. Local participation is thus both a policy measure and part of a process for social change and empowerment.

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Chapter 11
Community Conservation of Marine Turtles and Sustainable Ecosystems

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Abstract A declining trend in the nesting of olive ridley turtles has been recorded throughout the coasts of Kerala. It is essential to establish an empowered community which can work in collaboration with the government and nongovernment institutions to conserve the species. In Kerala, several groups like Neythal in Kasaragod and Theeram in Kozhikode district are involved in the conservation of olive ridley turtles with the support of local people. The turtle eggs collected were reared in a hatchery at Thaikadappuram and young ones released back to the sea. Children as future crusaders of biodiversity play a vital role in biodiversity conservation; as such awareness programs were conducted in schools and seabird viewing camps were organized, and pamphlets and activity books for children were distributed as part of the program. The chapter gives an insight into community conservation of marine turtles in Kerala, threats identified, and actions to be taken to protect the nesting sites of marine turtles.

Keywords Turtles • Olive ridley • Community conservation • Hatchery • Threats

11.1 Introduction

Kerala, the southernmost state lying on the west coast of India, has a 590 km coastal belt with a stretch of beach interrupted frequently by inlets and backwaters. Sea turtles occupy a salient position within the food web consuming an assortment of prey, including puffer fish, crustaceans, sponges, tunicates, sea grasses, and algae. Their migratory life cycle plays a vital role in transportation of nutrients from the highly productive marine habitats such as sea-grass beds to energy-poor habitats

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like sandy beaches. Olive ridley turtles have been reported to nest frequently along the coasts of Kerala, in eight districts, namely, Kasaragod, Kannur, Kozhikode, Malappuram, Thrissur, Alappuzha, Kollam, and Thiruvananthapuram, during the last 6 years. The olive ridley turtle (*Lepidochelys olivacea*) is classified as vulnerable according to the International Union for Conservation of Nature and Natural Resources (IUCN) Red Data Book. The species was listed in Appendix I under the Convention on International Trade in Endangered Species (CITES), and subsequently the international trade of the species, which fuelled the large-scale commercial exploitation of the olive ridley turtles from the 1960s to the 1980s, was effectively halted. According to the Marine Turtle Specialist Group (MTSG) of the IUCN, there has been a 50 % reduction in population size since the 1960s. The highly migratory behavior of olive ridley species makes them shared resources among many nations. The nesting habitat in each of the target countries must be protected to ensure future generations of the species.

11.2 Marine Turtles in International Treaties

Sea turtles are protected by various international treaties and agreements as well as national laws:

- CITES: listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna, which prohibits international trade
- CMS: listed in Appendices I and II of the Convention on Migratory Species
- IOSEA: Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia
- SPAW: protected under Annex II of the Specially Protected Areas and Wildlife Protocol of the Cartagena Convention

11.3 Olive Ridley Turtles

Olive ridley turtles display a complex life cycle, which requires a range of geographically separated localities and multiple habitats. Females lay the eggs on coastal sandy beaches from which neonates emerge and enter the marine environment to continue their development. They remain in a pelagic phase, drifting passively with major currents that disperse far from their natal sites, with juveniles sharing some of the adults' habitats (Kopitsky et al. 2000) until sexual maturity is reached. The turtles experience high mortality in their early life stages. Juveniles are believed to occur in similar habitats as the adults (i.e., pelagic waters) where they forage on gelatinous prey such as jellyfish and salps. Olive ridley turtles reach sexual maturity around 15 years, a young age compared to some other sea turtle species. They have a unique nesting habit whereby large groups of turtles gather offshore of nesting beaches. Then, all at once, vast numbers of turtles come ashore and nest "arribada." Females nest every year, once or twice a season, laying clutches of approximately 100 eggs. Incubation takes about 2 months. Climate change may impact the ecosystems upon which sea turtles depend (Doney et al. 2012).

11.3.1 Threats to Olive Ridley Turtles in Kerala

The incidental capture of turtles in trawl fisheries, gill net and other net fisheries, and hook and line fisheries is a major reason for their mortality. The survival of juveniles is affected by beach transformation and destruction of natural nesting beaches due to coastal developments. The major threats identified are as follows:

1. Loss of nesting beaches and habitat degradation (due to erosion, sand mining, pollution, exotic plantations, etc.)
2. Coastal lighting (disorientation of both adults and hatchlings)
3. Poaching of eggs and lack of awareness

11.3.2 Empowered Community for Turtle Conservation

A declining trend in nesting of olive ridley turtles has been recorded throughout the coasts of Kerala. During 2005–2011, the highest nesting numbers have been observed in Kizhoor, Chembirika, and Chittari in Kasaragod district, Kolavipalam in Kozhikode district, Puthenkadapuram and Edakkazhiyoor in Thrissur district, and Thottappally and Punnapra in Alappuzha district. The highest number of nests was recorded in Kozhikode district in 2007 which recorded a nesting density of 2.875 nests/km; 2011 has recorded, among the least, a nesting density of 0.875 nests/km with Kasaragod recording just 17 nests in 2011 when compared to 34 nests in 2010. It is essential to establish an empowered community which can work in collaboration with the government and nongovernment institutions to conserve the natural resources of the area. NGOs can play a facilitating role by involving local community members, community-based groups, youths, fishermen communities, and other stakeholders in conservation activities.

In Kerala, several groups like Neythal in Kasaragod and Theeram in Kozhikode district are involved in the conservation of environment and biodiversity and have taken protection of these turtles as a challenge. Many of their efforts are paying off, resulting in an increased awareness of conserving endangered turtles. The local residents, who used to dig up the eggs for consumption, have become ardent conservationists. The strong pressure from the nature lovers and the Theeram team, a voluntary organization at Kolavipalam for the conservation of marine turtle, has resulted in the much needed intervention of the Hon'ble Court in the matter, and there is presently a direction to stop the mining activities in the turtle nesting areas. Animal slaughter and sacrifice were an integral part of the life among rural

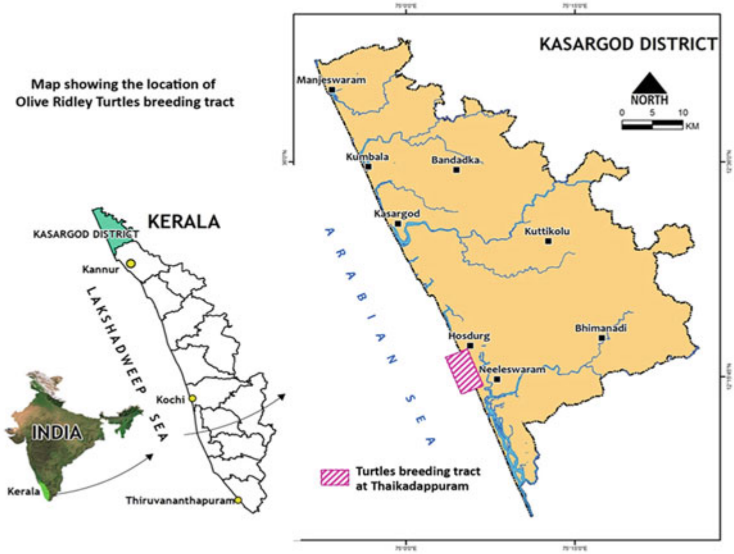

Fig. 11.1 Turtle nesting site, Kasaragod

community. The sacrifice of animals was practiced during Kulavan Theyyam (a traditional dance) in some parts of Kasaragod. This included sacrifices of wild animals like wild boar, barking deer, monkey, porcupine, civet, and Malabar giant squirrel. Some of these animals are entitled to absolute protection under Schedules I and II of the Wildlife Protection Act in India. Neythal, an NGO working in this field, filed a public interest petition against this, which resulted in Kerala High Court banning animal sacrifice during Kulavan Theyyam. The group started its dedicated task of collecting and protecting the eggs of the olive ridley turtles right from 2002.

The sand dune ecosystem on the beaches was the original hatching grounds of turtles. The ecosystem has been degraded due to unscientific construction of coastal walls which has forced the turtles to lay eggs on temporary sand bars. The eggs are collected and allowed to hatch in the sandpits of a hatchery, which is protected from any type of interference and damage.

As part of the turtle conservation project with support of the Forest Department and with community participation, the organization took up monitoring of nesting activity along the 23 km stretch of seashore including Ajani, Kananga, Neeleswaram, and Padanna (Fig. 11.1). Monitoring was done by trained volunteers taking into consideration low tide and high tide. Kasaragod was declared as a turtle conservation zone. The turtle eggs collected were reared in a hatchery at Thaikadappuram and young ones released back to the sea (Figs. 11.2 and 11.3). With participation of Forest Department, locals, and school children, 548 hatchlings of turtles were released to the sea during 2013–2014, and the injured turtles rescued in the turtle rescue center were released back to the sea (Figs. 11.4 and 11.5). Children as future crusaders of biodiversity play a vital role in biodiversity conservation; as such

Fig. 11.2 Rescue of turtle hatchlings

Fig. 11.3 Release of turtles to sea

awareness programs were conducted in schools and seabird viewing camps were organized, and pamphlets and activity books for children were distributed as part of the program. Mass awareness campaigns were organized for fisherfolk and local community through educational institutions and religious institutions from Chittari to Thaikadappuram. In order to attract more youngsters and children into conservation activities, Neythal has constituted a group exclusively for kids – the

Fig. 11.4 Rescue of injured turtles

Fig. 11.5 Olive ridley turtles

"Neythal Kids." Considering these efforts, Neythal was given the P.V. Thampi Endowment Award for the best environmental activity in the state, and the group has also won the Central Government's National Accreditation under the National Turtle Conservation Programme.

Since 2002, Neythal has collected about 19,000 eggs, of which about 14,000 have hatched, and turtle hatchlings were released into the sea. Owing to the

Table 11.1 Nesting and breeding of marine turtles at Neeleswaram to Thaikadappuram, Kasaragod district

Sl. no.	Year	No. of nests	No. of eggs collected	No. of hatchlings
1	2002–2003	12	1548	927
2	2003–2004	26	3216	1853
3	2004–2005	21	2913	2514
4	2005–2006	24	3119	2817
5	2006–2007	21	2518	1765
6	2007–2008	18	2178	1594
7	2008–2009	8	1091	676
8	2009–2010	7	754	617
9	2010–2011	6	566	424
10	2011–2012	4	397	319
11	2012–2013	4	481	–
12	2013–2014		1079	548

Source: Neythal

Table 11.2 Nesting and breeding of marine turtles at Kolavipalam, Kozhikode, from 1998 to 2013

Year	Number	Egg	Hatchling
1998	82	7500	5000
1998–1999	52	4501	3328
1999–2000	65	5843	4900
2000–2001	65	6264	5508
2001–2002	51	5605	4646
2002–2003	48	5255	4692
2003–2004	8	894	840
2004–2005	8	738	544
2005–2006	23	2040	1776
2006–2007	9	944	733
2007–2008	6	820	710
2008–2009	11	1214	947
2009–2010	7	707	406
2010–2011	10	1154	760
2012–2013	5	527	439

Source: Theeram

awareness creation, the local inhabitants will report the sighting of injured turtles to Neythal. Volunteers will collect them and protect them in the "Turtles and Seabirds Rescue Centre," in tanks filled with saltwater. Once recovered, they are released into the sea. The data regarding nesting and breeding of marine turtles at Kasaragod and Kozhikode district is given in Tables 11.1 and 11.2, respectively.

11.3.3 Challenges for Environment Sustainability

Plantation of exotic beach vegetation drastically alters the beach profile and may often be a deterrent for sea turtle nesting. Alien vegetation such as *Casuarina* with its superficial root growth and thick litter fall renders the beach unsuitable for turtles to nest. Dense *Casuarina* and other plantations cause excessive shading of the nesting beach. Nests laid in shaded areas are subject to lower incubation temperature, which alters the natural sex ratio of turtle hatchlings, producing more males. Artificial illumination on nesting beaches impacts adult sea turtles by disrupting nest site selection, abandonment of nesting behavior, disruption of sea finding ability, and disorientation following unsuccessful nesting. Sea turtle hatchlings orient themselves toward the sea as soon as they emerge from the nest. Hatchling sea turtles emerging from nests at night are strongly attracted to visible light sources along the beach. They thus fail to find their way to the sea and succumb to predators or exhaustion or dehydrate in the morning sun. Substantial part of the coast has been walled to prevent erosion, and this has made these beaches unsuitable for nesting. At sea there are numerous potential threats including marine pollution, lost and discarded fishing gear, changes in prey abundance and distribution due to commercial fishing, habitat alteration and destruction caused by fishing gear and practices, agricultural runoff, and sewage and industrial discharge (Bramha et al. 2011). Turtle excluder device has been suggested in all trawling nets, so as to exclude turtle from nets in case of an accidental capture (Pareparambil and Renjan 2013). In Odisha, India, to protect the olive ridley sea turtles that arrive during winters for nesting, the Forest Department has imposed a 7-month ban on fishing along the coast. A major step toward saving the dwindling population of this endangered species would be giving protected area status to the sea turtle nesting beaches as well as the coastal waters having high sea turtle concentration.

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Chapter 12
Grassroots Initiatives for Environmental Sustainability

Preetha Nilayangode, K.P. Laladhas, G.S. Unnikrishnan Nair, Annie Mathai, B. Baijulal, and Oommen V. Oommen

Abstract People's participation is a key element in biodiversity conservation and sustainable development. Biological diversity is maintained by the indigenous communities through systems of stewardship, customary laws and biocultural protocols. Governments can formulate laws, but ultimately the true guardians of biodiversity are the local people. In addition to community participation, there are innumerable cases of people who have worked single-handedly for the protection and conservation of biodiversity. Many of these efforts pass unnoticed, and this chapter highlights the efforts of a few individuals to live in harmony with nature by maintaining a sustainable lifestyle. It is hoped that these case studies serve to increase participation of local people in the use and management of natural resources in a sustainable manner.

Keywords Mangroves • Traditional varieties • Native breeds • Vechur • Breed saviour

12.1 Introduction

People's participation is a key element in biodiversity conservation and sustainable development. Millions of people in India including farmers, tribal communities, fishermen, vaids and artisans depend on biodiversity for their livelihoods. Over 8000 species of plants are being used by the people of India traditionally for primary healthcare. Natural selection over centuries has resulted in a large number of traditional varieties and breeds in the farming sector possessing special traits like resistance to biotic and abiotic stresses and ability to adapt to drought or floods and quality attributes like medicinal value, aroma and resistance to diseases. This diversity is maintained by the indigenous communities through systems of stewardship,

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customary laws and biocultural protocols. Governments can formulate laws, but ultimately the true guardians of biodiversity are the local people. In addition to community participation, there are innumerable cases of people who have worked single-handedly for the protection and conservation of biodiversity. Many of these efforts pass unnoticed, and this chapter highlights the efforts of a few individuals who have been committed to biodiversity conservation in Kerala.

12.2 Ecosystem Conservation for Environment Sustainability

Wetland ecosystem directly and indirectly supports a large number of people, providing tangible and intangible benefits. The 590 km long coastline of Kerala is facing coastal erosion, and artificial sea walls have been constructed in 53 % of coasts. Mangroves act as natural barriers to erosion and flooding and are much more effective than artificial sea walls. Mangrove forests are one of the most productive and complex ecosystems serving as a source of food, fuel, fodder and medicine and provide sustainable livelihood to millions of people. Mangroves serve as 'nature's nursery' for a variety of marine fishes and shrimp species that migrate to the mangroves, where they swarm their fingerlings and young ones. Mangroves serve as coast guards due to its numerous prop roots and other respiratory roots that form a biological network. The leaf litter of the mangrove vegetation, decomposed by bacteria and fungi, is an important source of food for the molluscs, crustaceans and juvenile fish. Mangrove forests fix more carbon dioxide per unit area than phytoplankton in tropical oceans. Mangroves in Kerala provide habitat to about 489 species of fauna comprising 144 species of invertebrates (Arachnida, 24 species; Chalcidoidea, 11 species; Odonata, 23 species; Lepidoptera, 33 species; Mollusca, 21 species; Annelida, 7 species; and Crustacea, 25 species), 122 species of fishes, 14 species of herpetofauna, 196 species of birds and 13 species of mammals. Due to unsustainable development, the mangrove vegetation of Kerala has reduced from 70,000 ha during 1975 to a mere 663 ha in 2015.

Kallen Pokkudan, alias *Kandal Pokkudan* from a backward community in Kannur district, devoted his life for conservation of mangrove diversity in Kerala. He has planted over one lakh mangrove saplings with his own hands in association with state government agencies across Kerala. The movement for conservation of mangroves in Kannur, which he began in the 1980s, soon became a mass effort, and countless mangroves have been planted in almost all parts of Kerala over the years. His campaign started when he noticed that monsoon storms and the lashing winds would frequently blow away the umbrellas of school children and storm waves would regularly destroy the embankments in the paddy fields. He realized that mangroves are the first line of defence against the fury of nature and that conservation of mangroves is necessary for protection of coasts. For Pokkudan and the other members of his community, the mangrove forests had always been a perennial source of food, fuel, fodder and medicine. Realizing the need for creating an environmentally sensitive people, he conducted more than 500 classes about conservation of mangroves and wetland biodiversity in schools and colleges across India. He continued his tireless crusade for conserving nature's barrier against tidal vagaries, in spite of criticism and ridicule from people. The fact that Kannur still has to its credit nearly 45 % of the state's remaining wetlands reflects the dedication behind Pokkudan's campaign. In Kerala, the name of Kallen Pokkudan is associated with mangroves, and a major credit for conserving these remaining patches of 'lungs of the sea' goes to this campaigner of mangroves. In his autobiography, he describes in detail 20 kinds of mangroves and how they thrive in marshes and swamps, the birds and insects that nest amidst them and the innumerable fish varieties that inhabit the swamps. He was awarded the Kerala State Green Award for environment conservation by the Kerala State Biodiversity Board (KSBB) and Vana Mitra Award by the Kerala Forests and Wildlife Department.

12.3 Conservation of Indigenous Varieties of Rice

India is one of the eight Vavilovian centres of origin of crop diversity and also a major centre of crop plant domestication with 25 crop species domesticated here. In India, farmers have developed and nurtured genetic diversity of crop plants for generations. The major components of crop diversity include landraces, farmer varieties, folk varieties, improved cultivars, hybrids and closely related wild relatives, adapted to varied agro-ecological conditions, viz. altitude, temperature, rainfall, soil type, etc., and possessed varied agro-morphophysiological characteristics. A total of 167 cultivated crop species and 326 wild relatives of crops (116 genera and 48 families) have originated in Hindustan centre of origin. Changes in land use, land degradation, deforestation, habitat loss and intensification of agriculture have severe impacts on agrobiodiversity.

The agroecosystem of Wayanad, Kerala, which was rich in biodiversity is greatly endangered today. Most of the landraces and farmer varieties have already vanished, and seed materials are not available, due to the preference for high-yielding varieties, poor profitability, lack of quality seeds and low yields of traditional varieties. The area under cultivation of local varieties of paddy in Kerala has reduced drastically from 19.23 % of total area under paddy in 2002–2003 to 6.45 % in 2011–2012.

The Kurichiya and Kuruma tribal communities of Wayanad, Kerala, cultivate diverse traditional varieties of rice to meet multiple needs including food, fodder, fuel and thatching material. They classify Vayals into three types, namely, Kuni Vayal, Kundu Vayal and Koravu Vayal, on basis of soil texture, mud content, percolation and retention of water, fertility of land and location of the field and cultivate different rice varieties based on this. The varieties with different duration help them to adjust the days of transplantation.

Fig. 12.1 Conservation of local landraces

Cheruvayal Raman, a member of Kurichiya tribal community, Wayanad, and a winner of Kerala Biodiversity Award for conservation of traditional varieties, in 2012–2013, is conserving 65 varieties of different crops in which 47 are paddy varieties (Fig. 12.1). To promote cultivation of indigenous varieties of rice, he promotes a system of seed exchange where seeds are given free of cost on the condition that seeds are returned after harvest. The seeds preserved by him include aromatic rice seeds such as Gandhakasala, Kayama and Jeerakasala, short-term rice varieties such as Thonnuramthondi and medicinal varieties such as Njavara and Chennellu. The rice varieties Chennellu, Kanni Chennellu, Chettuveliyan, Marathondi, Chembakam, Chenthadi, Vellachenthadi, Mundakan, Chennal Thondi, Chomala, Velumpala, Adukkan, Kothandan, Gandhakasala, Kayama, Urunikayama, Jeerakasala, Palthondi, Onamottan, Onachanna, Kotuveliyan, Palthondi-Vella, Cheriyakuruva, Thavalakannan, Kalladiaryan, Okkapuncha, Thonnuram Thondi, Thonnuram Puncha, Navara, Punnadan Thondi, Karuthan, Kurumbali and Palveliyan are maintained each in five cents of his land. Organic cultivation is practised with green manure and ploughing is done using cattle. The method of storage of seeds is traditional called Moodakettal which is done 2 weeks after harvest. For this different varieties are dried separately for a week, and dried seeds are wrapped in a layer of dry hay with bamboo plinths. Each mooda can hold 10–60 kg of rice seeds. The seeds thus preserved will not be much susceptible to pest attack or moisture loss. The Kurichiya and Kuruma tribal communities of Wayanad, Kerala, received the Plant Genome Saviour Community Recognition Certificate Award instituted by the Protection of Plant Varieties and Farmers' Rights Authority, Government of India, during 2008–2009, for conservation of rice landraces with drought tolerance, medicinal properties, etc. It is expected that the seed-care movement initiated by Cheruvayal Raman would contribute to the conservation of rice diversity in Kerala thereby improving the adaptive capacity of farmers to biotic and abiotic stress and provide sustainable livelihood to resource-poor tribal communities.

12.4 Conservation of Native Breeds

Domestication of livestock species, migrations, selection, adaptation, mutation and selective breeding has created an enormous diversity of local breeds. Native livestock and poultry breeds are resistant to parasites or disease and adapted to humidity, drought or extremes of heat and cold. Domestic animal diversity is essential to sustain and enhance the productivity of agriculture. Genetic erosion of domestic animal diversity has placed over a quarter of the world's breeds at risk of extinction. Of the more than 7600 breeds in FAO's Global Databank for Farm Animal Genetic Resources, 190 have become extinct in the past 15 years, and a further 1500 are considered 'at risk' of extinction. India's share in the world genetic wealth of sheep, goat and cattle is around 20 %, 33 % and 16.5 %, respectively. The total number of indigenous breeds in India registered by the National Bureau of Animal Genetic Resources (NBAGR), Karnal, is 144, which include 37 cattle, 13 buffaloes, 23 goats, 39 sheep, 6 horses and ponies, eight camels, two pigs, one donkey and 15 chicken breeds.

Hybrid cattle are not suitable to the hot and humid climate of Kerala; they also require more feed and are susceptible to diseases. Small farmers could not afford the high cost involved in maintaining hybrid cows. Malabari and Attapady goats, Vechur cattle and Tellicherry chicken are the indigenous breeds registered from Kerala. High Range Dwarf and Cheruvally cattle, Angamaly pig, Kuttanad buffalo and Kuttanad ducks are the other prominent local breeds in Kerala. Local breeds of Kerala are small sized and adapted to the hot humid climate. The World Watch List of Domestic Animal Diversity, published by the FAO, has listed the Vechur cattle, a dwarf breed from Kerala under the category of Critical Breeds. Vechur cow with an average weight of 130 kg, a height of 90 cm and an average yield of 3.0 litre of milk per day comes in light red, black and white. The milk of Vechur cows has high medicinal value. The lactoferrin protein in milk is known for its nutritional value. The antibacterial property of the lactoferrin protein of the Vechur cow milk is similar to that of the antibiotic ampicillin. Due to the higher level of 'arginine' in the lactoferrin, it can be used for treating chest pain, atherosclerosis (clogged arteries) and heart diseases. Studies have also proven the presence of A2 beta-casein in the milk.

The policy of massive crossbreeding with exotic breeds pursued since the 1960s to increase milk yield transformed the local breeds including Vechur to crossbreed throughout the state. Local bulls were not permitted to be retained as per Kerala Livestock Act, 1961. However, temple bulls were exempted from this. The government policy of massive crossbreeding with exotic breeds and compulsory castration of native bulls has led to the gradual disappearance of native breeds from the farmlands and homesteads of Kerala although milk production has increased.

Fig. 12.2 Conservation of native breeds of cattle

12.4.1 M. Brahmadathan, from Pattambi, a winner of the Kerala Biodiversity Award for conservation of indigenous cattle varieties in 2013–2014 and the Breed Saviour Award in 2010, is a farmer engaged in rearing of Vechur cows for the last 14 years (Fig. 12.2). The lightweight strong bulls of Vechur breed were commonly used for ploughing the marshy paddy fields. The adaptability to the hot humid environment and low feed requirement are some of the good qualities of the cows. Brahmadathan practices pure breeding in the herd, and breeding males are selected based on good pedigree and phenotype and breed characteristics. Females are selected according to their phenotype, mainly milk production. Since Vechur cattle require very little sophistication in their management, they are fed with leftovers from the households. Open grazing is also practised. Straw and other by-products from paddy cultivation are another source of feed. Nonedible parts of seasonal vegetables and fruits like jackfruit, banana, pineapple, mango and others contribute to the roughages in a big way. Oil cakes and bran available are also given to the cows. Grazing in the farm and seasonally in paddy fields is practised. His farm has maintained four generations of Vechur cows with about 17 Vechur cows, a work started since 1998 when he purchased a 10-month-old calf.

12.4.2 Chandran Master from Thrissur, Kerala, is conserving 16 native Indian breeds in his homestead and garden land spread over 9 acres (Fig. 12.3). Being the member of an agricultural family, Chandran Master had an early passion towards farming and farm animal rearing. After retirement, he got fully engrossed in conservation of local breeds and natural farming. He gives local feeds to the cattle, which includes green grass, rice powder and oil cakes. He has all the local dwarf cattle breeds of Kerala including the Vechur cow (85 to 100 cm height) and Kasaragod

Fig. 12.3 Conservation of Vechur cow

Dwarf. He got the rare hornless Vadakara Dwarf cattle measuring 95–110 cm in height from the tribes of Chimmini forest. The milk of these cattle has high medicinal value. Native to the Western Ghats of Karnataka, Malnad Gidda (81–88 cm) is also in Chandran Master's collection. This breed recently got registered by the National Bureau of Animal Genetic Resources, Karnal. The sacred Kapila cow, which has an average height of 83 cm, is also with him. It has got immense tolerance to diseases. It is grown by Tulu Brahmins and usually they do not sell calf to outsiders. Kuttampuzha Kullan, another dwarf breed of cattle from the Kurichiya tribes in Edamalayar forest region, is similar to Kasaragod Dwarf and yields 2.0 litre of milk per day. It is 85–95 cm tall. Another dwarf Indian breed, the Punganur, is also there in his collection. It originated in Chittoor district of Andhra Pradesh. Punganur's milk has high fat content and rich medicinal properties. While cow milk normally has a fat content of 3–3.5 %, the Punganur breed's milk contains 8 %, similar to buffalo milk. A total of 26 dwarf cows and four bulls are kept in his farm. Master's collection also has the Gir cow and bull he brought from Gujarat spending about 50,000 rupees. The origin of the breed is in the Gir forest region and surrounding districts of Saurashtra region of Gujarat state. These cows yield 1590 kg of milk per lactation with a fat content of about 4.5 %. Master has also acquired a prestigious breed of Rajasthan, the Tharparkar, and the famous Red Sindhi cattle that originated in the Sindh province; Tamilnadu breeds which include the hardy breeds like Kangayam and Manapparai used for ploughing and transport. The Kankrej is one of the heaviest of the Indian breeds of cattle originated in northern Gujarat. Male is well known for his 'majestic gait'. They are fast powerful draught cattle. The Krishna Valley cattle is a heavy draught breed suitable for ploughing in the black cotton soil on the watershed of the Krishna River, which becomes extremely difficult to work during the rainy season. It is also used for hauling heavy loads. Chandran Master was awarded the Breed Saviour Award instituted by the National Biodiversity Authority in 2012 and the Kerala Biodiversity Award (2012–2013) for conservation of native breeds.

12.5 Man-Made Forest

Sacred groves in India are pieces of land akin to forest with densely wooded areas, harbouring unique flora and fauna with perennial water sources in the vicinity and a soil amply covered with a sheath of decaying leaves and twigs. Sacred groves were once an integral part of the rural villages and ancestral homes. Conducive climate and fertile soil, along with traditional beliefs, made sacred groves a basic part of each and every village of Kerala. In almost every ancestral house in Kerala, a corner of the compound is set apart for a snake shrine called Sarpa Kavu where the members of the family used to worship snakes by lighting a lamp. Such areas are left undisturbed from human interventions.

Abdul Kareem, of Parappa, Kasaragod, Kerala, the recipient of the Kerala State Green Awards of KSBB, had a liking to 'Kavu', the sacred groves right from his childhood. He would frequently visit his wife's house in Puliyankulam village, Kasaragod, and it was during such visits that he noticed the barren hillside land nearby. He had a dream to live a quiet life, in harmony with nature. In 1977, he bought 5 acres of barren land for a nominal rate, where he planted saplings. The property had only a single well that remained almost dry throughout the year. To water the saplings that he planted, he would carry water in cans from outside sources on his two-wheeler. This continued for 3 years; at the end of which, the barren land slowly came back to life, saplings started growing and water level rose. Soon other forms of life also appeared and the ecosystem slowly started stabilizing. Birds started to nest and water level in the well rose. Spurred by the success of his work, Kareem bought another 27 acres of land and planted trees. One remarkable feature of this man-made forest is that it is a self-sustaining one growing naturally with minimum human intervention. He has never weeded the forest; neither does he sweep away the fallen leaves. He has never used fertilizers or insecticides.

The forest has brought about amazing changes to the surroundings. The underground water table in an area of about 10 km has risen, it is said. Kareem has been living inside the forest since 1986; visitors are allowed inside, provided they comply with Kareem's regulations. Plastic is banned inside the forest and also the use of automobiles. Kareem has resisted various offers to commercialize the forest and to turn it into a theme park. Recognition has come from various corners, including the Sahara Parivar Award, Limca Books Person of the Year and so on. Visitors have come from many foreign countries, and his forest remains as a testimony to a single man's relentless work in creating a better place to live – a thick, green-wooded area.

Chapter 13
Conservation Through Payment for Ecosystem Services

K.P. Laladhas, Sujith V. Gopalan, Preetha Nilayangode, and Oommen V. Oommen

Abstract Water birds are considered as an important bioindicator for the ecological conditions and health of wetland ecosystems. The number of heronries is declining in Kerala due to habitat loss, land-use change, hunting for meat, poisoning by pesticides, felling of nesting trees, etc. Community efforts have frequently led to the conservation of habitats, species and ecological services. The project 'Kottilla Samrakshana' by the Kerala State Biodiversity Board (KSBB) is a community conservation programme for heronries in Kottayam and Alappuzha districts of Kerala. The programme aims to estimate the number of heronries, species of birds, number of adults and young, nesting trees, girth of the tree at breast height (GBH) and height of the nesting trees in the project area. Conservation incentives were provided to the landowners willing to protect heronries, and further awareness programmes were conducted followed by the installation of signboards. Measures such as payment for ecosystem services provide incentives to conserve biodiversity and use it sustainably which can be developed as an important tool for sustainable development.

Keywords Payment for ecosystem services • Heronries • Nesting • Community conservation • Water birds

13.1 Introduction

Kerala, India, with a diverse range of ecosystems provides a habitat to 469 species of birds, of which 4 are listed as critically endangered, 8 endangered and 13 vulnerable under the International Union for Conservation of Nature and Natural Resources (IUCN) Red list. The pioneering works of Salim Ali (1969) and Neelakantan et al.

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(1993) documented the avifauna of the state. Water birds are considered as one of the important indicators for the ecological conditions, productivity, trophic structure, human disturbance and contamination of wetland ecosystems (Subramanya 1996). The availability of suitable feeding habitat and safe nesting sites are the factors governing the occurrence of heronry.

Herons of Kerala are declining in number due to many reasons such as habitat loss, land-use change, hunting for meat, poisoning by pesticides, felling of nesting trees, etc. The lack of protection and continued disturbance of the nesting activity of birds affect nesting colony. Climate change is yet another factor which imparts changes to the bird population of Kerala. Climate change can influence migration, foraging conditions, courtship behaviour, breeding success (egg size, nesting success), population sizes and population distribution of birds. Climate change is reported to influence the breeding behaviour of birds; birds would start breeding earlier than their usual breeding season or produce lesser offsprings due to reduced reproductive rate resulting in population decline (Wormworth and Sekercioğlu 2011). Change in temperature and humidity could bring changes to the life cycles of birds as it is tied to seasonal events such as flowering, seeds, insect emergence, etc. Resulting from these, there are reports of birds abandoning their habitat, and the birds are also likely to come into contact with different prey species, predators, parasites and competitors.

As part of the food chain, birds play many roles, as predators, pollinators, scavengers and seed dispersers. In agricultural systems, birds can also be beneficial through the regulation of pests, by scavenging carcasses and waste, by controlling populations of invertebrate and vertebrate pests and by pollinating and dispersing the seeds of plants.

13.2 Community Conservation of Heronries

Biodiversity and ecosystems provide invaluable tangible and intangible services to the society. Payments for ecosystem services (PES) are agreements whereby a user of an ecosystem service makes a payment to an individual or communities whose practices like land use or deforestation directly affect the use of that ecosystem services. Measures that provide incentives to conserve biodiversity and use its components in a sustainable manner are developing as an important tool for sustainability.

Local communities depend on bioresources for their livelihood, but still community efforts have led to the conservation of habitats, species and ecological services. There are innumerable reports of community conservation of heronries in villages across India (e.g. Sareli village in Uttar Pradesh, Nelapattu in Andhra Pradesh, Chitrangudi in Tamil Nadu). Nelapattu and Vedurupattu are two villages situated in Nellore district of Andhra Pradesh. The villagers believe that the advent of the birds in their village is a good omen and a forecast for good monsoons. The village is home to diverse species of birds such as Asian open-billed stork, black-headed ibis, cranes and cormorants that visit these villages between the months of October and May for nesting.

At Kokkare var, Karnataka, villagers offer protection against hunting, sometimes even foregoing their tamarind yield so that nesting birds are not disturbed. Fisherfolk in Mangalajodi and other villages at the Chilika Lagoon, Orissa, are protecting hundreds of thousands of waterfowl. Andhra Pradesh is rich in nesting sites for water birds. In Veerapuram village, painted storks, pelicans and white ibises have been nesting since time immemorial, at times exceeding 5000 in numbers. Due to its ecological importance, Nelapattu was declared a wildlife sanctuary in 1997. In Tamil Nadu, the Chitrangudi tank, built in 1800, attracts storks, ibises, herons, egrets, cormorants and other migratory birds. Villagers do not allow any hunting or stealing of bird eggs and avoid commercial fishing. In Khichan village in Rajasthan, the local population provides refuge and food to a wintering population of up to 10,000 demoiselle cranes (Neema et al. 2012).

13.3 Kottilla Samrakshana Programme (Heronry Conservation Programme)

Colonial birds tend to desert nests and entire colonies if disturbed during the periods of pair formation, nest construction, or early egg laying (Tremblay and Ellison 1980).The maintenance of established heronries and associated feeding areas is essential to ensure the stability of breeding populations of herons and egrets and other wetland birds. These colonial nesters are especially vulnerable to human disturbance and habitat destruction during the breeding season when large numbers of birds are concentrated in a relatively confined area.

Established heronries, and in particular large heronries consisting of hundreds of nesting pairs, are a valuable biological resource. They may be occupied for decades or even centuries because of habitat conditions that are conducive to reproductive success. If forced to relocate, alternative habitats may be of a poorer quality. Other consequences of disturbance include fragmentation of breeding populations, total reproductive failure in colonies that have relocated or reduced numbers of nesting pairs and reduced reproductive output per pair in relocated colonies (Buckley and Buckley 1978). Desertion of large colonies that are responsible for the major portion of a population's reproductive output can affect the stability of the entire regional population of herons, even if the desertion is followed by relocation.

Heronries are communal nesting places of water birds. Being top predators of the freshwater food chain, water birds are excellent indicators of environmental health in the countryside. They build large stick nests, mostly in colonies at traditional sites. The protection of heronries is very important for the conservation and management of these species, many of which are an essential part of our agricultural ecosystem because of the range of ecosystem services provided. Documentation of these heronries, information of the species breeding within our area and knowledge of the current status of our heronries are the first basic steps in the direction of chalking out a conservation strategy regarding these birds. In a drive aimed at restoring the dwindling number of heronries, KSBB along with Kottayam Nature Society launched the ‘Kottilla Samrakshana Programme’ with the involvement of local people.

13.4 Payment for Ecosystem Services

Survey of heronries of Alappuzha and Kottayam district was conducted from 03 July 2008 to 03 August 2008. Figure 13.1 shows the details of the study area. Direct observation method was adopted for the survey of heronry (Altman et al. 1974). Counting was done with the help of DPS I 10×50 binocular and zoom cameras. The nests in each tree were counted; the adult and young were counted separately, along with the identification of the tree species used for nesting and details like GBH and approximate height of tree. Information was collected from the owners of the land regarding the age of the heronry (number of years the heronry was known to exist), and the distance from the heronry to the nearest wetland was also recorded. The identification of the birds was done with the help of field guides ‘Birds of Southern India’ by Grimmett et al. (1998).

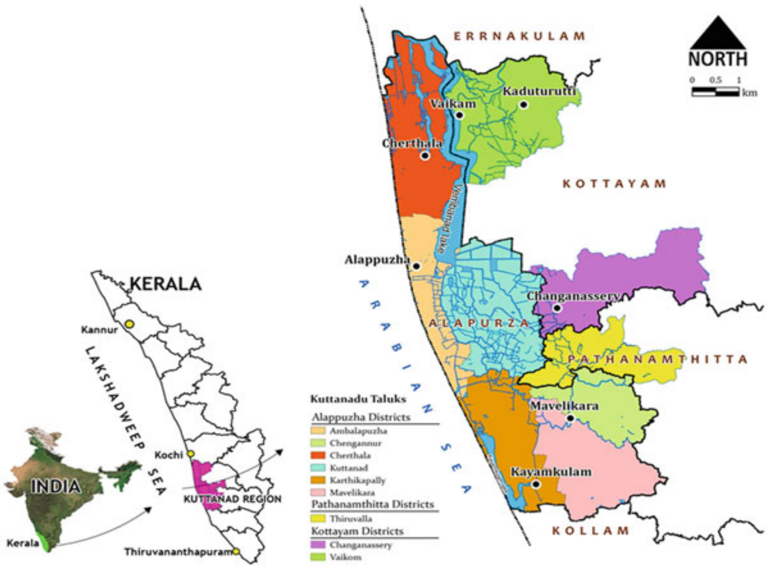

Fig. 13.1 Study area

Table 13.1 Details of nesting tree species

Sl no.	Species of tree	No. of trees	Height range (m)	Average tree height (m)	GBH range (cm)	GBH average (cm)
1	*Artocarpus hirsutus*	68	6–45	13.1	22–200	68.325
2	*Talipariti* sp.	2	4.5	4.5	40	40
3	*Mangifera indica*	32	4.5–15	10.55	20–150	65.97
4	*Samanea saman*	7	8–15	12.67	100–200	164.29
5	*Alstonia scholaris*	6	9.6–16	12.27	200–300	283.33
6	*Tectona grandis*	2	10	10	40	40
8	*Mimusops elengi*	2	5	5	20	20
9	*Phragmites karka*	7	1.1–3.3	1.79	0	0
10	*Swietenia macrophylla*	4	8–12	9.5	54–90	81
11	*Tamarindus indica*	18	7–20	11.71	45–173	82.56
12	*Thespesia populnea*	6	7–9	7.33	38–90	64.17
13	*Ailanthus triphysa*	4	7–8	7.5	30–64	48.5
14	*Artocarpus heterophyllus*	27	8–25	17.56	35–119	77.33
15	*Terminalia catappa*	4	11–12.1	11.38	35–50	45
16	*Macaranga peltata*	2	9.6–12	10.8	45	45
17	*Hevea brasiliensis*	2	11.2	11.2	50–52	51
18	*Sonneratia caseolaris*	2	14–18	16	29–40	34.5
19	*Hibiscus tiliaceus*	4	4.5–10	5.88	15–35	21.25
20	*Reed*	5	1	1	1	1
21	*Annona glabra*	1	10	10	28	28
22	*Racosperma auriculiforme*	10	12	12	65–155	97.5
23	*Acacia mangium*	80	9–10.6	9.04	40–42.5	42.44
24	*Bambusa bambos*	1	12.1	12.1	25	25
25	*Cocos nucifera*	2	12–12.1	12.05	6–35	20.5
26	*Lannea coromandelica*	2	10–11.5	10.75	26–105	65.5
27	*Trewia nudiflora*	2	12.1	12.1	32	32
28	*Cerbera odollam*	3	5.4	5.4	20	20
29	*Pandanus odoratissimus*	1	4.8	4.8	20	20
30	*Anacardium occidentale*	1	10	10	113	113

During the period of survey, a total of 17 heronries were identified; 1782 nests were located in these 17 heronries on 307 trees belonging to 30 different species (Table 13.1). A total of 3869 birds were identified which comprised of 1184 adult and 2685 young birds representing 10 species of birds (Tables 13.2 and 13.3, Fig. 13.2). Among the birds listed, 'little cormorant' (*Phalacrocorax fuscicollis*) was the most common followed by Oriental darter (*Anhinga melanogaster*) and Indian pond heron (*Ardeola grayii*), respectively (Table 13.2). The bird species inhabiting these heronries used diverse kind of trees, a total of 307 trees representing 30 species to construct nest. The tree species used for nesting are listed in Table 13.1. The tree

Table 13.2 Identified bird species in heronries

Sl no.	Common name	Species name	IUCN status	No. of adult	No. of young	Total	No. of trees	No. of nests
1	Indian pond heron	*Ardeola grayii*	LC	100	23	123	89	196
2	Little cormorant	*Microcarbo niger*	LC	667	1484	2151	124	825
3	Indian shag	*Phalacrocorax fuscicollis*	LC	84	148	232	10	64
4	Large cormorant	*Phalacrocorax carbo*	LC	6	10	16	2	4
5	Little egret	*Egretta garzetta*	LC	6	9	15	2	3
6	Intermediate egret	*Ardea intermedia*	LC	15	24	39	2	9
7	Large egret	*Ardea alba*	LC	16	26	42	5	10
8	Oriental darter	*Anhinga melanogaster*	NT	265	919	1184	68	654
9	Purple heron	*Ardea purpurea*	LC	24	39	63	4	15
10	Black-crowned night heron	*Nycticorax nycticorax*	LC	1	3	4	1	2
	Total	Ten species		1184	2685	3869	307	1782

species selected was within a height range of 1.1–18 m, and GBH was in a range of 20–350 cm. The study finds that the selection of tree for nesting within the 30 species was random and more than species the height range was the criteria for each bird species considered in choosing nesting trees.

13.5 Environment Sustainability

Most of the heronries were located in private properties; hence exposed to greater risk of destruction and survival was largely depended on the mercy of the owner of the land. The current study was more focused on identification of these heronries and designing practical efforts derived from the study to conserve the heronries. The identified heronries were conserved by providing timely incentives to the landowners willing to protect them and also spread awareness among general public by installing signboards in public places near the heronries.

The preservation of heronries needs an integrated approach, with participation of stakeholders. The new opportunities that ecosystem service approaches provide for biodiversity conservation include managing ecosystems sustainably outside protected areas. In many cases, the importance of ecosystem services may help incentivise conservation and sustainable management of land and water outside protected areas in human-inhabited landscapes. Active participation of locals in long-term monitoring and creating awareness will increase the chances of conservation of heronries and herons sustainably. As the payments provide incentives to landowners, PES is a market-based mechanism, similar to subsidies, to encourage the conservation of natural resources. The programme shows how an equitable and

Table 13.3 Details of the heronries studied

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
1	Private property	Neelamperoor	Alappuzha	6	1	*Ardeola grayii*	3	1	0	*Artocarpus hirsutus*	6.00	50
					2	*Microcarbo niger*	5	3	0	*Artocarpus hirsutus*	6.00	50
					3	*Ardeola grayii*	2	1	3	*Talipariti*	4.50	40
					4	*Ardeola grayii*	7	3	10	*Mangifera indica*	4.50	30
					5	*Ardeola grayii*	4	2	6	*Mangifera indica*	4.50	40
					6	*Ardeola grayii*	2	1	3	*Artocarpus hirsutus*	12.10	60
					7	*Microcarbo niger*	15	8	23	*Artocarpus hirsutus*	12.10	60
2	Government property	TB road	Kottayam	1	8	*Phalacrocorax fuscicollis*	24	45	69	*Samanea saman*	8.00	200
					9	*Microcarbo niger*	32	50	82	*Alstonia scholaris*	9.60	300
					10	*Anhinga melanogaster*	1	2	3	*Alstonia scholaris*	9.60	300
					11	*Microcarbo niger*	81	170	251	*Alstonia scholaris*	11.20	200
					12	*Anhinga melanogaster*	7	16	23	*Alstonia scholaris*	11.20	200
					13	*Microcarbo niger*	26	32	58	*Alstonia scholaris*	16.00	350

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					14	*Anhinga melanogaster*	5	8	13	*Alstonia scholaris*	16.00	350
				0.7	15	*Microcarbo niger*	13	24	37	*Artocarpus hirsutus*	14.50	200
					16	*Anhinga melanogaster*	29	35	64	*Artocarpus hirsutus*	14.50	200
					17	*Anhinga melanogaster*	2	2	4	*Tectona grandis*	10.00	40
					18	*Microcarbo niger*	1	1	2	*Tectona grandis*	10.00	40
					19	*Anhinga melanogaster*	58	45	103	*Samanea saman*	15.00	200
					20	*Microcarbo niger*	29	36	65	*Samanea saman*	15.00	200
					21	*Anhinga melanogaster*	28	30	58	*Samanea saman*	15.00	150
					22	*Microcarbo niger*	70	48	118	*Samanea saman*	15.00	150
	Private property				23	*Microcarbo niger*	17	5	22	*Mangifera indica*	9.60	30
					24	*Ardeola grayii*	1	2	3	*Artocarpus heterophyllus*	12.00	40
					25	*Microcarbo niger*	3	2	5	*Mangifera indica*	13.00	40
					26	*Ardeola grayii*	2	1	3	*Mangifera indica*	13.00	40
					27	*Ardeola grayii*	1	1	2	*Mangifera indica*	12.00	40

3	Government property	Mutherimada	Kottayam	2.7	28	*Ardeola grayii*	1	1	2	*Mimusops elengi*	5.00	20
					29	*Ardeola grayii*	2	1	3	*Mimusops elengi*	5.00	20
					30	*Ardeola grayii*	4	4	8	*Artocarpus hirsutus*	9.00	28
					31	*Ardeola grayii*	2	2	4	*Artocarpus hirsutus*	10.00	28
					32	*Ardeola grayii*	1	1	2	*Artocarpus hirsutus*	9.00	35
					33	*Ardeola grayii*	2	2	4	*Artocarpus hirsutus*	9.00	30
					34	*Ardeola grayii*	2	2	4	*Artocarpus hirsutus*	9.00	35
					35	*Ardeola grayii*	2	2	4	*Artocarpus hirsutus*	10.00	38

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
4	Private property	Chakkachampakka	Alappuzha	0.03	36	*Microcarbo niger*	7	0	7	*Artocarpus hirsutus*	13.70	30
					37	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.70	25
					38	*Microcarbo niger*	2	0	2	*Artocarpus hirsutus*	13.70	25
					39	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.70	25
					40	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.70	25
					41	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.70	25
					42	*Microcarbo niger*	4	0	4	*Artocarpus hirsutus*	14.60	22
					43	*Ardeola grayii*	1	0	1	*Artocarpus hirsutus*	9.10	29
					44	*Ardeola grayii*	1	0	1	*Mangifera indica*	5.50	20
					45	*Ardeola grayii*	1	0	1	*Mangifera indica*	12.20	25
					46	*Ardeola grayii*	2	0	2	*Artocarpus hirsutus*	13.70	40
					47	*Ardeola grayii*	4	0	4	*Artocarpus hirsutus*	13.70	40
					48	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.70	40
					49	*Microcarbo niger*	2	0	2	*Artocarpus hirsutus*	13.70	35

5	Private property	Marangattady	Alappuzha	1	50	*Ardea purpurea*	1	0	1	*Phragmites karka*	3.30	0
					51	*Ardea purpurea*	1	0	1	*Phragmites karka*	3.30	0
6	Private property	Kumarakom	Kottayam	2	52	*Microcarbo niger*	3	6	9	*Swietenia macrophylla*	12.00	90
					53	*Microcarbo niger*	3	6	9	*Swietenia macrophylla*	10.00	90
					54	*Ardeola grayii*	2	2	4	*Swietenia macrophylla*	8.00	90
					55	*Microcarbo niger*	1	2	3	*Swietenia macrophylla*	8.00	54
					56	*Microcarbo niger*	3	4	7	*Tamarindus indica*	8.00	110
					57	*Ardeola grayii*	1	2	3	*Tamarindus indica*	8.00	110
					58	*Microcarbo niger*	10	15	25	*Thespesia populnea*	7.00	60
					59	*Ardeola grayii*	3	3	6	*Thespesia populnea*	7.00	60
					60	*Microcarbo niger*	2	0	2	*Thespesia populnea*	7.00	52
					61	*Ardeola grayii*	1	2	3	*Thespesia populnea*	7.00	90
					62	*Microcarbo niger*	3	3	6	*Thespesia populnea*	7.00	85
					63	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	8.00	76

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					64	*Ardeola grayii*	1	0	1	*Artocarpus hirsutus*	8.00	76
					65	*Ardeola grayii*	2	1	3	*Ailanthus triphysa*	8.00	64
					66	*Ardeola grayii*	1	1	2	*Tamarindus indica*	8.00	100
					67	*Microcarbo niger*	1	2	3	*Artocarpus hirsutus*	6.00	100
					68	*Ardeola grayii*	1	1	2	*Artocarpus hirsutus*	6.00	100
					69	*Microcarbo niger*	6	8	14	*Mangifera indica*	12.00	110
					70	*Ardeola grayii*	2	2	4	*Mangifera indica*	12.00	110
					71	*Microcarbo niger*	1	0	1	*Mangifera indica*	8.00	70
					72	*Ardeola grayii*	2	1	3	*Mangifera indica*	8.00	70
					73	*Microcarbo niger*	1	2	3	*Artocarpus heterophyllus*	8.00	80
					74	*Ardeola grayii*	1	0	1	*Artocarpus heterophyllus*	8.00	80
					75	*Microcarbo niger*	1	2	3	*Tamarindus indica*	7.00	80
					76	*Ardeola grayii*	2	0	2	*Tamarindus indica*	7.00	80
					77	*Microcarbo niger*	1	0	1	*Ailanthus triphysa*	7.00	50
					78	*Ardeola grayii*	1	0	1	*Ailanthus triphysa*	7.00	50

					79	*Ardeola grayii*	1	0	1	*Artocarpus heterophyllus*	10.00	85
					80	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	13.00	100
					81	*Microcarbo niger*	3	0	3	*Mangifera indica*	12.00	70
					82	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	13.00	95
					83	*Microcarbo niger*	1	2	3	*Tamarindus indica*	7.00	62
					84	*Ardeola grayii*	1	2	3	*Artocarpus hirsutus*	8.00	30
					85	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	13.00	90
					86	*Ardeola grayii*	2	0	2	*Artocarpus hirsutus*	13.00	90
					87	*Ardeola grayii*	1	2	3	*Artocarpus hirsutus*	7.00	50
					88	*Microcarbo niger*	1	2	3	*Tamarindus indica*	7.00	73
					89	*Ardeola grayii*	3	0	3	*Tamarindus indica*	7.00	73
					90	*Microcarbo niger*	3	4	7	*Mangifera indica*	12.00	44
					91	*Microcarbo niger*	3	4	7	*Artocarpus hirsutus*	7.00	28

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					92	*Ardeola grayii*	1	2	3	*Artocarpus hirsutus*	7.00	28
					93	*Microcarbo niger*	3	3	6	*Artocarpus hirsutus*	12.00	100
					94	*Ardeola grayii*	4	5	9	*Artocarpus hirsutus*	12.00	100
7	Private property	Purakkad Smruthi Vanam	Alappuzha	1.5	95	*Ardeola grayii*	7	8	15	*Artocarpus heterophyllus*	12.00	75
					96	*Ardeola grayii*	4	9	13	*Artocarpus heterophyllus*	12.00	40
					97	*Ardeola grayii*	3	5	8	*Mangifera indica*	12.00	100
					98	*Microcarbo niger*	2	0	2	*Mangifera indica*	10.00	32
8	Government property	Kavanattinkara	Kottayam	0.5	99	*Anhinga melanogaster*	8	10	18	*Terminalia catappa*	11.20	50
					100	*Anhinga melanogaster*	2	4	6	*Terminalia catappa*	11.20	50
					101	*Anhinga melanogaster*	1	2	3	*Artocarpus hirsutus*	11.20	50
					102	*Anhinga melanogaster*	2	4	6	*Artocarpus hirsutus*	11.20	50
					103	*Anhinga melanogaster*	1	2	3	*Macaranga peltata*	9.60	45
					104	*Anhinga melanogaster*	3	5	8	*Hevea brasiliensis*	11.20	50
					105	*Phalacrocorax carbo*	3	5	8	*Terminalia catappa*	11.00	45

					106	*Phalacrocorax fuscicollis*	1	2	3	*Hevea brasiliensis*	11.20	52
					107	*Ardea alba*	2	4	6	*Sonneratia caseolaris*	14.00	29
					108	*Ardea alba*	4	5	9	*Sonneratia caseolaris*	18.00	40
					109	*Ardea alba*	1	1	2	*Hibiscus tiliaceus*	10.00	35
					110	*Ardea purpurea*	8	16	24	*Reed*	0.00	0
					111	*Ardea intermedia*	8	13	21	*Reed*	0.00	0
					112	*Ardea alba*	1	2	3	*Reed*	0.00	0
					113	*Anhinga melanogaster*	11	14	25	*Reed*	0.00	0
					114	*Microcarbo niger*	1	0	1	*Reed*	0.00	0
					115	*Phalacrocorax fuscicollis*	1	1	2	*Macaranga peltata*	12.00	45
					116	*Egretta garzetta*	1	2	3	*Annona glabra*	10.00	28
					117	*Microcarbo niger*	25	35	60	*Samanea saman*	9.50	150
					118	*Microcarbo niger*	3	5	8	*Samanea saman*	11.20	100

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
9	Private property	Puthuppally	Kottayam	0.8	119	*Microcarbo niger*	8	16	24	*Racosperma auriculiforme*	12.00	65
					120	*Microcarbo niger*	12	20	32	*Racosperma auriculiforme*	12.00	90
					121	*Anhinga melanogaster*	1	2	3	*Racosperma auriculiforme*	12.00	90
					122	*Microcarbo niger*	10	14	24	*Racosperma auriculiforme*	12.00	80
					123	*Phalacrocorax carbo*	1	1	2	*Racosperma auriculiforme*	12.00	80
					124	*Microcarbo niger*	3	3	6	*Racosperma auriculiforme*	12.00	100
					125	*Microcarbo niger*	10	15	25	*Racosperma auriculiforme*	12.00	80
					126	*Anhinga melanogaster*	1	2	3	*Racosperma auriculiforme*	12.00	80
					127	*Microcarbo niger*	2	4	6	*Racosperma auriculiforme*	12.00	155
					128	*Anhinga melanogaster*	1	2	3	*Racosperma auriculiforme*	12.00	155
10	Government property	Pathiramanal Island	Alappuzha	4	129	*Ardeola grayii*	1	1	2	*Artocarpus heterophyllus*	10.00	60
					130	*Ardeola grayii*	1	0	1	*Artocarpus heterophyllus*	10.00	50
					131	*Microcarbo niger*	10	8	18	*Mangifera indica*	7.00	30

11	Private property	Pandy	Alappuzha	0.1	132	*Ardeola grayii*	1	2	3	*Mangifera indica*	12.50	50
					133	*Microcarbo niger*	8	0	8	*Mangifera indica*	12.50	50
					134	*Ardeola grayii*	1	1	2	*Thespesia populnea*	9.00	38
					135	*Microcarbo niger*	6	6	12	*Artocarpus heterophyllus*	13.00	58
					136	*Phalacrocorax fuscicollis*	3	1	4	*Mangifera indica*	11.00	50
					137	*Microcarbo niger*	10	3	13	*Talipariti, Artocarpus heterophyllus*	12.00	55
					138	*Phalacrocorax fuscicollis*	1	1	2	*Artocarpus heterophyllus*	22.00	40
					139	*Microcarbo niger*	7	1	8	*Artocarpus heterophyllus*	22.00	35
					140	*Anhinga melanogaster*	46	25	71	*Artocarpus heterophyllus*	20.00	90
					141	*Phalacrocorax fuscicollis*	5	5	10	*Artocarpus heterophyllus*	20.00	90
					142	*Microcarbo niger*	4	4	8	*Artocarpus heterophyllus*	20.00	90
					143	*Anhinga melanogaster*	3	3	6	*Tamarindus indica*	20.00	49
					144	*Microcarbo niger*	20	20	40	*Tamarindus indica*	20.00	49

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					145	*Phalacrocorax fuscicollis*	19	19	38	*Tamarindus indica*	20.00	49
					146	*Anhinga melanogaster*	4	4	8	*Artocarpus heterophyllus*	23.00	68
					147	*Microcarbo niger*	5	5	10	*Artocarpus heterophyllus*	23.00	68
					148	*Anhinga melanogaster*	10	8	18	*Artocarpus heterophyllus*	25.00	100
					149	*Microcarbo niger*	4	4	8	*Artocarpus heterophyllus*	25.00	100
					150	*Phalacrocorax fuscicollis*	7	7	14	*Artocarpus heterophyllus*	25.00	100
					151	*Anhinga melanogaster*	4	4	8	*Artocarpus heterophyllus*	18.00	90
					152	*Microcarbo niger*	3	3	6	*Artocarpus heterophyllus*	18.00	90
					153	*Phalacrocorax fuscicollis*	2	2	4	*Artocarpus heterophyllus*	18.00	90
					154	*Anhinga melanogaster*	20	14	34	*Artocarpus heterophyllus*	22.00	115
					155	*Microcarbo niger*	17	11	28	*Artocarpus heterophyllus*	22.00	115
					156	*Microcarbo niger*	14	14	28	*Mangifera indica*	15.00	125
					157	*Anhinga melanogaster*	30	22	52	*Artocarpus heterophyllus*	18.00	60

					158	*Microcarbo niger*	7	7	14	*Artocarpus heterophyllus*	18.00	60
12	Government property	R Block	Alappuzha	0.6	159	*Anhinga melanogaster*	11	0	11	*Acacia mangium*	9.00	42.5
					160	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					161	*Anhinga melanogaster*	7	0	7	*Acacia mangium*	9.00	42.5
					162	*Anhinga melanogaster*	20	0	20	*Acacia mangium*	9.00	42.5
					163	*Microcarbo niger*	7	0	7	*Acacia mangium*	9.00	42.5
					164	*Anhinga melanogaster*	20	0	20	*Acacia mangium*	9.00	42.5
					165	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					166	*Anhinga melanogaster*	13	0	13	*Acacia mangium*	9.00	42.5
					167	*Microcarbo niger*	11	0	11	*Acacia mangium*	9.00	42.5
					168	*Microcarbo niger*	19	0	19	*Acacia mangium*	9.00	42.5
					169	*Microcarbo niger*	9	0	9	*Acacia mangium*	9.00	42.5
					170	*Anhinga melanogaster*	4	0	4	*Acacia mangium*	9.00	42.5

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					171	*Anhinga melanogaster*	1	0	1	*Acacia mangium*	9.00	42.5
					172	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					173	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					174	*Anhinga melanogaster*	6	0	6	*Acacia mangium*	9.00	42.5
					175	*Anhinga melanogaster*	1	0	1	*Acacia mangium*	9.00	42.5
					176	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					177	*Anhinga melanogaster*	1	0	1	*Acacia mangium*	9.00	42.5
					178	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					179	*Anhinga melanogaster*	9	0	9	*Acacia mangium*	9.00	42.5
					180	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					181	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					182	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					183	*Anhinga melanogaster*	19	0	19	*Acacia mangium*	9.00	42.5

					184	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					185	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					186	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					187	*Anhinga melanogaster*	9	0	9	*Acacia mangium*	9.00	42.5
					188	*Microcarbo niger*	3	0	3	*Acacia mangium*	9.00	42.5
					189	*Anhinga melanogaster*	12	0	12	*Acacia mangium*	9.00	42.5
					190	*Microcarbo niger*	3	0	3	*Acacia mangium*	9.00	42.5
					191	*Anhinga melanogaster*	6	0	6	*Acacia mangium*	9.00	42.5
					192	*Microcarbo niger*	5	0	5	*Acacia mangium*	9.00	42.5
					193	*Anhinga melanogaster*	2	0	2	*Acacia mangium*	9.00	42.5
					194	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					195	*Microcarbo niger*	10	0	10	*Acacia mangium*	9.00	42.5
					196	*Anhinga melanogaster*	1	0	1	*Acacia mangium*	9.00	42.5

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					197	*Microcarbo niger*	19	0	19	*Acacia mangium*	9.00	42.5
					198	*Anhinga melanogaster*	25	0	25	*Acacia mangium*	9.00	42.5
					199	*Microcarbo niger*	11	0	11	*Acacia mangium*	9.00	42.5
					200	*Anhinga melanogaster*	5	0	5	*Acacia mangium*	9.00	42.5
					201	*Microcarbo niger*	22	0	22	*Acacia mangium*	9.00	42.5
					202	*Anhinga melanogaster*	5	0	5	*Acacia mangium*	9.00	42.5
					203	*Microcarbo niger*	9	0	9	*Acacia mangium*	9.00	42.5
					204	*Anhinga melanogaster*	2	0	2	*Acacia mangium*	9.00	42.5
					205	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					206	*Anhinga melanogaster*	1	0	1	*Acacia mangium*	9.00	42.5
					207	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					208	*Anhinga melanogaster*	1	0	1	*Acacia mangium*	9.00	42.5
					209	*Anhinga melanogaster*	4	0	4	*Acacia mangium*	9.00	42.5

					210	*Microcarbo niger*	4	0	4	*Acacia mangium*	9.00	42.5
					211	*Anhinga melanogaster*	3	0	3	*Acacia mangium*	9.00	42.5
					212	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					213	*Microcarbo niger*	7	0	7	*Acacia mangium*	9.00	42.5
					214	*Anhinga melanogaster*	7	0	7	*Acacia mangium*	9.00	42.5
					215	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					216	*Anhinga melanogaster*	13	0	13	*Acacia mangium*	9.00	42.5
					217	*Microcarbo niger*	13	0	13	*Acacia mangium*	9.00	42.5
					218	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					219	*Anhinga melanogaster*	20	0	20	*Acacia mangium*	9.00	42.5
					220	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					221	*Anhinga melanogaster*	18	0	18	*Acacia mangium*	9.00	42.5

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					222	*Anhinga melanogaster*	10	0	10	*Acacia mangium*	9.00	42.5
					223	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					224	*Anhinga melanogaster*	4	0	4	*Acacia mangium*	9.00	42.5
					225	*Microcarbo niger*	2	0	2	*Acacia mangium*	9.00	42.5
					226	*Anhinga melanogaster*	18	0	18	*Acacia mangium*	9.00	42.5
					227	*Microcarbo niger*	7	0	7	*Acacia mangium*	9.00	42.5
					228	*Anhinga melanogaster*	9	0	9	*Acacia mangium*	9.00	42.5
					229	*Microcarbo niger*	8	0	8	*Acacia mangium*	9.00	42.5
					230	*Anhinga melanogaster*	18	0	18	*Acacia mangium*	9.00	42.5
					231	*Anhinga melanogaster*	19	0	19	*Acacia mangium*	9.00	42.5
					232	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					233	*Anhinga melanogaster*	7	0	7	*Acacia mangium*	9.00	42.5

					234	*Anhinga melanogaster*	16	0	16	*Acacia mangium*	9.00	42.5
					235	*Anhinga melanogaster*	11	0	11	*Acacia mangium*	9.00	42.5
					236	*Microcarbo niger*	1	0	1	*Acacia mangium*	9.00	42.5
					237	*Egretta garzetta*	2	4	6	*Phragmites karka*	1.10	0
					238	*Ardea intermedia*	1	2	3	*Phragmites karka*	1.10	0
					239	*Ardea alba*	2	4	6	*Phragmites karka*	1.10	0
					240	*Ardea purpurea*	5	8	13	*Phragmites karka*	1.10	0
					241	*Nycticorax nycticorax*	2	1	3	*Phragmites karka*	1.10	0
					242	*Ardeola grayii*	2	0	2	*Mangifera indica*	7.60	40
					243	*Ardeola grayii*	3	0	3	*Bambusa bambos*	12.10	25
					244	*Ardeola grayii*	1	0	1	*Cocos nucifera*	12.10	35
					245	*Ardeola grayii*	1	0	1	*Acacia mangium*	10.60	40
					246	*Microcarbo niger*	2	0	2	*Acacia mangium*	10.60	40
					247	*Ardeola grayii*	1	0	1	*Cocos nucifera*	12.00	6
					248	*Ardeola grayii*	7	0	7	*Tamarindus indica*	11.50	45
					249	*Microcarbo niger*	14	0	14	*Tamarindus indica*	11.50	45
					250	*Microcarbo niger*	3	0	3	*Lannea coromandelica*	11.50	26

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
13	Private property	Ramankary	Alappuzha	0.003	251	*Microcarbo niger*	3	0	3	*Artocarpus hirsutus*	12.20	30
					252	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	12.20	30
					253	*Ardeola grayii*	2	0	2	*Artocarpus hirsutus*	15.20	30
					254	*Ardeola grayii*	1	0	1	*Tamarindus indica*	15.20	45
14	Private property	Thekkekara near to Moncombu	Alappuzha	0.08	255	*Microcarbo niger*	3	0	3	*Hibiscus tiliaceus*	4.50	20
					256	*Microcarbo niger*	1	0	1	*Trewia nudiflora*	12.10	32
					257	*Ardeola grayii*	1	0	1	*Trewia nudiflora*	12.10	32
					258	*Ardeola grayii*	3	0	3	*Hibiscus tiliaceus*	4.50	15
					259	*Microcarbo niger*	13	0	13	*Hibiscus tiliaceus*	4.50	15
					260	*Microcarbo niger*	3	0	3	*Terminalia catappa*	12.10	35
					261	*Microcarbo niger*	10	0	10	*Mangifera indica*	9.70	40
					262	*Ardeola grayii*	2	0	2	*Mangifera indica*	9.70	40
					263	*Ardeola grayii*	2	0	2	*Cerbera odollam*	5.40	20
					264	*Ardeola grayii*	2	0	2	*Cerbera odollam*	5.40	20
					265	*Ardeola grayii*	1	0	1	*Pandanus odoratissimus*	4.80	20
					266	*Ardeola grayii*	1	0	1	*Cerbera odollam*	5.40	20

15	Government property	Vechoor Panchayat, Thottappally	Kottayam	0.7	267	*Ardeola grayii*	1	0	1	*Artocarpus hirsutus*	13.00	97
					268	*Ardeola grayii*	1	1	2	*Ailanthus triphysa*	8.00	30
					269	*Microcarbo niger*	2	2	4	*Artocarpus hirsutus*	10.00	81
					270	*Ardeola grayii*	3	3	6	*Artocarpus hirsutus*	10.00	81
					271	*Ardeola grayii*	1	2	3	*Artocarpus hirsutus*	13.00	90
					272	*Ardeola grayii*	3	3	6	*Artocarpus hirsutus*	10.00	67
					273	*Ardeola grayii*	1	1	2	*Artocarpus hirsutus*	10.00	55
					274	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.00	84
					275	*Microcarbo niger*	4	6	10	*Artocarpus hirsutus*	15.00	113
					276	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	15.00	113
					277	*Microcarbo niger*	1	2	3	*Artocarpus hirsutus*	13.00	76
					278	*Ardeola grayii*	3	4	7	*Mangifera indica*	13.00	147
					279	*Microcarbo niger*	2	2	4	*Artocarpus hirsutus*	13.00	69
					280	*Microcarbo niger*	2	1	3	*Artocarpus hirsutus*	13.00	140

(continued)

Table 13.3 (continued)

Heronry no.	Ownership	Location	District	Distance from wetland (km)	Tree no.	Species	Number of nests	Number of birds		Species of the nest tree	Height of nesting tree	GBH of nesting tree (cm)
								Adult	Young			
					281	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	13.00	100
					282	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	13.00	30
					283	*Microcarbo niger*	1	1	2	*Anacardium occidentale*	10.00	113
					284	*Microcarbo niger*	3	3	6	*Artocarpus hirsutus*	13.00	60
					285	*Ardeola grayii*	1	1	2	*Artocarpus hirsutus*	13.00	98
					286	*Ardeola grayii*	2	1	3	*Artocarpus hirsutus*	17.00	82
					287	*Microcarbo niger*	3	0	3	*Tamarindus indica*	20.00	173
					288	*Microcarbo niger*	1	0	1	*Artocarpus hirsutus*	13.00	113
					289	*Ardeola grayii*	4	0	4	*Mangifera indica*	10.00	112
					290	*Ardeola grayii*	2	0	2	*Artocarpus hirsutus*	12.00	120
					291	*Ardeola grayii*	4	0	4	*Mangifera indica*	13.00	150
					292	*Ardeola grayii*	2	0	2	*Artocarpus heterophyllus*	20.00	119
					293	*Ardeola grayii*	2	0	2	*Mangifera indica*	15.00	133
					294	*Ardeola grayii*	1	0	1	*Tamarindus indica*	17.00	170

					295	*Ardeola grayii*	2	0	2	*Artocarpus hirsutus*	17.00	125
					296	*Ardeola grayii*	1	0	1	*Tamarindus indica*	13.00	95
					297	*Ardeola grayii*	3	0	3	*Artocarpus hirsutus*	13.00	120
					298	*Ardeola grayii*	1	0	1	*Lannea coromandelica*	10.00	105
					299	*Ardeola grayii*	3	0	3	*Artocarpus hirsutus*	8.00	79
					300	*Ardeola grayii*	11	0	11	*Tamarindus indica*	7.00	78
16	Private property	Kaippuzhamuttu	Kottayam	1	301	*Ardeola grayii*	6	0	6	*Mangifera indica*	13.00	98
17	Private property	Kallara	Kottayam	0.5	302	*Phalacrocorax fuscicollis*	1	1	2	*Artocarpus hirsutus*	45.00	75
					303	*Microcarbo niger*	1	1	2	*Artocarpus hirsutus*	45.00	75
					304	*Ardeola grayii*	3	1	4	*Artocarpus hirsutus*	45.00	75
					305	*Ardeola grayii*	2	1	3	*Mangifera indica*	8.00	50
					306	*Ardeola grayii*	3	2	5	*Mangifera indica*	10.00	50
					307	*Ardeola grayii*	2	1	0	*Mangifera indica*	10.00	75

(continued)

Fig. 13.2 Nesting bird species: (**A**) Indian pond heron, (**B**) little cormorant, (**C**) Indian shag, (**D**) large cormorant, (**E**) little egret, (**F**) intermediate egret, (**G**) large egret, (**H**) Oriental darter, (**I**) purple heron, (**J**) black-crowned night heron

financially sustainable payment scheme can compensate local landholders for conserving and restoring habitats. Incentive schemes need to be developed by appropriately compensating protectors of biodiversity and providing tangible incentives for conservation. By making biodiversity conservation a livelihood opportunity, a payment scheme can give sustainable livelihood options as well as meet the targets for biodiversity conservation.

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Chapter 14
Geographical Indications and Sustainable Livelihood

Preetha Nilayangode, G.S. Unnikrishnan Nair, K.P. Laladhas, and Oommen V. Oommen

Abstract A geographical indication (GI) is a legal tool for the protection of traditional knowledge (TK) as it is associated with traditions of a community or a region. Geographical indications are based on the concept of collective rights and reward members of the community following the traditional practices. Branding and promotion of products with unique qualities can generate premium market for such products thereby providing sustainable livelihood options for the community. In India, agricultural, natural and manufactured goods can be brought under the ambit of GI. This chapter outlines five case studies from Kerala, India, wherein GI registration has been obtained for a bioproduct rice variety and has succeeded in enhancing the livelihood of farmers. The GI tag improves the market prospects of the rice variety and earns commercial benefit for farmers by assuring a niche market.

Keywords Geographical indications • Navara • Gandhakasala • Jeerakasala • Rice

14.1 Introduction

In India geographical indications regime is regulated by the Geographical Indications of Goods (Registration & Protection) Act, 1999, which was enacted to comply with the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement and the Geographical Indication of Goods (Regulation and Protection) Rules, 2002. Article 22 of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement mandates member countries to provide for the protection of all geographical indications (GIs). GI is defined as 'indications which identify a good as originating in the territory of a member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin'. Under Article 22, the scope of protection includes: protection against the use of indications that mislead the public or are

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deceptive and protection against the use of indications in a manner that are acts of unfair competition.

A GI can also be a more appropriate tool for the protection of traditional knowledge than other intellectual property rights (IPR) tools as both GIs and TK are location specific and are associated with traditions of a community or a region (Nair and Kumar 2005). GIs protect TK indirectly, by preventing others from unfairly profiting from a community's TK. Branding and promotion of these products with unique qualities can generate premium market for such products in addition to contributing to conservation of biodiversity. GI registration contributes to conservation of biodiversity by incentivizing local people to collect sustainably and continue traditional farming practices (Pant 2015). GIs also serve to honour the local community who has maintained the germplasm for centuries.

14.2 Community Benefits of GI Registration: Protection of Traditional Knowledge

A geographical indication (GI) is a sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin. Geographical indications are based on the concept of collective rights and reward members of an established community adhering to traditional practices. GI is an effective legal tool for protection of the collective rights of the rural and indigenous communities, ensuring that the entire community, which has preserved the knowledge and has passed it on over generations, stands to benefit from the knowledge.

The major advantages of GI registration are that the knowledge remains in the public domain, the scope of protection is limited to controlling the class and/or location of people who may use the protected indication, and the rights can potentially be held in perpetuity as long as the product-place link is maintained (Commission on Intellectual Property Rights 2004). Holders of a GI do not have the right to transfer the rights to indication to non-local producers.

Different countries have different approaches for providing legal means to protect GIs. Except Thailand, all the countries offer remedies in the form of injunctions and damages by conferring rights to initiate legal proceedings. In Thailand, the plaintiff can claim compensation for infringement of GIs (and other IP rights) (Gopalakrishnan et al. 2007). A notable feature of all the *sui generis* is that they do not contain any specific provision for quality control.

In India, agricultural, natural and manufactured goods can be brought under the ambit of GI. Traditional knowledge in India is either codified or uncodified and passed on from generations to generations. The traditional knowledge holders may be individuals, groups or groups of communities. Traditional knowledge related to bioresources includes utilization of bioresources in arts and culture, agriculture, animal husbandry, biodiversity conservation and utilization, eco-friendly practices, fisheries, forest and wildlife management, healthcare, medicinal and food plants, rural technology, etc. The Biodiversity Act 2002 and Rules 2004 exempt local people and communities of the area including growers and cultivators of biodiversity from its ambit. In this scenario GIs can help communities promote markets and at the same time provide protection for the biocultural products they have developed using knowledge acquired over generations.

14.3 GI Registration from Kerala

Twenty products from Kerala have got geographical indication registration so far:

- Kaipad rice
- Chendamangalam dhoties and set mundu
- Payyannur Pavithra ring
- Wayanad Jeerakasala rice
- Wayanad Gandhakasala rice
- Kasaragod sarees
- Kuthampully sarees
- Balaramapuram sarees and fine cotton fabrics
- Cannanore home furnishings
- Vazhakulam pineapple
- Pokkali rice
- Brass-broidered coconut shell crafts
- Screw pine craft of Kerala
- Maddalam of Palakkad
- Alleppey green cardamom
- Malabar pepper
- Navara rice
- Palakkadan Matta rice
- Alleppey coir
- Aranmula kannadi

This chapter outlines five case studies from Kerala, India, wherein GI registration has been obtained for a bioproduct rice variety (Fig. 14.1) and has succeeded in enhancing the income of farmers. About 2000 local land races of rice are grown in Kerala differing in crop duration, plant height, tillering, panicle characters, grain characters as well as grain and straw production. Careful selection over centuries has resulted in a large number of traditional varieties possessing special traits like resistance to biotic and abiotic stresses and ability to adapt to drought or floods and quality attributes like medicinal value, aroma and resistance to diseases. The disappearance of local landraces leads to loss of folk knowledge related to the properties of varieties with quality attributes, extinction of many traditional agricultural systems, changes in nutritional values and displacement of marginal farmers.

Fig. 14.1 Ricefields in Kerala

14.3.1 Navara Rice

Navara is the first agricultural product in India to be registered as GI under a farmer-led initiative 'Navara Rice Farmers Society'. Navara is grown in nine districts of Kerala, namely, Palakkad, Malappuram, Calicut, Wayanad, Kannur, Thrissur, Ernakulam, Kottayam and Alleppey. Navara is medicinal rice and its grain, bran, powder and root are used in Ayurveda for the treatment of different ailments. It is of two varieties – black glumed and golden yellow glumed. Navarakizhi and Navaratheppu are two major treatments in the Panchakarma method of treatment within Ayurveda for conditions such as arthritis, paralysis and neurological disorders. In Navarakizhi, a decoction of Navara rice is made with different kinds of herbs and milk. It is then enclosed in cloth pouches (kizhis) and is used for massaging. In Navaratheppu, a paste of boiled Navara rice in kurunthotti kashayam is applied on the body. For mouth ulcers and for peptic ulcers, traditional doctors advise Navara bran mixed with jaggery. Navara rice is used after snake bites to reduce pain and for the healing of the wound. Navara root boiled in water is used as a drink for urinary tract infection and also as a diuretic. Navara rice powder cooked with brown sugar and milk is found to be a nourishing food for babies. During the period of July 15–Aug 15 (or Karkidakam, as it is known in the Kerala calendar), Kerala receives the maximum amount of the southwest monsoon rains, and body defences are perceived to become weak. In this month, Navara gruel is included in the diet to help develop immunity.

14.3.2 Kaipad Rice

The Kaipad system of rice cultivation is an integrated organic farming system of North Kerala (Kozhikode, Kannur and Kasaragod districts) in coastal brackish water marshes in which rice cultivation and aquaculture are done. The tidal flows make the fields highly fertile through a symbiotic relationship between rice crop and prawn, shrimp and fish etc. The most popular traditional cultivars of this tract are Kuthiru and Orkayama, and improved cultivars are Ezhome-1 and Ezhome-2. The cultivars like Orpandy, Kandorkutty, Mundon, Orissa, Odiyan and Punchakayama are being cultivated in a very minimal extent at some parts of Kaipad tracts. Rice produced in Kaipad farming system is red in colour and it is nonsticky and tasty. It is richer in iron content than 'Navara'. The farming system is unique and consists of marshes, swamps, ponds and paddy fields which help in controlling sedimentation, flood and pollution. Mangroves which are seen on the fringes of backwaters and estuaries provide breeding sites for fishes and prawn and maintain productivity of Kaipad ecosystem. As Kaipad tract is in coastal area, there will be flood during monsoon and salinity during summer season. To prevent water from entering the fields, bunds are constructed using wild grasses and sticky mud taken from riverbanks. The flow of water is regulated by sluice made up of wood. Agricultural operation begins in the beginning of April by draining out saline water completely from the Kaipad field, and fields are left to dry for a period of 1 month. After that, small mounds of diameter about 45 cm and height about 60 cm are made. In early June, when southwest monsoon starts and intensifies, the salinity from the top of the mound leaches away. Soils on the mounds attain low levels of salinity on washing and leaching with rainwater and can be used for sowing seeds, while salts accumulate in the soils between the mounds. When there is enough freshwater flow in the river, the sluices are opened fully. Along with the river water, the Kaipad field receives highly fertile organic matter which along with excreta of migratory birds and remnants of aqua culture makes the Kaipad ecosystem highly fertile. Harvested products are brought in yachts from the interior parts of Kaipad rice tracts. Neither chemical fertilizers nor plant protection chemicals are used in rice, fish or shrimp farming. The fingerlings of fish, shrimp, prawn, etc. which swim in from the sea and the backwaters after the rice harvest feed on the leftovers of the harvested crop. The paddy stubbles, algae and other debris in Kaipad form food material for the prawns, fishes and others. Members of the Malabar Kaipad Farmers' Society of Kannur with help of Centre for IP Protection in Kerala Agricultural University (KAU) received the registration certificate in 2014.

14.3.3 Palakkadan Matta

Palakkadan Matta with a distinct taste got the GI tag in 2008. Under the registry, there are ten varieties of the Palakkadan Matta rice: Aryan, Aruvakkari, Chitteni, Chenkazhama, Chettadi, Thavalakannan, Eruppu, Poochamban, Vattan Jyothy and Kunjukunj. The Palakkadan Matta is described as bold red rice with a unique taste because of the geographical area it is grown in and the peculiar weather there owing to the eastern wind. This rice is fibre rich because of intact bran and rich in many nutrients and hence is suitable for infants and children. Brown Matta rice is a rich source of magnesium, a mineral that acts as a cofactor for more than 300 enzymes, including enzymes involved in the body's use of glucose and insulin secretion. There are two types of Matta rice, Red Matta and Rose Matta rice grown in Kerala, especially in the Palakkad district. The Red Matta rice is a brown rice because each grain retains its outer bran layer. It is this russet-coloured bran layer which gives Red Matta its name. The harvested crop is thrashed the same day, the paddy is cleaned, and it is sun-dried the next day to retain the colour and quality of the rice. The coarse rice with red pericarp by itself ensures high content of nutrients. 'Parboiling' of the rice further ensures retention of nutritional value. The grains are grown on unique black cotton or soil, derived from rocks rich in lime peculiar to Palakkad where the soil is heavy, containing 60–80 % of clay and silt and possess low permeability and high water holding capacity.

14.3.4 Pokkali Rice

The name Pokkali refers to the peculiar system of 'rice cultivation' in the coastal saline soils of Kerala extending over the districts of Ernakulam, Alappuzha and Thrissur which is under the influence of tide and is overgrown with mangroves and also the salt-tolerant traditional 'rice cultivars' grown in this tract. One season of rice farming is alternated with another season of prawn culture. Pokkali rice, which is grown only on a few hundred acres in the coastal areas of central Kerala, was awarded the GI tag in 2008. Pokkali rice is medium bold in shape with good cooking quality. The daily inflow and outflow of backwater, luxuriant growth of micro- and macroflora and natural deposit of decomposed aquatic algae make the field fertile (Fig. 14.2)

14.3.5 Jeerakasala and Gandhakasala

Jeerakasala and Gandhakasala are scented rice varieties grown in Panamaram, Sultan Bathery and Mananthavady in Wayanad district mainly cultivated in deep fields (Figs. 14.3 and 14.4). They are cultivated chiefly by Wayanad Chetti, Kuruma

Fig. 14.2 Integrated farming in Kerala

Fig. 14.3 Jeerakasala rice

and Kurichiya communities based on traditional knowledge of varieties and environmental factors. Two separate applications for both the varieties were filed by Kerala Agricultural University and Wayanad Jilla Sugandha Nellulpadaka Karshaka Samithi and have been granted registration during 2010 under class 30 of the Geographical Indication Act.

Fig. 14.4 Gandhakasala rice

The uniqueness and aroma of the product are maintained by adopting organic methods for cultivation. For better aroma, the crop is raised in the Nancha season (winter season) so that flowering coincides with the coldest months of November and December. The faunal diversity associated with paddy fields is rich and plays a significant role in controlling harmful insects and pests. The diversity of fish is also reported to be high in deep fields. The Protection of Plant Varieties and Farmers' Rights Authority, Govt. of India, honoured the Kuruma and Kurichiya tribal communities of Wayanad district through 'Plant Genome Saviour Community Award 2008' for their contributions in the conservation of traditional rice varieties including Jeerakasala. Grains of Wayanad Jeerakasala rice are of medium size and shape with golden yellow colour and partial short awns. Wayanad Gandhakasala rice grains are aromatic, short bold and awnless with a lemma and palea (hull) colour of straw. Grains have golden yellow colour.

14.4 GI Products and Sustainable Livelihood

Although GI products are expected to fetch a premium price in the market, the benefits reach the farmers to a limited extent, and the economic benefits are mostly enjoyed by the traders. There is a need for building capacity and awareness about GIs among various stakeholders including consumers. The case studies reveal that in Kerala there are many traditional agricultural practices leading to bioproducts with quality attributes specific to the locality and GI can play an important role in protecting this traditional knowledge. Support for direct marketing of the product

Fig. 14.5 Local farmer winnowing the rice by traditional way

will ensure fair and equitable sharing of benefits to the communities who have nurtured this diversity (Fig. 14.5).

External support is essential in promoting GI until a sustainable business model can be developed and demonstrated, for the benefit of marginal farmers.

14.5 Conclusions

GI acts as a system that helps the producers to differentiate their products from competing products in the market and enable them to build a reputation and goodwill which often fetch a premium price. The case studies demonstrate that the local communities play an important role in nurturing the diversity of agricultural crops and have yielded enhanced socioeconomic benefits. The major drawback is that the resource-poor farmers do not have the capacity to market the product without the support of external agencies. Hence, there is a need to ensure sound enforcement mechanism in domestic and export markets to assure that the benefits are accrued to the local community. Further enhancing industry/farming linkages and the development of an entrepreneurial attitude among the rural community to market their products for a sustainable livelihood are necessary.

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Chapter 15
Grassroot Initiatives for Sustainable Livelihood

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Abstract On-farm management of agrobiodiversity in the Western Ghats, the biodiversity hotspot and a UN-accredited World Heritage Centre has become difficult due to an array of reasons. In rice paddy ecosystem, the conversion of ricefields and dwindling diversity of rice landraces are found to be the biggest challenge. This chapter describes the case of Wayanad District of Kerala, India, where, recognising the importance of paddy fields in terms of ecological, food and livelihood security provided by them, M.S. Swaminathan Research Foundation (MSSRF) launched a rice conservation programme in 1998 and a Seed-Care movement. This movement has been facilitated since 1998 by involving the major farming groups of Wayanad, especially the tribal communities of *Kurichya*, *Kuruma*, *Pathiyar* and *Wayanadan Chetty*, to promote the conservation and sustainable use of the indigenous crop varieties. This case study illustrates a movement that has promoted conservation of seeds of indigenous varieties in smallholders' family farms in Wayanad District of Kerala. The active integration of agrobiodiversity into the overall issue of sustainable development is necessary, giving equal consideration to all the three dimensions of it: economic, ecological and social sustainability. Efforts have been made to integrate conservation issues, cultivation knowledge, consumption awareness and commercial aspects into one overarching policy strategy.

Keywords Agrobiodiversity • Tribal community • Community seed bank • Conservation • Consumption • Cultivation • Commercialization

15.1 Introduction

Way back in 1983, Prof. M.S. Swaminathan had stressed the need for a conservation continuum, beginning with revitalising conservation of domesticated plants by farm families in all countries, extending to the establishment of an international genetic resource repository maintained under permafrost conditions. This has resulted in the

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establishment of the global seed vault in Arctic Svalbard archipelago to store copies of seeds from all over the world and a number of national level gene banks in many countries (Swaminathan 2009). However, the current global trend in the conservation of plant genetic resources (PGRs) is to work directly with farmers rather than through gene banks, and hence in situ on-farm conservation became more important, while ex situ collections are regarded as backups for PGR management. This is all the more important when on-farm level erosion of genetic diversity of crops, breeds and strains is reported which may lead to a complete wipe out of such diversity in the near future. As an adaptation option, in situ on-farm conservation of traditional crops and breeds that cope with wide agroclimatic and agro-ecological conditions is seen as a reliable tool. This chapter highlights the results of M.S. Swaminathan Research Foundation's (MSSRF) interventions that has taken place since 1997 to promote on-farm conservation and save the vanishing crop diversity in the Malabar region of Kerala where a majority of people depend heavily on the traditionally conserved PGRs for their food, nutrition, income security[1] and livelihood.

15.2 Wayanad District in Kerala: An Agrobiodiversity Heritage/Hot Spot

Wayanad qualifies simultaneously as an agrobiodiversity heritage site and a hotspot of biodiversity. It is a hilly terrain in southern Western Ghats and lies at an average altitude of 750 m above sea level. The district is unique for its rich wealth of flora and fauna and for the diverse cultural heritage. It is believed that the name Wayanad is said to be derived from *wayanad* meaning upper land or from *vayalnadu* meaning land (*nadu*) of paddy fields (*vayal*) or from *vananadu* meaning land of forests (*vanam*) (Gopalan Nair 1911).

The Adivasi population contributes 18.53 %, which is the largest in the state of Kerala (ORGCCI 2011). They include farming communities, landless agricultural labourers, artisan communities and hunter–gatherer communities. The five dominant Adivasi groups of Wayanad are *Kurichya*, *Mullukuruma*, *Paniya*, *Adiya* and *Kattunaikka*. Others are *Thachanadan Mooppan*, *Karimbalar*, *Uralikuruma*, *Pathiyar* and *Wayanadan Kadar* (Gopalan Nair 1911; IIM 2006). Wayanad also has the largest settler population in Kerala. The *Jains* from the neighbouring state of Karnataka are believed to have arrived in the thirteenth century. The *Nairs* of neighbouring districts made an entry in the fourteenth century, followed by Muslims. There was a large-scale migration from southern Kerala in the early 1940s; most of whom were Christians. Wayanad comes under the high-range agro-ecological zone, one amongst the 13 categories given by Kerala Agricultural University (2011). This classification was based on the altitude (Type II, more than 500 m above MSL), rainfall (Pattern I, both the southwest and northeast monsoons are active and mod-

[1] The information and data presented in this paper are substantially drawn from the annual reports of M.S. Swaminathan Research Foundation (1998–1999 to 2013–2014).

erately distributed, southwest monsoon with June maximum, south of 11°N latitude, or Pattern II, poorly distributed rainfall, southwest monsoon with July maximum and concentrated in 3–4 months, northeast monsoon relatively weak, north of 110°N latitude), soil type (red loam) and topography (Model III with narrow valleys, steep gradient hills and steep slopes). Predominantly, Wayanad paddy fields are cultivated by one crop in the southwest monsoon, commencing in July and harvested in December (*Nancha*). The *Puncha* season is also cultivated with rice in lesser areas, between January and May. The genetic diversity in paddy is also notable with over 20 landraces cultivated presently in the district. Special varieties like *Gandhakasala* and *Jeerakasala*, two geographical indications from Wayanad (Geographical Indication Registry 2010), medicinal varieties like *Navara* and *Chennellu* and a handful of other varieties which are having peculiarities in response to flood, drought, pest and diseases are cultivated and conserved by the rural and Adivasi farmers (Anon 2001; Parameswaran et al. 2014). Almost the entire district is drained by the Kabini river and its three main tributaries, viz. *Panamaram*, *Mananthavady* and *Thirunelli*, and they carved the present landscape of Wayanad (Vinayachandran and Joji 2007). The paddy fields of Wayanad are fed by these drainages. The floristic exploration of the district had recorded a total of 2034 species of angiosperms which forms nearly 49 % of the flora of the Kerala state and more than 10 % of the flora of India. The study had reported a total of 596 endemic taxa in which 491 are endemic to Western Ghats. 338 taxa are endemic to southern Western Ghats of which 59 are restricted to Kerala and 15 exclusive to the district (Ratheesh Narayanan 2009).

Paddy cultivation all over Kerala, especially in Wayanad, is under tremendous pressure due to a large-scale conversion to nonfood grain cultivation and for commercial purposes. It is evident that the paddy area in the district had dropped by 66 % (from 30,000 to 10,230 ha) during the period 1980–1981 to 2012–1913 (DES 1983; DES 2013). The ratio between cash crop and food crop in the year 1973 was 30:70. By the end of the 1990s, this had reversed to a ratio of 70:30 (Kumar et al. 2010). M.S. Swaminathan Research Foundation's study on the native seed diversity had commenced in 1998 with a survey of traditional germplasm, and subsequently, a case study was conducted focusing on the *Kurichya* and *Kuruma* communities of Wayanad. The *Kurichya* and *Kuruma* are two major Adivasi communities practising rice cultivation in the district. Rice is an integral part of the culture and traditions of these communities. Cultivation of certain traditional varieties is central to following the rituals. For example, a rice variety called *Chennellu* is an inevitable offering to God; and another one named *Veliyan* is for community feasts. It was observed that the family structure and sociocultural patterns of these communities (Suma 2014), their rituals and ceremonies and taste preferences favour the cultivation of traditional rice varieties. They also have developed a management system based on the specialties of ricefields and rice varieties and follow the basic principles of organic farming. They cultivate rice irrespective of the economic benefits, for their own consumption and a few specialty rice varieties for treating their special guests. Tribal communities pay special attention to cultivate traditional rice varieties for multiple needs that include food, fodder, medicine, fuel and thatching as well as to satisfy their cultural sentiments (Anon 2001). Their folk songs have connotations with their agricultural practices, especially the cultivation of rice, which indicates their long association with rice cultivation. They have developed apathy towards high-yielding varieties and the varieties brought to the region by the settlers. Irrespective of the drastic fall in rice cropping area for the years since 1970s, these communities were conserving about 20 traditional rice varieties (Anon 2001; Girigan et al. 2004). Malabar region – the northern half of Kerala and some coastal regions of present day Karnataka – is considered as one of the centres of origin of crops like pepper (Willis 1996) and diversity of rice. Rice cultivation here dates back to 3000 BC (Manilal 1990). Wayanad district of this region was endowed with a number of traditional rice varieties with a wide range of unique characters. The rural and Adivasi farmers of Wayanad used to cultivate hundreds of traditional rice varieties which satisfy their dietary, economic and other requirements. Most of these varieties have either disappeared or are on the verge of disappearance because of poor profitability, lack of quality seeds, low yields, paucity of pragmatic research and extension support (Kumar et al. 2010).

15.2.1 Grassroot Initiatives for a Seed-Care Movement

Recognising the importance of paddy fields in terms of ecological, food and livelihood security provided by them, MSSRF launched a rice conservation programme in 1998 in Wayanad district and a **Seed-Care movement** was an essential part of it. This movement has been facilitated since 1998 by involving the major farming groups of Wayanad, especially the communities of *Kurichya*, *Kuruma*, *Pathiyar* and *Wayanadan Chetty*, to promote the conservation and sustainable use of the indigenous crop varieties and was taken up by four grassroot institutions in the course of time, under the umbrella of MSSRF. **Wayanad District Tribal Development Action Council (WDTDAC)** and SEED CARE are the institutions which spearheaded the movement focusing on rice, **Wayanad Agricultural and Rural Development Association (WARDA)** and JEEVANI being the others who supported with the programmes centred on other agricultural crops and medicinal plants. In this case study, focus has been given to the former two organisations which are registered under the Societies Registration Act, 1860, XXI, and are actively involved in the programmes related to agrobiodiversity management along with MSSRF. **WDTDAC** is a community-based organisation which had started its operation in 2004 and got registered in 2007. WDTDAC has been visualised as a platform to work for securing and sustaining the privileges and rights of *Adivasi* people irrespective of political and other community entities. It has a 20-point objective as built-in to its by-law, including the conservation of traditional agricultural system and the conservation of indigenous varieties of agricultural crops. SEED CARE started its operation in Wayanad in the year 2009 and represents the farmers of Wayanad who conserve and cultivate indigenous varieties of plant genetic resources. The society has got a 15-point objective as built-in to its by-law, including the protection of the intellectual property rights (IPRs) of the cultivators.

The activities of the Seed-Care movement were in four areas, called a '4C Continuum', including conservation, cultivation, consumption and commercialization of plant genetic resources as visualised by Prof. M.S. Swaminathan. The 4C framework includes: (i) enhancement and sustainable use of biodiversity that comprises in situ, on-farm and ex situ conservation involving seed bank and community gene banks of varieties; (ii) promotion of low external input sustainable agriculture; (iii) food security and nutrition through revitalization of traditional food habits; and (iv) creating an economic stake in conservation for concurrently addressing the cause of conservation and livelihood security through value addition and marketing methods. The experience of MSSRF shows that the 4C approach helps effective engagement of local communities in several villages to continue their agrobiodiversity conservation and cultural traditions (Table 15.1).

Conservation issues, cultivation knowledge, consumption awareness and commercial aspects were integrated into one overarching logical strategy for creating sustainable livelihoods by this initiative. This resulted in getting at least 1000 families from the *Kurichya*, *Kuruma*, *Pathiyar* and *Wayanadan Chetty* communities into

Table 15.1 Activity chronicle – 4C continuum in promoting the conservation and enhancement of agrobiodiversity of Wayanad

Timeline	Area of intervention – 4C continuum	Activities involved
1998 onwards	Conservation (on-farm)	Survey and documentation of PGRs (especially indigenous and specialty rice varieties, medicinal plants, leafy greens, yams and taros – digitalized, video and printed versions); germplasm collection maintenance (Fig. 15.1)
		Awareness-raising programmes based on the training materials prepared
		Awareness on farmers' rights (starting in 2001)
		Documentation of farmers' varieties
		Promoting seed villages for the production of quality seeds of indigenous rice varieties (starting in 2011)
2000 onwards	Consumption	Awareness generation on the nutritional/medicinal characteristics of the PGRs
		Promotion of home nutrition gardens with nutritious yams, taros and leafy greens
2000 onwards	Cultivation	Formation of farmer cluster groups
		Participatory genetic purification of medicinal and specialty rice varieties, production and distribution of their quality seed for extending the area of cultivation
		Community gene and seed bank programme
2005 onwards	Commercialization	Market survey and study
		Exploring on-farm/off-farm enterprising opportunities and promoting value-added products from PGRs and establishing market linkages
		Promoting farmer-owned marketing ventures

Source: MSSRF Annual Reports, various years

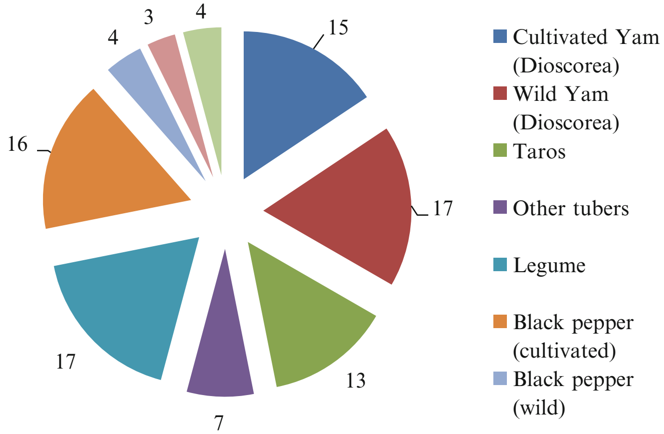

Fig. 15.1 Number of Crop varieties maintained in germplasm garden of MSSRF and conserved through the seed care movement (excluding paddy varieties)

a model of improved nutrition and sustainable livelihoods. The homesteads of these four communities sustained diverse food crops, medicinal and fruit trees, sacred groves and other alternate life-saving crops (the crops which stand over the adverse environmental conditions like drought, flood, etc.). The coffee, pepper, ginger, turmeric and areca nut from their farms were contributing to their income needs in a good way. MSSRF's core programme, the Livelihood Enhancement, Agriculture and Food Security initiative (2011–2016), supported by the Department of Science and Technology, Government of India, is another partnership with the rural and Adivasi communities of Wayanad, for which the pilot efforts for over a decade have contributed in a large way.

Various land legislations of independent India and the intra-regional farmer migrations from 1940 to the 1950s to Wayanad have triggered many conflicts. With the introduction of strict forest laws, shifting cultivation was also stopped. The Green Revolution started in 1960 had also made its on pressures on their system. Though with great constraints, these farm families have been remaining as conservators of native seed varieties and breeds. Recent studies also reveal that the ecosystem management system of some of these communities, like *Kurichya* and *Kuruma*, offers a high degree of socioecological resilience in the changing scenario (Betz et al. 2014). The Seed-Care movement has helped the local communities in many ways to adapt well with the ecological, economical and cultural vulnerabilities. For instance, the farmers revitalised their practising of agriculture in all the three forms of land they have, the waterlogged valleys in the foothills, the homesteads and the hill slopes between these two as an adaptation to climate variabilities like shifting monsoons, fluctuating day temperature and humidity. The ecosystem management that the communities adopt is based on the science of recycling with zero depletion of resources. Since the resilient capacity of many of the local communities is evident from the studies, even a small policy intervention from the state's side can be beneficial in the sustainability point of view. Integrating nutrition security in farming system is now gaining serious attention at policy level in India, which was taken as a motive to influence the general public, especially the youth, to adopt conservation and cultivation for improving health and longevity.

Involvement of women is an integral part of the Seed-Care movement. Under various forums like women self-help groups (SHGs), village knowledge centres and community seed banks, hundreds of women were able to come forward to engage in farming by giving thrust to vegetables, fruits and paddy. The movement has also taken much strength from the MSSRF's community-level education and training programmes for women and children. The initiatives like community banking, Every Child A Scientist and Department of Biotechnology Nature Awareness (DNA) Clubs are some of them. The initiative to train climate risk managers (one woman and one man from each *Panchayath*) for sustainable agricultural development was also capitalised towards the goal. Technological and skill empowerment training for home-makers, women of local bodies and tribal councils under the Kerala Kudumbasree Mission is also streamlined via this movement in the areas related to the conservation and sustainable and equitable use of agrobiodiversity. The nearly 15 years of experience in promotion of sustainable utilisation of the indigenous and traditional agricultural seed wealth in Wayanad district shows that focusing on improving the capacities of the small and marginal farmers of society would result in improved agroecosystem governance. This has been experienced even amongst the most vulnerable communities like *Paniya*, *Adiya* and *Kattunaikka* in the Adivasi sectors. This has equipped the communities to freely express their concerns and to negotiate for the sustainable improvement of their lives and livelihoods. It has also resulted significantly in raising the necessary support towards eradication of poverty and hunger through sustainable agricultural intervention, education for all and improved maternal and child health – the key Millennium Development Goals (MDGs). Linkages were also established with various poverty eradication programmes of local self, state and national governments. The capacity and confidence thus attained by the people have also paved the way for community asset-building activities in the intervention locations in all the four areas of action – conservation, cultivation, consumption and commerce with both economic and environmental benefits.

The anticipated ultimate impact for the movement is achieving some of the key MDGs by the most vulnerable communities in the Malabar region. Although Kerala is well ahead in achieving many of the global targets, the vulnerable in the society, the Adivasi community, lag way behind in most of the MDGs. The movement focused this issue by developing and sustaining capacity of the indigenous community of Wayanad district and concurrently improving the accountability, transparency and efficiency of delivery mechanisms of the state and other key civil society institutions. One of the major social impacts of the intervention was improved knowledge base of the Adivasi communities in the most relevant legislation like (i) Right to Information, (ii) Right to Education, (iii) Farmers' Rights, (iv) Forest Rights and (v) Biological Diversity Act, 2002. The movement has helped in conserving the genetic base of many of the crop diversity of the region from the verge of disappearance. The kind of indigenous rice varieties which were conserved have ensured the ability to

Table 15.2 Major outputs/outcomes of the Seed-Care movement

Outputs	Outcomes
On-farm conservation of 25 indigenous varieties of rice and 15 varieties of yams and taros	Increased awareness about the value of heterogeneity and diversity in landscapes and landraces
Recognising the conservation efforts of rural and Adivasi communities	Genetic erosion checked
Legal recognition to 25[a] (6 + 19[a]) rice varieties as farmers' varieties by the Government of India and their wider cultivation through 10 seed villages by involving 250 farm families	Ensured conservation of the provisioning and regulating ecosystem services of socially and ecologically productive landscapes
Education about the need of consuming diversity by reaching out over 1, 00,000 families and establishment of 500 home nutrition gardens for the most vulnerable indigenous communities	Increased awareness on the cultural and spiritual dimension of resource management by the rural and Adivasi communities

[a]Applications under consideration

withstand pest and disease emergence and water pressures. Conserving the wetlands along the valleys in its natural form itself is contributing to the water security of the region. Conservation of different species of trees in their homesteads reduces the impact of climate change on a micro-environment. The innovations in this movement in keeping the heterogeneity of landscapes, conserving water bodies and reducing chemical pollution has also helped the farm families to potentially adapt to a wide range of climate vulnerabilities including reduced yield and productivity. Major outputs/outcomes of the Seed-Care movement are listed in Table 15.2.

15.2.2 Major Outcome

15.2.2.1 Kurichya and Kuruma Adivasi Communities Bag Second Plant Genome Saviour Community Recognition (2008)

Kurichya and *Kuruma* Adivasi communities were recognised with the *Second Plant Genome Saviour Community Recognition* in 2008 under the provisions of the *Protection of Plant Varieties and Farmers' Rights Act, 2001*, India. These communities have been conserving 20 traditional rice varieties with unique characteristics like flood/drought resistance, pest/disease resistance and medicinal and aromatic properties. The *Protection of Plant Varieties and Farmers' Rights Act, 2001* (GoI 2001), is meant for providing the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants. The *Protection of Plant Varieties and Farmers' Rights Authority* (PPV&FR Authority) which was established under the provisions of this Act has launched the *Plant Genome Saviour Community Recognition Award* in 2007 and *Plant Genome Saviour Award* in 2010 as a mark of recognition and reward to the agrobiodiversity conservers and protectors of the country (Fig 15.2).

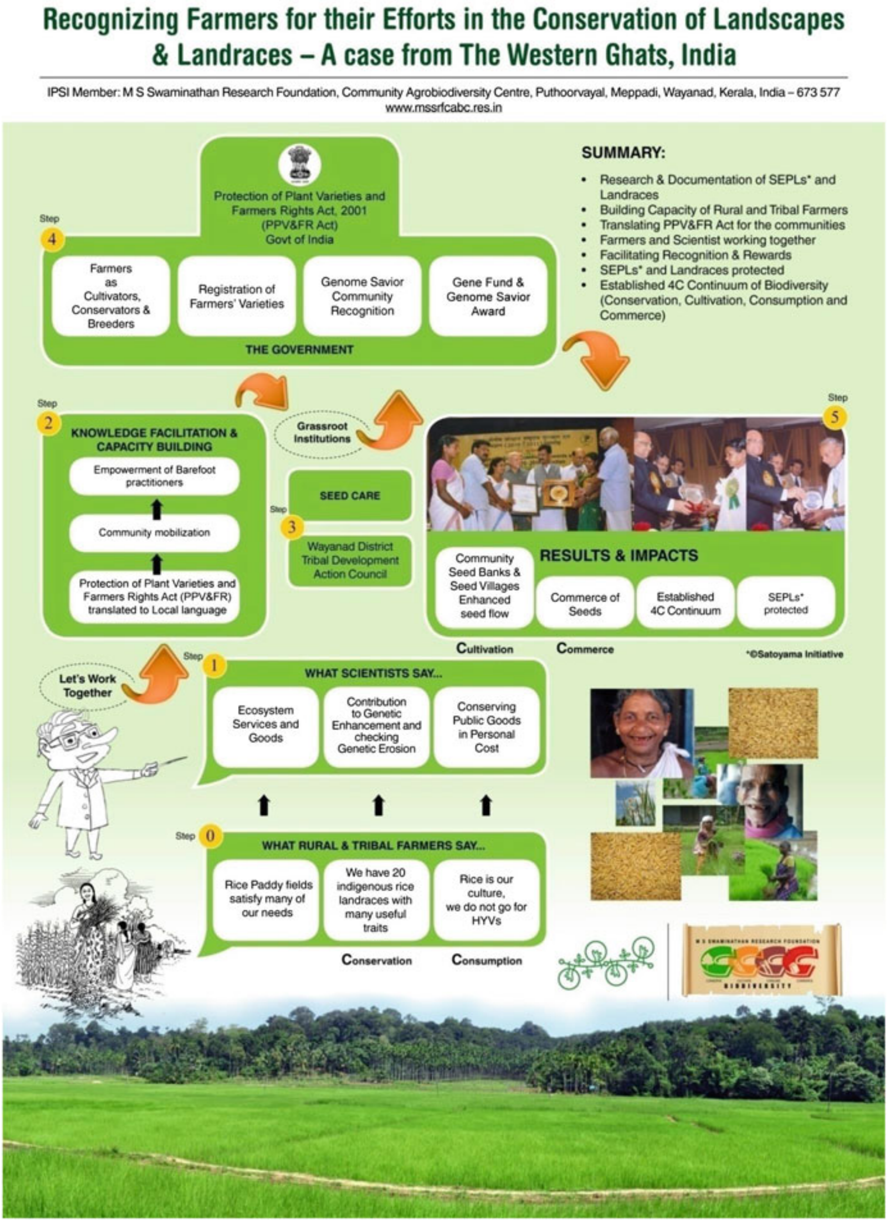

Fig. 15.2 MSSRF's efforts in recognizing the farmers' for their contribution in the conservation of Plant Genetic Resources (Source: https://satoyama-initiative.org/wp/wp-content/uploads/2015/01/32.-MSSRF-Community-Agrobiodiversity-Centre.pdf)

15.2.2.2 Wayanad District Tribal Development Action Council Bags Second Plant Genome Saviour Community Award

MSSRF has been extending support for all the preliminary actions and activities of WDTDAC including financial, technical, managerial and training needs. MSSRF has also played a fair role to help the council in establishing linkages with like-minded organisations and government departments. MSSRF was doing the role of a facilitator between WDTDAC and PPV&FR Authority for submitting the successful application for the Ten Lakhs rupees that came as a Plant Genome Saviour Community Award (2010–2011). WDTDAC has the objective of strengthening the community conservation efforts in agrobiodiversity by utilising the award money and by giving emphasis to 20 existing traditional rice cultivars in the district.

15.2.2.3 SEED CARE Registers Farmers' Varieties

SEED CARE, which is actively involved in advocating farmers' rights and protection of plant varieties, has forwarded 27 applications for farmers' varieties of rice to PPV&FR Authority, Government of India, out of which 6 got registered in 2013, viz. *Veliyan*, *Thondi*, *Chennellu*, *Chomala*, *Gandhakasala* and *Jeerakasala* (Reg. nos. 56–61 of 2013). The provision of registration of farmers' varieties allows the farmers to register a variety which has been traditionally cultivated and evolved by the farmers in their fields, or it is a wild relative or land race of a variety about which the farmers possess the common knowledge. As per the registration, given under the provision of Protection of Plant Varieties and Farmers' Rights Act of India, 2001, Wayanad farmers have the exclusive right to produce, sell, market, distribute, import or export the registered farmers' varieties for a specified period.

15.2.2.4 MSSRF Launches Its Seed Village Programme in Partnership with WDTDAC and SEED CARE

Starting in 2011, the movement has mobilised rice farmers from ten villages of Wayanad district and clustered them into seed villages, mainly serving as seed, grain and gene banks. SEED CARE has been spearheading the processes of community mobilisation, awareness generation for PGR management, quality seed production and management of seed and gene banks of traditional paddy varieties. There are 105 households, spread across ten selected seed villages in the district. The intervention is now spread across 74.8 ha of wetland. Every seed village has taken up the cultivation of two to eight traditional varieties of paddy. The farmers of the seed villages are able to sell off their excess produce every year in a rate which is much higher than the rate in the local market. During the year 2013–2014, only 2.15 tonnes of seeds of traditional rice varieties have been produced and distributed from the seed villages. Traditionally seeds were handled by men in the Adivasi communities, but now women have an important role in the decision-making process regarding the selling of produce being the member of seed bank management committee. There is an exclusive women group belonging to *Kuruma* community undertaking the cultivation and marketing of traditional varieties. Due to changes in the climate and unpredicted floods and drought, now more farmers have moved to traditional varieties which are more hardy and tolerant to climate vagaries. Hence there is an increased demand for the seeds of such varieties, provided the quality of the seeds is maintained. To overcome the issue of contamination/mixing of seeds, one hectare of paddy land is maintained for purification of the selected ten varieties (*Chennellu*, *Chenthadi*, *Chomala*, *Jeerakasala*, *Gandhakasala*, *Mullankaima*, *Thondi*, *Adukkan*, *Veliyan* and *Kalladiyaryan*). Participatory purification methods were adopted for selection and purification of seeds sourcing the expertise of lead farmers. Purification techniques like rouging of weeds and removing off types were performed, and the purified seeds were brought in to the distribution chain every year. Trainings were also provided on purification techniques, seed and grain management, mechanisation, etc. for helping the community in their efforts to conserve speciality varieties (Smitha 2014).

15.2.2.5 The Seed-Care Movement Launches Its Community Seed Fest

The movement has launched its first district level Seed Fest in February, 2015. The Wayanad Community Seed Fest was an initiative supported by the National Bank for Agriculture and Rural Development (NABARD) and Kerala State Biodiversity Board (KSBB) with the following objectives:

- Creating awareness amongst farmers and other local communities about famer's rights and community rights on biodiversity
- Equipping the Biodiversity Management Committees (BMCs – the committee formed at the local self-government level under the Biological Diversity Act 2002) to take the lead role at the local level for a 4C (conservation, cultivation, consumption and commercialization) management approach in agrobiodiversity conservation
- Encouraging farmers who conserve biodiversity on-farm and creating a platform for traditional farmers and new generation farmers to exchange seeds, for farmer–buyer meetings and for traditional and scientific knowledge exchange on agrobiodiversity management

Standing true to the spirit and ethos of the event, guardians of traditional seeds were felicitated in the event. Community Agrobiodiversity Awards, 2015, instituted by the Wayanad District Tribal Development Action Council were also been given away to *Kurichya* and *Kuruma* Adivasi farm families (MSSRF 2015a, b).

15.3 Conclusion

The whole exercise behind the Seed-Care movement in a biocultural heritage site like Wayanad was to generate transforming knowledge towards a sustainable and gender-equitable use of agrobiodiversity through a multilateral approach of action research and policy advocacy (The Thazhava Plan of Action 2009; Thiruvananthapuram Declaration 2010) in a partnership mode. The key learning is that the active integration of agrobiodiversity into the overall issue of sustainable development is necessary, giving equal consideration to all the three dimensions of it – economic, ecological and social sustainability. Even though the Governments of India and Kerala have enacted various acts and implemented various schemes for promoting agrobiodiversity conservation, these measures could not gather the desired results due to an array of reasons. The cultivation and conservation of traditional plant genetic resources are mostly confined to the Adivasi and rural areas of the state. They conserve and preserve these valuable plant genetic resources irrespective of economic benefits. Their efforts need to be recognised and properly acknowledged for continuing their services towards humanity. In this backdrop, the Seed-Care movement in Wayanad was instrumental to lead the farmers of the district in agrobiodiversity management. The members of Wayanad District Tribal Development Action Council and SEED CARE have become the ambassadors for this prompt and sought-after action. The relevance of this case is so important at the juncture, where the conversion of agricultural land and dwindling diversity in PGRs have become the biggest challenges in conserving agrobiodiversity at the farm level. Such initiative is also important in view of the likelihood of climate change impacts, as many of these varieties hold innate characteristics to combat stress including that of drought and flood. It is also widely accepted that the variability in diversity, which assures the stability of the population, must be conserved and used in appropriate ways in order to provide source materials to realise the future demand for new varieties. In the given case of community agrobiodiversity management, steps have also been taken to ensure the equitable sharing of benefits arising out of the conservation and utilisation of plant genetic resources.

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Part III
Biodiversity for Sustainable Livelihood

Chapter 16
Release of Indigenous Tribal Community from Debt Trap

Sanjayan Kumar and S.M. Vairavel

Abstract Periyar, Kerala, India, was selected as one of the seven sites to implement eco-development activities under the India Eco-development Project (IEDP) in 1996. As part of trust building with local communities, interactions were made with the tribal people. Eco-development committees (EDCs) were formed, and harvesting of bioresources and their judicious marketing were done under the leadership of EDC. Savings bank accounts were opened jointly in the name of the male and female heads of each family providing gender equality. As part of the project, income-generating activities were initiated in many neighbourhoods, and also financial loan facilities for agriculture were provided to individuals and groups. This made a platform for the people and officials to have a healthy relationship with mutual trust and belief. People were willing to come forward for forest protection by self-motivation. The chapter describes the initiatives under the Eco-development Project for providing sustainable livelihood to tribal communities at Periyar.

Keywords Eco-development committee • Ecotourism • Poachers • Debt • Tribal community

16.1 Introduction

Mannans and Paliyans are the two prominent tribal groups in Periyar. They were living inside the forest at places like Ummikuppan, Mlappara, Thannikudy, etc., and their main occupation was cardamom cultivation and fishing. In the 1940s, they were relocated to the fringe area of Periyar. Hence after relocation, in technical terms, they were inside the forest itself, but for all practical purposes, they were in the mainstream amongst people.

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The place they are now living was fertile and much suitable for pepper internationally known as 'black gold'. As pepper was in much demand and valuable, local moneylenders had taken advantage of the innocence of the tribals for their greedy marketing techniques. The moneylenders were ready to give any amount of money as loan, and in return the tribal people had to provide pepper under their terms and conditions. During harvest, the moneylenders would weigh the yield and calculate the price. The tribes were being cheated in terms of weight and also in terms of price. Every time, the calculation was in such a way that the debt was increasing year after year.

They also asked the tribes to do more tending operations to increase the yield. Since the tribes were not having enough money to do this tending work, the moneylenders promised to do it for them, with a cost. The work was being done by the tribes themselves, and hence due to the deal, the owners of the land became the labourers.

16.2 Sustainable Livelihood and Poverty Reduction

Periyar was selected as one of the seven sites to implement eco-development activities under India Eco-development Project in 1996. As part of the trust building with local communities, interactions were made with these tribes. While collecting details of financial background of households, it was found that every household in the tribal hamlet was having a huge debt to the moneylenders. Assessment of the volume of debt has given a figure of about INR 7.00 lakh (US $ 10,539.79) for the total number of 350 families. The moneylenders were contacted by the forest officials, and the figure mentioned by them was INR 21 lakh (US $31,619.36).

In order to come to a realistic figure, the officials collected a list prepared by the leaders of the eco-development committee. A similar list was asked from the moneylenders also and they also presented a list. The moneylenders said that the tribes have not calculated the interest portion. In the end, the officials arrived at an understanding with both parties, adding the reasonable interest part, and the amount thus calculated came to INR 11 lakh (US $ 16,562.52).

As part of community mobilisation, the Forest Department had organised a medical camp in the tribal hamlets. It was during the period of tussle between the moneylenders and the tribes. Knowing the importance of such a camp, all the members of the tribal hamlets were eager to participate in it. But on the day of the camp, the attendance was very poor. With the help of social workers including a sociologist, the reason was traced out. The moneylenders had gone to the extent of convincing the innocent people that 'the Forest Department has organised the Medical Camp for secret sterilisation of tribal women so that no new generation will be there'. It was really a very hard day's work for the social workers of the Forest Department to make the camp a success at the end of the day.

Then the Principal Chief Conservator of Forests of Kerala made arrangements to pay off the entire calculated money to the lenders from a separate head of account under the ‘World Food Programme’. Harvesting was done under the leadership of EDC and arrangements were made for the judicious marketing. Token advance money was given to every household. At the end of the harvesting season, the yield was for INR 52 lakh (US $ 78,295.57). Savings bank accounts were opened jointly in the name of the male and female heads of each family, and their share of money was deposited and the debt of the tribal households was paid off. The real owners, the Mannans and the Paliyans, realised their ownership rights and started the act of actual cultivation, and they began to do the tending operations in time for improved yield. The traditional way of organic cultivation enabled them to get certification for international export, and the benefits were directly imbibed to the local community by the Kerala Forest Department.

16.3 Community-Based Ecotourism (CBET) and Sustainable Livelihood

Periyar Tiger Reserve is rich in biodiversity and provides habitat to elephants, tigers and other fauna and flora. But the main challenges faced by the law-enforcing officials are the 96 km long Kerala-Tamil Nadu interstate border and the inaccessibility due to the nature of terrain inside the sanctuary. Due to these practical problems, many areas inside the sanctuary became the ‘territory’ for illegal activities. One of the main illegal activities was collecting barks of cinnamon tree locally known as *vayana*. Groups of seven to eight persons will go to the so-called territory and debark the *vayana* trees and dry, bundle and transport the material to Tamil Nadu by head-load, and the material was sold. The operation will last for 8–10 days, and all these days, the group will camp in a safe place suitable for overnight camping with adequate supply of water for cooking, and their food requirements will be met by illegal poaching from the forest, leading to physical combat between them and the forest staff many a times. A number of forest offences were booked against them and only a few were apprehended.

Periyar was selected as one of the seven sites to implement eco-development activities under the India Eco-development Project, which started in 1996. All the fringe area people were motivated for a symbiotic relationship or coexistence with nature. As part of the project, income-generating activities were initiated in many neighbourhoods and also financial loan facilities for agriculture and other small projects by individuals and groups. This made a platform for the people and the officials to have a healthy relationship with mutual trust and belief. People were willing to come forward for forest protection by self-motivation.

The *vayana* bark-collecting groups from the Kerala side were getting less opportunity for their activities as the neighbourhood people, by forming eco-development committees, were giving proper secret information. With the help of a mediator, a local political leader with whom some of the forest officials were having good relationship, these poachers presented their willingness to stop the illegal activities and to help in the conservation of forest wealth, if they were allowed to do so. A private platform was made for the in-house discussions with them. They promised to stop these activities and also to catch the other groups who are still in operation as the operational areas are predefined and no group would intrude into other's territory. Their only plea was to allow them to sleep in their own houses without the fear of being arrested. Discussions were made between the officials and they were given 6 months time to prove their integrity. During this grace period of 6 months, they gave secret information about the presence of other groups in their 'territory', and the officials were able to catch the offenders. All information was passed on to a selected set of officials whom they believe. Once, when they were not able to find such a person within the short period of time available, they themselves caught the offenders. When the surveillance period of 6 months was over, mutual trust was established and the tribals were rehabilitated. All the places they used to camp during their illegal activities were suitable for overnight camping and ecotourism. The officials thought of a new protection strategy of using the services of these ex-poachers. The main advantages of ecotourism are as follows:

- The protection of forests at the same time, providing alternative means of livelihood to the local inhabitants directly or indirectly
- Imparting nature education and interpretation through awareness programmes
- Generating public support and goodwill for the cause of conservation and protection of forests and wildlife
- Providing ecotourism opportunities to the tourists
- Generation of revenue incidental to ecotourism

The park managers thought of starting an ecotourism programme with these group members subject to the following conditions:

- The total number of visitors is limited to the carrying capacity of the designated area in the protected area (PA).
- The activities of the visitors are also regulated in accordance with the existing sanctuary/national park rules.
- The visitors are accompanied by trained guides (local fringe area people) on one hand to impart nature education and on the other to protect the PA.

The fees so collected will be deposited in the account of the EDC formed for these 'ex-*vayana* bark collectors', numbering 23, and were utilised to give wages to them based on the number of days they have done the protection work by camping inside the selected points. In order to make this plan feasible, tie-up was made with a tour operator, 'Kerala Travels', and an agreement signed with them. Under this agreement, they were allowed to send in tourists to attend this programme of 'Periyar Tiger Trail' by collecting some fees, and in turn they will give monthly wages to the members of the EDC including insurance facilities. This was made operational and it became a most sought-after programme.

16.3.1 Protected Area Management with Local Participation

The programme has resulted in rehabilitating the poachers by empowering them to function as protectors of the forest. The team members are trained in first aid, tracking wildlife, collection of primary data of wildlife sighting, bird watching, etiquette, etc., apart from the basic skills needed for tourist guides. Offences from debarking the *vayana* tree have become almost nil (Table 16.1).

In the beginning of the programme, the camps with tourists were less in number, and at the same time, the protection camps were high. But in the later stage, the camps with tourists overrode the protection camps because of the increasing popularity of the programme.

The team as a whole has opened out a new vista in the protected area management.

One of their members, Mr. Suganthan, aged 40, sacrificed his life for Periyar Tiger Reserve in the attack by a herd of wild elephants while chasing a group of poachers in the forests on 29 July 2000. The team did like to remember this incident as a life sacrifice to Periyar Tiger Reserve and as compensation for their illegal activities in the past.

The remarkable conservation efforts of the team have already been recognised by various concerned sectors. It has been accredited as one of the topmost protection-oriented ecotourism efforts in the national scenario by the Tourism Department. The team has been recognised as the best antipoaching team among all the tiger reserves in the country by ‘The Junglees’ (a wildlife-concerned NGO) and has received the ‘Green Guard Award’ in 2001–2002.

16.3.2 Impact on the Ecosystem: Before and After Implementation

Before the implementation of the project, these people were mainly involved in the large-scale extraction of *vayana* bark (30,000 kg/year) leading to the destruction of the forest with other associated negative impacts on the park. Earlier, around 9800 tree saplings were cut every year for making platforms for drying the *vayana* bark, and nearly 36 animals, including sambar deer, Nilgiri langur, etc., were poached by them (Table 16.2).

The formation of the eco-development committee has changed the entire scenario. The collection of *vayana* bark is entirely stopped, and cutting of tree saplings and poaching have ceased completely.

Table 16.1 Involvement of ex-*vayana* bark collectors in eco-development committee in detecting offence cases during 1998–2002

	Sandalwood smuggling		*Vayana* bark collection		Elephant tusk poaching		Poaching		Illegal activities	
Year	Information	Arrest	Information	Arrest	Information	Arrest	Information	Arrest	Information	Arrest
1998	2	3	1	16	0	2	3	0	2	0
1999	3	1	0	2	0	0	1	0	0	0
2000	1	6	1	1	0	0	0	0	0	7
2001	3	3	0	0	0	0			1	0
2002	6	6	0	1	0	0	1	1	3	0
Total	15	19	2	20	0	2	5	1	6	7

Total no. of cases in which the EDC assisted the staff to arrest the forest offenders – 49

Table 16.2 Quantity of *vayana* barks removal (in kg) (from November 1996 to October 1997) by former poachers

Sl. no.	Name of the former poachers	Quantity of dry *vayana* removed	Number of days spent in forest
1	Sadhanandhan, E.G.	2300	184
2	Thankachan, P.J.	0	–
3	Arumugam	995	146
4	Aji, M.B.	1425	120
5	Naushad, M.M.	2600	177
6	Kunjumon, V.J.	3100	156
7	Babu, V.J.	2300	184
8	Selvam, R.	2500	191
9	Surendran, M.S.	245	24
10	Pandiyan, S.	1360	140
11	Monachan, M.P.	1010	118
12	Gunasekaran, A.	1115	48
13	Ganesan, P.	1500	174
14	Naushad, M.	1500	181
15	Baby, C.A.	1360	149
16	Koshy, P.J.	1650	136
17	Thomas, C.C.	1950	100
18	Jose, K.P.	1185	99
19	Sugandhan, N.	1050	55
20	Kunjumon, P.G.	990	120
	Total	30,135	2318

The details are revealed by the former poachers now functioning as EDC members and is approximate quantity.

16.3.3 Conclusions

The illegal activities accounted for the collection and removal of about 30,000 kg of cinnamon bark with 10,000 trees/saplings being cut every year. This problem is now under full control. The resultant regeneration of cinnamon trees has caused the degraded areas to graduate to medium- and even high-density categories. The EDC has directly or indirectly helped the management apprehend offenders in 77 cases. More than 20 persons were appointed for protection work, and over 20 families were given ample financial support for a sustainable living.

Chapter 17
Sustainable Development of Idamalakudy: A Tribal Panchayat

B. Baijulal, Preetha Nilayangode, K.P. Laladhas, and Oommen V. Oommen

Abstract The Muthuvan tribe in Idamalakudy, Kerala remains one of the most isolated indigenous tribes of the Western Ghats, as they dwell in the deep jungle. Forest and forest resources play a significant role in the daily life of Muthuvans providing them with food, medicine, fodder, fuel, wood and a wide range of non-timber forest products (NTFPs). The indigenous ecological knowledge of Muthuvans is generally based on sustainability, productivity and optimum balanced utilisation of available land and other natural resources. Traditional ecological knowledge rooted in indigenous cultures plays an essential role in contributing to local biodiversity conservation, and they often have been attributed to a practical knowledge of utilising bioresource sustainably. The tribal population in this area has learnt to maintain the ecological balance in a sustainable manner and is mostly self-sufficient for their daily requirements. The chapter explores the traditional ecological knowledge of Muthuvans and the tribal social structure.

Keywords Muthuvans • Tribals • Huts • Household utensils • Idukki

17.1 Introduction

Idamalakudy is the lone tribal Grama Panchayat in Kerala with 26 tribal villages with around 2200 people. It is the only Grama Panchayat in Kerala with no motorable roads and limited electric connections and telecommunication facilities. Amongst the 36 Scheduled Tribes (STs) notified in Kerala, Paniyan is the most populous tribe constituting 22.5 % of the total tribal population of the state. Kurichiya is the second largest tribe constituting 9 % of the total ST population. Five other STs, namely, Muthuvan, Kanikkaran, Irular, Kuruman and Malai Arayan

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having a population ranging from 21,000 to 32,000 along with Paniyan and Kurichiya, constitute 73.6 % of the total tribal population. Seven tribes, namely, Malayan, Malai Vedan, Mannan, etc. having 5000–16,000 population, account for another 20 %, and the remaining 20 tribes along with the generic tribes constitute the residual 6.4 % of the state's tribal population. Tribes having below 500 population are 11 in number. Out of them, Kota, Kammara, Kochu Velan and Konda Kapus are the smallest groups, each having less than 50 population.

The population of Idamalakudy belongs to Muthuvan community and is commonly known as the 'basket-making community' with their own dialect and cultural entity. The panchayat is remotely located around 18 kms from Pettimudi which is the last point one can go in a vehicle. Forest and forest resources play a significant role in the daily life of Muthuvans providing them with food, medicine, fodder, fuel, wood and a wide range of non-timber forest products (NTFPs). The Muthuvan tribe in Idamalakudy remains one of the most isolated indigenous tribes of the Western Ghats, as they dwell in the deep jungle. The extreme difficulty in reaching the place, as one has to travel more than 10 km by foot through the dense forest, makes them isolated from urbanisation. Traditional ecological knowledge rooted in indigenous cultures plays an essential role in contributing to local biodiversity conservation, and they often have been attributed to a practical knowledge of utilising bioresource sustainably. The tribal population in this area has learnt to maintain the ecological balance in a sustainable manner and is mostly self-sufficient for their daily requirements.

17.2 Geographical Jurisdiction

Located in Idukki district, Idamalakudy Panchayat is spread over 101.6 km^2 area, 2010 m above sea level on a hilltop called Pettimudi (Fig. 17.1). The hilly nature of the terrain makes transportation difficult. The team from the Kerala State Biodiversity Board reached the first *kudi* (settlement), Ampalappadi, on foot, covering a distance of 11 kms from the last point where a vehicle can access. There are 28 Adivasi *kudis* spread out in the Idamalakudy Panchayat. The panchayat with 13 wards has a total population of 2236 which includes 1196 men and 1040 women.

Recently, 8 blocks and 52 Grama Panchayats of Idukki district were connected on optical fibre and Idamalakudy is connected through VSAT. The Kerala State Electricity Board also has done a primary inspection to install electric posts in the panchayat to provide electricity.

17.3 Tribal Social Structure

The social organisation of Muthuvan community is unique, and they have a dormitory system in every settlement to house both boys and girls separately. The headman called *moopan* holds supreme control of the community and presides over the

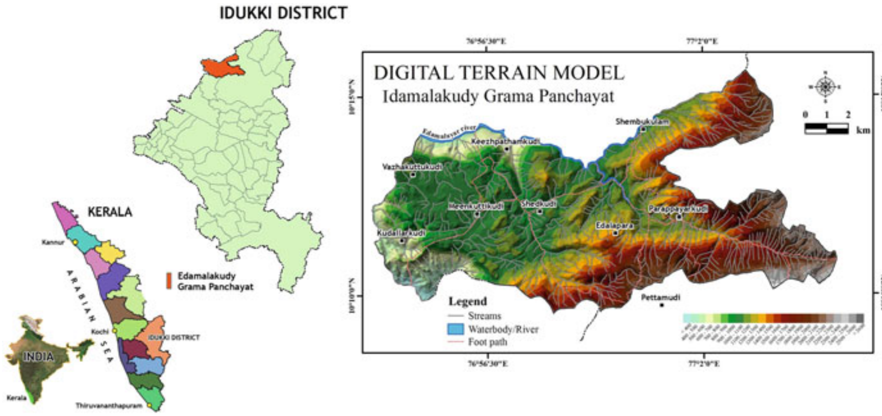

Fig. 17.1 Map of the study area

council of elders. In some area a *kani* is nominated to deal with the officials. The name Muthuvan tribe originated from their practice of keeping their children on shoulders using a cloth sling. The settlement of this tribe is called *kudi*. There are several huts in a *kudi* ranging from 15 to 40 depending on the family size. The Muthuvan tribe is categorised into three races, specifically called Kootam. They are Kaniyattu Kootam, Suchannai Kootam and Illi Kootam. The Kootam is considered to have originated from an individual stalk and have no marital relation within and is considered as brothers and sisters. This lineage is restricted to male members only.

17.3.1 Concept of Community Life in the Sathram

Children of age above 7 in Idamalakudy have to stay the night at the *sathram*. There are separate *sathrams* for male and female children. The life in the *sathram* begins every day after their dinner. Each member staying in the *sathram* should have their own sleeping facility. Each member in the *sathram* has to carry enough firewood for fuelling the *agnikundam*, the campfire for light, for heat and also for protection from mosquitoes. The *sathram* is the place where these people get the information about world knowledge, social commitment and community life. Senior persons from a *kudi* will lead the team.

17.3.2 Ecofriendly Huts

In each *kudi* every family has their own house – an ecofriendly hut – made up of traditional environment-friendly materials like clay, stone, wood, bamboo and grass. The environment-friendly huts are made of locally available raw materials. The

Fig. 17.2 Tribal huts at Idamalakudy

walls of the hut are made with vertically placed wooden frames, and bamboo sticks are placed horizontally. The area between the wooden frames and bamboo sticks is filled with small stones and pastry mud reinforced with split culms of *Bambusa arundinacea* or *Ochlandra travancorica*. The dried composition of these is hard and rigid. All these materials are also locally available and easily replaceable. The wooden frames are mostly made with *Terminalia* sp., *Bambusa arundinacea*, *Alstonia scholaris*, *Mesua ferrea* L., *Palaquium ellipticum* and *Gmelina arborea*. The split culms of *Bambusa arundinacea*, *Dendrocalamus strictus* or *Ochlandra travancorica* are placed inside the mud wall for support, and broad leaves are used for thatching. The roof is formed with *Ochlandra travancorica* pseudostem and with leaves of *Ochlandra* sp. (Figs. 17.2 and 17.3). The fibre for tying is obtained from *Calamus rotang* and tender *Ochlandra* sp. pseudostems. The doors are made with bamboo mat in frame of *Bambusa arundinacea*. Muthuvans also have the practice of constructing raised goat sheds and watch sheds made with *Ochlandra* sp., to protect them from wild animals. The pillars are made mostly with *Terminalia* sp.; side walls, roofings and ceilings are formed with *Ochlandra travancorica* pseudostems and thatchings with leaves of *Ochlandra travancorica*.

Other studies also report the use of plant materials for constructing *kudis* whereby the pillars are constructed with *Acronychia pedunculata*, *Anogeissus latifolia*, *Olea dioica*, *Syzygium arnottianum*, *Polyalthia fragrans*, *Syzygium cumini* and *Syzygium gardneri*. Walls are reinforced with mud, some grasses, *Calamus* spp. and bamboo. Plants like *Chionanthus linocieroides*, *Drypetes venusta* and *Xylopia parvifolia* are used to frame roof rafters. Some plants and plant parts are used as ropes (*Calamus rotang*, *Wattakaka volubilis*, *Debregeasia ceylanica*) for tying the structures. The

Fig. 17.3 Tribal village at Idamalakudy

roof is thatched with the leaves of some plants like *Caryota urens*, *Cymbopogon caesius*, *Saccharum spontaneum*, *Themeda cymbaria*, *Themeda triandra* and *Corypha umbraculifera*. Plants used for the construction of huts by Muthuvans of Idukki district are given in Table 17.1.

Muthuvans use mostly earthen pots for cooking. They also make use of the culms of *Ochlandra*, *Bambusa* and *Dendrocalamus* to collect and store food materials. For hunting, they use some plant-based weapons such as spears (*Bambusa bambos*), bow (*Bambusa bambos*, *Ficus benghalensis*) and arrow (*Alstonia scholaris*), and the bowstring is made up of the thread made from the bark of *Ficus*. Muthuvans engage themselves in fishing in the nearby streams and rivers. Generally, they use some small fishes, which are common in streams. For fishing, they generally use some mild poisons extracted from plants like *Anamirta cocculus*, *Diospyros cordifolia*, *Gnidia glauca*, *Haldina cordifolia* and *Derris scandens*. They use the raw leaves of *Medinilla beddomei* and fresh fruits of *Palaquium ellipticum*, as a refresher while going into the forest. Plants used for making household utensils by Muthuvans of the Idukki district are given in Table 17.2.

17.3.3 Farming

The utilisation of bioresources by tribal communities is based on traditional knowledge, and they are mostly dependent on natural resources for their livelihood. They utilise several major and minor crops in their agricultural systems which enable

Table 17.1 Plants used for the construction of huts by Muthuvans of Idukki district

Sl. no.	Botanical name	Family	Habit	Parts used	Tribal use
1	*Acronychia pedunculata*	Rutaceae	T	Timber	Pillar
2	*Anogeissus latifolia*	Combretaceae	T	Timber	Pillar
3	*Bambusa bambos*	Poaceae	S	Clums	Reinforcement of walls
4	*Calamus hookerianus*	Arecaceae	S	Cane	Reinforcement of walls
5	*Calamus pseudotenuis*	Arecaceae	S	Cane	Reinforcement of walls
6	*Calamus rotang*	Arecaceae	S	Cane	Reinforcement of walls/ rope
7	*Caryota urens*	Arecaceae	T	Leaves	Thatching
8	*Chionanthus linocieroides*	Oleaceae	T	Timber	Roof rafters
9	*Corypha umbraculifera*	Arecaceae	T	Leaf	Thatching
10	*Cymbopogon caesius*	Poaceae	H	Leaves	Thatching
11	*Drypetes venusta*	Euphorbiaceae	T	Timber	Roof rafters
12	*Olea dioica* Roxb.	Oleaceae	T	Wood	Pillar
13	*Polyalthia fragrans*	Annonaceae	T	Timber	Pillar
14	*Saccharum spontaneum*	Poaceae	H	Leaves	Thatching
15	*Syzygium arnottianum*	Myrtaceae	T	Timber	Pillar
16	*Syzygium cumini*	Myrtaceae	T	Timber	Pillar
17	*Syzygium gardneri*	Myrtaceae	T	Timber	Pillar
18	*Themeda cymbaria*	Poaceae	H	Leaves	Thatching
19	*Themeda triandra* Forsskal	Poaceae	H	Leaves	Thatching
20	*Wattakaka volubilis*	Rhamnaceae	C	Whole plant	Rope
21	*Xylopia parvifolia*	Annonaceae	T	Timber	Roof rafters

Source: Ajesh and Kumuthakalavalli (2013)

them to tide over various risks as drought, flooding, etc. They cultivate mixed crops in order to maximise yield and maintain the fertility of the soil. Muthuvans are known for their organic cultivation of ragi and paddy. They shift the cultivation site every 2 years. They use medicinal plants that are mostly locally available, easily accessible and often cost-effective in their traditional health-care system.

Other than the traditional food items of modern man, like rice, wheat, millets, etc., they have a treasure house of knowledge about potential food plants from the surrounding forests. These include leaves, stems, bark, roots, fruits of wild plants and a number of animals gathered as food items. The indigenous ecological knowledge of Muthuvans is generally based on sustainability, productivity and optimum balanced utilisation of available land and other natural resources. The Muthuvan

Table 17.2 Plants used for making household utensils by Muthuvans of Idukki district

No.	Scientific name	Family	Habit	Parts	Use
1	*Bambusa bambos*	Poaceae	S	Culms/stem	Cot
					Glass/tumbler
2	*Calamus hookerianus*	Arecaceae	S	Cane	Basket
3	*Calamus pseudotenuis*	Arecaceae	S	Cane	Basket
4	*Calamus rotang*	Arecaceae	S	Cane	Basket
5	*Calycopteris floribunda*	Combretaceae	C	Stem	Basket/winnow
6	*Cocculus laurifolius*	Menispermaceae	S	Bushy stem	Broom
7	*Corypha umbraculifera*	Arecaceae	T	Leaf	Mat, basket
8	*Dalbergia latifolia*	Fabaceae	T	Timber	Mortar for pounding
9	*Diospyros ebenum*	Ebenaceae	T	Timber	Mortar for pounding
10	*Ficus racemosa*	Moraceae	T	Leaf/bark	Domestic cloth
11	*Gmelina arborea*	Verbenaceae	T	Wood	Mortar for pounding
12	*Macaranga indica*	Euphorbiaceae	T	Leaves	Used as plates
13	*Macaranga peltata*	Euphorbiaceae	T	Leaves	Used as plate
14	*Ochlandra travancorica*	Poaceae	H	Culms	Mat/basket
15	*Schumannianthus virgatus* (Roxb.) Rolfe	Marantaceae	S	Leaves	Used as plate
16	*Wattakaka volubilis*	Rhamnaceae	C	Whole plant	Mat/basket

Source: Ajesh and Kumuthakalavalli (2013)

tribe follows a system of agriculture which is self-sustainable. The area adjacent to the *kudi* is utilised by the concerned family for farming. They cultivate for their routine use and not for storage. Mainly locally available tubers and indigenous varieties of rice, ragi and vegetables are cultivated. Traditionally, they gather secondary forest produce such as honey, wild fruits, vegetables, mushrooms and other NTFPs for meeting their livelihood. Cultivation of cash crops like cardamom and pepper is also prevalent nowadays. The method of cultivation at Idamalakudy is that they use a farm for cultivation in a single season. The land is left fallow for three consecutive years. In the fourth year during April, they burn whole bushes grown uncontrolled in the area, and the ash so obtained is utilised as manure for the fresh crops. They have to protect their harvested field from the attack of wild animals, and for this they make loud sound using large bamboo baskets atop watchtowers and poles of bamboo. Around 40 plant species belonging to 32 genera and 19 families are recorded as being used as wild edible vegetables by the Muthuvans of Idukki district (Ajesh et al. 2012a). Today, most human plant foods are based on a rather limited number of crops. Thirty-eight species of wild edible fruits belonging to 25 genera and 17 families used by Muthuvans were recorded (Ajesh et al. 2012b).

17.3.4 Sustainable Livelihood

The concept of sustainable livelihood of the Muthuvan tribe in Idamalakudy is commendable. The people occupying this area have acclimatised to live with the forest ecosystem and are well versed with sustainable use of natural resources. The community is solely depending on the forest in a sustainable manner for food, medicine, shelter and farming and leads an amicable life in harmony with nature. The community relies on traditional medicines passed down as folklore medicinal practice amongst the generations. This traditional knowledge is largely uncodified. Muthuvans have been reported to use about 145 single remedies and 21 combination drugs to treat diseases/disorders.

A livelihood based on sustainable use of natural resources as well as maintaining the environmental balance is being practised here. They rarely cut trees for firewood, but utilise the fallen trees. The range of diversity in the use of bioresources for food and medicines also ensures sustainability by preventing overexploitation and maintaining the biodiversity. They have managed to use the forests sustainably while practising shifting cultivation or hunting and gathering. Even in religious rituals, their love for nature is reflected.

The diverse and delicate ecosystem and biodiversity of Idamalakudy has been preserved by the Muthuvan ethnic model community for centuries without any interference from the outside so-called modern world. The government has announced several packages for the development of this tribal community. But an important point to be considered is that all development in the panchayat should be holistic, in synchronisation with the nature, the ecosystem and the environment.

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Chapter 18
Meliponiculture for Pollination Support, Yield Enhancement and Poverty Eradication

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Abstract *Trigona* (*Tetragonula*) *iridipennis* Smith is the common stingless bee found in South India. They are domesticated in mud pots, bamboo bits, wooden boxes or coconut shells. Meliponiculture is being popularized in the rural homesteads for poverty alleviation and additional income generation. The chapter discusses the studies conducted as part of All India Coordinated Research Project (AICRP) on Honey Bees and Pollinators at Vellayani Centre of Kerala Agricultural University. Among the various types of hives with different volumes, bamboo bits with 1500 cc showed better brood development and storage of honey. Due to scarcity of bamboo nodes, a wooden box with 1960 cc volume with two equal halves was designed which helped for easy division and mass multiplication of colonies. The technologies were disseminated to the public by imparting trainers' training in different districts of Kerala in which 174 women and 322 men were trained. Augmentation, conservation and management of *T. iridipennis* should be intensified for ensuring sustainable agriculture and the conservation of biological diversity resulting in food security for poverty eradication.

Keywords Stingless bee • Honey • Domestication • Hiving • Foraging plants

18.1 Introduction

Stingless bees are a class of hymenopteran insects under subfamily Meliponinae. These small-sized insects have a wide distribution in India. In Kerala, it is reared for backyard beekeeping practice mainly for honey production. Meliponiculture is being popularized in the rural homesteads for poverty alleviation and additional income generation. The stingless bee honey is unique in having great medicinal

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value, and it fetches a high price of up to $30 per kilogram. Concerted attempts are being made by AICRP on Honey Bees and Pollinators, to improve the hiving, domestication, conservation and management of stingless bee with a view to enhance the number of colonies and thereby meet the current demand of stingless bee honey and to enhance the pollination services provided by stingless bee.

18.2 Hiving of Feral Colonies

The domicile of *T. iridipennis* is the basements of old buildings, compound walls, tree trunks, etc. Hiving of feral colonies from the above sites lead to damage to the buildings and walls, and hence the people hesitate to transfer these colonies. Hence different methods were tried in hiving feral colonies, and a suitable method was standardized. The mouth of an earthen pot has to be placed in front of the entrance of a feral colony, and its rim is to be sealed to the wall using mud. Proper support to the pot should be provided whenever required. An opening is to be given at the opposite side of the pot as bee entrance which can be glued with wax of stingless bee. The worker bees pass through the hole into the pot using it as a new entrance. Gradually the bees realize that there is sufficient space inside the pot to store the brood and food material, and hence they start construction of pollen and honey pots in the earthen hive. Eventually, they build the brood combs and start brood rearing inside it. The colony and pot should be left undisturbed for 6 months for the feral colony to settle (Figs. 18.1, 18.2 and 18.3). Later the pot with brood, pollen, honey, worker bees and a queen can be detached and shifted to a suitable site to establish a new colony.

Photography: Dr. S. Devanesan

Fig. 18.1 Stingless bee workers in a colony (Photography: Dr. S. Devanesan)

Fig. 18.2 Queen bee of *T. iridipennis* (Photography: Dr. S. Devanesan)

Fig. 18.3 Inside view of a stingless bee colony with brood, honey and pollen (Photography: Dr. S. Devanesan)

18.2.1 Domestication of Stingless Bee

Stingless bees are domesticated in earthen pots, bamboo bits and wooden boxes. Different types of hives, *viz.*, wooden box, earthen pot and bamboo bit, with volumes of 1500, 2250, 3000 and 3750 cc were tried for hiving stingless bee, of which bamboo bits with 1500 cc capacity showed better brood development and honey storage than other hives with different capacities (Raakhee 2000).

Scarcity of bamboo nodes resulted in standardization of a new wooden hive with two equal halves and 1960 cc volume (Fig. 18.4). The inner volume is 1960 cc with measurements of length at 37 cm, breadth at 9 cm and height at 10 cm; alternatively, inner measurement of length can be at 35 cm, breadth at 7 cm and height at 8 cm, with hive entrance at 1 cm diameter. Honey extraction and division of colonies are easier in this hive which helped for mass multiplication of colonies and commercial meliponiculture.

18.2.2 Stingless Bee Honey

Despite the small amount of honey produced per hive, it is of great demand and fetches a comparatively higher price due to its medicinal value. It is more acidic than commercial *Apis* honey but it has unique taste.

The studies conducted at the Vellayani Centre indicated that the *Tetragonula* (*Trigona)* honey from different tracts of Kerala varied widely in colour from light yellow to dark amber with all intermediate shades. This is related to the varied flora in different locations. It also has specific flavour and aroma. Light-coloured honey is mild in flavour and a darker honey has a more pronounced flavour. The percentage of moisture varied from 18.96 to 20.48 which is significantly lower than *Apis* spp.,

Fig. 18.4 Stingless bee colony in wooden hive.

where the moisture percentage ranged from 19 to 23. The pH ranged from 3.76 to 4.40, which is lower than *Apis* honey. Stingless bee honeys were mostly multifloral. Hence variation in nectar quality was observed which influenced honey characters like colour and acidity. The major sugars in stingless honey are glucose and fructose, which account for 37.1 and 41.6 %, respectively. Sucrose content varied from 1.2 to 1.8 %. All the honey samples contain lesser amount of glucose. Mean percentage of total reducing sugars ranged from 69.85 to 77.10 and that of glucose content ranged from 32.29 to 37.36. Percentage of fructose ranged from 37.57 to 39.85 in stingless bee honey. Specific gravity and refractive index are important properties. The specific gravity of *Tetragonula* (*Trigona)* honey ranged from 1.350 to 1.377. The refractive index was in the range of 1.4855–1.4891 (Premila et al. 2007).

The stingless bee collects nectar and pollen from many medicinal plants with small flowers which are not visited by *Apis* spp. Its honey has great healing properties and is effective for asthma and allergy problems. It is beneficial in reducing the heat of the body, inflammation, bleeding in the throat, impurities of the blood, boils, etc. It is used in many medicines particularly in the Indian system of medicine, the Ayurveda, for many diseases even for cancer.

18.2.3 Pollination Service and Yield Enhancement

Besides being a honey producer, stingless bees possess many characteristics that enhance their importance as crop pollinator both in wild and agricultural situations. The stingless bees visit most of the horticultural and agricultural crops for their pollen and nectar resulting in pollination and yield enhancement (Roubik 1995; Amano et al. 1999). This centre has identified 142 stingless bee foraging plants which included vegetables, spices, oilseeds, plantation crops, ornamental plants, forest trees, medicinal plants and wild plants (Devanesan et al. 2009). Quantification of the role of stingless bees in pollination showed 25 % yield enhancement in vegetables and 20–40 % in coconut. Augmentation, conservation, popularization and management of *T. iridipennis* should be intensified.

The technologies were disseminated to the public by imparting trainers' training in different districts of Kerala in which 174 women and 322 men were trained. It is estimated that more than 50,000 stingless bee colonies are domesticated in the state.

18.3 Conclusion

Considering the importance of the species, meliponiculture should be popularized in Kerala for pollination service, ensuring sustainable agriculture and the conservation of biological diversity resulting in food security for poverty alleviation. Commercial utilization of stingless bees provides a sustainable environment-friendly food and source of income. Meliponiculture also provides good opportunity for contributing to household income.

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Chapter 19
Sustainable Use of Wild Yams (Dioscorea) by Tribal Communities in Kerala, India

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Abstract The tubers of wild yams (*Dioscorea*) form an important source of starchy food, which is consumed by the tribal inhabitants living dependent with the forest. Kerala, India, has a rich diversity of *Dioscorea* with unique properties, contributing to both food and health security needs of the local communities, especially the tribal communities. This chapter describes the diversity of wild *Dioscorea* that are found in Kerala part of Western Ghats and that are distinguished based on the morpho-taxonomic characters. Wayanad district has about 22 different taxa of *Dioscorea*, of which 21 are edible and serve as vital food during famine months to forest-dwelling tribes. For classification of wild Dioscorea folk system relies chiefly on the use classes of tubers such as edibility, taste, colour of the flesh, size, direction of growth, fibre content, cooking properties and occasionally its number. A folk taxonomic classification system has been devised by the user communities like Kattunaikka, Muduga and Paniya for the optimum utilization of various *Dioscorea* taxa.

Keywords Yams • Tribal communities • Food scarcity • Folk taxonomy • Medicinal

19.1 Introduction

Dioscorea, belonging to the family Dioscoreaceae, is believed to have originated from Southeast Asia, West Africa and pre-Columbian tropical America (Jayasurya 1984; Mabberly 1997; Wilkin 1998). The genus has about 850 taxa described from all over the world, in which about 50 species are from India, largely in west, east and northeast regions (Prain and Burkill 1936). Fischer and Gamble (1928) reported the occurrence of 23 taxa (16 species and 7 varieties) of *Dioscorea* from peninsular

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India. Out of the 16 species, *D. pentaphylla* was described with three varieties and *D. oppositifolia* and *D. bulbifera* each with two varieties.

Dioscorea shows remarkable variations even within single variety. The morphological characters of this group of plants are highly variable, and this usually makes it difficult to draw up the boundaries of variations by only morphological evidence (Burkill 1924, 1951; Prain and Burkill 1936; Sundara Raghavan 1960; Ayensu 1965, 1972; Abraham and Nair 1979; Jayasurya 1984; Rana 1991; Amalraj et al. 1991; Wilkin 1998; Caddick et al. 2002). It, therefore, demands a comprehensive approach integrating both conventional and frontier techniques for assessing, classifying and understanding the diversity of the *Dioscorea* complex up to the variety level.

The diversity of *Dioscorea* is rich as evidenced by diverse varieties occurring with unique properties, contributing to both food and health security needs of the local communities, especially the tribal communities. Studies conducted by the National Bureau of Plant Genetic Resources (NBPGR) show that about 20 distinct cultivars of greater yam (*Dioscorea alata*) exist in the peninsular region of India (Velayudhan et al. 1991). The species like *Dioscorea esculenta* and *Dioscorea alata*, once cultivated abundantly in the habitations of foothills of the Western Ghats, are now being restricted to only the backyards of the households of resource-poor farming communities.

19.2 Tribal Communities of Study Area

The study was undertaken in Kerala part of the southern Western Ghats, mainly in the highlands ranging from an average height of 900 m from msl to several peaks of over 1,800 m. The wider eastern highland region that constitutes many important tribal settlements and forest-dwelling tribes was surveyed extensively for the *Dioscorea* species. This region in general is rich in diversity of *Dioscorea*. The midland zone, where most of the human activities and agricultural settlements are concentrated, as also lowland areas, backwater plains, estuaries, mangroves and coastal vegetation, were also surveyed for the *Dioscorea* diversity.

The study mainly focused on the nomadic and forest-dwelling communities *Adiyan*, *Aranadan*, *Eravallan*, *Hill Pulaya*, *Irular*, *Kadar*, *Kammara*, *Kanikkar/Kanis*, *Kattunaika*, *Kochu Velan*, *Konda Kapus*, *Koraga*, *Kudiya*, *Kuruman*, *Kurichian*, *Kurumba*, *Mahamalasar*, *Malai Arayan*, *Mala Pandaram*, *Mala Vedan*, *Malakkuravan*, *Malasar*, *Mannan*, *Malayan*, *Muthuvan*, *Paniya*, *Palliyar*, *Ulladan* and *Uralikuruma* from Agastya Mala, Idukki, Palakkad, Malappuram, Wayanad and Kasaragod districts. In Kerala, Wayanad district has the highest tribal population density; the men and women of *Kattunaika* and *Paniya* among them hold rich traditional knowledge on wild yams. Among the targeted tribals of the study, Kattunaika and Paniya community of Wayanad region, Cholanaika community of Nilambur region and Muduga community of Palakkad region are more knowledgeable with regard to dependency and knowledge about *Dioscorea*.

19.3 Diversity of *Dioscorea*

The western peninsular region, which represents the true Indian flora (Nayar 1997), holds about 12–16 species of *Dioscorea*, but many of them posses high intraspecific morphological variations. The herbarium surveys of collections from this region have shown that only six to nine species are being frequently collected. The species like *Dioscorea wightii*, *D. kalkapershadii*, *D. hamiltonii*, *D. belophylla*, *D. pubera* and some varieties of *D. oppositifolia* and *D. pentaphylla* were not recorded in the recent past. There are several morphologically distinguishable forms existing at infraspecific level in species such as *D. pentaphylla*, *D. oppositifolia*, *D. hamiltonii* and *D. belophylla*. Interestingly, folk taxonomists of Kattunaika, one of the major targeted tribal communities of this study who use various *Dioscorea* species regularly in their diet, have named all these varieties based on their important utility characters.

The study shows that Wayanad district alone has about 22 different taxa of *Dioscorea*, of which 21 are edible and serve as vital food to forest-dwelling tribes during famine months. From the study, it is observed that the maximum number of variations is seen in *D. pentaphylla* and *D. oppositifolia*. Few variants are found in *D. belophylla*, but the absence of both male and female flowers in our collections, which are key morpho-taxonomic characters, restricted us from finding the exact identity of variations.

The Mankombu Sambasivan Swaminathan Research Foundation (MSSRF) study on *Dioscorea* yielded a collection of 31 distinct taxa, but identification of 9 of them is difficult because of the nonavailability of the plant in question with all reproductive and key materials like flowers, fruits, bulbils and tubers. Some were only the male plants or only female plants or with no flowers at all. All these taxa are planted in the germplasm plot of MSSRF's Community Agrobiodiversity Centre at Wayanad district of Kerala state for future studies. As of today, live collections of nearly 22 species of *Dioscorea* are maintained in this germplasm plot. Apart from maintaining the collections in a greenhouse, each promising edible variety is planted in large numbers in the nearby forest area of Manikunnu Mala, Muthanga forest area involving the tribal community (Paniya and Kattunaika) and the forest department. It was intended to help increase the wild population of these species and thereby ensure the food security and build up the confidence of the members of these two communities in managing bioresources in a sustainable manner. A herbarium of all the voucher specimens with relevant information on taxonomy, ecology, ethnobotany and status of its availability is being maintained at the MS Swaminathan Herbarium (MSSH) of Community Agrobiodiversity Centre.

19.4 Enumeration of Taxa

19.4.1 **Dioscorea belophylla** *Voigt, Hort. Subhurb. Calcutta. 653. 1845*

The ethnic name of the taxa is ‘Hekku’ by Kattunaika tribe of Wayanad district. Key identifying characters of the taxa are basely conical coriaceous simple leaf and long stalked tuber. September to January is the season for flowering and fruiting. In India the taxon is distributed on very well-drained mountain slopes from the Himalaya of Kashmir and the Salt Range of Punjab, eastwards to the Khasi Hills and southwards to the Nilgiri Hills and in Kerala. It flourishes upon the rock crests of steep hilly slopes. In Kerala the plant grows best at altitudes between 1,300 and 1,500 m above MSL on hill slopes. The taxon is rare in the South Western Ghats. It is an edible taxon and consumed by almost all the tribal groups of the southern Western Ghats.

19.4.2 **Dioscorea bulbifera** *Linn., Hort.Mal.* **Helmia bulbifera** *(L.) Kunth, Enum*

The species is a native of the tropics of the old world and occurs in rainforests extending from the west coast of Africa to the farthest islands in the Pacific. It is common throughout India and grows up to an elevation of 6,000 ft MSL. In the southern Western Ghats, it is common in all the districts and is usually seen in openings of deciduous and semievergreen forests. Flowering season of the taxa is between July and December. Its habitat varies from the marshy area of the forest to lowland and coastal area. They are very acrid and bitter. These tubers are used as famine food of Paniya tribal community by coursing with ashes and steeping in cold water. Bulbils are edible after processing and are found marketed in the Goa vegetable market in India.

Note The tubers are used for the preparation of starch in Japan. *D. bulbifera* tubers are used in Kashmir for washing wool and as fish bait. Dried and pounded tubers are used as an application for ulcers, piles, dysentery and syphilis. Bulbils of this species are used as an application for sores. The paste of bulbils is used externally as a remedy in abdominal pain. It is also used in dysentery, bone fracture and jaundice (Wealth of India series Vol.III D-E).

19.4.3 **Dioscorea hamiltonii** *Hook. f. Fl. Brit. India 6: 295. 1892*

The ethnic name of the taxa varies from one community to another such as ‘Venni kilangu’ (Kattunaika), Noolvenni kilangu (Chola Naika), Arikilangu and Kalu Venni (Muduka). September to December is the flowering and fruiting period of this taxa. It is distributed in Northeast India and eastwards to Laos and southwards to Tenasserim and in southwest India. It grows luxuriantly in the wet hilly areas. In southern Western Ghats, it is rarely seen in moist deciduous forest and semievergreen forests.

19.4.4 **Dioscorea hispida** *Dennst., Schluss. Zum Malab. 15, 20, 33.1818 (Fig. 19.1)*

Ethnic names for the species are ‘Podava kelengu’ Rheede, Bolkande (Naika of Kasaragod District Kerala, India), ‘Podava-kizhangu’ (Paniya and Kuruma), ‘Podukkilangu’ (Paniya) and ‘Venni Nangu’ (Cholanaika). Compound leaf and numerous clusters of globose tubers looking like tuber of elephant foot yam are the key identification characters. Months from May to September is the flowering and fruiting season of the taxa. It is distributed in the tropics of Asia from India through Malaysia, the Philippine Islands to New Guinea. In southern Western Ghats, the species is seen from sea level up to an altitude of 1,200 m in semievergreen forests and is not common. This species of *Dioscorea* is poisonous but it is consumed by few tribal groups after a series of processing (Fig. 19.1).

Note Bulbils were not reported so far in *Dioscorea hispida*. A collection from Kinningar forest of Kasaragod district shows bulbils having 5 cm diameter and pale yellow colour. A collection of male plant (collection no. 2360, MSSH) from this area possesses young bulbils, and another collection of female plant in capsule stage possesses little to large bulbils. All the other characters in the collection are similar to that of *Dioscorea hispida* proper.

19.4.5 **Dioscorea intermedia** *Thwaites Enum. P1., 326. 1864; Hook. F., Fl. Brit. India 6: 297. 1892*

The key identification character of the species is the elliptic or oblanceolate leaf with tuber cylindrical in shape having more than one in a single plant. October to January is the flowering and fruiting season. Its distribution ranges from Sri Lanka to Southern India. In southern Western Ghats, the distribution is rare. The taxon is edible.

19.4.6 **Dioscorea kalkapershadii** *Prain and Burkill, J. Asiat. Soc. Bengal 10: 30. 1914*

The ethnic name of the species is ‘Nara’ by Kattunaika tribes of Wayanad region. Tomentose and fibrous cylindrical tuber and five to seven leaflets are the key identifying characters of this taxon. September to December is the flowering season.

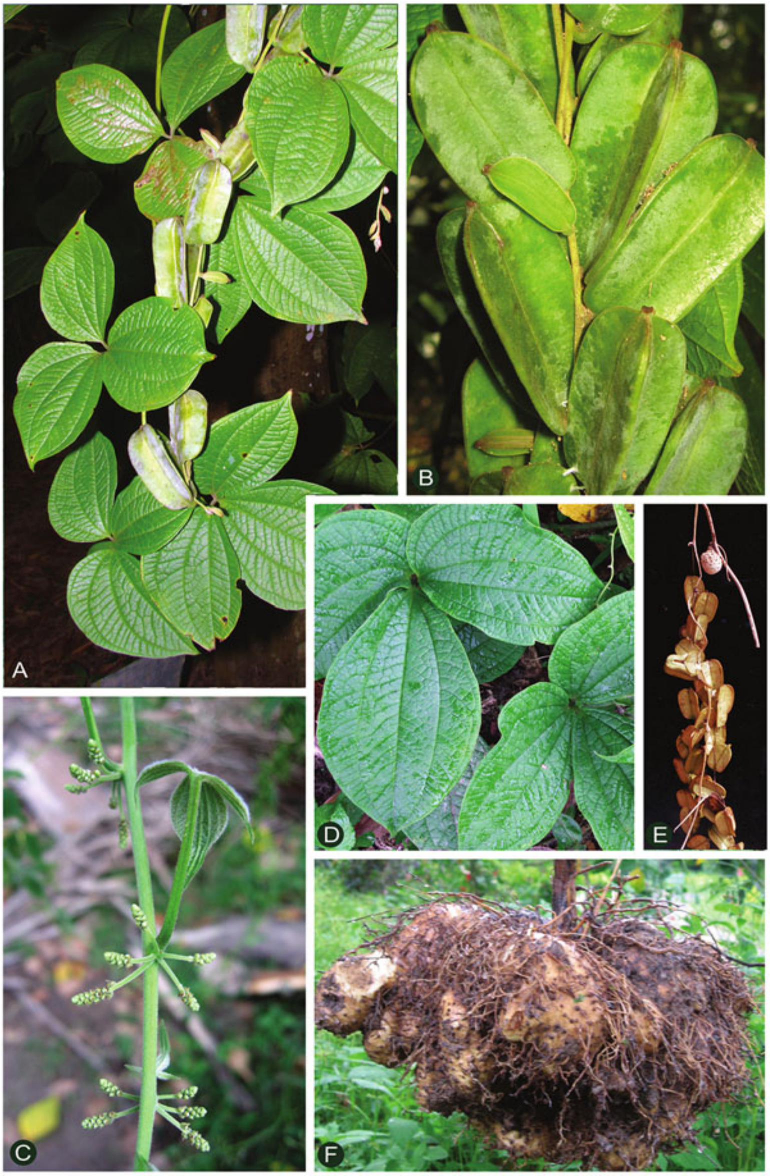

Fig. 19.1 *Dioscorea hispida*; (**A**) Habit, (**B**) Capsules, (**C**) Male inflorescence, (**D**) Leaf showing variations, (**E**) Mature female inflorescence with bulbil, (**F**) Tuber

Its distribution is restricted and ranges from Shevaroy Hills, in the southern Western Ghats reported from Wayanad and Kasaragod and a collection in Goa. The species is edible and rare in status.

Note This has the appearance of being a hybrid between *D. pentaphylla* and *D. tomentosa*.

19.4.7 **Dioscorea oppositifolia** *L., Sp. P1. ed. 1, 1033. 1753; Roxb., Fl. Ind. III: 804. 1832*

Wide variation could be seen in this species in the entire Western Ghats area. During the study a total of four varieties of *Dioscorea oppositifolia* were collected and described. The species is termed as 'Kavala Kilangu' by Kattunaika tribes. Four varieties of *Dioscorea oppositifolia* are described.

19.4.7.1 *Dioscorea oppositifolia* L. var. *oppositifolia*

The key identifying features of this taxon are; tuber solitary, cylindrical, base fusiform, rarely branched, flesh white, sometimes marked with purple flecks, very mucilaginous, leaves opposite to subopposite, simple and lamina broadly ovate-cordate to elliptic or obovate, glabrous, and green or pinkish. August to December is the flowering and fruiting season. Its distribution is in India through Deccan and Sri Lanka. In southern Western Ghats, the variety is seen in semievergreen forest, grassland up to 1,500 m. Its status is common in southern Western Ghats and the taxon is edible.

19.4.7.2 *Dioscorea oppositifolia* L. var. *dhukunensis* Prain and Burkill. Hook. f., Fl. Brit. India 6: 292. 1892

The key identifying characters of the taxon are that the flowers are on axillary spikes and the leaves are glabrous and pale greenish. September to November is the flowering and fruiting season of the taxon. It is distributed in India through Deccan plateau and Sri Lanka. In southern Western Ghats, it is commonly found in tea estate, open forest and places with more sunlight and wet soil. This variety is rare and edible.

19.4.7.3 *Dioscorea oppositifolia* L. var. *linnaei* Prain and Burkill

Ethnic name of this taxon is 'Kavala Kilangu' by the Kattunaika tribal community. September to December is the flowering and fruiting period. The distribution of the species ranges from North to South India. In southern Western Ghats, the distribution is common and seen normally in open forest, coffee and border of rubber plantations. It is also found in various sacred groves in Kerala part of southern Western Ghats in laterite soil. The tuber is edible.

19.4.7.4 *Dioscorea oppositifolia* L. var. *thwaitesii* Prain and Burkill

Flowering and fruiting season is in the month of October to November. The distribution is in the northern and southern part of India. In southern Western Ghats, the distribution is rare and found along the grasslands. The tuber is edible.

19.4.8 Dioscorea pentaphylla *L.*

Various ethnic names are attributed to this taxon such as Tjsageri nuren, Nurren Kelengu, Nooran (Paniya, Kattunaika, Kuruma, Kurichiya and Cholanaika tribes), Nooran Kilangu (Paniya) and Noora Galasu (Kattunaika).

The distribution of the taxon ranges from upper India, north along the Himalaya (to 1900 m.) and across South China through Malaysia to the remote islands of the Pacific (probably carried by man) and in Thursday Island but not in Australia.

Note *Dioscorea pentaphylla* is the most confusing species among *Dioscorea*, since its aerial morphological parts varied considerably in different agroclimatic and physiographic conditions. All the tribal community uses this species as edible food. 'Noora', the folk name of this species, is commonly used by the tribal community in Kerala part of Western Ghats. It shows its distribution in all the agroclimatic conditions. A number of morphotypes or variety can be seen in the wild as well as the forest openings. The habitat of this species varies from marshy streamside to the hilly rock crevices. Some of the varieties of *D. pentaphylla* grows in wet area and even up to dry deciduous forest and even in rocky area. Mainly five varieties, viz. *Dioscorea pentaphylla* L. var. *pentaphylla*, *D. pentaphylla* var. *communis*, *D. pentaphylla* var. *jacquemontii*, *D. pentaphylla* var. *rheedei* and *D. pentaphylla* var. *linnaei* are reported during this study, but a number of variations could be seen among these varieties.

In some of the recent publications like Flora of Kerala, varieties of *Dioscorea pentaphylla* were merged in variety *pentaphylla* proper. In this study it is revealed that all the varieties such as *Dioscorea pentaphylla* var. *pentaphylla*, *Dioscorea pentaphylla* var. *communis*, *Dioscorea pentaphylla* var. *jacquemontii*, *Dioscorea pentaphylla* var. *rheedei* and *Dioscorea pentaphylla* var. *linnaei* show variations in tuber characters, bulbils, leaves and stem, etc. Moreover ethnobotanical uses and season of tuber maturation show much variations from variety to variety. Hence the varieties are treated separately in this study. This is a very variable plant; Prain and Burkill distinguish 16 different varieties.

19.4.8.1 *Dioscorea pentaphylla* L. var. *pentaphylla* (Fig. 19.2)

Ethnic name of the taxon is 'Nalla Noora' by Kattunaika of Wayanad district. It is different from other *D. pentaphylla* varieties in its tuber without or very less rootlets. Flowering and fruiting season is September to December. It is distributed throughout the wetter parts of tropical Asia and eastwards to the farthest isles of the Pacific. In southern Western Ghats, the variety is rare and grows in laterite soil,

Fig. 19.2 *Dioscorea pentaphylla* L.var. *pentaphylla*; (**A**) Plant showing spines and left twining, (**B**) Male inflorescence, (**C**) Female inflorescence

moist deciduous forest especially in low elevation. It is consumed as famine food after much preparation. The flower buds especially the staminate are used as vegetable.

19.4.8.2 *Dioscorea pentaphylla* L. var. *communis* Prain and Burkill (Fig. 19.3)

Ethnic name of the taxon is 'Hendhikorana' (Kattunaika of Wayanad district). Key identifying character is the presence of abundant rootlets over the surface of the tuber. Flowering and fruiting of the taxon is during July to October. Its distribution ranges from French India, Indo-China to Lower Siam. In Kerala it is common, usually seen in the disturbed and open forests or along the riversides.

19.4.8.3 *Dioscorea pentaphylla* L. var. *jacquemontii* Hook. f

Ethnic name is 'Noora Korana' by Kattunaika of Wayanad district. Flowering and fruiting is in the season of July to November. Its distribution ranges from Western Ghats to the hills of South Canara. In southern Western Ghats, it is common in open forests and it is edible.

Note Jacquemont obtained the specimen first and hence the name 'Jacquemontii'.

19.4.8.4 *Dioscorea pentaphylla* L. var. *linnaei* Prain and Burkill

Ethnic name of the taxon is 'Eruma Noora' (Paniya) and 'Nalla Noora' (Kattunaika of Wayanad district). A key identifying character is that the tuber looks like that of *D. pentaphylla* var. *pentaphylla* with very less rootlets but the stem is glabrous and green. Flowering and fruiting is during the month of May to July. The distribution of the taxon ranges northwards from Sri Lanka through much of Southern India. In southern Western Ghats, the distribution is common, usually in most deciduous forest, and it is edible.

19.4.8.5 *Dioscorea pentaphylla* L. var. *rheedei* Prain and Burkill

Ethnic name of the taxon is 'Korana' (Kattunaika of Wayanad district). The white flesh of the tuber is edible. It has less fibre content when compared with var. communis. Various Malayalam local names attributed to this taxon are Kattukizhangu, Kornapidan, Nurunnakizhangu, Noorakizhangu, Nooran, Nuranchaaval, Marakkizhangu, Mulluvalykizhangu and Vellachikizhangu. The distribution of the taxon ranges from Indonesia, Malaysia to China. In South Western Ghats, the variety is rare in distribution and seen in restricted areas in dry deciduous forest and degraded forest in Wayanad, Idukki and Kasaragod districts.

Fig. 19.3 *Dioscorea pentaphylla* L. var.*communis*; (**A**) Habit, (**B**) Plant with female inflorescence, (**C**) Spinous stem with left twining, (**D**) Stem with globose bulbil, (**E**) Capsules, (**F**) Male inflorescence, (**G**) Female inflorescence, (**H**) Tuber with numerous rootlets

19.4.8.6 *Dioscorea pentaphylla* var. nov. 1

It is a new variety described from the study area and is called by the name ‘Chena Korana’ by Kattunaika of Wayanad district. Key identification characters are leathery shining compound leaf and obovoid ‘chena’ (elephant foot yam)-shaped tuber. The plant is seen in dry deciduous forest, very rare in distribution. Though the var. *communis* is seen abundant in the area, this taxon is very rare and is edible.

Note Kattunaika community call it as Chena Korana because the tuber like yam and the other parts of the plant is more or less similar to that of the ‘Korana’ *Dioscorea pentaphylla* var. *communis* with abundant brown hairs on the leaf, stem, and even on flowers.

19.4.8.7 *Dioscorea pentaphylla* var. nov. 2

It is another new variety described from the study area and called by the name ‘Manal Korana’ by the Kattunaika tribe of Wayanad district. Key identification characters are white velvety tomentose compound leaf and it grows in sandy soil. Flowering period of the taxa starts from November to January and is edible.

Note ‘Manal Korana’ is a folk variety of *D. pentaphylla*. It is normally seen near the streamside bushes in the sandy soil. It is never found in the black soil or deep into the forest. The only collection locality is ‘Ma alla’, a border place to Kerala and Karnataka state near Ponkuzhy, Kattunaika colony in Wayanad district of Kerala. Kattunaika call this taxon as Manal Korana since it is growing in the sandy soil and has got affinity with the ‘Korana’, (*Dioscorea pentaphylla* var. *rheedei*) having pubescent hairs on leaf and stem. It is observed that shiny brown pubescent hairs are more on ‘Manal Korana’ than that of ‘Korana’ (*Dioscorea pentaphylla* var. *rheedei*). ‘Manal Korana’ can be identified from other related taxa only through its habitat and more velvety- leathery leaf and also from the long tuber for growing in the sandy soil.

19.4.9 Dioscorea pubera *Blume, Enum. (Fig. 19.4)*

The taxon is called as ‘Boojikavala’ by Kattunaika of Wayanad district. Key identifying characters are simple cordate tomentose leaf and long cylindrical tuber. Flowering and fruiting is during August to December. It is seen normally in marshy sandy soil in wet deciduous forest. The distribution of the taxon ranges from **Southeast Asia** (**and Malaysia, Sumatra coast, Java**). In Kerala the distribution is rare and known only from Wayanad district. Tubers and bulbils are used as a famine food after processing and are also used as an oral contraceptive.

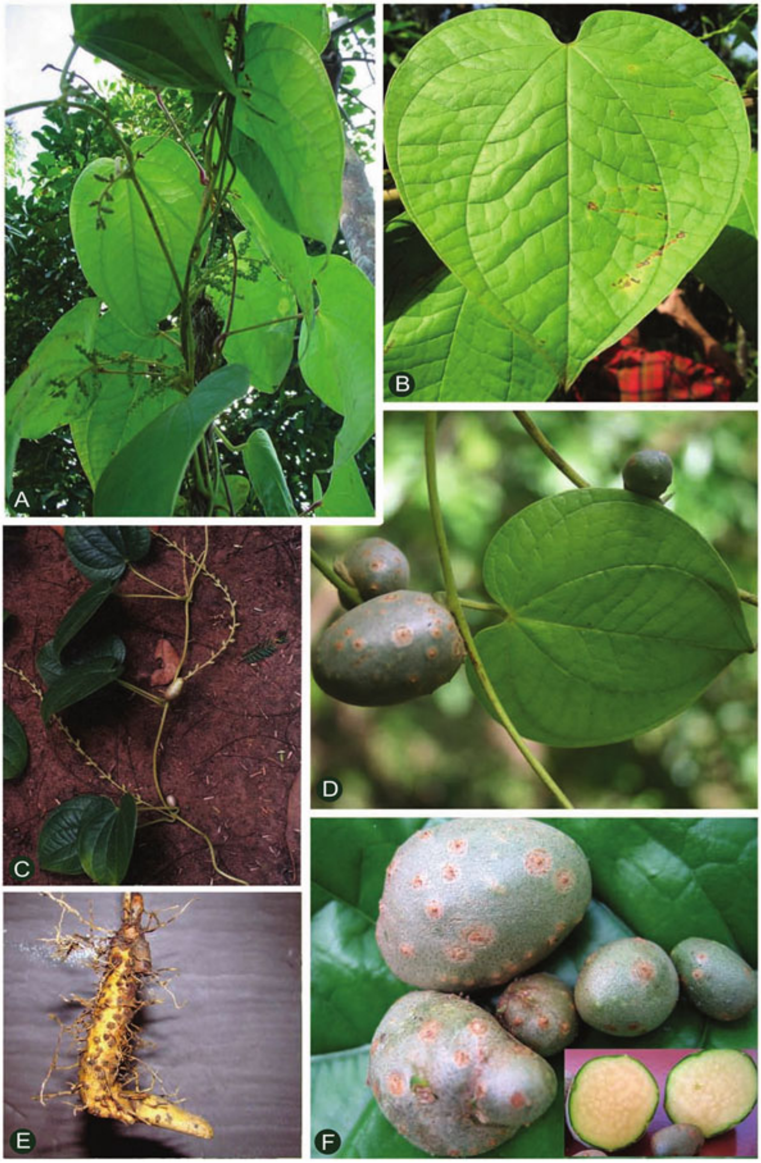

Fig. 19.4 *Dioscorea pubera*; (**A**) Habit with male inflorescence, (**B**) Leaf, (**C**) Female inflorescence, (**D**) Single leaf and bulbil, (**E**) Tuber, (**F**) Bulbils

Note Common name for *Dioscorea pubera* is 'Boojikavala' by 'Kattunaika' tribal communities of Wayanad district, Kerala, India. 'Kavala' is an ethnic name to *Dioscorea oppositifolia* by the tribal communities in southern Western Ghats region. The tuber of *Dioscorea* pubera looks similar to *Dioscorea oppositifolia*.

19.4.10 Dioscorea spicata *Roth*

Key identification characters of the taxon are its elliptic lanceolate leaf and small cylindrical tuber. Flowering and fruiting season is during September to December. The distribution of the taxon ranges from Sri Lankan tropical rainforests to Southern India. In southern Western Ghats, it is very rare and found about 1,800 m above MSL. The tuber is edible.

19.4.11 Dioscorea tomentosa *Koenig ex Roxb., Hort*

Ethnic name of the species is 'Noolan' by the Paniya community. Key identification characters are compound leaf and long cylindrical clustered tubers. Flowering and fruiting is in the months of July to November. The distribution of the taxon is in India, south of Gangetic plains, Sri Lanka and in one locality in Bangladesh. In the study area distribution is throughout southern Western Ghats, up to 1,000 m, forest borders and open areas, usually seen along open bamboo patches in dry deciduous forest. There is no report of using this tuber as food from the study area, but reports say that it is edible in the north and also used as medicine against the poison of other tubers.

Notes The species is called 'salu galasu' and 'noolan' by 'Kattunaika' and Paniya tribal communities in the study area. The name 'Noolan' refers to the thread (nool in local language)-like nature of the inner flesh of the tuber, which develops after boiling. Thus, it is not eaten by this community. Once eaten, the informants from the study site say it causes blockage of the throat especially for children and thus causes breathing problem.

19.4.12 Dioscorea wallichii *Hook. f*

Ethnic name of the taxon is 'Nara' (Paniya, Kattunaika, Kuruma and Kurichiya) and Katu-katchil by Kuruma community. The key identification characters are simple alternate cordate leaf and numerous long cylindrical fibrous tubers. Flowering and fruiting period is in the months of October to January. The taxon is distributed in India (Bombay coast to the Bengal plains, the lower Himalaya and hills of Assam-Burma frontier) to Indo-China with discontinuous distribution. In the southern Western Ghats area, it is reported from all the forest types but common in lowlands and wet deciduous forests and open forests and reported from the entire district in the study area. The name 'Nara' is because of the presence of hard fibre in the flesh of the tuber. It is consumed by some of the tribal communities in the study area. The tuber is used as medicine after delivery by the tribal communities.

19.4.13 Dioscorea wightii *Hook. f*

Key identifying characters of the taxon are its simple glabrous cordate leaf and long cylindrical brittle tuber. Flowering and fruiting is during the months of October to January. This species is imperfectly known in India. The distribution is from the east coast, Courtallam of Tamil Nadu, near the borders of Kerala state. In Kerala the distribution is rare and occurs only in certain areas, up to 900 m altitude.

19.5 Classification of *Dioscorea*: Evidences from the Linnaean and Folk Systems

For classifying *Dioscorea* species, the Linnaean system uses character classes pertaining to that of floral, fruit and seeds (reproductive characters) as well as the direction of twining of the stem. The size, shape and nature of tubers, as well as bulbils, are also used in certain cases as important taxonomic characters. The present study revealed that a total of 31 different taxa of wild *Dioscorea* are growing in Kerala. This includes 22 taxa that are already described based on the Linnaean system of classification, in which, 13 are distinct species, and 9 are distinct varieties.

There were nine taxa with reference to the Linnaean system of classification from the study locality, that are 'imperfectly identified'. By imperfect identification, it is meant that with reference to the formal taxonomic identification and description alone, these species cannot be identified. All these taxa are known in existence as quite different from the hitherto described species, and for the communities who have access to them, seven of such taxa have distinct names. For instance, two collections called 'Heruman' and 'Hekku Heruman' showed affinity to *D. belophylla* but differ in number and shape of the tuber, character of stem and size and shape of the bulbils. Two other taxa called 'Shoddi kalasu' and 'Ere kalasu' that were identified by Kattunaika tribe show affinity to *D. oppositifolia* and *D. spicata* but the tuber characters do not resemble with any of the varieties of *D. oppositifolia* and *D. spicata*.

Box: The *Dioscorea* taxa that are exclusively known to the Tribal Communities of Kerala

There were seven distinct folk taxa of *Dioscorea*, which could not be matched with any hitherto described varieties. These taxa have distinct folk names and are described with a wide range of categories, which could be referred to as 'use classes' that goes along the usefulness of species, and 'locality classes' which refers to the characters of locality (Peter Lister 2001). These taxa, which could not be described scientifically, but identified with the names attributed by the user communities, are the following:

1. ***Hekku heruman***: The tuber is irregular in shape and borne on a long thread. It is characterized by its black-coloured stem and spines at the base as well as the nodal regions. This is also very rare in distribution and seen only in moist deciduous forests. Flowers are scented attracting honeybee, stem with spines stem and leaf petiole pinkish in colour, tuber is tastiest among *Dioscorea*, bigger than that of Heruman.
2. ***Heruman*** (Kattunaika): In 'Heruman', the number of tubers is usually three and is irregularly shaped. Kattunaika consume this usually in the form of curry. Like the 'Hekku heruman', this is also rare in distribution and seen only in dry deciduous forests.
3. ***Mooda venni*** (Kattunaika): In 'Mooda venni', tuber-bearing stalk is small and the stem base is spinous. This tuber is also less fibrous and thus eaten afresh or in the form of liquid dishes. The aerial part of this plant bears bulbils, which are very similar to that of *D. alata*. The months of March to April are ideal for its harvest. Live specimen is preserved as germplasm accession in MSSRF germplasm. Even after 5 years of growth in germplasm of MSSRF, the plant didn't flower. In this case the regeneration is through tuber and bulbils.
4. ***Cholavalli kizhangu*** (**Muduka**), ***Chola hekku kalasu*** (Kattunaika): Kattunaika of Samippara region call this species as 'Chola hekku kalasu', which is edible. A similar species is noticed at Silent Valley region and the some tribal areas of Wayanad district.
5. ***Choora ganasu*** (Kannada), Chorakalangu (Adiya): Only once seen in semievergreen forests of Thalakaveri at altitudes of 3,814 ft and a latitude and longitude of 12° 23.09 N, 075° 30.45 E.
6. ***Shoddi Kalasu***: Consumed by Kattunaika tribe. Short climbers. **Tubers** 3–6, clavate, lower end conical, born on long stalk from stem base, stalk 20–45 cm long, tuber 30–50 cm long, surface smooth, rootlets small, skin whitish yellow, flesh white to lemon yellow, very mucilaginous and grows horizontally. **Leaves** alternate to opposite, simple, and lamina oblong-elliptic.
7. **Ere kalasu** (Fig. 19.5): Consumed by Kattunaika tribe. Short climbers. **Bulbils** were not seen. **Tuber** solitary, rod shaped, tuber 30–80 cm long, ca. 4 cm diameter, surface smooth, rootlets small, skin whitish yellow, flesh white to lemon yellow, very mucilaginous and grows horizontally. Very restricted in distribution; located in dry deciduous forest in Muthanga Wildlife Sanctuary in Wayanad district.

Fig. 19.5 *Dioscorea taxon 7 (Ere kalasu)*; (**A**) Habit, (**B**) Stem twinning, (**C**) Tuber

The forest-dwelling communities, who are in close contact with this peculiar plant group, classify each member of *Dioscorea*, based on characters of its edibility, other usefulness and applications. Such kind of classification of taxa based on use value and application by ordinary men and women is called folk taxonomy (Peter Lister 2001). Folk taxonomists, unlike professional taxonomists, depend upon a wide range of characters not only pertaining to the taxa in question but those associated with habitats and seasons. The **ethno-taxonomical** approach is useful in providing significant evidence and leads for delimiting precisely those taxa with continuous variation, particularly in case of species with use value.

The folk system relies chiefly on the use classes of tubers such as edibility, taste, colour of the flesh, size, direction of growth, fibre content, cooking properties and occasionally its number. Therefore, to make the taxonomy of this genus less problematic, it requires a comprehensive approach in weighing characters for delimiting the taxa, perhaps by integrating the morpho-taxonomy, folk taxonomy and modern taxonomic systems.

The folk taxonomic evidences with reference to the nine taxa were validated by using molecular studies (Balakrishnan and M.S. Swaminathan Ph D Thesis December 2008, Madras University). Two species such as *Dioscorea kalkapershadii* Prain and Burkill and *Dioscorea pentaphylla* L. var. *rheedei* Prain and Burkill were new reports from the study area. Two varieties of *D. pentaphylla* ('Chena Korana' and 'Manal Korana') were new to science. The study resulted in establishment of a germplasm bank of 22 species with 180 accessions of wild Dioscorea of the region in the CAbC Campus (Fig. 19.6).

19.6 Sustainable use of *Dioscorea*: The food and medicinal value

The tuberous roots of *Dioscorea* form an important source of starchy foods, which are much consumed by the tribal inhabitants living dependent with the forest tracts where such edible kinds occur. The wild *Dioscorea* are one of the major sources of food supply to poor forest communities in many tribal and rural regions in India (Rajyalakshmi and Greervani 1994; Singh and Arora 1978). *Dioscorea* serve as a 'life-saving' plant group to marginal farming and forest-dwelling communities, during periods of food scarcity (Roy et al. 1988; Kavinde et al. 2001; Jain 1964; Nizarudeen et al. 1996 and Arora and Pandey 1996). Wild edible yams and taros are more important because of the hugeness of the tubers and their wider occurrence and availability, particularly in the humid tropical-subtropical tracts. Many *Dioscorea* species are cultivated by the poor and common man widely as a staple food. Some *Dioscorea* species are rich in deep yellow colours, blue- purple colour and deep brown colours and contain dietary fibre and are gifted with a high percentage of antioxidants, which are considered to be important for improving and maintaining health. The plant group also offers excellent source of B complex group of vitamins and a rich mine of starch, good value protein, fats, fibres and minerals nutrients like K, Na, P, Ca, Mg, Cu, Fe, Mn, Zn and amino acid containing sulphur. Most species of this genus contain steroidal saponins and sapogenins like diosgenin which can be converted into steroid hormones used as anti-inflammatory, androgenic, estrogenic and contraceptive drugs. *Dioscorea alata* var. purpurea, a lesser explored tuber from Western Ghats of India, was confirmed as a probable source of diosgenin.

Fig. 19.6 Germplasm at CAbC; (**A**) Bulbils in the germplasm, (**B**) Germplasm planted in earthern pipes-an innovative approach to avoid the wild boar attack to the tuber

Fig. 19.7 *Knowledge providers*. (**A**) Then Kuruma, (**B**) Paniya, (**C**) Mudukar, (**D**, **F**, **G**, **I**, **K** and **L**) Kattunaika, (**E**) Kurichya, (**J** and **H**) Kuruma

19.7 Conclusion

This study has shown that the Kerala part of Western Ghats holds an impressive amount of diversity of *Dioscorea*. Though taxonomically this group of plants poses difficulties, ethnobotanically, the genus holds an eminent position since they are among the most prominent wild plants associated closely with human food security needs. This is evidenced from the folk taxonomic classification system devised by the user communities like Kattunaikka, Muduga and Paniya for the optimum utilization of various *Dioscorea* taxa. We suggest appropriate scientific and technologic innovations for validating the folk taxonomic evidences and traditional claims on the food and health value of *Dioscorea* species and varieties found in the entire stretch of Western Ghats. Hence it is suggested to undertake an action research targeting the wild and cultivated *Dioscorea* of Kerala. This kind of a research can be jointly executed by taxonomists, ethnobotanists and phytochemists with involvement of traditional knowledge holders (Fig. 19.7).

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Chapter 20
Sustainability of Native Fish Broods and Rural Livelihood

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Abstract Freshwater fishes are one of the keystone species of a freshwater ecosystem and also an indicator of ecosystem health. Freshwater diversity is subjected to numerous threats that have been pushing many species to the verge of extinction. One of the important threats to the population of fishes is monsoon migration of fishes “ootha elakkam”. The Kerala State Biodiversity Board initiated a project targeted to replenish the population of selected species of native fishes *kaari* (*Heteropneustes fossilis*), *varal* (*Channa striata*) and *manjakoori* (*Horabagrus brachysoma*) in their habitat. The project was implemented in two phases. During the first phase, awareness programmes on destructive fishing in monsoon migration “ootha elakkam” were conducted, and the second phase concentrated on captive breeding of native fishes in two districts, rearing the fingerlings and releasing them back to their native ecosystem. The interventions helped to increase the native fish stock and enhanced the rural livelihood in the project area.

Keywords Monsoon fishery • Fish broods • Spawning • Migration • Fingerlings

20.1 Introduction

The Western Ghats is one of the biodiversity hot spots of the world that supports numerous flora and fauna with a high degree of endemism (Myer et al. 2000). The high degree of endemism is due to the prevailing climatic conditions and geographical pattern. Kerala is rich in its water resources with 44 rivers, of which 41 flows westward emptying their water into the Arabian Sea. Most of these rivers originate as streams in the high mountain ranges of the Western Ghats and then empty their water to the rivers. Other than rivers, Kerala is also rich in lakes and backwaters.

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Owing to the diverse water sources and its diverse nature, Kerala is very rich in fish diversity with 189 freshwater species and 716 marine species which is characterized by many rare and endemic fish species. It is known that fishes account for the highest species diversity among all vertebrates, and they live in almost all conceivable aquatic habitats (Remadevi 2003). The freshwater fish diversity of the Western Ghats is estimated to be around 288 species with an endemism greater than 50 (Daniels 2002; Dahanukar et al. 2004). The highest level of endemism is found in the west-flowing rivers Chaliyar, Bharathapuzha, Chalakudy, Periyar and Pamba in Kerala.

The threats to fish diversity of Kerala include depleting water sources, uncontrolled pollution, invasive species and destructive fishing like dynamite and poisoning (Bijukumar 2000). Uncontrolled fishing during the breeding season severely affects the population status of the fishes. In Kerala the onset of normal monsoon, the heavy rain that lashes land and replenishes water in the water bodies, is by the first week of June. This triggers migration of the adult gravid female fishes along with adult males, and they enter into ponds and flooded paddy fields for breeding. This migration of fishes upstream with onset of monsoon is known as "ootha elakkam" locally.

20.2 Monsoon Floodplain Fishery (MFF)

A large variety of freshwater fish regularly migrates as a group, swimming against the flow in rivers, and enters the flooded fields and plains, mainly to breed. The females carry ripe eggs, and in the lowland plains, they become sluggish, move with their pairs and lay eggs in nutrient-rich rice fields and other such areas, which remain waterlogged during the rains. Spawning occurs in flooded paddy fields and ponds. After spawning, fishes return to rivers with their fingerlings. This monsoon journey of the fishes to the floodplains every season is of great importance for the survival of the species. The monsoon flood cycle and the seasonal inundation of floodplains of rivers are critical factors determining the survival of many species of freshwater fishes. The nutrients, including rotting vegetation and animal excreta, which accumulate in the floodplains during the dry months, mix with silt brought down by the rivers and provide the essential conditions for spawning, foraging and growth of many varieties of fish. A study conducted by the KSBB in Kannur, Wayanad, Thrissur, Kottayam and Pathanamthitta districts has revealed that more than 100 species of fishes were found to migrate to the lowland areas for breeding and spawning.

20.2.1 Declining Fisheries

Destruction of migratory passages, building of sidewalls and check dams, large-scale conversion of paddy fields, extensive use of pesticides in cultivation, sand mining in rivers and invasion and choking of waterways by alien plant species have all prevented migration of freshwater fish to the floodplains. Traditionally, diverse

Fig. 20.1 Traditional fishing gears used in Kerala

fishing gears like *ottal*, *koodu*, cast net, gill net and *kuthu vala* and the unique gears like *nathoodu*, *adichil* and *chattom* designed in various parts of the state were used for floodplain fishery (Shaji and Laladhas 2013). Recently, indiscriminate fishing during MFF has caused great decline in the diversity of freshwater fish species in the rivers of Kerala. The use of traditional gears like *koodu* did not create much pressure on the fishing, but recently monofilamentous gill nets have replaced the traditional gears (Fig. 20.1), and destructive fishing practices using excessive chemicals and explosives has affected the total population. The gill nets of varying mesh sizes sweep other macro-aquatic organisms, and frequently dead snakes, eels, birds and frogs can be found in the fields during *ootha* fishing.

Local fishermen are well aware of the monsoon migration of fishes, and they exploit the migration by fishing out the adult fishes using different local techniques. The number fished out is so huge that the fishes are often kept alive for several days utilizing small numbers daily and providing livelihood for the rural community. Due to destructive fishing practices, the adult brood stock of the native fishes have been fished out prior to their spawning, resulting in a drastically reduced population of several species. The unregulated fishing during monsoon migration is a great threat to the population and sustainability of many species of fishes.

The Kerala State Biodiversity Board undertook a detailed study to understand the underlying phenomena of fish migration and overexploitation of fishes, and the board envisaged a project to conserve native fishes of Kerala. The project was targeted to replenish the native fishes of Kerala in their respective natural habitat. The project also aims to create awareness among the local fishermen of the destructive nature of migratory fishing and to educate them of the role native fish diversity plays to sustain a healthy riverine ecosystem. Further, on the beneficial side, awareness to enforce the need of restoration of native fish populations as a healthy protein-rich food source to the rural community was also emphasized during the programmes.

20.2.2 Conservation of Native Fish Broods

The pilot project was implemented in two districts of Kerala, namely, Pathanamthitta and Alappuzha. The districts were chosen for the high species diversity of native fishes recorded from their freshwater. The river Pamba which originates in the high ranges of Pulachimalai hills flows down through Pathanamthitta district and further enters Alappuzha district and finally empties itself into the Arabian Sea at the coast of Alappuzha district (Fig. 20.2). Pamba is the third biggest river of Kerala state and is well known for its fish diversity. To date 60 fish species belonging to 17 families and 36 genera have been identified from Pamba River (Renjithkumar et al. 2011). Being reputed for fish diversity, the fishes of Pamba are subjected to severe overfishing leading to reduction in average size constituting the fishery (size overfishing) and killing of spawner fish population with the onset of monsoon. A variety of destructive fishing techniques have been in practice throughout the length of the Pamba River; hence it is a priority to conserve the diversity of fishes of Pamba.

Prior to the implementation of the project, by the onset of monsoon, awareness programmes were conducted in two districts focused on unsustainable fishing, depletion of fish stocks and the danger it poses to the survival of several fish species and also steps to protect migration routes (Fig. 20.3). The native fishermen and general public were made aware of the destructive effect of fishing during monsoon migration, fish as a keystone species, ability of fishes to keep a check on insect vectors and ensure food security and the conservation steps which can be implemented.

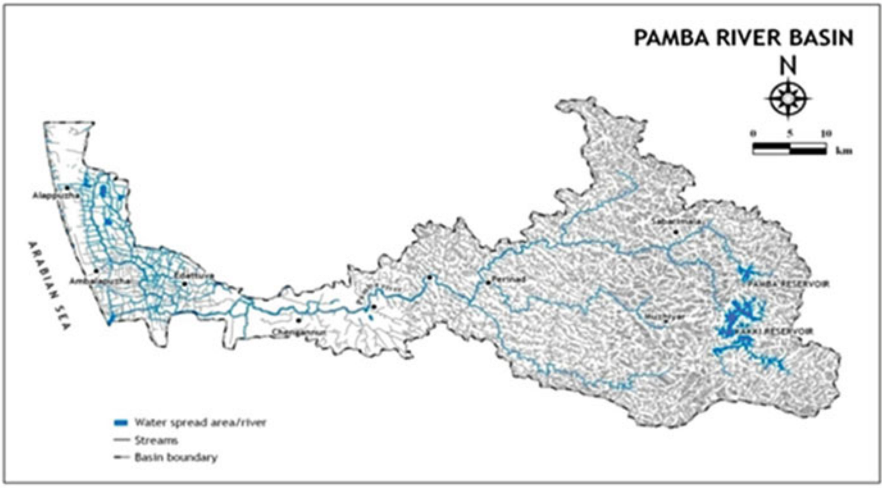

Fig. 20.2 Pamba River basin

Fig. 20.3 Poster and brochure for the awareness programmes

Table 20.1 Details of brood stock procured in each district and the species chosen for the project

Sl no.	Districts	Brood stock procured (KG)	Species chosen
1	Pathanamthitta	63	*Kaari* (*Heteropneustes fossilis*) and *manjakoori* (*Horabagrus brachysoma*)
2	Alappuzha	58	*Kaari* (*Heteropneustes fossilis*) and *manjakoori* (*Horabagrus brachysoma*)

A brood stock of 121 kg of native fishes belonging to two different species *kaari* (*Heteropneustes fossilis*) and *manjakoori* (*Horabagrus brachysoma*) was procured from fishermen of the selected two districts (Pathanamthitta and Alappuzha) (Table 20.1). *Horabagrus brachysoma* is an endemic species of the Western Ghats listed as vulnerable in the International Union for Conservation of Nature (IUCN). Each species was introduced in separate ponds in each of the two districts. Six ponds were prepared in Koipuram Grama Panchayat in Pathanamthitta district to spawn individuals of two species. Ten ponds were prepared in Mannar and Pandanad Grama Panchayats in Alappuzha district. The brood stock purchased from each district was acclimatized initially for 5 days near the pond and regularly monitored. On the sixth day, the healthy fishes from the acclimatization tank were introduced into ponds that were prepared for their spawning. For 30 days, they were regularly fed and monitored. After 30 days, almost all fishes had spawned. For the safety of the fish fingerlings, the adults were selectively caught using nets. The adults were reintroduced to rivers. Special care was taken to reintroduce species to their respective habitat and not to contaminate the gene pool of a population by introducing species from another locality. The fingerlings were raised to the size of 2 in. and were released to the respective rivers in two districts. Altogether about 2000 young ones and fingerlings of *kaari* and about 500 young ones and fingerlings of yellow *manjakoori* were released during 2014–2015.

20.2.3 Fisheries Management for Sustainable Livelihood

Native freshwater fishes are one of the best indicators of a healthy ecosystem and water quality, as they play a role of keystone species in freshwater ecosystem. The fishes are known to feed on a variety of organisms including the larvae of many of the insect vectors and keep a check on their uncontrolled proliferation. The fishes are also a source of healthy protein, and their sustainability is necessary for food and nutritional security. Monsoon floodplain fishery is an important source of livelihood and food security for indigenous community.

The current study was envisaged to replenish the population of freshwater fishes in the two districts of Kerala. The case study indicates that the fish stock of the freshwater ecosystem can be increased by keeping a check on the uncontrolled fishing during monsoon fish migration and allowing them to spawn. The study was indeed a pilot step for increasing the fish stock of native fishes in their freshwater ecosystem. But what would be more effective are restrictions in fishing during fish migration and spawning to perpetuate the generations. A sustainable solution to protect the spawning native fishes is necessary. Banning of destructive fishing, restriction of certain fishing gear, promotion of traditional fishing gears and above all ensuring community participation through local institutions are vital steps for maintaining the sustainability of monsoon floodplain fisheries to ensure sustainable livelihood to the local community.

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Chapter 21
Restoring Fish Habitats for Sustainable Livelihood

Linda John, K.P. Laladhas, and Oommen V. Oommen

Abstract For generations, artisanal fishermen of Kerala have relied on traditional knowledge (kanicham) to identify the location of reefs, where fishes converge, and have practised sustainable natural resource management. The sustainability of marine bioresources of Kerala and livelihood of local fisherman traditionally engaged in hook and line fishing in the rocky reef areas are adversely affected by unsustainable fishing, trawling and urbanisation. Artificial reefs are considered to play significant role in revitalising the aquatic environment which have been damaged by developmental projects and overfishing. This case study provides experiences on how the management of coastal fisheries through resource enhancement by deploying artificial reefs provides the incentive to sustainably use the resources. The reefs were manually built by fishermen using natural materials (wooden boats). The position for deposition of reefs and the raw materials to be used were decided by fishermen based on their time-tested knowledge. It illustrates that experiences on small-scale initiatives on local governance over resources and integration of traditional knowledge into planning and implementation of resource management regimes can ensure the resilience of marine bioresources and provide sustainable livelihood options to artisanal fishermen.

Keywords People's artificial reefs • Coral reefs • Artisanal fisherman • Fish eggs • Spawning fish

21.1 Introduction

Tropical coral reefs are a productive ecosystem as they provide habitat, spawning and nursery grounds for economically important fish species. Coral reefs are one of the most diverse ecosystems on the planet as the variety of species inhabiting a coral reef is greater than in any other shallow-water or marine ecosystems. Coral reefs are often called the rainforests of the sea, both due to the diverse species they harbour

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and due to their high productivity. They protect coastlines from waves during storms, hurricanes, typhoons and even tsunamis. They play an essential role in water filtration and provide a habitat for breeding fishes. Coral reefs are adversely affected by human activities. Different factors which damage coral reefs are overfishing, destructive fishing methods, unsustainable tourism, coastal development, pollution and global aquarium trade. Corals are also affected by climate change such as coral bleaching, rising sea levels and ocean acidification. Other causes for damaging coral reefs are coral disease, crown of thorns starfish and alien invasive species.

The Kerala coast in India runs north–south along the Arabian Sea and the 590 km coastal line ecosystem supports diverse species. The economic benefits derived from marine bioresources are the sole source of livelihood for many marginalised communities of Kerala including fishermen population living in the 222 marine villages. Kerala has many rocky areas which provide substratum for a variety of benthic organisms.

21.2 Traditional Knowledge of Artisanal Fishermen

For generations, artisanal fishermen of Kerala have relied on traditional knowledge (kanicham) to identify the location of reefs, where fishes converge, and have practised sustainable natural resource management. This traditional practice of identifying location of reefs is by a visual triangulation technique. Fisherman use landmark like peak of mountains, towers of churches and elevated marks for the purpose. By staying on the craft and looking at the land, they locate a number of landmarks of which any two, which are in transit (same line), are selected as one side of the triangle, and other two landmarks in line would be selected to get the other side of the triangle. The two sides of the triangle would meet at a single point, which is the position of the craft, and underneath the water column would be the reef or high-yielding fishing ground or the net at the seabed they would be searching for. The fishermen term this technique as kaniyam or kanicham which means position. This technique could be used only within the visibility range of the naked eye. Similarly night hours and bad weather render it difficult to resort to this technique. Experienced fishermen overcome the limitation with the aid of celestial bodies – positions of sun, moon and stars. Even though electronic equipment such as Global Positioning Systems are now in use, elderly fishermen rely solely on position of sun and length of shadows during the day and position of stars during night for position fixing.

Prime spots where aggregation of fishes occurs are known to local fishermen. The knowledge about the reef-sea-fish interactions had been passed down to them from the older generation and kept alive by their own practice of fishing. Traditional fishermen of Kerala have in-depth knowledge about seabed topography and consider reefs as an important basis for ecosystem rejuvenation. Particularly important is indigenous knowledge concerning location of spawning aggregations of reef fishes.

The sustainability of marine bioresources of Kerala and livelihood of local fisherman traditionally engaged in hook and line fishing in the rocky reef areas are adversely affected by unsustainable fishing, trawling and urbanisation. Artificial reefs are considered to play significant roles in revitalising the aquatic environments which have been damaged by developmental projects and overfishing. The recent developments in the artificial reef programme across the world show the increased awareness for habitat regeneration.

An artificial reef is a human-made underwater structure, typically built for the purpose of promoting marine life in areas of generally featureless bottom. They are generally designed to provide adequate space for various marine organisms to settle and thrive well, such as hard surfaces to which algae and invertebrates such as barnacles, corals and oysters attach. They develop into a complex ecosystem because of the creation of large number of niches, accumulation of attached marine life from single-celled algae to invertebrates, which in turn provide intricate structure and food for assemblages of fish, reptiles and mammals. It thus enhances various biological activities such as settlement of sedentary flora and fauna, which in turn attract many visitors either for feeding or resting in the shelter. The artificial reef gradually matures into a full-fledged ecosystem supporting these residents by providing feeding, breeding and nursery grounds, all in one place, thus naturally leading to the enhancement of the biological resources in area where the artificial reef is deployed.

Most artificial reefs are large, permanent structures set in rather shallow water. In some cases lighter structures made from locally available materials are installed temporarily to lure fish to a specific area, during a certain fishing season. Material should resist rapid corrosion and should not introduce harmful substances into the marine environment. Fishermen refer to all such sunken objects as kritrimapaar (artificial reefs).

During the 1600s reefs of building rubble and rocks were used in Japan to grow kelp, and the modern "artificial reef" concept comes from the eighteenth-century Japan. It spread to the USA in the 1830s, when logs from huts were used off the coast of South Carolina to improve fishing (Lockwood 2000) and subsequently to many different areas of the world. More recently, reefs have been used to protect marine resources from illegal fishing activities.

The first recorded artificial fish habitat construction was off Puthiathura (Thiruvananthapuram) in 1953 and subsequently off Eraviputhenthura (Kanyakumari Dist.) in 1957. However, an organised effort to construct artificial fish habitats and artificial reefs was made only from 1980 onwards.

21.3 People's Artificial Reefs for Sustainable Coastal Management

People's artificial reefs (PAR) project funded by Kerala State Biodiversity Board deployed two artificial reefs along the inshore region off the Valiathura coasts of Thiruvananthapuram, Kerala. The concept of PAR has its roots in the documented traditional knowledge in Marine Biodiversity Register that naturally available reef areas are swarming with fishes. The artificial reefs were designed to increase the biological productivity of the inshore waters for sustainable use and enhance the complexity of ecological niche which over a period of time will mature into a full-fledged near natural ecosystem supporting diverse species.

The main beneficiaries were two groups of selected fisherman from Valiathura by South Indian Fishermen Development society, an NGO actively involved in the welfare of fisher folks. The reefs were manually built by fishermen using natural materials (wooden boats). The position for deposition of reefs and the raw materials to be used were decided by fishermen based on their time-tested knowledge. The boats were sunk along with bundles of coconut leaves and sand bags for attracting spawning fishes (Figs. 21.1 and 21.2). Coconut leaves and coconut stumps, when decayed, help plankton and other organisms grow around and on them, which attracts large number of smaller and bigger fishes into the area (Fig. 21.3). Coconut leaves are dumped in the reefs mainly to attract cuttlefishes. Decaying leaves attract large number of cuttlefishes to the areas and provide ideal environment for the females to lay their eggs and for the juveniles to spend their early life (Philipose 1996). As the artificial reefs were deposited in the near shore areas about 2–3.5 km from the shore at a depth of 20–30 fathoms, fishermen need to spend less fuel and resources for fishing. The catch was of high quality and fresh as the fishing technique employed was hooks and line and gillnets. Monitoring is done by local people, and the resources are exclusively managed by fishermen ensuring equitable sharing of benefits to the real custodians of bioresources.

Fig. 21.1 Establishment of artificial reefs

Fig. 21.2 Artificial reefs made of locally available materials

Fig. 21.3 Fish eggs on PAR

21.3.1 Biodiversity Impact

Artificial structures in marine environment have the potential for enhancing various biological activities such as settlement of sedentary flora and fauna, which in turn attract many visitors either for feeding or resting in the shelter. The artificial reef gradually matures into a full-fledged ecosystem supporting these residents by providing feeding, breeding and nursery grounds, all in one place. This naturally leads to the enhancement of diversity and abundance of fish and crustaceans by providing preferred habitat and thereby helps in attracting, aggregating and regenerating pelagic, demersal, migratory and residential fishes. An artificial reef emulates a natural ecosystem and provides living space and shelter from predators and a suitable substratum for attachment of eggs serving as spawning ground and feeding ground.

21.3.2 Livelihood Impact

An increased biological productivity as a result of aggregation is indicated by a daily catch from the area where the artificial reefs were installed. Diversity of fishes includes *Megalaspis cordyla*, *Rastrelliger kanagurta*, *Atula mate*, *Terapon jarbua*, *Caranx sexfasciatus and Stolephorus indicus*. Against an initial investment of only Rs 30,000/-, the revenue realised during 1 month alone was nearly Rs.50,000/-. The same trend continued for the next 2 months. The benefits of artificial reefs are the availability of fish at all times of day and night. The catch is of high quality and very fresh as the fish are caught mostly by hooks and line and gill nets, and the journey time to and from the fishing ground is very short. The short distance to the fishing ground in the reef area helps the fishermen to save fuel and journey time. Fishermen without motorised craft also can reach the fishing ground with the help of sail or oars.

21.3.3 Socioeconomic Impacts

- Increased marine resources availability leading to improved food security and standard of living for local people.
- Protection of artisanal fisheries.
- Enhancement of biodiversity through habitat creation.
- Enhancement of capacity of local fishermen to manage their natural resources.
- Strengthening of institutional framework to manage their natural resources.
- Reefs reduce or prevent bottom trawling in the area and almost serve as a mini marine protected area.

By all means artificial reef is an excellent intervention for better conservation and enhancement of our biological resource in general and fishery resources in particular. This case study provides experiences on how the management of coastal fisheries through resource enhancement provides the incentive to sustainably use the resources. It illustrates that experiences on small-scale initiatives on local governance over resources and integration of traditional knowledge into planning and implementation of resource management regimes can ensure the resilience of marine bioresources. The interventions based on traditional practices, community-led enterprise development at local level and leveraging of markets provide new innovative approaches for assessing resources, value add them and safeguard equitable sharing of the benefits arising out of the utilisation of marine resources.

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Chapter 22
Sustainable Livestock Farming: Issues and Concepts

T.P. Sethumadhavan

Abstract Sustainability encompasses economic, social, cultural and environmental issues. Food and nutritional security and sustainability in farming practices are assuming greater significance in this era of changing environment. Dairying provides protection against failure of agriculture due to various reasons and contributes to rural livelihood, employment and income generation by providing fodder, fuel and food. The livestock sector plays an important role in providing sustainable rural livelihood in India. India possesses a good number of recognised breeds of cattle that can withstand stress better than crossbreds. This chapter gives an overview of the livestock sector in India, native breeds of cattle and buffaloes in India, and advocates greater thrust on preserving and augmenting superior native breeds of livestock. Approaches to livestock development and enhancing the livelihood of farmers through formation of new-generation cooperatives and promotion of the cooperative culture are recommended for augmenting the market share.

Keywords Livestock • Native breeds • Dairy farming • Rural livelihood • Cooperatives

22.1 Introduction

Food and nutritional security and sustainability in farming practices are assuming greater significance in this era of changing environment. Intensive cultivation practices using chemical fertilisers and pesticides could pave way for spectacular growth in agriculture and allied sectors, but organic and natural farming are emerging as the viable farming system in the country for clean, green and ethical food production. Livestock farming and conservation practices facilitate organic farming in the country. Dairying provides protection against failure of agriculture due to various reasons and contributes to rural livelihood, employment and income generation.

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In India, dairying is predominantly unorganised and is centred around rural households, but the organised sector in the dairy industry is growing at a rate of more than 10 % per annum. The mythical 'Kamadhenu' symbolised livestock as a perennial source of wealth. A great variety of recorded production systems for cattle have been practised in the country at various places. Through these practices, fine native breeds of cattle have evolved that are suited to the local conditions and hardy, which are much sought out for their special characteristics of disease resistance. Indian breeds like Gir and Sahiwal are among the hardiest of high yielders in the world. Hallikar bullocks are excellent draught animals.

It appears from the reports in ancient literature that breed improvement was never taken up in isolation, but always linked to housing, nutrition and management. This is in marked contrast to majority of the present-day breed improvement programmes. India possesses a good number of recognised breeds of cattle that can withstand stress better than crossbreds. There is a need for greater thrust on preserving and augmenting superior native breeds of livestock. A judicious balance will be sought to be achieved between requirements of milk, milk products and the draught power. Conservation of the genetic resources in the livestock sector has been recognised as a matter of national priority and is being coordinated by the National Bureau of Animal Genetic Resources (NBAGR), Karnal, India. The cattle and buffalo breeds of India are listed in Tables 22.1 and 22.2.

The livestock sector plays an important role in rural livelihood, employment and income generation. Major livestock products like milk and milk products, meat and eggs contribute around one-sixth of the calories and one-third of the proteins in the per capita food supplies of the world. Per capita consumption of livestock products is four to five times higher in developed countries than in developing countries. India's 530 million livestock forms 12 % of the world's livestock population. Milch animal population is on the rise, and the country is producing 127.3 million tonnes of milk per annum. Per capita milk availability is 323 g per day which is above ICMR recommendations. Poultry meat and egg production is moving at a faster rate. Per capita egg consumption is 54 eggs per annum. The livestock sector contributes 27 % of agricultural GDP and 3.6 % of total GDP of the country. The availability of per capita animal protein is 10.8 g, whereas the requirement as per world average is 25 g. National sample survey reports that 70–75 % of the food budget is for milk and milk products. Output from the livestock sector is $58,885,749,000. Global demands for livestock products are increasing. With regard to bovine meat, competitive market is outside the country. Sustainable livestock production can be achieved only when sound animal health system is available.

Animal husbandry is the second largest economic activity of rural India. In arid and semiarid regions, the livestock sector ranks first in earnings to skilled, semi-skilled and unskilled populations. In the case of failure in agriculture, the livestock sector forms a source of income and gives insurance to resource poor farmers. Animal husbandry is a growth engine and annual growth rate in dairying is above 6 %, and in poultry it is 11 %. This sector contributes to alleviation of rural poverty and uplifts the rural farmer. If the country has to sustain economically, the livestock

Table 22.1 Cattle breeds of India

Sl. no.	Name of the breed	Type	Origin
1	Amrit Mahal	Draught	Hassan and Chikmagalur, Karnataka
2	Bachaur	Small, draught	Sitamarhi, Bihar
3	Bargur	Draught	Periyar, Tamil Nadu
4	Dangi	Dual	Nashik and Ahmednagar, Maharashtra
5	Deoni	Dual	Latur, Parbhani and Nanded, Maharashtra
6	Gaolao	Dual	Balaghat and Chhindwara, Madhya Pradesh
7	Gir	Milch	Junagarh, Bhavnagar and Amreli, Gujarat
8	Hallikar	Draught	Mysore and Mandya, Karnataka
9	Hariana	Dual	Rohtak and Hisar, Haryana
10	Kangayam	Draught	Erode and Dindigul, Tamil Nadu
11	Kankrej	Dual	Kachchh and Mehsana, Gujarat
12	Kenkatha	Small, draught	Lalitpur and Banda, Uttar Pradesh
13	Kherigarh	Draught	Lakhimpur Kheri, Uttar Pradesh
14	Khillari	Draught	Satara, Solapur and Sangli, Maharashtra
15	Krishna Valley	Draught	Belgaum, Karnataka and Sangli, Maharashtra
16	Malvi	Draught	Indore, Dewas and Ujjain, Madhya Pradesh
17	Mewati	Dual	Alwar and Bharatpur, Rajasthan
18	Nagori	Draught	Nagpur, Rajasthan
19	Nimari	Draught	Khandwa and Khargone, Madhya Pradesh
20	Ongole	Dual	Nellore and Guntur, Andhra Pradesh
21	Ponwar	Small, draught	Pilibhit, Uttar Pradesh
22	Punganur	Small, dual	Chittoor, Andhra Pradesh
23	Rathi	Milch	Bikaner and Sri Ganganagar, Rajasthan
24	Red Kandhari	Draught	Nanded, Maharashtra
25	Red Sindhi	Milch	Government organised herds
26	Sahiwal	Milch	Ferozepur, Punjab and Sri Ganganagar, Rajasthan
27	Siri	Dual	Darjeeling, West Bengal and Sikkim
28	Tharparkar	Dual	Rann of Kutch, Gujarat and Barmer and Jaisalmer, Rajasthan
29	Umbalacherry	Draught	Thanjavur and Dindigul, Tamil Nadu
30	Vechur	Miniature	Vechur, Kottayam, Kerala

sector has to be strengthened. The need of the hour is to increase production, productivity, and improve the marketing channel.

Milk production in India has increased from 17 million tonnes in 1965 to 246.3 million tons. This sector contributes 30 % of agriculture GDP. India has 240 million cattle, 160 million buffaloes and 64 million goats. By 2020, the requirement of milk in India is expected to be 191 million tonnes. New Zealand has 1.5 % of the world milk production, and India has 15 % of the world milk production, but contribution in the international market is less than 2 %.

Market situation of livestock products are heavily gloomy as the increase in cost of production reduces the profit margin. To make dairying profitable, age at puberty

Table 22.2 Buffalo breeds of India

Serial number	Name of the breed	Origin
1	Bhadawari	Agra and Etawah, Uttar Pradesh; Bhind and Morena, Madhya Pradesh
2	Jaffarabadi	Junagadh, Bhavnagar and Amreli, Gujarat
3	Marathwada	Parbhani, Nanded and Latur, Maharashtra
4	Mehsana	Mehsana, Banaskantha, and Sabarkantha, Gujarat
5	Murrah	Rohtak, Jind and Hisar, Haryana
6	Nagpuri	Nagpur, Wardha and Berar, Maharashtra
7	Nili-Ravi	Ferozepur and Amritsar, Punjab
8	Surti	Anand, Kaira and Baroda, Gujarat
9	Toda	Nilgiri, Tamil Nadu
10	Pandharpuri	Kolhapur, Solapur and Satara, Maharashtra

of cattle has to be reduced. One calf per year for cows and one calf per 15 months for buffaloes are ideal. Value addition of milk will improve profitability. There is enough data for cost of production in agriculture, but with regard to livestock, not much data is available.

With regard to production and consumption of milk, this is a golden era in the dairy sector. Organised sector is growing at a rate of more than 11 % per annum. Milk production is increasing in Asia and India, and increasing prices are favourable to developing countries. International Farm Comparison Network (IFCN), Germany, reported that India has the lowest cost of milk production when compared to developed countries.

In the changing environments dairy entrepreneurship is acquiring momentum across the country. Even though 90 % of dairying is under subsistence farming, commercial dairy farming activities have started flourishing in the country. Increased land pressure, lack of available land for fodder cultivation, increased cost of production and decreasing productivity are the important challenges in dairy sector.

22.2 Approaches to Livestock Development

22.2.1 Productivity

Productivity per cattle is comparatively less in India. According to recent reports, 70 % of Indian cows and 60 % buffaloes have very low productivity. Average milk yield from local cows is about 3–3.5 l, for buffaloes 3.96–5.39 l and for crossbred cows 5.82–7.80 l per day which is significantly lower than the productivity in developed countries. Scientific breeding, feeding and management practices along with quality inputs and extension support services are required for achieving better productivity. It clearly indicates that properly devised and implemented policy in the dairy sector can change the economic status of stakeholders. There exist a wide deficit in the supply of feeds and fodders countrywide. Recent estimates reveal that green fodder is deficit by 23 %, while dry fodder and concentrates are deficit by 31 % and 47 %, respectively, in the country. Awareness programmes on quality of feed and fodder acquire much significance in this scenario. National Dairy Plan (NDP) envisages productivity enhancement through ration balancing and introduction of new technologies for formulation of mineral mixture, densification straw and fodder seed production.

22.2.2 Strengthening of Extension Services

There are studies available to suggest that farmers are ready to pay at market rates, provided appropriate quality services are made available at their door steps. Extension programmes play a key role in augmenting production. Awareness on scientific breeding, feeding, disease control and marketing will help to attain sustainability in dairying. Strategic programmes are required for reaching out among smallholder population for facilitating technology transfer and extension support. Veterinary services should be more oriented towards preventive rather than curative in nature.

22.2.3 Quality

Quality of inputs and outputs must be assured. To maintain quality and food safety standards, monitoring of the entire commodity chain is required. Food Safety and Standards Act 2006, hazard analysis and critical control points, good manufacturing and retail practices, and total quality management play a key role in this sector. Farmers have to be linked with processing and exporting agencies so that the quality can be ensured right from the raw material production stage.

22.2.4 Producers Company: Emerging Model in Dairy Sector

As a sequel to ASEAN agreement, Indian dairy industry can trade products to cater to the demand of native Indian residents abroad especially in Asian countries. Promotion of producer companies through formation of new-generation cooperatives under company's act may go a long way in ensuring the cooperative culture and corporate governance apart from augmenting the market share of organised sector to 65 %, as envisaged under National Dairy Plan. National Dairy Development Board has been promoting the producers company popularly known as the new-generation cooperatives. They can use the online agri-marketing portal of the Government of India and trade the products within the country and in the international market.

22.2.5 Demand-Supply Perspective

Among various livestock products, the major surplus in 2020 is reported to emerge in the case of milk and eggs as production growth will be significantly higher than consumption growth for these two specific commodities produced in India. In 2020, the major surplus to the tune of 85 million litres will emerge for milk alone, followed by 69 billion eggs. Fish, chicken and beef and buffalo meat produced in India are also likely to generate surplus in 2020.

India has high potential in export of meat. It is estimated that about 6 % cattle, 10 % buffaloes, 31 % sheep, 39 % goats and almost 100 % pigs are slaughtered each year with total meat production at 6.2 million tonnes in the country. While buffalo meat is the major item of Indian meat export, accounting for 59 %, share of Indian meat in the world market is less than 2 %. Linking quality production of livestock products with lucrative incentives and popularisation and development of traditional products through technology can facilitate quantum jump in this industry. Since the meat sector provides livelihood to 40 million people, most meats are sold in the domestic market needs. This sector need total restructuring in tune with Food Safety and Standards Act 2006, to provide quality meat and meat products to the consumers. Divisibility, value addition and export of meat and meat products need to be strengthened for generating more employment as well as trade benefits.

The Indian dairy sector would be competitive only if the export subsidies on dairy products are abolished. In the era of globalisation and liberalisation, the real challenge posed before in the Indian livestock sector would be in terms of Sanitary and Phytosanitary Measures (SPS), Agreement on Technical Barriers to Trade (TBT) and animal welfare-related issues. To meet these requirements, modernisation of supply chain is to be given due importance.

One Agriculture-One Science policy, a Global Education Consortium, is emerging across the world. This will pave way for delivering stakeholder-based open online courses as part of the move to open online courses with a global perspective and will facilitate funding for developing appropriate content and knowledge dissemination process in the university. Moreover it will help to create new-generation agriculture scientists to cater the emerging food security issues across the globe.

Chapter 23
Biodiversity and Sustainable Development: A Retrospect

Preetha Nilayangode, K.P. Laladhas, and Oommen V. Oommen

Abstract The UN Rio+20 outcome document 'The Future We Want' acknowledged the need for mainstreaming sustainable development at all levels; integrating economic, social and environmental aspects; and recognising their interlinkages, so as to achieve sustainable development in all its dimensions. It was recognised that sustainable management of natural resources and ecosystems is the foundation for sustainable development, poverty eradication and human well-being. The main challenge for sustainable development in the twenty-first century was identified as poverty reduction. Biodiversity loss will severely reduce the capacity of ecosystems to provide provisioning services, regulating services, supporting services or cultural services. The main effect of this reduced ecosystem services will be reflected on the livelihood of the forest-dependent communities. Hence, the preceding three sections has focussed on the role of sustainable utilisation of natural capital for poverty alleviation and sustainable livelihood coupled with decentralised governance for an inclusive, participatory and sustainable management of natural resources.

Keywords Poverty alleviation • Nutritional security • Sustainable utilisation • ABS • Women empowerment • Decentralized governance

23.1 Poverty Alleviation and Nutritional Security

India's varied biophysical environment with ten biogeographic zones and a variety of ecosystems and habitats have contributed to a rich biological heritage. Although India covers only 2.4 % of the world's land area, it is one of the 17 mega-diverse countries and one of the eight Vavilovian centres of origin of crop diversity. The Sustainable Development Goals adopted in September 2015 have set a target to eradicate extreme poverty of people globally and reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions

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according to national definitions by 2030 (www.un.org/sustainabledevelopment/sustainable-development-goals/). It was acknowledged that poverty, in addition to lack of sustainable livelihood, includes hunger, malnutrition and limited access to education, social discrimination and the lack of participation in decision-making. India has a poverty ratio of 21 % and is still home to a quarter of all the undernourished population in the world (FAO 2014). Any global efforts for eradicating hunger require progress in food and nutrition security in India. Forty-three per cent of Indian children below 5 years of age are underweight, and 48 % (i.e. 61 million children) are stunted due to chronic undernutrition. In India 20 % of children under 5 years of age suffer from wasting due to acute undernutrition (www.unicef.in).

Achieving food security is a crucial pillar of human development but can have severe negative impacts on biodiversity through land clearing, the introduction of non-native species, excessive water use, habitat conversion, excessive use of chemical fertilisers and pesticides and chemical run-off leading to soil and water contamination and declining soil fertility associated with unsustainable production. The 2014 Global Harvest Initiative Report estimates that India's domestic production will only meet 59 % of the country's food demand by 2030 at the current growth rate. Since the 1900s, some 75 % of crop diversity has been lost from farmers' fields globally. Better use of agricultural biodiversity can contribute to more nutritious diets, enhanced livelihood for farming communities and more resilient and sustainable farming systems. The traditional practice of maintaining genetic diversity in the field is the key to long-term sustainable food production.

India is the primary centre of origin of rice, and about 166 species of crops including 25 major and minor crops have originated and/or developed diversity in India, and 320 species of wild relatives of crop plants are known to occur here (National Bureau of Plant Genetic Resources 2007). Many of the landraces and primitive cultivars have already vanished due to the preference for high-yielding varieties. The remaining ones are genetically deteriorating gradually due to hybridisation, selection or genetic drift. India has put in place an enabling legal mechanism under the National Biodiversity Authority and a monitoring framework, National Biodiversity Targets (NBTs), with indicators for each of the targets which are in harmony with Aichi Targets. Aichi Biodiversity Target 13 and National Biodiversity Target 7 have envisaged that by 2020, genetic diversity of cultivated plants, livestock and wild relatives are maintained and strategies are developed for safeguarding their genetic diversity (India's Fifth National Report to the Convention on Biological Diversity 2014).

There are many initiatives from India as seed movement in Wayanad, Kalajeera rice from Jeypore, Orissa, etc. which serve as novel models of sustainable development for nutritional and food security where linkages between a formal seed distribution system and traditional system have been established. Jeypore tract in Orissa is home to a diversity of rice landraces. A village-level seed bank was developed, and a seed management committee was constituted with representatives from village farming community in Jeypore, with the assistance of M.S. Swaminathan Research Foundation. Participatory breeding efforts were initiated to demonstrate that traditional landraces of rice have potential to ensure nutritional, livelihood and economic security to the tribal poor. This initiative demonstrates how traditional knowledge with modern techniques can enhance the productivity of traditional varieties bringing better benefit to community (Bhatt et al. 2012).

Seed movement by involving the major farming groups of Wayanad, especially the tribal communities of *Kurichya*, *Kuruma*, *Pathiya* and *Wayanadan Chetty*, to promote the conservation and sustainable use of the indigenous crop varieties through a '4C continuum,' that is, conservation, cultivation, consumption and commercialisation, of plant genetic resources was visualised by Prof. M.S. Swaminathan. Food security and nutrition are promoted through revitalisation of traditional food habits and livelihood security through value addition and marketing methods. Minor crops and underutilised species such as tubers and wild yams play a significant role in enlarging the food basket and providing nutritional security. The diversity-rich areas of such underutilised species are located in the tribal dominated places. The All India Coordinated Research Project on Ethnobiology records about 8,900 species used by tribal communities of which 3,900 are used for food (National Bureau of Plant Genetic Resources 2007). Neglected or underutilised crops play an important role in food security being (i) a part of a focused effort to help the poor for subsistence and income, (ii) a way to reduce the risk of over-reliance on very limited numbers of major crops, (iii) a way to increase sustainability of agriculture through a reduction in inputs, (iv) a way to contribute to food quality and (v) a way to preserve and celebrate cultural and dietary diversity (Mayes et al. 2011). The section on Biodiversity for sustainable livelihood has foccused on the role of landraces, indigenous breeds and biodiversity on food and nutiritional security to end all forms of malnutirion as aimed in Sustainable Development Goals.

23.2 Biodiversity Conservation and Sustainable Utilisation of Bioresources

In India about 275 million people are dependent on forests for livelihood; forests also meet 30 % of fodder needs of the cattle population and 40 % of domestic fuel wood needs of the people. The basis of development agenda for India is the National Environment Policy 2006 whereby it is recognised that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from conservation, than from degradation of the resource. The NBTs ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services is in line with obligations under international agreements. The NBT 2 has set a goal that by 2020 values of biodiversity are integrated into national- and state-level planning process, development programmes and poverty alleviation strategies. NBT 8 has set a goal that by 2020 ecosystem services relating to water, human health, livelihoods and well-being are enumerated and measures to safeguard them are identified taking into account the needs of the poor and vulnerable society (India's Fifth National Report to the Convention on Biological Diversity 2014).

Experiences have shown that a transition to sustainable development is not possible without the participation of the local people and developing solutions to the local issues. The traditional knowledge and practices of indigenous people and biocultural protocols and good environmental practices for stewarding sustainability of natural resources contribute to achieving developmental goals. Decentralised biodiversity governance would improve resource outcomes, livelihoods and equity and also lead to a greater focus on tenure reform and participation of local people in addition to reducing local people's dependence on destructive practices in the conservation areas by promoting a range of ecosystem-based and alternative livelihoods (Krishnan et al. 2012).

The Biodiversity Act 2002 and Rules 2004 and other *sui generis* systems such as Protection of Plant Varieties and Farmers' Rights (PPVFR) Act and Geographical Indications of Goods Act in India recognise the right of local people over natural resources. The right to registration of farmers' varieties has served primarily as a means to recognise the past contributions of farmers to the preservation of biodiversity. Registered farmers' varieties of Wayanad, Kerala, includes Veliyan, Thondi, Chennellu, Chomala, Gandhakasala, Jeerakasala, Mullankayama, Valichoori, Onavattan, Kurumottan, Kunjoottimatta, Marathondi, Chenthadi, Koduveliyan, Thuroodi and Thonnooran Thondi. As per the registration, given under the provisions of Protection of Plant Varieties and Farmers' Rights (PPVFR) Act of India 2001, Wayanad farmers have the exclusive right to produce, sell, market, distribute, import or export the registered farmers' varieties for a specified period.

Geographical indications (GI) is another effective legal tool for protection of the collective rights of the rural and indigenous communities, ensuring that the entire community which has preserved the knowledge and has passed it on over generations stand to benefit from the knowledge. In India there are many traditional agricultural practices leading to bioproducts with quality attributes specific to the locality, where GI registration has resulted in creating a niche market for the product. One such example is the Aranmula Kannadi, a metal mirror produced only in Aranmula village of Kerala, a tradition handed over through generations. The artisans believe that the composition of the metal mirror is divine, and some undisclosed metals alloyed with silver, bronze, copper and tin are responsible for the distortion-free images. For casting and moulding, they use clay from Aranmula itself, and the proportion of the clay used in different parts of the mould is also a secret. The traditional knowledge for making this product is kept as a secret, and this has resulted in enhanced socioeconomic benefits to the artisans involved. Government cooperative societies in Kerala such as Surabhi and Kairali have taken the initiative for marketing the product. The Development Commission of the Handicrafts and Handloom Department has issued identity cards and artisans' credit cards to them. The case studies demonstrate that the local communities play an important role in nurturing the diversity of nature leading to enhanced socioeconomic benefits. Support for direct marketing of the product will ensure fair and equitable sharing of benefits to the communities who have nurtured this diversity.

Innovative models to link biodiversity and livelihoods can be found in the case study from Periyar Tiger Reserve which links ecotourism with alternate livelihoods and benefit accrual mechanism, where some of the poachers have turned into conservationist. At one time they used their traditional skills to illegally hunt and smuggle forest products; this knowledge is now used to guide tourists by functioning as tour guides. Local communities were organised into ecodevelopment committees involved in conservation. This is an example of a nonconsumptive/non-extractive use of participatory management of biodiversity (Bhatt et al. 2012).

Kerala is a unique rural-urban continuum with a large percentage of its population educated but unemployed, and most of them lack the entrepreneurial skill for self-employment. Empowerment of women and their participation in the development process is an essential feature of sustainable development. The Kudumbasree Mission is an innovative programme of the Government of Kerala introduced for the eradication of absolute poverty and empowerment of women, under the leadership of local self-governments and is built around three vital components, microcredit, entrepreneurship and empowerment. A three-tier structure has been designed and developed by the Mission with the Neighbourhood Groups (NHGs) at its grass roots, a federated unit, namely, Area Development Society (ADS), at every ward of the local body and the Community Development Society (CDS) at the local body level. The Neighbourhood Groups at grass-roots level consist of 15–40 members, each member representing a family that forms the building block of the organisation. The second tier is Area Development Society, which is formed at ward level by federating 8–10 NHGs. At the Panchayat level a Community Development Society (CDS), a registered body under the Charitable Societies Act, is formed by federating various ADSs (John 2009). Kudumbasree promotes thrift mobilisation by setting up Thrift & Credit Societies at NHG level to facilitate the poor to save and to provide them cost-effective and easy credit. The activities taken up include agribusiness; tourism-related activities; food processing; dairy products; solar cookers; vidayasree (IT@School); integrated coconut processing (Kerashree); vegetables and fruits; hotels; sanitary napkin; Ayurvedic tooth powder, soaps, etc.; ornamental fish culture; solid waste management units; biofertiliser manufacturing units; courier service; etc., all run by women from poor families. Kudumbasree has become a vast workforce in Kerala with 39,97,000 members, 2,58,000 neighbourhood groups and 2,16,725 women farmers.

The section Biodiversity Governance for Sustainable Development through case studies focused on different models of governance as Decentralized governance through local self governments, sui generis systems of Kerala, community efforts, local action and women empowerment for environmental sustainability and sustainable development.

23.3 Access to Bioresources and Equitable Sharing of Benefits

The Biodiversity Act 2002 provides an approach to sustainably use the economic potential provided by biodiversity and ecosystem services for human welfare by imposing regulations, through a decentralized governance at the same time exempting local communities from such restrictions. India is one of the few countries in the world that has been able to utilise the potential of Access and Benefit-sharing (ABS). Financing biodiversity is vital for its conservation and management, and mobilising adequate finance is acknowledged as a huge challenge. By promoting the use of genetic resources and associated traditional knowledge, and by strengthening the opportunities for fair and equitable sharing of benefits from their use, ABS mechanism will create incentives to conserve biodiversity and enhance the contribution of biodiversity to sustainable development and human well-being.

The first internationally recognised certificate of compliance as provided by Nagoya Protocol was issued in October 2015, following a permit made available to the Access and Benefit-sharing (ABS) Clearing House of CBD by India. The permit was issued by India's National Biodiversity Authority, the competent national authority under the Nagoya Protocol. The certificate constituted through the ABS Clearing House serves as evidence of the decision by India to grant access to ethnomedicinal knowledge of the Siddi community from Gujarat to a researcher affiliated with the University of Kent in the United Kingdom. India has signed 25 agreements so far as evidence that the genetic resource which it covers has been accessed in accordance with Prior Informed Consent (PIC) and that Mutually Agreed Terms (MAT) has been established, as required by the domestic access and benefit-sharing legislation.

Domestic-level access measures create legal certainty and provide for issuance of a permit or equivalent when access is granted. At the same time it ensures a regulatory mechanism for sustainable harvest and quality raw materials for the industries. In most cases current price represents only an exchange rate and not the real value of the resources (Suneetha and Pisupati 2009). In such cases enforcing the terms on the commercial implications of access granted for research purposes becomes difficult especially when it is a collaborative research and the bioresource has been taken out of the country. As per section 7, Indian citizens are required to give prior intimation to State Biodiversity Boards (SBBs) for obtaining bioresources for biosurvey and bio-utilisation for commercial utilisation. Small-scale manufacturing units depend on secondary sources such as databases and published literature in peer-reviewed journals for prospecting bioresources with commercial value, and hence custodians of traditional knowledge who supplied the information for the original research may be bypassed. The People's Biodiversity Register (PBR), a document that records the diversity of species of flora and fauna by SBBs, seeks to give legal protection to traditional knowledge. As per Kerala Biological Diversity Rules 2008, regulation of access and protection of the biodiversity information and traditional knowledge included in such registers from outside persons and agencies is the responsibility of local self-government and Biodiversity Management

Committee. A major predicament in implementing ABS at state level is the lack of traceability of collection source. The local communities have nurtured the genetic diversity over the years, and BD Act provides the legislative framework to ensure that communities benefit from the use of their genetic resources and traditional knowledge. This will also help in creating awareness of value of bioresources of their locality which will ultimately lead to creation of a sense of ownership of natural resources among communities and aid in conservation of biodiversity in the long term. The implementation of a proper ABS regime through BD Act and Rules will ensure that bioresource consumers and local communities value the industrial use of their resources while creating incentives for conservation.

23.4 Conclusions

A pathway to achieve sustainable development involves recognising the importance of social drivers that are related not only to poverty reduction but also to enhanced productive capacity and employment, social justice and empowerment. Social and solidarity economy relates to ways of organising the production, exchange and consumption of food that involve the (i) prioritisation of smallholder and low-external input agriculture; (ii) organisation of and cooperation among agriculturalists, farm workers, herders, fisherfolk, indigenous peoples and others; (iii) local development and decision-making, as well as more localised trade circuits; (iv) direct links between producers and consumers; and (v) principles of agroecology and food as a basic human right (UNRISD 2013).

Although India has enacted a range of policy decisions, there are several barriers to realising the Sustainable Development Goals. The crisis of biodiversity loss can be addressed seriously only if the values of biodiversity and ecosystem services are fully recognised and represented in decision-making. The attainment of economic efficiency should not be at the cost of environmental quality. The publication seeks to highlight the ways by which local communities utilise bioresources for sustainable livelihood. The Sustainable Development Goals can be achieved only by integrating the value of natural resources into developmental planning and policy directions and by promoting corporate social responsibility for a green economy with greater investment in clean technologies, renewable energy and sustainable utilisation of natural capital.

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