BIODIVERSITY WATCH

INTERNATIONAL JOURNAL ON BIODIVERSITY ISSUES

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About the Journal

International Journal on Biodiversity Watch is a peer reviewed journal developed to publish original, innovative and novel research articles related to research on Forest Law Enforcement, Forest related policies and laws, Legal framework to support and protect land tenure, ownership and use rights, Concordance of Broader Development Policies with Forest Policies, existence of legal provisions and mechanisms for equitable sharing of forest revenue, cooperation and coordination of national law enforcement agencies, including policy and customs, in forest law enforcement at different levels and across agencies, administration of land tenure and property rights, measures to address corruption, transparency of forest revenue collection, budgeting, expenditure, accounting, redistribution and audit, medicinal plants and practices, Biodiversity Conservation issues, forest governance policy, programs and related issues.

This peer-reviewed scientific journal has been quarterly brought out by VRM Foundation International, Bhubaneswar, Odisha, India.

The Journal publishes investigative and empirical papers covering research findings across the sectors of forest governance, biodiversity conservation, issues relating to climate change, community based conservation, traditional medicine and medicinal plants.

All theoretical and methodological perspectives are welcomed.

The Editorial Board of the journal also encourage the submission of, original manuscript translations, short papers/communications presenting various research based articles related to use of medicinal plants and folk medicine system across different regions of India and world.

Aim and Scope

The main aim of the journal is to publish significant research focusing on Biodiversity Conservation and Forest Governance issues.

This journal aims at publishing investigative research articles covering policies, programs of Biodiversity Conservation, Challenges & threats to forest governance, conservation of medicinal plants and mainstreaming traditional knowledge into protection of biodiversity, community based conservation approach and so on.

Subjects Covered in the Journal

The International Journal on Biodiversity Watch presents original research in naturally occurring medicines and their related foods and cosmetics.

The International Journal publishes Reviews, Mini-Reviews, Original Papers, Notes, Rapid Communications, Natural Medicine Notes, and Natural Resource Letters Three papers in each volume will be honored as Excellent Papers.

It covers different dimensions of biodiversity conservation, sustainable development and environmental governances, best practices of Corporate Social Responsibility, Environmental Auditing, climate and ecosystem practices, sustainability management in corporate culture and corporate practices, substantive engineering in ecosystem functionality.

The International Journal on Biodiversity Watch is an open access journal that provides rapid publication (quarterly) of articles in all areas of the subject related to different issues of Biodiversity Conservation and Forest governance.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published approximately two months after acceptance.

Types of Paper

Regular Articles: The regular research based articles covering different dimensions of thematic area of the journal are invited from scientist and researchers working in different universities and institutes in India.

The works should be original. The length of a full paper should be the minimum required to describe and interpret the work clearly.

Reviews: The journal accepts review of books by scientists and researchers published in India and abroad.

Reviews should be concise and no longer than 4-6 printed pages.

Reviews manuscripts are also peer-reviewed

Review Process : All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers.

Decisions will be made as rapidly as possible, and the journal strives to return reviewers comments to authors within 3 weeks.

The editorial board will re-review manuscripts that are accepted pending revision.

Editor's Note

This special issue of Biodiversity Watch is dedicated to International Seminar on Integrated Natural Resource Management: Issues & Challenges and prospective, 27-31 January, 2014 at Pt. Ravishankar Shukla University, Raipur, Chhattisgarh. This volume covers a wide range of topics on Natural Resource Management such as Integrated Natural Resource Management and Ecosystem Service, Water Governance and Climate Change Policy, Managing Natural Resources for Sustainable Livelihoods, Biodiversity Conservation for Sustainable Use: Challenges for Future, Ecological Resources and Tribal Livelihood, Impact of Degradation of Forest on the Livelihood, Application of eco-technology for sustaining soil fertility and crop productivity in slash and burn agriculture, Climate Change Impact and Conservation, Non-Destructive Harvest of Non Timber Forest Products and Application of bioinformatics in management, analysis and conservation of biodiversity data. These research articles offer a wide frame work of natural resource management within which agricultural biodiversity has been sustainably integrated INRM has strong co-relation with agricultural biodiversity which contributes towards poverty alleviation, food and nutritional security and maintenance of environmental health. The domain of INRM is not only subject for forest administrators but for researchers, academicians, farmers, communities and development agencies. I will critically explain the relevance of community based mode of natural resource management, diversity management strategies, mobilizing social capital, valuing biodiversity and related issues as experienced by Gonds and Halba of Chhattisgarh.

Integrated Natural Resource Management is a very challenging issue which involves adoption of management strategies in the production enabling the human population to achieve the required products for their survival apart from ensuring balance between environment and sustainability. The forest dwelling communities of India are best examples of sustainable communities practicing integrated natural resource management and promoting genetic diversity since time immemorial. Integrated natural resource management and genetic diversity are two sides of the coin for sustainable livelihood and economic development. The forest dwelling communities contribute towards biodiversity conservation through community based mode of conservation. The community based mode of natural resource management operates on certain fundamental principles. These principles emphasized that natural resources are neither infinite nor indestructible. The land use practice and agriculture adopted by the community lead to depletion and destruction of such natural resources. These natural resources are therefore exploited by these communities in holistic and integrated manner. The community based mode of natural resource management emphasizes on promotion of complicity of echo system and inter relation among various components of the system. The research studies indicate that the forest dwelling tribal communities contribute significantly towards preservation of agricultural biodiversity through food production and preservation of genetic diversity and agricultural ecosystem. They emphasize on balancing mechanism among various components of agricultural biodiversity and benefit sharing mechanism among users in terms of food security, agricultural productivity, environmental sustainability and socio economic benefits. The community based mode of natural resource management adopted by indigenous community always focus on stronger integration between agricultural biodiversity, water conservation, soil conservation, sustainable livelihood and other components of resource management. The resources that occur naturally are treated as natural resources. These resources are exploited by human population for their survival since time immemorial. These natural resources are principal elements within the environment that caters to multiple needs of human population in terms of livelihood and their rights. The population growth, industrialization, mining and growing demand on natural resources have led to over exploitation of natural resources. The resource use does not compromise with their availability for future generation. This is a burning problem for all of us. In different international conferences and global summits, it has been advocated by scientists that natural resource needs to be used not only for agriculture to satisfy changing human needs but enhancing quality of environment and conserving these resources. The participatory natural resource management with involvement of communities living around particularly natural resource domain has been taken as a main agenda by policy makers of natural resources in our country. The forest dwellers need to be empowered for sustainable management of forest and be involved in the development policies and regulation for ensuring sustainable use of resources. The community mode of management of natural resources is driven by their sense ownership and communal responsibility in management of natural resources with strong mode of benefit sharing mechanism. Three major components such as benefit sharing mechanism, sense of ownership and communal responsibility of management resources govern community based mode of resource management.

The issues and challenges hindering effective natural resource management are numerous and complex. Different international and national level conferences prioritised on involvement and empowerment of people in management and conservation of natural resources and make them custodian of resources where they live. These international and national agenda have not been meaningfully translated into action at grass roots due to administrative apathy and top down approach adopted by forest bureaucracy. A very little attempt has been made by forest administration to examine the frame work of community based conservation mode which consist of all components of sustainability, sustainable use and benefit sharing mechanism. The forest communities are neither empowered nor actively involved in development of policies and regulation for ensuring sustainable use of natural resources. The programmes of natural resource management not only revolve around the people, their livelihood and their rights, but also around agricultural biodiversity, wild biodiversity, water conservation, soil conservation and energy conservation. Traditional ecological knowledge upheld by community is major component of diversity management of plants and animal species. The forest communities in India and other parts of the world apply ecological traditional knowledge for management and use of plants and animal species towards sustaining traditional farming system over centuries. This component of diversity management by application of ecological traditional knowledge needs to be incorporated in ongoing programmes of natural resource management by Government. The research studies have highlighted different dimension of diversity management strategies adopted by farmers. The community based mode of diversity management becomes central part of livelihood management strategies of tribal farmers of Chhattisgarh and other parts of the country. The community based mode of diversity management comprises of two important components that are fundamentally significant to natural resource management and conservation of agricultural biodiversity. These components are resilience and resistance. The scientists and researchers always emphasize on ecosystem, resilience and resistance which are key to prevention of loss in agricultural biodiversity. The issues and challenges relating to protection of agricultural biodiversity have been debated at different international conferences and increasingly recognized by international agencies. Gond and Halba of Chhattisgarh are best example of tribes practicing natural resource management in sustainable manner. The community based mode of natural resource management adopted by forest tribes of Gond and Halba reveals that conservation of agricultural biodiversity is closely inter related with its use to enhance agriculture and natural resources around the community. The community upholds an unique ecological knowledge and understanding of relationship among different components of agro biodiversity such as crops livestock, agricultural productivity, soil health, technology for renovation of soil fertility, agro system health. These tribal communities have adopted different diversity management strategic plan to valuing diversity. Valuing biodiversity is an important component in terms of providing ecosystem service and sustainably use of natural resource management. The scientists have recognized that biodiversity always carries additional values. These values are manifested in ecosystem services and ecosystem functions. Conventionally ecosystem services are neither given any values nor regarded as free resources. Both ecosystem services, ecosystem function are exploited by forest dwelling tribes like Gond and Halba in Chhattisgarh for their survival and benefits. The ecosystem function such and nutrient cycle, water regime, biological control of diseases and pest, regulation of destructive harvest are key components of natural resource management and adding value to biodiversity. These components need to be incorporated in forest administration policy and programmes of State Government.

Social capital plays a vital role in enhancing community based natural resource management as well as adopting technology in renewing soil fertility and renovation of degraded forest and promoting market access among Gond and Halba tribes of Chhattisgarh. The forest administrators have not recognized the prominent of social capital in enhancing integrated natural resource management at grass root level. The multiple natural resource management activities carried out by these tribes are governed by social institutions, social bonds and social norms. These activities are capitalized on social capital which is a feature of social organizations such as network norms and social trust stimulating collective action for mutual benefit. The forest dwelling tribes in Bastar regions of Chhattisgarh have shown that kin network, membership in JFM Committees, Women Self Help Groups, co-operatives are major source of social collective action on community based management of natural resources and biodiversity conservation. The households with better social network have better ways of eliminating constraints and dissemination of information relating to natural resources.

Social capital comprising of local institutions is key components of natural resource management. The sustainable use of natural resource management in different states of India and other parts of the world are brutally affected by population density, industrialization, mining activities and diversity of products. Local institutions and local bodies who are the custodians of natural resources and key actors for collective action are ignored and not appropriately involved in agenda of INRM. These institutions play key role in engaging energy and collective willingness and actions of the community not only to articulate community needs but also to conserve natural resources by enforcement of customary rules. For example, biodiversity conservation among Gonds and Halba of Chhattisgarh governed by different type of local institutions which can be classified on the basis of their objectives and functions. These institutions are land institutions involved in share cropping, contacting and renting, labour institution involved in management of labour force, religious institutions involved in conservation of sacred groves and enforcement of customary rules, recreational institutions promoting folk dance, council of elders involved in conflict resolution, health institutions involved in providing service of traditional healers and midwifes and mutual assistance involved in crisis management. These social institutions are informal and operate at community level in maintaining strong link with service providers. These institutions warehouse of traditional ecological knowledge and sustenance of community based of conservation. These institutions not only organize forest communities to enforce customary rules, but also structure their activities and interaction with environment and develop strategy how to exploit natural resources for their livelihood and survival. The forces of globalization have brutally affected these local institutions and community based conservation mode apart from promoting emergence of new type of local institutions. These new types of institutions pose serious threat to enforcement of customary rules and effective functioning of traditional institutions for asset management and environmental governance. The sacred groves which conserved natural resources in sacred sites of forest since generation together are in threat. Chhattisgarh, the herbal state of India is best reservoir of sacred groves of India in terms of reflecting important ecological functions and protecting public goods and environmental services through enforcement of customary rules by forest dwelling communities like Gond and Halba.

The Bastar region of Chhattisgarh is best example in India depicting community based conservation approach towards genetic diversity and agro biodiversity. This region consists of large ecosystem of Dandakaranya where four major tribes such as Gond, Halba, Muria, Maria, Bhatra live and sustain traditional practice of conservation of biodiversity and agriculture diversity. These communities have sustained a reservoir of as many as 40,000 rice varieties through conservation of agricultural diversity. These tribal communities have traditional technology, ecological knowledge and practices developed through participatory approach to ensure sustainable use of natural resources since generation together. These practices are suited to household and livelihood priorities as well as individual practice and capabilities, farming system, climate, pest and disease control soil, and topography. The Gond and Halba Tribes of Bastar adopt multiple indigenous land management practice such as traditional soil bunding, field boundary drainage ditches, deep tillage along the contour. These practices could be applied in wider scale and circumstances and be integrated with other practices. The community based conservation approach has been sustained through customary laws and the traditional practices operated through customary institutions for management of common property resources and sustainable use of forest resources and related knowledge from sustainable land use practices. These forest dwelling tribes have preserved various spiritual landscapes and provided ample physical space for customary use of biodiversity, free sharing of knowledge and resources and ensuring protection of biodiversity and knowledge system. The customary laws enforced among these tribes for natural resource management are evolved from natural resource use, their customary world view, cultural values, rules and code of conduct and established practices. These customary rules are locally recognized, orally held, adoptable and continuously evolving. These customary rules relating to INRM among forest dwelling tribes of Chhattisgarh have sustained through belief and practice since time immemorial.

The socio cultural dimensions of community based mode of natural resource management needs to be understood prior to introducing any INRM programme in the area. The INRM practices adopted by forest dwelling tribes are governed by customary rules and ecological traditional knowledge. Collection of non timber forest produce, management of common property resources, celebration of seed festivals and various land management activities such as land leveling, raising of bunds, mulching, weeding, transplantation of seeds, crop rotation, relying on self saved seeds, practice of seed exchange among villages are governed by customary rules since generations together. The celebration of seed festival “Akti” or “Matti Thyohar” among forest dwelling communities in Bastar region is a traditional customary practice among small land holders not only to disseminate ecological knowledge and benefit sharing mechanism but also to strengthen social network and collective action promoting productivity, equity and environment.

Indigenous ecological belief system prevalent among these tribes influences judicious management of natural resource in forest regions. The tribal farmers believe that forest related knowledge comes from spirits associated with species, mountains, sacred landscape, sacred plants and super natural forces controlling human and natural world. Ecological knowledge and bioresources have evolved collectively. The individual cannot claim rights over traditional ecological knowledge which is a gift from supernatural forces. The indigenous belief system cannot be ignored from the agenda directed to promote collective conservation action of the community. The governance of customary rules and belief system operate through customary institutions for effective management of common property resources. Sustainable use of natural resources and related ecological knowledge sustained by the forest dwelling communities for centuries constitutes sustainable land use system. Biological resources and ecological knowledge are interrelated. The application of ecological knowledge upheld by the forest dwelling communities since centuries contribute towards sustenance of hundreds traditional crop varieties and livestock. The present generation has taken over the responsibility for ensuring conservation, renewal and improvement.

The judicious management of natural resources by forest dwelling communities in Bastar is governed by principles of reciprocity sustained by communities since generations. The customary rules of this community enforce the principle of reciprocity where greater priority is given on benefit sharing mechanism through exchange of seed among different ethnic groups and mutual exchange of knowledge and experience on agriculture operations. The knowledge dissemination and sharing of genetic resources are strictly monitored through agro festivals, food festivals and seed fairs. Such traditional practices enforce through customary rules promote peaceful coexistence of different ethnic groups as well as sharing of ecological knowledge, manpower and bioresources.

The liberalization of market forces coupled with mining and industrial activities has posed great threat to traditional community based mode of natural resource management. The local markets have been converted into hub of collection and trading centre of national and international traders. The genetic diversity has been eliminated through over exploitation of bioresources. The landscape change in forest regions has led to declining of traditional variety of crops and habitat of medicinal plants. The entry of big players coupled with industrialization and mining activities along with control of natural resources isolating forest dwelling communities and depriving their collective rights over natural resources have seriously affected participatory natural resource management by forest dwelling communities. In spite of important international enactments and national policies, the forest dwelling communities are yet to be considered as real custodians of natural resources and protectors of traditional territories by forest administrators. The Convention of Biodiversity Article 8 (J) recognizes "the knowledge innovation and practices of innovation of local communities" for conservation and sustainable use of biodiversity. CBD Article 8(J) and 10(C) emphasizes on State to protect and encourage customary use of biological resources in accordance with customary practices. This agenda of international enactment is yet to be translated into action with back up of forest bureaucracy and political willingness. The translation of international and national enactments on natural resource management will go a long way in renewing community based conservation and bottoms up approach towards integrated natural resource management and sustainable use of bioresources.

Editor

R.N. PATI

Guidelines for Contributors/ Subscribers

A. GUIDELINES:

Scope

The themes of the submitted article should be on forest governance, policy and programs on Biodiversity Conservation, conservation of medicinal plants and mainstreaming traditional knowledge into protection of biodiversity. Original research articles are invited on specific thematic area of forest governance and biodiversity conservation. The spectrum is very broad. It covers a wide range of issues relating to research on Biodiversity Conservation and forest governance.

Procedure for submission of article

The language of the article should be written in English. All portions of the manuscript must be typed **double-spaced** and all pages numbered starting from the title page.

The **Title** should be a brief phrase describing the contents of the paper. The Title Page should include the authors' full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

The **Abstract** should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The abstract should be 100 to 200 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited.

Following the abstract, about 3 to 10 **key words** that will provide indexing references should be listed.

A list of non-standard **Abbreviations** should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelt out and introduced in parentheses the first time it is used in the text. Authors should use the solidus presentation (mg/ml). Standard abbreviations need not be defined.

The **Introduction**should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and Methods should be complete enough to allow experiments to be reproduced. However, only truly new procedures should be described in detail; previously published procedures should be cited, and important modifications of published procedures should be mentioned briefly. Capitalize trade names and include the manufacturer's name and address. Subheadings should be used. Methods in general use need not be described in detail.

Findings should be presented with clarity and precision. The results should be written in the past tense when describing findings in the author(s)' experiments. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the results but should be put into the discussion section.

The **Observations** should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

B. CONTACT ADDRESS:

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Call for Papers

The special issue of Biodiversity Watch on Biodiversity and Ecosystem Services will be published in next issue. The environmental scientist, conservationist and researchers are requested to contribute their research articles to the Editor.

Please note that the article should contain following components:

(1) The article should cover the guidelines for the author

(2) The length of the paper should be about 10-20 pages

(3) The paper must be neatly typed

(4) It must not be previously published

(5) Please send your computerized typed papers signed by you along with a C.D. to the residential address of the Editor.

(6) A brief biodata of the author along with photograph must be forwarded

(7) For further details, the editorial office may be contacted by email or mobile

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Guest Editorial

The International Seminar on Integrated Natural Resource Management: Issues, Challenges and Perspectives have been organized Pt. Ravishankar Shukla University, Raipur, Chhattisgarh to celebrate its Golden Jubilee year. This global event provides and unique platform to scientists and scholars from different discipline to share their research findings and relevance of inter disciplinary approach towards unfolding key areas of natural resource management participated by forest dwelling tribes since centuries. I would like to emphasize on significance of anthropological approach to understanding the community based mode of natural resource management and contribution towards developing strategies for sustainable use of natural resources and redesigning programme approach by forest bureaucracy. I would highlight different aspects of anthropological approach to study community based mode of conservation. The anthropologists study the natural resources in holistic manner and unfold the inter-linkages between management and development of natural resources, in which socio cultural issues of forest dwelling communities are prioritized. The challenges threatening livelihood, genetic diversities, human rights and ecosystem are identified and appropriate intervention suggested for streamlining natural resources management. Rio Conference in 1992 has prioritized sustainable development and encourage anthropologists to redesign their research approach on equitable and sustainable forest management, Community knowledge on Biodiversity management, cultural practices on conservation, gender sensitivity, application of community institutions and livelihood system etc. Greater priorities are given in anthropological model on unfolding participatory decision making process protection, management, benefit sharing mechanism at community level. The inputs generated through anthropological research contribute significantly towards developing viable and social acceptable action plan for natural resource management at grass root level. The forest administrators have not properly recognized the significance of anthropological research in developing participatory intervention project for community based natural resource management. The anthropologists in different Universities of India undertake explorative research on tribal health and role of tribal people in conservation, preservation and protection of medicinal plants for cure of various diseases without depending on doctors. The anthropological research findings on perceptions and conception of tribal in their own cultural system utilizing and managing their bioresources and genetic diversities of plants reflect potential dimensions of community based conservation. The anthropological approach critically examines the impact of forest policy and programmes and initiatives of cultural, environmental preservation and sustainable development in shaping community relationship with landscape and natural environment. Greater focus is given on research activities which involve inter disciplinary collaborations, application of qualitative and quantitative methodologies and understanding of research problem across time and space, application of geographic information system and participatory techniques. The anthropologists use participatory research mapping to document the subsistence land used by forest dwelling communities. The elite groups of the communities are trained by anthropologists to develop land use map by use of questionnaire and sketch map through application of Participatory Rural Appraisal (PRA) technique. The anthropologists always encourage the elite section of forest dwelling communities to work with them for data collection, land use mapping, interpreting and transforming their cognitive knowledge into standard form and producing excellent empirical and applied result enhancing their ability to manage own natural resources. The anthropologists consider tribal farmers and tribal healers as innovators. Their innovation is appreciated as a result of linear process by which scientific knowledge is applied in practice. The cultural practices such as celebration of seed festivals and agricultural festivals provide platform for diffusion of innovations and dissemination of knowledge from farmers to farmers. The anthropological research is more of a learning and action research which explores innovations and outcome of mutual learning process between actors and complementary contributions. The anthropological research projects on natural resource management prioritize on action research and the systematic evaluation and analysis of case studies in close collaboration with local communities and forest administrators. Such participatory research approach is considered as strategic research not in the sense of the linear research development continuum but by addressing strategic issues relating to natural resource management. No other discipline except anthropology focuses on participatory learning and action research directed towards generating strategic knowledge, methodological principles and approaches through systematization and conceptualization of grass root experience on Natural Resource Management (NRM). Involving local communities in research and data collection facilitate the researchers for conceptualization of knowledge from intervention process. No doubt, the participatory research approach adopted by anthropologists are very often constrained and clashed with bureaucratic goals to be met, organizational structures and cultures and unequal power relationships. The anthropologists adopt critical awareness and continuous learning and self reflection process which contribute great success to their research approach to natural resource management.

The relevance of anthropological research in designing policy research on Natural Resource Management (NRM) has been recognized by policy makers and administrators after Rio Earth Summit in 1992. New priorities were given on developing strategy, design and implementation of policies to support local organizations as managers of natural resources. The anthropologists always focus on participatory research and involvement of local organisations in natural resource management. There were various constraints that affect involvement of local organisations. These factors are economic, legal, institutional and political which isolate local organisations from policy research and programme on natural resource management. The key policy research questions very often raised by anthropologists are to estimate or to credit the level or type of influence of particular policies on Local Organisations relating to natural resources and how to identify the leverage point through which the forest governance policy may influence the local organisations, the key components of social capitals. The anthropologists focused on comparative analysis between case studies on community based natural resource management which involves regular collection and reporting information for testing key hypothesis. The participant's observation method adopted by anthropologists helps in identifying key variables of group structure and function and of resource management outcomes apart from identifying key issues to be addressed in selecting indicators for these variables. The anthropological approach further prioritize variable and indicators for developing standard measurement techniques which cover use of indicator based on local people's matrix of evaluation. No other discipline except anthropology prioritize on empirical research related to cultural property rights and collective action of the community in natural resource management which provide a promising platform for discussion and testing alternative approaches with wide range of research questions required for developing standard data protocols for comparison of results. Environmental anthropological studies have significantly proved that interaction among indigenous forest dwelling communities and supernatural agencies contribute towards community based conservation. The sacred groves, sacred landscapes and sacred trees honoured by the communities ignite collective action for management of natural resources among all tribal communities in forest regions of India. The anthropological studies only provide platform for indepth understanding of values of local resource management practices in promotion of self directed and effective natural resource management by the communities. The anthropologists always explain how local resource management is embedded in wider social-cultural context of the local communities and how collective action is generated towards protection and preservation of sacred sites and collectively owned natural resource management. The indigenous mode of natural resource management by tribal communities is closely linked with people's belief in supernatural forces and the social cultural context. The interaction between human world and supernatural world sustained through rituals and festivals promote well structured use of natural resource by communities since time immemorial. The anthropological approach unfolds the symbiotic relations of people with forest and natural resources reflected in community based conservation mode. This international seminar on Integrated Natural Resources Management (INRM): Issues, Challenges and Perspectives provides a platform for scientists from different disciplines for discussing in a holistic manner on different issues of natural resource management and inter-linkage between different disciplines involved in research on natural resource management. I strongly offer my views and experience on importance of social anthropology in research on natural resource management involving bottoms up management approach.

The anthropologists very often investigate local perceptions on forest space and landscape, biodiversity conservation and indigenous belief and their significance for natural resource management. The anthropological approach provides immense insights into changing values of forest dwelling communities in relation to protected areas such as sacred groves and forest reserves and the management of natural resources. The anthropological studies unfolds the roles of traditional beliefs, taboos and rituals in the management and conservation of key natural resources of the country by forest dwelling communities. The liberalization of market forces, mining, industrialization and globalization forces have led to break down of community mode of conservation and traditional belief and associated taboos which under pin traditional natural resource management practices.

The anthropologists often study protection of community rights over traditional knowledge and its relevance towards community based conservation. The forest dwelling communities enforce customary laws to sustain their conservation practice since time immemorial. These practices have relevant inputs towards developing appropriate policies and mechanisms for the protection of bio-genetic resources and traditional knowledge at local, national and international level. The anthropological approach recognizes the indigenous world view and its inter relation with traditional knowledge, biodiversity, landscape, cultural values and customary laws. The anthropological approach always focuses on exploring the concept of collecting bio-cultural heritage in context of natural resource management. This approach is missing from the projects and programmes implemented by forest department. There is an urgent need to study Sui generis systems for traditional knowledge protection which is considered a key area of anthropological investigation. The tribal communities have their own method of economic, political, social and cultural articulations which govern community based mode of conservation. The practice of free sharing and exchange of resources, collective custodianship and spiritual beliefs are key components of community mode of natural resource management. Commercialisation of traditional knowledge and encroachment on forest resources are strictly prohibited by the protocols of community based natural resource management. Without involvement of anthropologist, no viable socially acceptable natural resource management action plan can be effectively designed to meet community based protocols for sustainable use and conservation of Natural Resourct.

Pratap Aditya Mishra

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1

Traditional Remedies Among the Inhabitants of the Bhilangna Valley, Garhwal Himalaya, Uttarakhand

— M.S. Gusain, C.S. Rana

ABSTRACT

Vegetation is the most precious gift, nature has provided to us, as it is meets all kinds of essential requirements of the humans in the form of food, fodder, fuel, medicine, timber, resins, and oil, etc. (Gaur, 1999). The plant community is playing a pivotal role in sustainable management by maintaining biodiversity and conserving the environment. Societies of developing nations always had a deep interest and respect for the plant world. The intrinsic relation between plants and man has been depicted in number of ways. Primitive communities and tribes who live in the vicinity of forests, due to being close to the nature, posses a deep practical knowledge on indigenous flora, pertaining to curatives, culture, customs, ethos, religious beliefs, myths and other miscellaneous uses.

Keywords: Biodiversity, curatives, culture, customs, ethos, religious beliefs, myths.

Introduction

India has the privileged Ayurvedic system of medicine. The "Rig Veda" supplies curious information on the subject, basically derived from various societies of the past, however, authentic reports on several medicinal plants of the people of the past are still wanted. Plants are mentioned in the ancient Indian Sanskrit literature like Rigveda (ca 1500-400 B.C.), Atharvaveda (1500 B.C.), Upanishads (1000-600 B.C.), Mahabharata and Purans (700-400 B.C.), etc. These include use of plants in worship, as medicine, food, fuel and for tools of agriculture. A specific mention of the different varieties of Rudraksha exists in Laxmipuran and Shivpuran. Uses of about 1200 plant drugs along with their action and specific therapeutic applications are mentioned in Sushruta Samhita (ca 500 B.C.), Charak Samhita (ca 100 A.D.) and Ashtanga, Hriadaya Samhita (Jain and Mudgal, 1999).

India is one of the main centers of the ancient human civilization in the world, where plants have been used for various purposes including medicine. Himalayan ranges are a home for a number of economically important plants, which have been used by traditional societies since the dawn of civilization (Gaur, 1999). Simultaneously there has been a harmonious relationship between man and environment. This harmony with the nature is now gradually deteriorating and our past knowledge about the uses of plants in different modes is dwindling. Therefore, all over the world there has been a great concern to restore the available old herital knowledge about plant uses in different modes and societies (Badoni and Badoni, 2001). In India there are many communities residing in diverge geographical and climatic zones. They represent distinct traditions, life-styles, and cultures. However, as usual with the evolution of civilization and modern technology, environment where the primitive groups restored knowledge on flora is rapidly disappearing. These communities are more intimate to the nature and the finding to learn from their ancestors through trial and error, have developed into a complex as well as specific knowledge of their surrounding vegetation, which sustain their lives. There are about 400 large and small tribal communities in India marking about 7.5 per cent of the total population of India acquiring about 15 per cent of geographical area.

The Uttarakhand State is inhabited by tribal in areas where ecosystem is still not distributed. This is particularly true of the variety of medicinal, edible and other uses to which plants of alpine, temperate and tropical ecosystems are put to by the local people. Usually, these high attitude areas are suitable for crop cultivation in the summer season, so they come here during this season. They cultivate some of the short cycled crops like potato, beans, etc. The ambient vegetational wealth of the region plays a vital role for these communities (tribal as well as permanently settled), as up to a large extent they fulfill their requirements from their surrounding environment (Tiwari, 1986; Kala et. al., 2005 and 2006; Dangwal et. al., 2010). The Bhilangana valley comprises the following villages Ghonti, Ghanshali, Gweeli, Pukhar, Devat, Ghuttu, Sankari, Duphand, Gangi, Devshari, Rhee, Nalan, Kelbagi, Saman Gaon, Loni, Devkhuri. It is rich in floral biodiversity and particularly medicinal plant resource (Dey et. al., 1969; Uniyal et. al., 2007).

Material and Methods

During the year 2010-2011 documentations of traditional indigenous knowledge on health care system were conducted Bhilanagana valley in Tehri district of the higher Himalayan State of Uttarakhand. The data related to Tradition Knowledge was gathered from knowledgeable tribal and local man and woman populace through questionnaires and personal interviews, to record plant uses for medicine in particular and food, fiber, fodder, oils, dyes, tannins, gums, resins etc in general. Medicinal uses of plants, the data was gathered from the herbal healers, 'Vaidhyas' and from others knowledgeable informants. During the course of this investigation, the data on the names of plants, parts used and their mode of processing and preparation, dosage and mode of various recipes and remedies was also gathered. The healer and other informants accompanied the author to collect herbarium specimen from the adjoining forest areas in the Bhilangana valley. The most frequent visited villages and places were Chadoli, Saman Gaon, Tonakhand, Mentu, Ghanshli, Gangi, Rhee Nalan, Kailbagi, Jogyada and Devling.

It has been observed that the experienced inhabitants maintain certain level of secrecy about the medicinal uses of plants. Special efforts were made to develop intimacy with the informants by acquiring their confidence by respecting their customs and rituals, eating, drinking, sitting and living with them, with the help of village- head and other respected person. At the time of interview the plant specimens and samples were the centre of discussions. Sometimes fresh plants were collected from the nearby forests and shown to old knowledgeable informants, who were unable to visit the forests, in order to provide right identification.

No doubt, they had clear-cut knowledge about the plant species regarding habitat, local name, fragrance, appearance and taste. Mostly the specimens were collected in flowering and fruiting stages. The discussions regarding various uses of plants in their daily life was noted in field note books. The data was verified and compared from other informants of the same village and other villages during the same trip or in the next trip.

Enumeration

The present study is based on an extensive ethno-taxonomical survey of the plants and their uses especially as curatives in the areas of Bhilangna valleys villages like Devling, Kharsholi, Rhee, Gangi, etc. The Plants have been arranged alphabetically for easily understood. Species are described with citation, vernacular name, family and habit. Finally information on part used, folk-medicinal properties, along with method of preparation and dosages patterns have been presented in table below.

Table 1.1 Taxa with family, local names, life form, part used and dosage as medicinal use

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
1.	***Aconitum balfourii*** Holmes;	Bish	Ranunculaceae	Herb	The paste of tubers is applied externally on affected body part thrice a day, as an antidote of snake bite and scorpion sting. Root powder is boiled with clarified butter, made into paste and applied externally on affected area twice a day for 2-3 months in the treatment of rheumatic arthritis (locally known as *Baat*).

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
2.	***Aconitum heterophyllum*** Wall. ex Royle	Atish	Ranunculaceae	Herb	The aqueous extract of the root 5-10 ml. is given twice a day, early in morning empty stomach and at night after meals for 7 to 28 days in chronic fever, and digestive disorders.
3.	***Achyranthes aspera***	Latajeera	Amaranthaceae	Herb	Root use for toothaches
4.	***Arnebia benthamii*** (Wall. ex G. Don) I. M. Johnston	Balchhari	Boraginaceae	Herb	Decoction of rhizomatous root is applied on burnt part thrice a day for a week for early healing as antiseptic. Extract of root with mustard oil is applied on hairs as hair tonic and for coloration
5.	***Angelica glauca*** Edgew	Choru	Apiaceae	Herb	Root grind and extract juice. The juice approximately ½ teaspoonful twice a day early in the morning empty stomach and at night after meals is given upto 15-30 days to the treatment of warm and cold efficacy.
6.	***Arisaema jacquemontii*** Bl.	Bag Mungri	Araceae	Herb	Paste of the bulbous root is applied thrice a day for a week on affected part to the treatment of snake bite and antidote of scorpion sting.
7.	***Ajuga parviflora*** Benth.	Neelbadi	Lamiaceae	Herb	Grinded leaves approximately ½ teaspoonful is given tiwice a dat for 5 to 10 days with cold or hot water to the treatment of constipation and indigestion (locally known as *Kabz*).
8.	***Acorus calamus*** L.	Bauchu	Araceae	Herb	Root tied for the treatment of jaundice as well as along with seeds of *Solanum erietinum* dried in shade and grind. The powder approximately 0.3 to 0.5g given thrice a day upto one month to the treatment of Jaundice.

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
9.	***Bombax ceiba*** L.	Simule	Bombacaceae	Tree	Bark grind with water and made into paste. The paste applied externally on affected pat twice a day for 5 to 10 days in the treatment of boils and blisters (locally known as *Bal Tod*).
10.	***Bergenia ligulata*** (Wall.) Engl.	Kamlya	Saxifragaceae	Herb	Root dried in shade and grind make into powder. The powder approximately one chutaki (0.5g) is given thrice a day upto three to six months in the treatment of Bile stone (locally known as *Pattheri*).
11.	***Berberis asiatica*** Roxb. ex DC.	Kingida	Berberidaceae	Shrub	Decoction of root paste given approximately 0.5 g twice a day for 15 to 30 days in the treatment of eye ailment.
12.	***Cirsium wallichii*** DC.	Kanjyalu	Asteraceae	Herb	Aqueous extract of root is given a tablespoonful thrice a day for 7 to 21 days for the treatment of chronic fever in livestock.
13.	***Celastrus paniculatus***	Malkagni	Asclepiadaceae	Shrub	Seed oil massaged in the treatment of rheumatic arthritis.
14.	***Cyathulla tomentosa*** (Roth.) Moq.	Kur	Amaranthaceae	Herb	Root paste applied on affected part thrice a day up to 7 to 15 days to the treatment of herpogester (locally known as *Makada*).
15.	***Delphinium vestitum*** Wall. ex Royle	Nirvishi	Ranunculaceae	Herb	Root paste applied externally on effected part twice a day, in morning and at night for the treatment of boil and blister. Root along with cow urine used for killing worms of injured livestock.
16.	***Dactylorhiza hatagirea*** (D. Don) Soo	Hattajadi	Orchidaceae	Herb	Root paste applied externally on effected part twice a day, in morning and at night for the treatment cuts and wounds.

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
17.	***Euporbia pilosa***	Dudhi	Euphorbiaceae	Herb	Root extract is given for vomiting and for loose motion in constipation
18.	***Juglans regia*** L.	Akhor	Juglandace-ae	Tree	Root powder approximately ½ teaspoonfuls given twice a day for a week to kill intestinal worms as well as for the treatment of toothache.
19.	***Lyonia ovalifolia*** (Wall.) Drude	Anyaar	Ericaceae	Tree	Leaves grinded with cow urine and made into paste. The paste is applied on affected part twice a day upto 5 to 10 days to the treatment of skin ailments (locally known as *Khaj and Khujali*)
20.	***Megacarpaea polyandra*** Benth.	Barmola	Brassicaceae	Herb	Extract of root is given a tablespoonful twice a day, early in morning and at night after feeding for a week to treat chronic fever in livestock.
21.	***Myrica esculenata***	Kapal	Myricaceae	Tree	Extract of bark given 0.5 ml twice a day early in the morning empty stomach and at night after meals for 15-45 days in the treatment of red leucorrhoea.
22.	***Nardostachys grandiflora*** DC.	Jatamasi	Valerianaceae	Herb	Root are dried in shade, and powdered with bark of *Betula utilis* than roasted with clarified butter (Ghee) and applied twice a day upto three months in the treatment of arthritis (locally known as Baat).
23.	***Origanum vulgare*** L.	Bantulsi	Lamiaceae	Herb	Decoction of leaves is given approximately half teaspoonful twice a day for a week in the treatment of cough and cold. Leaf paste applied on cuts and wounds (locally known as *Khatu, Dukhnna*).

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
24.	***Prinsepia utilis*** Royle	Bhainkal	Rosaceae	Shrub	Dried leave grinded and make into paste. The paste is given ½ teaspoonfuls twice a day for 5 to 10 day in the treatment of loose motion (locally known as *katay*).
25.	***Polygonatum verticillatum***	Meda Mahameda	Liliaceae	Herb	Boiled root given as a aphrodisiac
26.	***Paeonia emodi*** Wall. ex Royle	Chanduru	Paeonaceae	Herb	Roots and leaves boiled with water and made into decoction. One or two drops given twice a day with cow milk or either with warm water upto a week in the treatment of colic (locally known as shool).
27.	***Pyrus pashia*** Buch.-Ham. ex D. Don	Melu	Rosaceae	Tree	Fruits juice dropped into eyes of Cow and Buffalos to the treatment of eye ailments (locally known as *phulya*) in livestock.
28.	***Potentilla fulgens*** Wall. ex Hk.f.	Bajardanti	Rosaceae	Herb	The paste of root is filled in cavity of teeth in toothache, and for strong tooth. Decoction of roots applied on affected area twice a day in burns as antiseptic.
29.	***Prunus cerasoides*** D. Don	Payan	Rosaceae	Tree	The decoction of bark and leaves is given a teaspoonful twice a day with cow's milk for 14 to 28 days in internal injury. Seed oil applied externally in arthritis. Bark paste is applied on dislocated joints and fractured bones as plaster for a month.
30.	***Picrorhiza kurrooa*** Royle	Katuki, Kadwi	Scrophulariaceae	Herb	The aqueous extract of root is given half teaspoonful twice a day, for 7 to 28 days for the treatment of chronic fever, stomachache and as cold efficacy.

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
31.	***Rhamnus virgatus***	Chadola	Rhamnaceae	Shrub	Extract of the wood used to kill germs after bite of tiger or wild animal
32.	***Rheum australe***	Dolu	Polygonaceae	Herb	Extract of root along with turmeric and cow milk is given thrice a day for a week in internal injury. Root paste applied on cuts and wounds.
33.	***Rheum moocroftianum*** Royle	Archu	Polygonaceae	Herb	Root paste applied on cuts and wounds.
34.	***Rhus parviflora***	Tungla	Anacardiaceae	Small tree	Fruits used in bile ailments
35.	***Rubia cordifolia***	Kuru	Rubiaceae	Climber	Decoction of roots given in the treatment of red leucorrhoea
36.	***Selinum vaginatum*** (Edgew.) Cl.	Bhootkeshi	Apiaceae	Herb	Root dried in shade, powdered and given ¼ teaspoonful thrice a day early in morning and at night after meals for three to six months for the treatment of hysteria, epilepsy (locally known as *Jhaanku*).
37.	***Tanacetum longifolium*** Wall. ex DC.	Guggl dhoop	Asteraceae	Herb	Root and leaf paste applied on cuts and wounds. Root dried in shade, powdered, and boiled with water. The decoction is applied or massaged thrice a day for a month in the treatment of chest pain, paralytic affliction, and in arthritis (locally known as *Baat Pida*).
38.	***Thalictrum foliolosum*** DC.	Makara Jhad	Ranunculaceae	Herb	Extract of roots is given 1 /2 teaspoonful twice a day, early in morning and at night after meals for 7 to 28 days for the treatment of headache, as carminative (locally known as *Naal*). The paste of leaves along with cow-urine is applied externally on affected part (locally known as *Makada*) once a day for a week in the treatment of herpes zoster

Sl. No.	Botanical Name	Vernacular Name	Family	Habit	Uses
39.	***Tinospora sinensis***	Giloy	Rubiaceae	Climber	Decoction of the plants with roots of *Asparagus* spp. is given twice a day for 45 days in the treatment of chronic fever
40.	***Thymus cerphyllum***	Marchwana ghass	Lamiaceae	Herb	Roated leaves given in the treatment of colic
41.	***Ulmus walliciana***	Medu	Ulmaceae	Tree	Bark paste used in the tretment of dislocated joints of used as plaster for ealy healing of the fractured bones
42.	***Urtica dioica*** L.	Kandai	Urticaceae	Herb	Infusin of the spinous twigs twice a day upto a month is given in the treatment of paralytic affection (locally known as *Lakua*) of the affected part of the body.
43.	***Verbascum thapsus*** L.	Yakul veer	Scrophulariaceae	Herb	Flowers sap approximately 0.3 to 0.5 ml dropped into eyes twice a day upto one week in the treatment of eye ailments (locally known as *phool*).
44.	***Viola betonicifolia*** J. E. Sm.	Amoya	Violaceae	Herb	Decoction of whole herb is given ½ teaspoon twice a day for a month to treat cough, coryza, and colic. Paste of plant applied externally on cuts boils and wounds as antiseptic.
45.	***Zanthoxylum armatum*** DC.	Timmuru	Rutaceae	Shrub	Leaves made into paste. The paste approximately ½ teaspoonfuls is given twice a day for a week in the treatment of (locally known as *Pith*).

Conclusion

Due to close association with the forest and relative isolation from modern civilization, the inhabitants are dependent on natural resources for their subsistence and have their own traditions and customs. They have learnt to utilize many plants and plant products by trial and error from their ancestors. Traditionally, they collect and utilize the forest product for medicine, food, fibre, fuel, oil, dye, gum, resin, fodder, timber and woodwork, magico-socio- religious beliefs, etc. in their daily life. They cure most of diseases and disorders from the surrounding vegetation. They have also deep faith in alleviation of diseases through Tantra-Mantra. The inhabitants have very unique knowledge about the therapeutical properties of plants, a knowledge which passes from generation to generation by visual tradition only. The present investigation includes mostly Angiosperms only, due to their wide occurrence and easy identification by the local populace. The present account deals with total number 45 plant species belonging to 29 families and 43 genera (30 herbs, 02 climbers, 05 shrubs and 08 trees). The dominant families with respect to their uses in medicine in the study area are Lamiaceae (04), Ranunculaceae (04), Rosaceae (04), Apiaceae (02), Araceae (02), Asteraceae (02), Polygonaceae (2), and Scrophulariaceae (2) as used by the inhabitants of this region. During the course of field investigation the plants reported from the study area are highly valuable for medical uses like rheumatic arthritis, chronic fever, digestive disorder, cold, cough, antidote for snake bite and scorpion sting, constipation, indigestion, jaundice, eye ailments, boils and blisters, skin ailments, cuts and wounds, toothache, as antiseptic, stomachache, cuts and wounds etc. The plant parts used for medical preparation are roots, rhizomes, barks, leaves, fruits, seeds and flowers. The inhabitants prepare the formulation for medicines as in the form of powder, paste, decoction, juice and sap. The species like *Aconitum heterophyllum*, *Aconitum balfourii, Angelica glauca*, *Ajuga parviflora, Arnebia benthamii, Bergenia ligulata, Dactylorhiza hatagirea,* and *Picrorhiza kurrooa* are highly important in their daily life.

In the present study it is observed that the natural resources are dwindling due to recent environmental changes (man made and natural) in Garhwal Himalaya in particular and Himalayas in general. Due to over constructions of National Highways, Prime Minister Rural Road Development Scheme, Hydroelectric Power Projects and resettlement of new colonies of human being. The nearest and easily accessible natural resources in the form of medicine are in threat. In this context, this age old herital knowledge of local and traditional system of the health care is disappearing rapidly because second generation is not interested in traditions and local primary health care system.

Communities or particular healers those sharing their age old tradition should be benefited by means of recognition and monetary gains if any. The Nagoya Protocol too recommends for benefit sharing with community for utilizing their natural resources. . But above all first there need to identify the knowledgeable persons and document their wealth on use of medicinal plants. The same can also lead to mainstream them in their primary health care system.

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2

Integrating Gujjars' Indigenous Knowledge, Rehabilitation Programme and Wildlife Conservation for Policy Implications: Lessons from Rajaji National Park, North–West India

— Ritesh Joshi

ABSTRACT

Indigenous knowledge of forest resources has sustained Gujjar community for centuries in the parts of north-western Himalaya. In Shivaliks, Gujjars started arriving early in the 20th century and expanded slowly in various parts of Shavalik foothills and Terai landscape. Indigenous knowledge and close relationship with nature is helping them in surviving in these areas and to perform migrations in pasturelands of high altitude areas. In 1998, after the effective commencement and implementation of Gujjar rehabilitation programme, Gujjars started shifting to two rehabilitation sites allocated by the State Government. Later-on, this programme had been accelerated and as a result, out of nine forest ranges, seven had been vacated from Gujjars. On one hand, this programme has provided better livelihood opportunity to pastoral Gujjars and in attaining literacy lessons and on the other hand it has ensured restoration of Rajaji's ecosystem and thus wildlife conservation. Being nomadic people, Gujjars used to perform seasonal migrations between Shivalik foothills (lesser Himalayan zone) and alpine pastures. Today, when community based conservation is considered as one of the effective way to protect forests and wildlife, the participation of local communities especially people those are living in the outskirts of protected areas, is highly needed to be ensured in policy planning. Briefly, this study reveals on some aspects on Gujjar's indigenous knowledge & Gujjar rehabilitation programme and their relevance to the wildlife conservation. Study suggests that integration of this indigenous knowledge would be helpful in achieving better results in wildlife management practices and in proposing some policy-based conservation actions. The results would be further helpful in establishing a model demonstration, in context of Community Conserved Areas and restoration ecology for other range countries.

Keywords: Gujjar, rehabilitation, indigenous knowledge, Policy implication, Rajaji National Park, wildlife conservation

Introduction

Indigenous peoples are carriers of ancestral knowledge and their effective participation in biodiversity conservation programmes would result in more comprehensive and cost-effective conservation and management of biodiversity worldwide (Sobrevila, 2008). The Gujjars (a nomadic pastoral community) came to the Shivalik foothills from Jammu nearly 200 years ago as part of the dowry of a princess of Nahan (a present-day part of the Himachal Pradesh); here they raised livestock and practiced pastoralism, spending winter and autumn (October to April) in the Shivalik foothills and summer and monsoon (May to September) in high altitude areas/alpine pastures (Fig. 2.1). In the Himalayan region of northern India, the Gujjars are an important historical tribe, ruling over many former princely states for hundreds of years (TRCF, 2007). Gujjar's livelihood is primarily based around rearing buffalo & cattle, and selling milk in local markets. On an average one Gujjar family has 15-20 buffalos and relatively better off families may own 30-40 buffalo (Fig. 2.2).

In Rajaji National Park (RNP), 512 Gujjar families were estimated residing in 1985, which was increased to 1390 by 1998. In 2000, this equated to 6000 people with an estimated 13000 livestock. In addition to the Gujjar-owned livestock, approximately 3000 other locally-owned cattle had also used to graze in the park boundaries. Over the years, livestock over-grazing and lopping of trees for fodder had opened-up the forest's canopy, allowing introduction and spreading of few exotic alien species, which includes highly invasive *Lantana camara* and *Parthenium hysterophorus*. This had established a conflict for water and grazing resources among wild animals and livestock. Gujjars traditionally used to construct their deras (huts) near to natural waterholes to fulfill their routine requirements. Their livestock had also polluted these water bodies by lying and dung deposition._

Gujjars have their own traditional way to use various forest resources for livelihood needs and indigenous knowledge and close relationship with nature had helped them in utilizing these resources and in surviving contentedly. Despite the fact that Gujjars had placed negative impact over to biological resources, their role in conservation could not be ignored. Gujjar rehabilitation programme has played an important role in ecological restoration of RNP and to provide Gujjars with a sustainable livelihood opportunities and thus development. This study illustrates on some aspects of the Gujjar's indigenous knowledge and the Gujjar rehabilitation programme, which is still ongoing in RNP and its implications in wildlife conservation and policy formulation. This study is focusing on some experiences on indigenous knowledge of Gujjars, outstanding achievements of Gujjar rehabilitation programme and issues related to policy implications together and suggesting a model demonstration for management of wildlife through community participation approach. Such reports are largely absent from the literature despite their importance in illustrating success and failures of our wildlife management and conservation efforts.

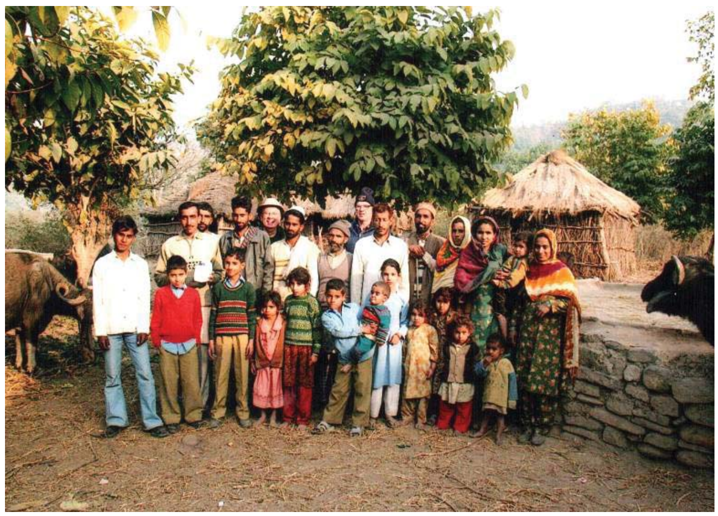

Fig. 2.1 A complete family of Gujjar in Chiriapur forest.

Fig. 2.2 Shelter: Gujjar dera inside a protected forest with a large group of buffaloes.

Means and Materials

Study Area

The RNP (Fig. 2.3) is located in north–west India at 29º15'-30º31' N 77º 52'-78º 22' E, elevation ranging from 250-1100 m asl, falls under the Gangetic plains biogeographic zone and upper Gangetic plains province. Remarkably, maximum portion of the park lies under Shivalik's biogeographic sub-division and as per Champion and Seth's (1968) classification of forest types of India, RNP falls within tropical moist deciduous forest type. RNP was established in 1983 with the aim of maintaining a viable Asian elephant's *Elephas maximus* population and is, designated a reserved area for 'Project Elephant' by the Ministry of Environment and Forests, Government of India. The total geographical area of the park is 820 km^2. This area also lies under Shivalik Elephant Reserve, which also covers the part of the Corbett Tiger Reserve. The dominant vegetation of the area comprises Sal *Shorea robusta*, Rohini *Mallotus phillipinensis*, Khair *Acacia catechu*, Haldu *Adina cordifolia*, Bahera *Terminalia bellirica*, Bar *Ficus bengalensis* and Shisham *Dalbergia sissoo*. The dominant fauna of the park consists of tiger *Panthera tigris*, leopard *Panthera pardus*, sloth bear *Melursus ursinus*, Hyaena *Hyaena hyaena*, barking deer *Muntiacus muntjak*, goral *Nemorhaedus goral*, spotted deer *Axis axis*, sambar *Cervous unicolor*, wild boar *Sus scrofa* and among reptilian fauna the mugger crocodile *Crocodylus palustris* and king cobra *Ophiophagus hannah* represents Rajaji's faunal diverseness.

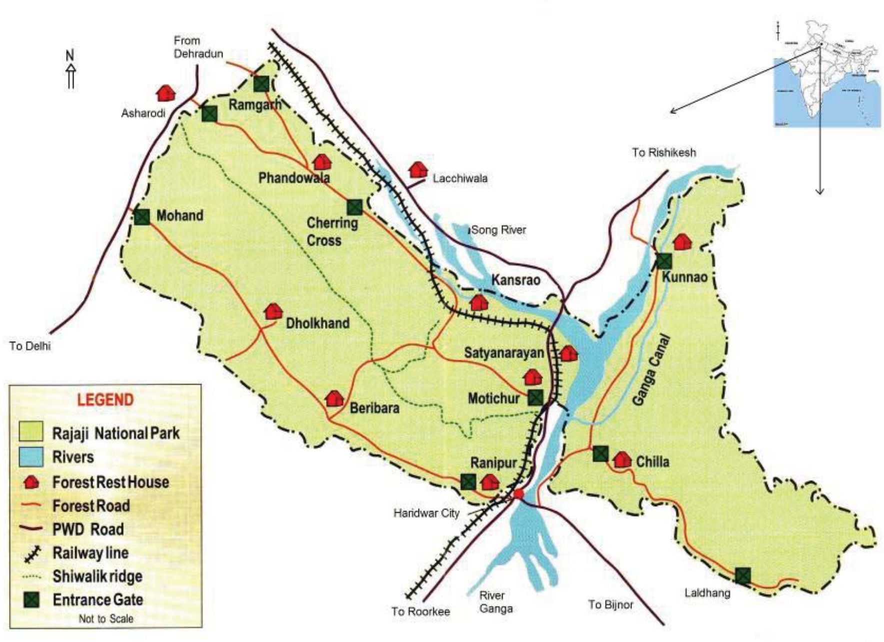

Fig. 2.3 Location map of Rajaji National Park.

Means

Conservation-based livelihood tools andvarious indigenous approaches, which were being used by the Gujjars during their stay in RNP were documented in the Haridwar, Motichur and Chilla forest ranges in between 2000-2002. In addition, dialogues were made with several families to know about their perceptions on forest resources and wildlife. Some field visits were also conducted with Gujjars and lessons were learnt on their experiences about forest routes and wildlife. In between 2005-2008, once again assessment surveys were carried out of the areas, where once these Gujjars were residing. In addition, dialogues were made with some families residing in rehabilitation sites and with the forest officials, engaged in this programme to obtain their views on livelihood related aspects and on ecological changes respectively. This study is a part of my long term study on the elephants of the RNP.

Key Findings And Empirical Observations

Since Gujjars are nomadic people, their ancestral indigenous knowledge and wide movement experiences is helping them to sustain in the forests, even though in adverse conditions. Before the resettlement, they were dependent upon various forest resources to meet out their livelihood and livestock related requirements. Noticeably, various natural ecosystems had been affected up to Gujjar's stay in RNP and conflict in between their cattle and wild animals was noted common phenomenon, which was mainly for water and fodder requirements. They also played an important role in ecological conservation. However, they were unaware of these technical aspects, which were directly linked with wildlife conservation in general and with ecosystem services broadly. Below mentioned are some lessons learned during my studies on elephants in RNP, which gave insight on the indigenous knowledge of Gujjars.

1. *Management of Natural Water Sources*

In forests, Gujjars always used to live or make their deras (shelters) near to perennial water sources and interestingly they managed these water sources till their stay in RNP to kept these live and clean (Fig. 2.4 and 2.5). Gujjars used these sources to drink, cook and bath. Their livestock also utilized these sources, especially in dry periods. All these sources, which were once present in different parts of the park, were found shrinked mainly because of lacking of management practices. Nauranga, Dhak, Jhabri and Bilkeshwar water sources are some feasible examples. Wild animals were found utilizing these managed sources most markedly after dusk and before dawn, up to Gujjar's stay in RNP. However, animals were found not approaching these sources in day hours, mainly because of anthropogenic activities, which include children's playing in surroundings, Gujjar's movement on foot and on bicycle/ motorbike and lopping of fodder trees & collection of fuel wood. Gujjars used to prepare rectangular bowl shaped utensil with the help of big logs of trees and store ground water for cattles. This utensil is also helpful to collect rain water. These traditional practices could be easily seen in high altitude areas, where water crises are more as compared to lower regions (Fig. 2.6).

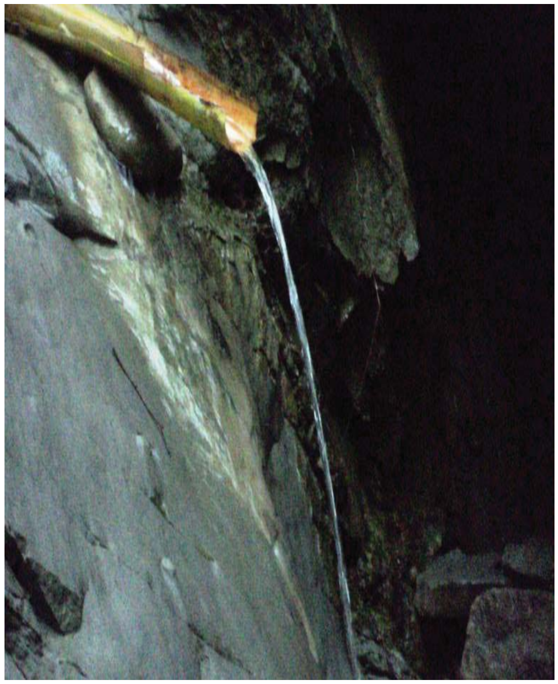

Fig. 2.4 Natural water source is being managed for drinking purpose

Fig. 2.5 A source of natural water inside Rajaji National Park; such sources were earlier conserved by Gujjars for livelihood, but observations acquired in between 2005-2008 revealed that these sources are slowly shrinking up mainly due to lack of management practices

Fig. 2.6 Indigenous knowledge: a big wooden piece is being used to store ground water for livestock needs

2. *Traditional Knowledge on Forest Tracks*

While residing in RNP, Gujjars were aware of various forest tracks, even in remote parts. They used to visit to their relatives on foot and graze their cattle's in different parts of the park, thus performing activities day round. These were some aspects, which made them aware of various activities happened in the park area. On many occasions, information on suspicious movement of human being in forest premise and information on animal's death had been communicated to forest staff by them. Sometimes they also used to explore new routes in search of new fodder grounds, which had boost up their knowledge on the geographical features of various tracts.

3. *Association with Wild Animals*

Elephants are considered as big opponent across this region and man–elephant conflict has been increased rapidly during the recent past, mainly due to increasing incidences of crop raiding, human killings by elephants, habitat fragmentation, human encroachment into the deeper forest regime and shrinking of migratory corridors. Despite these facts, several observations revealed that elephants are someway associated with Gujjars, which shows a great symbiotic relationship. The impeccable strategy of constructing realistic development project with a maintained nomadic lifestyle, emphasizing on a life within the framework of normality would be the ultimate sustainability measure for a sustainable development of nomadic people sharing symbiotic dependence on animals and nature (Nusrat et al., 2011).

Gujjars are well capable of recognizing elephant's presence in the forest and they used to communicate this to others through signaling a special recognizable long voice through which other colleague got cautious about elephant's presence. Sometimes they kept themselves safe by sitting silently over to the burly trees, while encountered elephants in the jungle. On the other hand remarkably elephants, mostly bulls sometimes were recorded to move/follow the Gujjar's cattle. Since some favourable fodder species like *Acacia catechu* (Khair), *Ficus bengalensis* (Bar), *Ficus religiosa* (Pipal) and *Grewia oppositifolia* (Bhimal) were lopped by Gujjars, elephants used to feed on remains, once Gujjar's cattle moved away especially after dusk. Noticeably, cattle used to feed upon leaves and elephants prefer to feed upon small twigs and bark. This relationship could be easily seen in parts of the Haridwar forest division, where Gujjars are still living in the forests. As elephants are well known for strong memory, they follow a strict seasonal pattern to get benefited with this strategy especially during summer.

4. *Traditional Knowledge on Elephant's Movement*

Eastern part of the RNP, Haridwar forest division (HFD) and Lansdowne Forest Division (LFD) is a same biological area and elephants use this entire stretch year round. Elephants starts moving in lower slopes in the plains of Ganges (Chilla forest of the RNP and Shyampur and Chiriapur forest of the HFD) especially at the onset of summer as part of their seasonal migration and due to scarcity of natural water in the higher elevations. At the same duration, their movements became common in various riparian corridors, as these consists of several grass species like *Saccharum spontaneum* (kans), *Saccharum munja* (sarkanda) and *Cynodon dactylon* (doob), which all are favourite food items of elephants. Likewise, at the onset of monsoon, when all the forest compartments are fulfilled with natural water and new vegetation starts growing rapidly, elephants start moving upward in the higher elevations. Some herds and bulls used to perform movements in the parts of Corbett Tiger Reserve (mostly upto Dogadda forest of LFD), however, only few small groups and solitary bulls continue their movements in lower regimes, especially in parts of HFD. These are some example of elephant's seasonal movements and about which Gujjars are familiar. However, most of the villagers are unaware of elephant's seasonal movements and thus elephant's presence in any particular forest year round and this is one of the significant reasons behind frequent human causalities near to boundaries of the park (Fig. 2.7).

Fig. 2.7 Sign of conflict: author is collecting information from an Gujjar family about elephant's attack. In 2007, a tusker had attacked a Gujjar dera (shelter) during night and killed two children on spot in Kotawali forest of the Haridwar forest division

5. *Traditional Knowledge on Species Existence*

Rodents play an important role in maintaining forest ecosystem, though only few studies are available which explores about their distribution. Since several species of mice and rats are found in RNP, Gujjars were aware of these species. Gujjars while residing in forests were aware of presence and existence of various species and they used to call them from their own name. Before the rehabilitation programme, on several occasions, signs of animal's movement like jungle cat, small Indian civet, jackal and hyaena were also recorded near to the Gujjar deras mainly to feed upon edible items. In addition, Gujjars while residing in forests were aware of presence of roosting sites of bats; however they were unaware of the species classification and ecological significance of species. These are some examples of Gujjar's knowledge on species existence in forests. Today, when documentation of field based data and community perceptions are considered as important conservation tools, Gujjars experiences could be used while formulating or implementing any wildlife management project to achieve better conservation results.

6. *Traditional Knowledge on the Medicinal Value of Wild Plants*

In the Indian Himalayan provinces, most of the rural communities and tribal are still utilizing various forest resources to cure common diseases concern with human and livestock as well. This knowledge flow is helping them to provide with primary treatment based on nature remedies. Gujjars are conscious about the forest vegetation especially of their medicinal properties, however they recognize these plants in their own words/ language and noticeably, maximum resources were being utilized to fulfill livelihood needs. In between 1999–2011, Gujjar's indigenous knowledge regarding utilization of various forest resources was learned, while moving with them inside the forest and when discussing with them in their deras. Gujjars are well aware of the traditional herbal system of medication for livestock. Since the characteristic feature of *Tinospora malabarica* (Giloe), *Aegle marmelos* (Bel) and *Acacia catechu* (Khair) are considered as cool, Gujjars used to provide these resources to their cattle during hot period. Similarly, they used to provide *Bombax ceiba* (Semal), *Ficus bengalensis* and *Ficus religiosa* (Pipal) during cold, as the character of these resources are considered as hot. The powder of the bark of *Litsaea chinensis* (Chandna/Maida-lakri) is being used by them to cure fractures in livestock.

Van Gujjars use their indigenous curative system when the characteristics of a disease get evident like khurpaka (foot and mouth disease), galghontu (Haemorrhagic septicaemia), nakada/thanela (mastitis), taku (epifemoral fever), rinderpest and surra. Gujjars likewise do diagnose some human diseases and have their own indigenous systems of curing them (Nusrat et al., 2011). The traditional knowledge of Gujjar community for healthcare of cattle requires great attention for phytochemical and pharmaceutical analysis and bioprospecting new drugs in the concerned field (Gaur et al., 2010). Gujjars are an important tribe in biodiversity of Jammu and Kashmir State; for centuries, Gujjars have used indigenous wild plants to satisfy their requirements for energy and essential nutrients (Rashid et al., 2008). In a study carried out on traditional knowledge of tribal in Mayurbhanj district in Orissa by Panda et al. (2011), it was found that the indigenous phototherapy of tribes can provide a useful alternative to conventional human health care.

Gujjars also used to cook the fruits of *Terminalia chebula* (Hararh) as vegetable. In 1970s-80s, they were known to make ropes from *Bauhinia vahlii* (Maljhan) and *Ischaemum angustifolium* (Bhabhar grass) especially to build their deras, which were sometimes helpful in knitting big logs of grass bundles and wooden blocks. Now a day, with the change in time this business is abating slowly, and Gujjars prefer to buy nylon ropes from market, as these are available in low costs and to knit a rope is also a time taking process.

Gujjar Rehabilitation

The sustainable development approach currently being promoted in India by government agencies seeks to encourage social change in remote villages in order to secure participation of these communities in biodiversity conservation through ecologically sound and culturally appropriate means of enhancing livelihoods (Mishra et al., 2009). Relocation of village communities has emerged as an important and contentious component of some such initiatives that needs to be examined more closely than it has been in the past (Rangarajan and Shahabuddin, 2006).

In view of the provisions of the Wildlife Protection Act, 1972, the first attempt to resettle Gujjars from the RNP was made in 1984 (by the then Uttar Pradesh state government) but somehow this was not successful. At the time of establishment of RNP, 512 Gujjar families had a permit for residing inside the park area and were identified for relocation to Pathri within an 80 hectare area of a reserve forest in Haridwar forest division. Somehow families could not be relocated at this time and slowly their numbers got increased. Gujjars had insisted on allocation of separate land for each family at rehabilitation sites and this was one of the major issues behind non successfulness of the programme. Then the case was assigned to the High Court of Uttar Pradesh State.

By 1994-1995, the number of families had increased to 1,390 and fortunately in 1996, the first family was rehabilitated to Pathri. In November 2000, after establishment of Uttarakhand State, the programme moved rapidly. At Gaindikhatta, rehabilitation commenced during 2003. Each family was given Rs. 2,000 to assist with moving and allocated a site upon which they can make their new shelters. They were permitted to collect timber from nearby forest for this purpose. In addition, each family was given a little over two acres (0.8 ha) of arable land for agriculture purpose (vegetable and cereal crop cultivation).

Uttarakhand State Government had also provided necessary basic facilities including provisions of drinking water, toilets, medicare, access roads to the new villages, primary schools, solar electric fencing, mid-day meal scheme (providing food to primary level students during schooling), Angan bari Yojna (to literate and motivate the rural children and women at their kitchen garden / villages), a widow pension scheme for the physically challenged, regular veterinary doctor visits, establishment of a fare price shop, and issuing of ration cards. Out of total 1,390 families which were present in the park area in 1998, 512 families were resettled to Pathri and 613 to Gaindikhatta. Thereafter in between 2000 to 2007, other families were also moved out from the park area. Currently only 93 families (residing in the Gohri and Chillawali forest range of RNP) are to be relocated (Table 2.1). The Gujjar rehabilitation programme in RNP is an integrated approach focusing on environmental conservation and providing better livelihood opportunities for pastoral Gujjar (Joshi, 2012).

Table 2.1 Total number of Gujjars families in different forest ranges in RNP and status of rehabilitated and remaining families up to 2010

Forest Range	No. of families	Families rehabilitated at Pathri	Families rehabilitated at Gaindikhatta	Total	Remaining Families
Chillawali	260	2	206	208	52
Chilla	193	-	193	193	-
Haridwar	254	188	66	254	-
Ramgarh	99	42	57	99	-
Kansrao	85	43	42	85	-
Motichur	115	102	13	115	-
Dholkhand & Beribara	235	135	100	235	-
Gohri	149	-	108	108	41
Total	1390	512	785	1297	93

Source: Records of Gujjar Rehabilitation Programme, State Forest Department 2010.

Policy Implications

With increasing international emphasis on the conservation of biodiversity, policies need to be devised out for the Van Gujjars so that they are able to benefit from recognition of their role in conserving livestock genetic diversity, promoters of valuable indigenous breeds of buffalo and indigenous knowledge and also about coping mechanisms from environmental stresses (Nusrat et al., 2011). Now it is widely acknowledged and accepted that indigenous knowledge of the locals should be documented and these people should be involved in management and conservation of biodiversity. India is also a Party to the Convention on Biological Diversity, which is a major international legal framework for biodiversity conservation. Government of India has also enacted the Biological Diversity Act, 2002 and under to this Act, State Biodiversity Boards has been established. Biodiversity Management Committees at local level are also being made, which are working under the administrative guidance of State Biodiversity Boards. One of the major functions of these Committees is to prepare People's Biodiversity Register, which shall contain comprehensive information on existing biological resources and associated traditional knowledge.

In the recent past, Gujjar rehabilitation programme in RNP was thought controversial, as this was placing a mass movement from forests and Gujjars were not comfortable with sudden change in their livelihood especially at the very beginning stage. However, later on it has evolved as one of the nature conservation tool, which has taken worldwide attention. State Government and some Non Governmental Organizations

(Rural Litigation and Entitlement Kendra, Friends of Doon, Wildlife Trust of India, Wildlife Protection Society of India and Future–Vision India) had made favourable efforts to brought forward them, by supporting them in the areas of education, women empowerment, medicare, veterinary care etc. (Fig. 2.8 and 2.9).

Fig. 2.8 Conservation & Community participation: An NGO is imparting training/technical-know-how to Gujjar women on making of handicraft items

Fig. 2.9 Workers of an international organization discussing with Gujjars on livestock management related issues

Since this region of north-western Shivalik landscape is not exempted with the phenomenon of habitat fragmentation and man-animal conflict, a regional based conservation planning is needed to be implemented, which incorporates the views of local people, Gujjars, scientists and other workers engaged in conservation based projects. Lessons learnt from Gujjar's traditional knowledge and experiences had placed an insight on the forest conservation related aspects. However, there is a need to study this in detail. On the other hand rehabilitation programme had placed a model demonstration for ecological restoration and in retaining the species to their native areas. Notably, we also now are aware of some drawbacks of this programme and had received feedbacks from various sources in this regard (how to more it more effective). Now a need is felt to place the results of all these at a place and to incorporate the results of these conservation initiatives in the management/working plan of RNP, so that further actions would be taken based on these experiences learned. These experiences could also be incorporated in various policies, related to forest/biodiversity conservation to showcase the achievements in biodiversity and livelihood improvement conservation projects.

Is the flow of Indigenous Knowledge Continues with Gujjars?

The greatest diversity of indigenous groups coincides with the world's largest tropical forest wilderness areas in the Americas including Amazon, Africa, and Asia and 11 percent of world forest lands are legally owned by indigenous peoples and communities (Sobrevila, 2008). Van Gujjars are well known for having evolved a resource management practice by utilizing the alpine grazing resources in summer and migrating to foot hill forests in winter (Nusrat et al., 2011). With the change in time the livelihood of Gujjars is also changing; now they are slowly losing their traditional lifestyle. However, some families who are still residing inside the forests continue their traditional livelihood. Since maximum number of Gujjars in the rehabilitation sites are not keeping large herds of cattle, not conducting annual migrations to sub-alpine/alpine pasturelands. These migrations had given a unique identity to Gujjars in north-western Himalaya, which play an important role in conserving cultural diversity as well (Fig. 2.10 and 2.11). Overall it could be concluded that with the passage of time Gujjar's children are learning new lessons in urban life. However, some families who are still performing these giant migrations across Shivaliks and high altitude pastures are carrying forward the indigenous knowledge for future generations, as their ancestors used to do. Challenges related to migration have to be documented and incorporated in management practices, so that this precious cultural diversity could be managed and conserved.

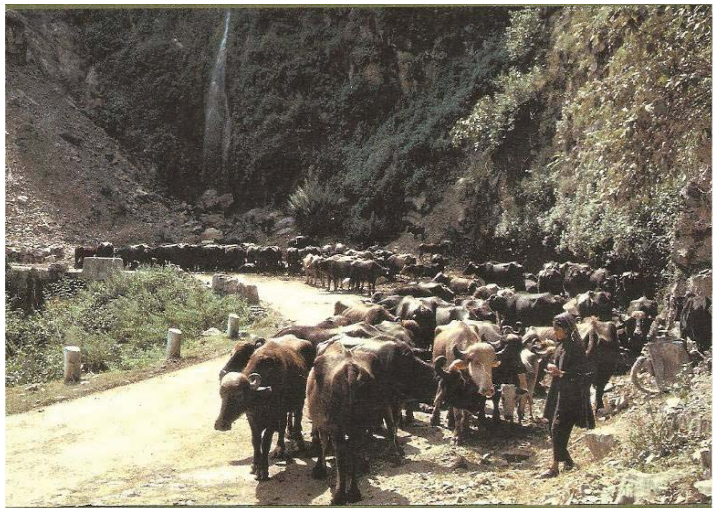

Fig. 2.10 Giant migrations: a large herd of Gujjar's buffalo during migration

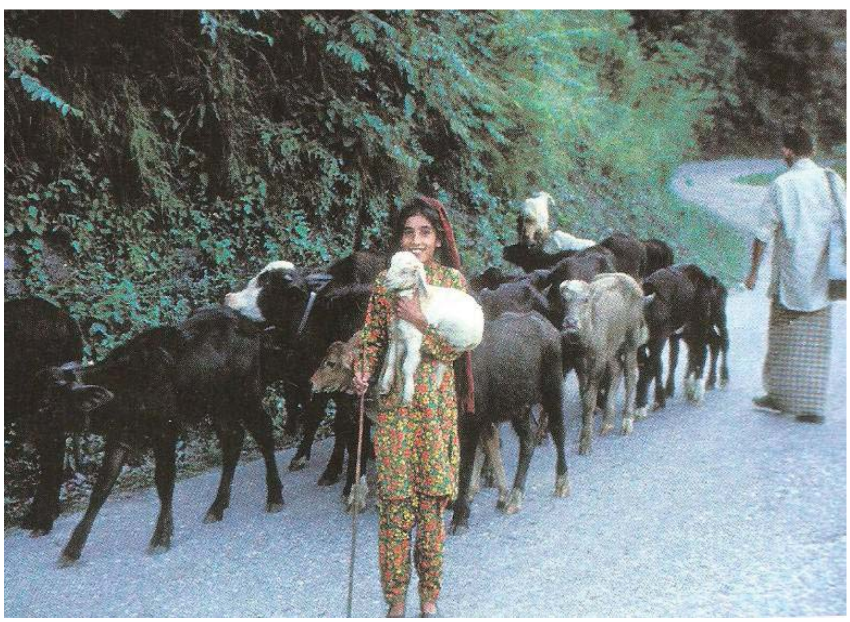

Fig. 2.11 Conserving the culture: A Gujjar child during migration

The traditional cultures of Gujjars including their knowledge and use of wild edible plants are rapidly changing through contact with other cultures. The documentation and conservation of their traditional indigenous knowledge on plants is of great significance in the light of food problem likely to be faced in the near future for ever growing human population (Rashid et al., 2008). Being the nomadic people, Gujjars used to migrate within the Himalayan foothills (upper Gangetic plains/lowlands) and sub-alpine/alpine pastures. Notably, before the commencement of Gujjar rehabilitation programme, most of their families did not want to come forward with the society/urban life. Subsequently, when the programme was initiated and some families started to resettle in rehabilitation sites, they learnt about the change in livelihood and benefits especially in terms of education, medi-care, modern life etc. The resettled Gujjars are now satisfied with the process and ongoing benefits incurred by the programme, and consider that this programme has improved their livelihood and some of them also felt that this would be implemented at wide scale so that they can walk together with the urban society and forests/wildlife could be conserved. Resettled Gujjars at Pathri acknowledged that their previous nomadic life-style had denied them of modern facilities and that they now enjoy the benefits of such things as mobile phones, electricity, running water, more stable livelihoods, upward mobility and integration into the social mainstream. Gujjar rehabilitation programme in RNP has provided better option for schooling to Gujjar children, which has enhanced the literacy level besides, women empowerment level has found increasing as State Government together with various NGOs is making favourable effort in this direction (Joshi and Singh, 2011).

Conclusion and Recommendations

Gujjars who has sustained a symbiotic relationship with the forests over years are one of the important resource persons in the context of wildlife conservation. Documentation of Gujjar's indigenous knowledge and results of the Gujjar rehabilitation programme are still a matter of concern. However, several studies have highlighted the impact of this programme. Today when most of our protected areas are facing the threat of habitat fragmentation and many species are categorizing under the threatened category, we can organize consultation meetings wherein all the stakeholders would give their suggestions. Rehabilitation programme has placed a model to conserve forests and wildlife and to ensure the goals of Wildlife Protection Act and livelihood improvement project. If we would link the results of the programme and Gujjar's experiences, then it would be useful in learning some new lessons in the context of environmental conservation. Gujjar's participation in wildlife related management activities can sustain the ecosystem of Rajaji, but for this more attractive and effective conservation strategies are needed to be implemented. A considerable amount of research and development inputs are also required to strengthen our database on Gujjar's indigenous knowledge and outcome of the Gujjar rehabilitation programme.

1. In the recent past, ecotourism has been considered as a potential tool for biodiversity conservation. In RNP, this aspect is slowly emerging. Gujjars should be involved in drafting ecotourism related guidelines, in exploring new tracks, historical places etc.
2. Gujjar's indigenous knowledge on use of various forest resources should be documented and benefits arising out from their use shall be shared with them, so that they would know about their role and credit in conserving biodiversity.
3. Since Gujjars have expertise in making handicraft items with the help of forest produces (broom making, knitting of grass etc.), capacity building programmes could be initiated for them which includes training on making of small handmade furniture from *Lantana camara.* In 1999-2000, Eco-development Committees which are being established by the State forest department, had made small furniture like stool, table, chair and showcase with the help of lantana, which had given backup to support their livelihood needs.
4. Projects related to establishment of indigenous conservation areas could be implemented.
5. Gujjars are well aware of forest tracks and fire inflammable species, therefore they can be engaged as forest fire watcher during fire season and their knowledge could be used to trace the remote areas, which are inaccessible.
6. Regular meetings with Gujjars, both in the forests (where they are still residing) and at rehabilitation sites should be conducted, which would be helpful in reducing communication gap. In addition, emphasis should be given to Gujjar's participation in biodiversity conservation initiatives.
7. Capacity building programmes, trainings, consultations and workshops should be organized for Gujjars, so that their perceptions and suggestions regarding forest/ wildlife management can be documented and if necessary, may be incorporated while drafting the guidelines in context of wildlife conservation.

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Indigenous Knowledge System among Odisha Tribal Communities with Emphasis on Proto-Peasantry, Arts and Crafts: A Few Observations

— Harapriya Samantaraya, Premananda Panda

ABSTRACT

Tribal population of India, as per 2011 census is 84.3 million i.e. 8.2% of the total population. A large section of this population has been distributed over the harsh ecological areas like hills, forest and deserts in states like Andhra Pradesh, Bihar, Chhattishgarh, Gujrat, Madya Pradesh, Maharastra, Rajasthan, Odisha, West Bengal , Andaman and Nicobar Islands Lakhyadeep island and the eight states of the Northeast. Thus, while many are highlanders, a few are islanders. India has identified 75 number of area specific tribal groups who have been designated as Particularly Vulnerable Tribal Groups (PVTGS) for special treatment. The communities across generations not only invented the tools and techniques to adopt themselves meaningfully with the given ecology but also developed devices, institutions, beliefs and practices and handed over such acquired knowledge to the posterities. Thus, indigenous Knowledge Systems (IKS) refers to the knowledge that a local community experiences and gains over generations of living in a definite milieu. It includes all forms of knowledge like technological knowhow, skills, practices and attitude that enable a community to achieve sustainable livelihoods in its own natural settings. IKS is culture specific and area specific. It is unique to a cultural community in practices, institutions, relationships, rituals, socio-natural and disaster conditions, etc. IKS is based on, and is deeply rooted in local experience and historic reality. It plays an important role in defining the identity of the community for development. For any development intervention one must understand holistically the critical issues of the community *per se* in order to have inclusive sustainable growth among the indigenous communities.

Keywords: Tribal, Forest, Ecology, Culture, Socio cultural, Historic reality

Introduction

Recently throughout the globe the indigenous peoples' knowledge system assumed importance. When the debate on equality vis-a-vis efficiency argument continued for valuing natural resources like land, water, forest and wildlife in favor and/or against the natives, the people at the grassroots have been put to commission. The knowledge they have are the generated and accumulated ideas across generations which are being practiced for the purpose of their living. Accordingly, the perception on their own art and artifacts, the ecology and cosmology got paved with norms, beliefs, customs and oriented practices. However, these are not stagnant. Due to external influence, enforced rules and compulsions, they accept some alien elements under duress. Being marginalized section of society some of the jerks they receive are beyond their tolerance. However, the murky side of development has reminded the elite section about the importance of indigenous knowledge system .The indigenous communities are the most deprived sections as they fail to understand the long term roles and forces of the capitalistic mode of development. By the time they start knowing, the state authorities level them as unwanted and not serious .This led to the agitations and migrations of the people at the grassroots. Wherever, they migrate for a living they plant their own cultural knowledge as a cyst for survival but often face humiliations that inflicted up on them by the greater society.

Usually the indigenous communities believe that the patch of earth surface they have been occupying for generations is the best suitable for their habitat. Irrespective of the degree of harshness and inadequacies, the communities have invented tools and techniques to adopt themselves to the given ecological conditions. Their life style is dependent mainly on natural resources drawn from their surroundings. The houses they live in are roofed by the locally available materials, bamboo. Grass leaves an also stone and clay materials like slates and baked curved tiles. The foods they consume are the collection from forest and harvested from upland cultivation. The cloth materials were made up of fibers and leaves but however since recently they get clothes from local markets on exchange of their forest and agro products . The material culture and associated aesthetic value wove around those are handed down to them by their ancestors. In their world view, the cosmology, the legends, the myths art and artifacts they have speak of their rich cultural heritage. Cooperation and conflict settlement between the groups are often culturally codified. Customary law works supreme and the aged are the watch dogs of their tradition.

The communities across generations not only invented the tools and techniques to adopt themselves meaningfully with the given ecology but also developed devices, institutions and beliefs and practices and handed over the acquired knowledge to the posterities. The earth surface they live in is subjected to ecological conditions such that a definite set of living and nonliving objects available are being meaningfully associated to the community in its worldview, education , health, religious practices, and orienting the resources for suitable living moved from one place to another in search of sustainable productive ecology .

One of the social anthropologists of last century Late Prof. Evans-Pritchard narrated the reverential perception of the Nuers of Africa on their ecology (1940). Some practicing anthropologists often use synonyms of Indigenous Knowledge System (IKS), such as the 'local knowledge', 'traditional knowledge', 'peasant knowledge', 'ethnic knowledge', 'endogenous knowledge', 'folk knowledge', 'ethno science', 'science of concrete', etc. IKS has two distinct aspects: social and practical. Indigenous Knowledge System (IKS) has been connected with the life support system of the indigenous people. The knowledge and skill utilized remains explicit as it is usually acquired through the process socialization -learning by doing / learning in doing largely through imitation and /or instruction during group interaction. IKS as factual knowledge, skills and capabilities, are local to the extent that they are acquired and applied by people with respect to local objectives, situations and problems. Creativity and innovativeness as parts of IKS, of the least mobile men like tribes, have remained slow and often imperceptible but long survived since it developed befitting to the ecological conditions. The communities in order to cope up with their natural and socio-cultural environment have generated this IKS in a sustainable manner. This being culturally and ecologically integrated is also important, particularly for developmental measures i.e., problem solutions, based on local knowledge, drawn on locally available raw materials and energy sources.

They are known to practice herbal medicine and follow the principle of naturopathy. The specialists among them are the inventory of traditional therapeutic knowledge and skill. With the entire migratory trauma and impact of urban culture, the indigenous knowledge system does not die although reach to a stage nearing to death. This is a typical feature of the Asiatic mode of production. In a sense, when the indigenous community senses some of its core cultural components, especially those basic to ethnic markers, moving towards the vanishing stage, it attaches ritual importance to enable the community to sustain the cultural element alive.

The tribal communities have relatively stable tangible and intangible special relationships with their land, water, forest and the environment of their habitat. They possess knowledge about their natural resources based on observation and experience. Indigenous knowledge is important to the tribal systems for natural resource management. Such knowledge can best be understood along with their traditional belief systems and not in isolation. Many tribal communities hold the vital natural forest, water and land resources as sacred. They believe that natural resources are the ingenuous gift, blessing and creation of supernatural entities. Therefore, these are being guarded by the ancestral spirits. Such resources of the commons are the sources of life and livelihoods. It also links to the past, present and future generations. Tribal people are provided with knowledge of proper use and management of natural resources across generation. The different resources have their respective context of use are being guarded by different spirits that ensure their proper use and management. Violations result in severe punishments and retribution from the respective spirit

Indigenous Knowledge Systems refers to the knowledge that a local community experiences and gains over generations of living in a definite milieu. It includes all forms of knowledge like technologies, know-how, skills, practices and beliefs that enable a community to achieve sustainable livelihoods in its own natural settings. IKS is culture specific and area specific. It is unique to a cultural community and found in community practices, institutions, relationships, rituals, socio-natural and disaster conditions, etc. IKS is based on, and is deeply rooted in local experience and historic reality, and is therefore spatial and temporal explicit. It plays an important role in defining the identity of the community. It has developed over the centuries of experimentation and observation of people to adapt to local conditions. Therefore, IKS represents all forms of skills and innovations of people collective wisdom and resourcefulness of the community. On basis of observations and studies made on the above knowledge, practical anthropologists suggest various thematic fields of indigenous technical knowledge which may be put under broad heads:

- Systematic knowledge of celestial bodies such as sun, moon, star, comets, cloud, thunder, etc and natural environment such as plants, animals, water, fire and natural disasters, coping mechanism and crises management style
- Knowledge and skill involved in pursuing agriculture, soil conservation, animal husbandry, hunting, fishing, forest , land and water management and labor management.
- Traditional Knowledge on herbal medicines (diagnosis of diseases, therapeutic applications and healing procedures) and reintegration of the sick into society as a participant
- Circulation of messages(for example ;date and time of initiation of cultivation and other rituals ,change of clan name through meeting of the lineage heads , awarding punishment to the deviants etc) of urgent nature among the members of the communities and Institutional mechanisms built for dissemination of personalized knowledge.

India's Scenario

Accessibility to the forest as the properties of the commons has never been restricted to the tribal in their culture. For the first time during British in India the Forest Act 1865 intervened in the cultural processes of the tribal ownership and established monopoly holding rights of the state. This initiated tempering the indigenous knowledge system. Since then the intervention of the corporate bodies in the traditional forest resources with the connivance of the state administration are being impacted and in many places mutilated the nerve centre of the indigenous communities. Even the recent Panchayatiraj (Extension to scheduled areas) Act 1996 that has provision in favor of the communities owning forest resources and its non-timber forest produces could not stop depriving these voiceless people from their right to manage the forest and deterred the condition of people's socioeconomic condition.

In India, ethnic groups being certified by the president of nation under Article 342 are treated as scheduled tribes to be preferentially discriminated for development are considered as indigenous communities. Most of them live in the forest belt. A forest supports the indigenous people and sustains their economic, environmental and social wellbeing (Biswas2005). Similarly, for them the medicinal plants are as important as food in the primary health care system. The forest resources provide various kinds of benefits .Three important range benefits are: the job and income that supplement the inadequate return from peasantry produces and also things like the fuel wood, fodder and building materials for homes and environmental benefits (FAC 1979). The way the forest resources are managed by the forest dwellers (tribes people) are typical.

The comprehensive framework for the all round development of the trbal people have been enshrined by constitution in Articles 15, 16, 17, 23, 29, 46, 244, 275, 330, 332, 335, 338, 339, 430 ,341 and 371 . Land and forest are inseparable entities in the tribal life and living. Law prohibits transfer of tribal land to non-tribals but not to fellow rich tribal families. Even after independences with the presence of pro-tribal central and state Acts the indigenous people remained at the margin. The state took almost decades to prepare its rules in response to the Acts. This facilitated the non-tribal to exploit the resources of the tribal area. The Panchayat Extension to Scheduled area (PESA) Act 1996 and the Forest Act 2006 have been openly violated. Displacement due to development has been the major issue tribal dissent in which the indigenous people suffer from deprivation of basic entitlements. There are many contradictions between the customary rights and the state legislations. Even due to non existence of uniform law an s procedure the state bordering communities who lose their tribal identities and get deprived of the legitimate rights. The state administration hardly bothers them. Besides, they often become subjected to the wrath of the extremists.

Tribal population of India, as per 2011 census, is 84.3 million, 8.2% of the total population and majority among whom have been distributed over the harsh ecological areas like hills, forest and deserts states like Andhra Pradesh, Bihar, Chhattishgarh, Gujrat, Madya Pradesh, Maharastra, Odisha, West Bengal and the eight states of the North-east. Thus, while many are highlanders a few are islanders. In terms of population a few small tribal communities are islanders. Economically the have been categorized as hunters and gatherers, proto-peasants, settled cultivators, artisans, fishing, animal husbandry, agricultural laborers, and migrant construction workers. Some of them are far away from basic amenities, lowly literate, stagnant or declined population strength; suffer from food scarcity and poor in health condition. Researchers have identified the area specific groups as vulnerable groups. Government took many initiatives to cover all such members in different schemes. The convergence approaches of development are being initiated since recently. In India we have 75 PVTGs in India.

Tribal Scenario of Odisha:

Odisha has 62 different Scheduled Tribal communities who constitute 22.13% of the total population of Odisha. The scheduled tribes (STs) and/ or some of their sections with their cultural conservatism have been identified by Government as Particularly Vulnerable Tribal Groups (PVTGs) for conservation of their culture and development. So far the Government of Odisha has identified 13 PVTGs and Ministry of Tribal Affaires (MOTA) Government of India (GOI), New Delhi has taken cognizance of it. These PTGs are: Bonda, Birhor, Chuktia Bhunjia, Didayi, Dongria Kondh, Hill Kharia, Juang, Kutia Kondh, Lanjia Saora, Lodha, Mankadia, Paudi Bhuiyan and Saora. Needless to say that the Scheduled Tribes of Odisha in general and the PVTGs in particular present a vast opportunities to be tried for penetrating into the tribal land, explore and exploit their wealth of IKS (human capital) and local material resources (raw materials) as well as natural resources that could be pooled and put into practice for preservation of IKS and their application in the economic and social development of people. While the IKS practice among the STs has been reduced considerably, however, such practice among the PVTGs seems to be integral. With the association of rituals and rites some such 'archaic' practices are kept alive.

Government of Odisha has tall claims on tribal development and spent some thousand crores of rupees since independence. The present result has been the growth of extremists in almost 22 districts out of 30 districts. On close observation, it is known that an elite tribal section has been created who hardly bothers on the development of their own ethnic brothers .Of the total 62 scheduled tribal communities only some families of five communities have economically developed and many of them have lost the tribal identity

Indigenous knowledge systems are of varieties and meant for many purposes. Almost all tribal communities have inventories of knowledge on food care food management, health care and health management. The traditional medicines composed of organic products of micro ecology has been kept alive though rituals among almost all indigenous communities. The Koyas domesticate spiders to put them in crop field as a tool to control pests. The Binjhals plant lemon plants nearer the drum stick plant and put wood ash at the roots so that there will be good harvest of both . The Santals produce a sound to call the wild birds and animals and catch them in nest. The Soaras domesticate water to water their terrace. The rope making of the Mankidias and Birhors from the plant fiber, the bamboo crafts of the Mahars, the Oil crushing of the Kondhs and Binjhals, the honey collection of the Mankidias, the looming and textile of the Bondas, basket making of the Mahalis and turmeric cultivation and embroidery of Kutia Kondhas are linked to native forest and land resources. The concept of Child care among the Binhjals, the sanitation and cleanliness of the Laal Mahal of Chukti Bhunjia are typical So also is house decoration and maintenance of the Santals . The site selection for *podu* patch of among the Juangs is normally led by the village head followed by the lineage head is determined by the echo of the howling in chorus while they would be moving up-hills. Similarly, among many tribal communities the site selection for house construction is determined by the movement of the insects at the selected sacred spot. The medicine preparation of the Ojhas among Santals, the fishing techniques of the Orams are unique. The Soara and Santal colored wall-paints that reveal their worldview are very attractive. The indigenous water harvesting techniques of many tribes are very typical. The water harvesting and preparation of bunds and small dykes to hold water for irrigation on seasonal *nalas* in hill slopes of Sundargarh and Sambalpur, Koraput and Rayagada districts are unique.

As an example, among the Saoras one observes practice of IKS of mixed cropping in cleared forest areas (high hill slopes), rice cultivation in upper and lower terraces with agro-forestry and horticultural activities supported by collections of MFPs. Lanjia Saora carve terraces in the hill slopes and make stone bonding through group labor and cultivate the terraces as well as *podu* fields by using low external inputs agricultural system (LEIAS). They practice “Zero Tillage” or “Minimum Tillage” for raising mixed crops of pulses and millets in *podu* fields and crop synergy is best reflected in such practices as the crops are sequentially harvested while managing bio-diversity. They use Traditional Ethnological Agricultural System (TEAK) to maximum possible extent for managing the cropping system.

In form of sacred groove, (for example; *Budharaja* deity in western Odisha, the guardian spirit *Jahira* among the Santals) and in terms of totemic objects. Many wild plants, animals and a few inanimate objects are being nurtured through their cultural matrix. Traditionally, in the forest belt, each tribal group had a culturally defined territory which periodically redefined the boundary through ritual processes and demarked by the natural objects like stream, hills, long surviving plants and the abodes of the deities and such other sacred spots etc.

The uniqueness of the System is that it is a very sustainable mode of agricultural practice which not only provides sustenance for their livelihoods, but also helps in maintenance of Bio-Diversity. It is a system by which the Lanjia Saoras make stone bonding and also prepare terraces and water channels and cultivate such fields using their traditional/indigenous knowledge. The entire work of rice terraces and podu cultivation is done with the help of ***Ansir*** - traditional labor co-operative - exchange of labor among themselves free of cost.

Moreover, the Soara perceive their natural resources as an ancestral heritage. Ownership of natural resources is vested upon the whole community. The present generation runs a responsibility of trusteeship over the resources. Since natural resources do not belong to only one generation, they cannot be privately possessed or controlled by any single members of the community, only its fruits. The natural resources are used for many purposes. The products of the land sustain life men, bovines and birds. The forests serve as sources of gathered foods, wildlife for hunting, pasture, construction materials, household furniture and utensils, traditional medicine, wild honey, fuel wood, etc. Apart from serving as a windbreak, forests provide hospitable and stable environment. The springs, streams and rivers are a source of potable water aquatic animals. Shifting cultivation is an indigenous agro-ecological knowledge used to maintain the complex agro-ecosystem. The fields are shifted to use the nutrients of the natural vegetation-soil complex. Thus, by skillfully maintaining the natural forest and vegetation ecosystem, the other equally important natural resource components such as soil, waters and wild animals are managed in a sustainable way.

Culture and social systems are dynamic. While we speak about traditional tribal societies we always depict a society in transition, more due to the impact of external agencies and less from within due to innovation. It has been well revealed in this study that the tribes like Santhal has been changing at a certain pace along with their health seeking behavior, Dangaria Kondh in horticulture and the like The rapid depletion of natural surrounding and eco-system of tribal people compounded with infiltration and intrusion of non-tribal elements into tribal domain play a major role in changing tribal ethos, value system and their worldview. The study certainly points out that the traditional health care system and peasantry still find meaning of survival in tribal domain. The traditional medicines, healers and the priests can still relate a link between men, nature and the super-natural beings. Similarly the Langia Soaras have water management technique for agricultural activities through diverting the streams to water the terrace and *podu* patches and Paudi Bhunyas for slashing and burning the weeds and distributing the ashes while tilling *podu* patches This is the link on which the uniqueness of tribal society exists. Obviously, the tribal people feel at home with the protection given by their traditional healers against psychosocial problems or spiritual insecurity. This very spiritual insecurity plays vital role in tribal health care services, lack of which leads to failure of the system. It has been revealed from several studies that the Christian Missionaries used religion branded with modern allopathic medicines as a spiritual shield to propagate Christianity among tribal groups with known success. But it is sad to see that many government policies hardly accept this very component in their health related aids and campaigns for a better result. A rational synthesis of traditional perception with modern facilities would certainly.

This indigenous knowledge of natural resource management mostly conditioned by norms, values, ethics and taboos that have been institutionalized as customary laws and conventions within the community. The elders, who are respected by the community, members enforce these institutions. Although these indigenous forms of natural resource management are stable, policy planners have ignored them. Therefore, this study attempts to investigate and reveal the enormous wealth of indigenous knowledge of the Soaras and their skillful natural resource management strategies in tribal Odisha.

They make bonding terraces in such a manner that at various degrees various kinds of stuff are grown (for example, up to 20 degree slope and in plain land areas rice is grown and kitchen garden/backyard cultivation are also done; terrace fields between 20-40 degree slopes the rice is grown; in between 40-60 degree slopes (upper terrace) millets are grown and orchards developed); in 60 degree slope and above the forest plants and cashew plants are grown. Besides, in the small chunks of *podu* fields mixed cropping of pulses and cereals are grown. Mono cropping is never done by them. Shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, and then abandoned. This system often involves clearing of a piece of land followed by several years of wood harvesting or farming, until the soil loses fertility. Once the land becomes inadequate for crop production, it is left to be reclaimed by natural vegetation, or sometimes converted to a different long-term cyclical farming practice. The ecological consequences are often deleterious, but can be partially mitigated if new forests are not invaded. Of these cultivators, many use a practice of slash-and-burn as one element of their farming cycle. Others employ land clearing without any burning, and some cultivators are purely migratory and do not use any cyclical method on a given plot. Sometimes no slashing at all is needed where re-growth is purely of grasses, an outcome not uncommon when soils are near exhaustion and need to lie fallow.

The Terraces are made in such a manner that precious resources like soil and water are conserved and used to the maximum extent as a result of which, two assured crops are grown in majority of the area and the tribal people have never experienced drought here during their lifetime.

The ingenious system of developing terraces using stone bonding and water management practices are hall mark of the system and are revealed as the most effective soil and water conservation measures. Among a few tribal communities, on stone bonding the allow a type of creeper that sustain the pressure of water flow and binds the stones. The system has remained sustainable and has shown remarkable resilience in the face of environmental and socio-economic changes over time.

Need to Understand IKS and Actions t be Taken

IKS has made people capable to live in 'harmony' with their environment across generations. Over the centuries it has guided indigenous peoples the use of their natural resources by means of a variety of community innovations to deal with sustainable economy, environmental conservation and natural disaster management.

Besides, tribal health through the application of traditional healing practices exclusively influenced by this Indigenous Knowledge. This knowledge is usually passed from generation to generation through traditional socialization processes by elder to the younger. Ritual practices involved in transferring the IKS to the younger generation are treated as a form of language. Documented literature on IKS is limited in Tribal Odisha. The reliability of this mode of information transfer is under threat in these modern times mainly due to the influx of western culture, higher levels of interaction between different communities, as well as the passing on of the custodians of this knowledge. The inroads of capital to tribal belt are likely to uproot the IKS at a faster pace. Thus, inventory of IKS needs to be recognized and recorded before it is too late.

Anthropological literature and films on technology and agrology focus on materials, work process and work products, and on underlying technological knowledge. The texts cover topic such as ethno perception of celestial bodies, color perception, ethno-art and artifacts, ethno-medicine (medical anthropology), ethno-botany, ethno-zoology etc. Besides, agricultural anthropology, particularly an application-orientated field, deals with peoples' knowledge on crop pattern, pest control, harvesting, processing, preservation of seeds, extraction of oil, as well as natural resource management and real life information management. Recording down traditional knowledge has become a necessity as its use and application is on the decline due to incursions of modern technology.

Oral traditions have lost their major functions of guiding members of the respective communities in their day-to-day activities. In the process communities are facing identity crisis. Scientists' and pressure groups' concern for this is enormous. Thus, it is high time; the traditional knowledge need be systematically documented before it is lost. Documentation of traditional knowledge is not a matter of recording down the knowledge contents as a product, but describing and analyzing systematically the relevant social, economic, cultural and ecological process associated with it. It is widely felt that integration of traditional and scientific/external knowledge needs to be established for the well being of human beings across societies.

It is necessary to take stock of the expertise already available in the areas with the local cultivators and then build up on that edifice. This expertise should not be lost for future development of that area. Synchronically, the prejudices and superstitions acquired through generations should not hold up future development. So a study may be taken up to analyze the defects, which may not be possible for a village community with its static thinking. The experience gained from the traditional cultivation need to be synthesized and analyzed for evolving better method of cultivation. There is thus need of influx of outside knowledge, without abandoning the traditional knowledge and technology already available with the indigenous people.

Still the other areas, which require inventory, are ethno-medicine, ethno-art and artifacts, etc. in all these the indigenous people show their traditional skills, expertise, craftsmanship, artistry, aesthetic manifestations, originality and simplicity. Ethnographic data on the origin and historical development of the objects, material used techniques of manufacturing and manipulating, their socio cultural significance and information about the persons involved like craftsmen, artisan and medicine men are to be gathered. For scientific study of indigenous tribal technology applied in the trades of painting, jewellery, textiles, art and artifacts, agricultural engineering, etc., and providing the require educational services like lectures, demonstrations, research publications, seminars, workshops, exhibitions, an ITK Cell need to be created to gather and disseminate information.

The blending between of traditional knowledge and scientific knowledge needs to be established and applied for the well being and development of the society. It is necessary to take stock of the expertise already available in the areas with the local cultivators and artists and craftsmen and then build up on that edifice. The experience gained from the traditional practice needs be synthesized and analyzed for evolving better method of cultivation. There is a need of influx of outside knowledge, without abandoning positive aspects of the traditional knowledge and technology already available with the indigenous people. It is reported that tradition knowledge at times leads over the other knowledge during crises.

These indigenous skills of PVTGs can be upgraded and developed for income generation activities and improvement of their quality of life. Further, organic agricultural and forest based non-agricultural practices followed by most of the PVTGs are not managed on commercial lines. Thus it needs to be carefully planned to guarded .They tries to manage at subsistence level so as to meet the requirement food for their families round the year. Now the demand of organic food is steadily increasing in the developed and developing countries. Therefore, what is required is that, with the support of welfare government, the PVTG farmers should be helped to produce organic products in commercial quantities in which they shall have the right to fix the price.

Government at State and National level are supposed to extend financial, technical supports and facilitate the patent rights in favor of the community to protect and promote the interests in the local knowledge of the peasants and its products. This will definitely raise the self esteem of the indigenous people for their own products. There is a need for interfacing between the industrial personnel and the administrators for possible mutual benefits in favor of indigenous communities and the industries working in tribal belt. The Agro-industrial Scientists and Tribal Development Administrators should come forward with a well planned agenda based on empirical investigation to help assist the PVTG people for their economic development by utilizing their traditional and indigenous skills in the areas of agriculture, horticulture, beekeeping, arts, crafts, etc. For the IKS studies usually areas picked up by researchers are mainly

- To surface the indigenous science and technology for preservation and development of native knowledge system/ practices.
- To investigate and document traditional knowledge and techniques of forecasting natural seasonal events and Publish extensive literature on IKS with special reference to persistence and change.
- To preserve and promote human capital (IKS) in face of the cultural diversity and global tendency towards monoculture.
- To help optimize development measures by integrating IKS with modern science and technology.
- To identify the traditional knowledge holders and empower them through orientation training and value addition to their products and also assist for patent of their knowledge and product in favor f the community that retains.

- To suggest the effective use of the findings of the study on the indigenous Knowledge System (IKS) in the Context of Development.
- To document the Traditional Knowledge and Forest Management Practices.
- To document the Traditional Practices for Sustainable use of natural resources and promote the best Practices.
- To document the Traditional Knowledge and NTFP procurement, process, preservation and utilization.
- Case studies on joint initiatives and utilization of traditional and formal scientific knowledge in water, forest and land management activities.
- Exploring the legal and policy landscapes for traditional knowledge conservation and sustainable utilization.

Further, the studies made by researchers dwell upon a wide spectrum of stakeholders including Government Decision-makers and Development Planners, Environmental and disaster managers / Practitioners, Academic and research institutions, Media, Indigenous people and communities, Donors, and other developing agencies.

The contemporary field researchers working on indigenous knowledge systems claim to adopt holistic approach without raising critical response to their own question as how holistic is holism. However, the popular methods adopted by practical anthropologists are: application case study ,empirical study with audiovisual evidences, sample study in STs/PVTGs concentrated areas, recording and analysis of bio-cultural markers of each community, interview with representative case studies , administration of Schedules and participatory observation, group discussion on dispute management in sharing resources, photography as proof of identities *in situ,* collection of secondary source information and historicity of the community.

In the process of working on indigenous knowledge system it has been confirmed that significant contributions to global knowledge have been sourced from indigenous people. Thus in many places Indigenous knowledge system is nurtured and developed and adopted uninterrupted to gradually changing environments so that the environmental deterioration can be mitigated. This knowledge is closely interlinked with people's cultural values. Indigenous knowledge is also the social capital of the poor and remaining as their main asset to invest during the struggle for survival, to produce food, to provide for shelter and justice or to achieve control of their own lives. Keeping this knowledge system in view, there is a need to continue research on various coping mechanisms adopted by the people at the grassroots to understand the following

a. How does contemporary world respond to the inroads of modern scientific knowledge in retaining the capacity of indigenous knowledge systems?

b. In the transitional culture how the tribes people from other culture recognize the co-existence of multiple worldviews and knowledge systems at the expense of what they already know and the way they have come to know it today , how do they find ways to understand and relate to their own world with available multiple dimensions and varied perspectives.

Remarks

There has been some change in the tribal areas in terms of infrastructure development due to government intervention. The corporate bodies, especially mining correlations, who exploited the natural resources, have not done justice to the area and indigenous people although they have binding social responsibilities as per law. The social transformation that has taken place has benefitted a few tribal families of around five tribal communities the protective discrimination has not awarded adequate justice to the poor tribal. It is high time that the well-off tribal need be eliminated at least from the scope of Art 46 and 335 in view of serious resources crunch .Where development initiatives of the Government are dictated by sycophant bureaucrats what happened to the tribal people as beneficiaries and how do they grow through their own genius? Handlooms and many traditional handcrafts are on the verge of extinction. The reasons of such a process are many; however, the lack of resources tops the list. Since there has been a demand for the ethnic products at the international and national market, care needs to be taken by the developers I favor of the traditional arts and crafts by organizing certain forums where the indigenous people having expertise can indoctrinate their skills to their own ethnic brothers. The community based culturally known industries can enhance their economic condition. Thus these activities should be strengthened and promoted. Further, such a condition is possible if the indigenous people are allowed to retain their control over the natural resources. This is likely to stop the tribal children and women trafficked. The traditional healers with state sponsored technology can be a support to ensure better health services. The existing pro-people Acts that guarantee the forest dwellers and other indigenous communities on livelihood resources if managed properly and if the community based institutions are not undervalued by the development interventionists , then the marginalized can be rescued efficiently and can be ensured for a life upholding democratic values with dignity of their labor. .

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Medicinal Plants of Ramagiri Hill Forest of Karimnagar District, Andhra Pradesh, India: Treasure-Trove of Traditional Herbal Healers

— EN Murthy, Vatsavaya S. Raju, MNV Prasad

ABSTRACT

Ramagiri hill forest is a good reserve of medicinal plants in Karimnagar district of Andhra Pradesh, India. It is a sacred groove and historical site. There are 150 medicinal plants recorded. which represent 55 angiosperm families. Papilionaceae are the dominant family with 10 species, followed by Caesalpiniaceae, seven each by Apocynaceae, Combretaceae, Cucurbitaceae and Mimosaceae, five each by Euphorbiaceae, Malvaceae and Rubiaceae. Plant habit-wise, herbs dominante with 57 species, followed by trees (50), shrubs (36), twiners (6) and parasites (1) as source of medicines. This study underscores the need to declare Ramagiri hill as a Medicinal Plant Conservation Centre.

Key words: Medicinal plants, Ramagiri hill fort, forest, Andhra Pradesh, India

Introduction

Plant-based traditional medical systems continue to provide the primary health care to more than three-quarters of the world's populace. WHO has estimated that over 80% of the global populations rely chiefly on traditional medicine (Akerele, 1991). Indigenous herbal treatment is a part of the culture and dominant mode of therapy in most of the developing countries. It was officially recognized that 2500 plant species have medicinal value while over 6000 are estimated to be explored in traditional, folk and herbal medicine (Huxley, 1984). More emphasis is being placed on possible economic benefits, especially of the medicinal use of tropical forest products (non-woody forest produce) instead of pure timber harvesting (Pimbert and Parks, 1995). In many developing countries, a large population especially in rural and forest areas, depends on traditional medicines for their primary health care. Ramagiri hill forest is located in Karimnagar district of Andhra Pradesh. It not only known for its rich wealth of medicinal plants but also historic value with the fort built by Kakatiyas. During the Telugu month of Shravana (Aug.-Sep.), the fort attracts pilgrims to offer their rituals and many Botanists and Ayurvedic scholars explore the plant wealth there in.

Kapoor and Kapoor (1980) were the first to publish the medicinal plant wealth of Karimnagar district. Later, Hemadri (1990) enlisted 436 medicinal plants (mere botanical names and vernaculars) for Karimnagar and Warangal ditricts. Ravishankar (1990) studied the ethnobotany of Karimnagar and Adilabad districts. An estimation of tribal dependency on local forest (Mahadevpur reserve) was made by Reddy. (1996). Rao *et al*. (1998) reported 30-33 plants used in ethno-medicine by the tribals of Mahadevapur. Reddy *et al*. (2003) reported the ethnoveterinary medicinal plants used by the Gonds of Karimangar district. Naqvi (2001) discussed briefly some of the ethnomedicinal plants from the district as part of his study of flora. Murthy *et al*. (2008) recorded ethnomedicinal plants used by the tribes of Mahamuttaram and Yamanpally villages of Karimnagar district. The present report is the inventory the ethnomedicinal plants from Ramagiri Hill forests of Karimnagar district of Andhra Pradesh, India.

Materials and Methods

Study site

Ramagiri hill forest is located 40 km away from Karimnagar, the district head quarters. It includes seven forest beats of Manthani forest range of Karimnagar East Forest Division, *viz.* Mydambunda, Kundaram, Lakkaram, Peddapally, Sabbitham, Kalvacherla and Maredugonda (Fig. 4.1). It lies between 79 ^{0} 25’ E - 79 ^{0}28’ E long. and 18 ^{0} 34’ N – 18 ^{0} 38’ lat. The hills extend over 14.7 km, attaining an altitude 679 m. The hill top is plateau of surface area over 40 sq km in which a rock fort was built, called Ramagiri Hill Fort or Quilla. The total forest area of Ramagiri hill ranges is 3205.16 sq ha. Ramagiri hill is often referred as Ratnagiri or Ratnagarbha. The history of Ramagiri Hill fort began from the first century AD. This fort was once called Vajra kootami. Gowthami Puthra Shri Shathakarni in 62 AD and Pulomavi in 86 AD ruled this region. The historians believe that the fort was developed by the Mouryan emperors - Chandragupta, Bindusara and Asoka. Kakatiyas defeated Chalukya Gunda Raju and occupied the fort in 1158 AD. Later, the fort went under the rule of Bahamani Sultans, followed by Reddy King, Vemareddy. History depicts that Bahamany Sultans ruled the fort between 1442-1457 and till 1597 AD under the rule of Moghuls. In 1606 AD, Golconda Nawabs occupied the fort. Muslim Kings ruled the fort till the Nizam regime. Now the glory of the fort is history and it is in ruins due to the negligence. (Rajagopal, 1974; Naqvi, 2001; Rajesham, 2006).

Ramagiri hill ranges and the surrounding forests are known for its medicinal plants. Many families of herbal vendors, traditional medicine men, village Vaidyas and folk healers gather the medicinal plants. Some collect the crude medicinal plants to be sold in towns like Karimnagar, Peddapally, Manthani, Jagitial, Siricilla and Huzurabad. Students visit this place to collect the plant to prepare the herbarium specimens. There is a great scope to develop the fort area as a Medico-Botanical centre.

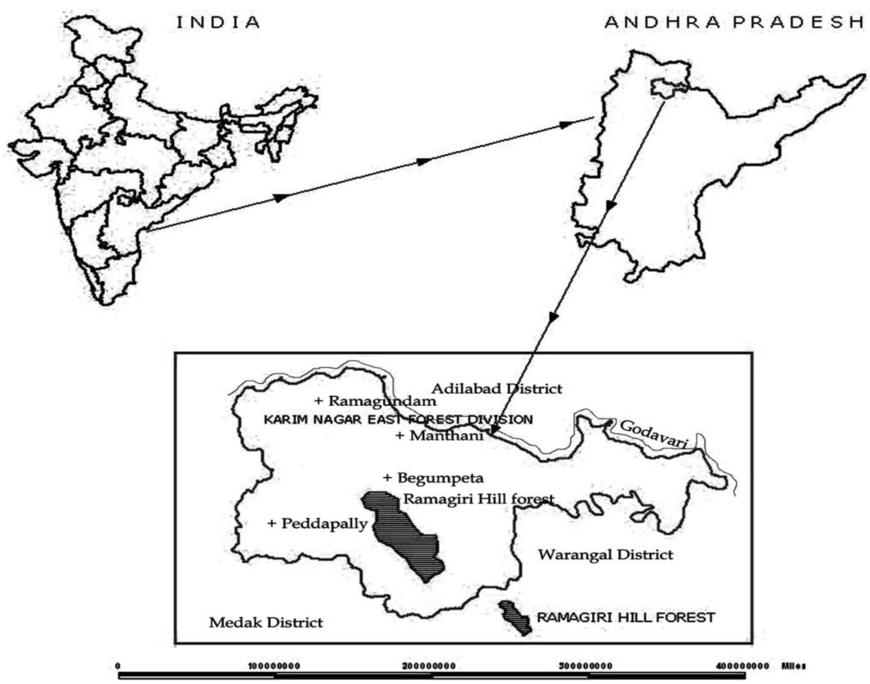

Fig. 4.1 The study area.

Data Collection

The medicinal plant survey included repeated interviews with aged local people, herbal healers, shepherds, tribal headmen, owners of cattle herds, etc., in different seasons for two consecutive years. Field trips were conducted during 2009-2011. The information on useful plant species, parts used, local names and mode of utilization was collected. Plants used in their traditional uses were identified with the help of regional floras (Gamble and Fischer, 1915-35).The plant specimens were pressed and deposited in the Herbarium of Botany Department (KUH), Kakatiya University, Warangal, India.

Key Findings and Empirical Observations

There are 150 medicinal plants recorded from the Ramagiri hill forest representing 55 Angiosperm families. The detailed list of medicinal plants are enumerated in the Table 4.1 with their local/vernacular names, habit, medicinal uses and part used etc.

Table 4.1 Ethno medicinal plants of Ramagiri Hill forest, Karimnagar District, Andhra Pradesh, India

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
1	*Abelmoschus ficulneus* (L.)Wight andArn.	H	Malvaceae	Adavi benda	Contraceptive, boils, sprains, sores	L
2	*Abrus precatorius* L.	C	Papilionaceae	Guriginja	Aphrodisiac, anti-inflammatory, eye-troubles	Sd
3	*Abutilon indicum* (L.) Sweet	S	Malvaceae	Tuturu benda	Leprosy, urethritis	W
4	*Acalypha indica* L.	H	Euphorbiaceae	Pippentaku	Antihelmenthic, hysteria, rheumatism	W
5	*Acacia catechu* Willd.	T	Mimosaceae	Chandra	Skin disease, diarrhea	B
6	*Acacia chundra* (Rottl.)Willd.	T	Mimosaceae	Chandrabheda	Skin diseases, toothache	B
7	*Acacia farnesiana* (L.) Willd.	T	Mimosaceae	Murki tumma	Toothache, gum swelling	B
8	*Acacia leucophloea* (Roxb.) Willd.	T	Mimosaceae	Tella tumma	Stringent	B
9	*Acacia nilotica* (L.) Del.	T	Mimosaceae	Nalla tumma	Toothache, gum swelling	B
10	*Achyranthus aspera* L.	H	Amaranthaceae	Uttareni	Piles, diuretics, easy child birth	W
11	*Actinopteris radiat*a (Sw.)Link.	H	Actinopteridaceae	Mayursika	Antihelmintic	W
12	*Adiantum incisum* Forssk,	H	Adiantaceae	Rajahamsa	Skin diseases, diabetes	W
13	*Aegle marmelos* (L.) Corr.	H	Rutaceae	Maredu	Dysentery, vomiting, colic, deafness, piles, jaundice	RB,L,Fr
14	*Ailanthes excelasa* Roxb.	T	Simarubaceae	Pedda manu	Dyspepsia, bronchitis, arthritis	B,L.
15	*Alangium salvifolium* (L.)Wang	T	Alangiaceae	Uduga	Poisioning, dog bite	L.R.Sd
16	*Albizia lebbeck* (L.) Benth.	T	Mimosaceae	Dirisenamu	Snake-bite, scropion sting	B

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
17	*Aloe vera* (L.)Burm.f.	H	Liliaceae	Kalabanda	Piles, menorrhagia	L
18	*Alternanthra sessilis* (L.)R.Br.	H	Amaranthaceae	Ponagantikura	Snake-bite	W
19	*Andrographis paniculata* (Burm.f.) Nees	H	Acanthaceae	Nalavemu	Fevers, antihelmintic	W
20	*Anisochillus carnosus* (L.f.)Wall.	H	Lamiaceae	Bhutankusham	Diaphoretic expectorant	W
21	**Annona squamosa* L.	T	Annonaceae	Seethapalam	Paste of seed to kill lice	Sd
22	*Anogeissus acuminata* (DC.)Guill. and Perr.	T	Combretaceae	Peruleni chettu	Healings of wounds	B
23	*Anogeissus latifolia* (DC.) Bedd.	T	Combretaceae	Chiru manu	Snake-bite, scorpion sting	B
24	**Argemone mexicana* L.	H	Papaveraceae	Brahma dandi	Syphlis gonorrhoea, leprosy, eczema, eye trouble	W
25	*Aristolochia bracteolate* L.	H	Aristolochiaceae	Gaddapaku	Anti helminthic, amenorrhoea	W
26	*Aristolochia* indica L.	H	Aristolochiaceae	Nalla eeshwari	Snake-bite, arthritis	W
27	*Asparagus recemosus* Willd.	C	Liliaceae	Adavipatri, pilli teegalu	Stomach-ache	L
28	*Azadiracta indica* Juss.	T	Meliaceae	Vepa	Fevers, antiseptic, malarial fever, febrifuge	W
29	*Balanites roxburghii* Planch.	T	Simarubaceae	Garachettu	Leprosy, wounds, antheimantic, snakebite	B,Fl,Sd
30	*Baliospermum montanum* (Willd.) Muell.-Arg.	H	Euphorbiaceae	Danthi,	Purgative, stimulent	L,R,Sd
31	*Barleria prionitis* L.	S	Acanthaceae	Mulugorinta	Sprematorrhea, ootitis	SD
32	**Basella rubra* L.	C	Basellaceae	Batchali teega	Catarrha affections bilious, vomting	W
33	*Bauhinia racemosa* Lam.	T	Caesalpiniaceae	Arechettu	Headache, malaria	L
34	*Boerhavia diffusa* L.	H	Nyctaginaceae	Galli jeru	Urinary disorders, anthelmentic, fever	W
35	*Buchanania lanzan* Spreng.	T	Anacardiaceae	Charapappu	Urinary dissorders	Fr
36	*Butea monosperma* (Lam.)Taub.	T	Papilionaceae	Moduga	Leucorrhoea	B,Fl

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
37	*Butea monosperma* (Lam.)Taub. *var. lutea* Maheshwari	T	Papilionaceae	Tellamoduga	Tonic after delivery	B
38	*Butea superba* Roxb.	C(Liana)	Papilionaceae	Tigamoduga	Leucorrhoea	B,Fl
39	*Caesalpinia bonduc* (L.) Roxb.	S	Caesalpiniaceae	Gachapoda	Emmenagogue, gastic tonic	Sd
40	*Calotropis gigantean* (L.) R.Br.	S	Asclepiadaceae	Tella jilledu	Alterative, tonic, spasmodic, expectorant, eye trouble	Sd
41	*Calotropis procera* (Ait.)R.Br.	S	Asclepiadaceae	Jilledu	Alterative, tonic, spasmodic, expectorant, eye trouble	W
42	*Capparis zeylanica* L.	S	Capparaceae	Are donda	Sedative, diuretic	R
43	*Caralluma adscendens* var. *attenuata* (Wight) Gravely and Mayur.	H	Asclepiadaceae	Kundeti kommu	Analgetic, toothache	W
44	*Cordiospermum helicacabum* L.	C	Sapindaceae	Budda teega	Diuretic, laxative, emetic, rheumatism, piles	W
45	**Carica papaya* L.	T	Caricaceae	Boppayee	Dyspepsia, psoriasis, chronic eczema	Fr, St
46	*Carissa spinarum* L.	S	Apocynaceae	Kalimi	Fevers, stomachc, digestive	Fr
47	*Carissa carandas* L.	S	Apocynaceae	Kalimi	Digestive, carminative	Fr
48	*Cassia auriculata* (L.) Roxb.	S	Caesalpiniaceae	Tangedu	Diabetes, bed wetting	Fr, L
49	*Cassia fistula* L.	T	Caesalpiniaceae	Rela	Laxative, diabetes, gout, rhematism	Fr, S
50	*Cassia occidentalis* (L.) Link	H	Caesalpiniaceae	Kaasinta	Asthma, skin deseases, laxative	W
51	*Cassia sophera* (L.) Roxb.	H	Caesalpiniaceae	Chennangi	Antiseptic	W
52	*Cassia tora* (L.) Roxb.	H	Caesalpiniaceae	Kasivinda	Leprosy, psoriasis, plague, gout, sciatia, pains	W
53	*Cassytha filiformis* L.	P/C	Lauraceae	Pachiteega	Bilious affectious, urethrilis, skin diseases	W
54	*Catharanthus roseus* (L.)G.Don	H	Apocynaceae	Billa gannera	Cancer, blood pressure	W

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
55	*Catunaregum spinosa* (Thunb.)Tirv.	S	Rubiaceae	Manga (Konda)	Emetic	Fr
56	*Cleome gynandra* L.	H	Cleomaceae	Vamintaku	Ear diseases, wounds, ulcers	L
57	*Cleome viscosa* L.	H	Cleomaceae	Kukka vaminta	Infalmnation of middle ear, applied to wounds	L
58	*Clerodendrum phlomidis* L.f.	S	Verbenaceae	Takkali	Gonorrhoea, pherperal diseases	L
59	*Coccinia grandis* (L.) Voigt	C	Cucurbitaceae	Donga teega	Cooling effect	Fr
60	*Cocculus hirsutus* (L.) Diels	C	Menispermaceae	Dusara teega	Acute gonorrhoea, rhemnatism, syphilis	L
61	*Cochlospermum religiosum* (L.) Alston	C	Cochlospermaceae	Konda gogu	Diarrhoea, dysentery	B
62	*Commelina benghalensis* L.	H	Commelinaceae	Venna veduru	Laxative, diabetes, gout, rhematism	W
63	*Crotalaria verrucosa* L.	H	Papilionaceae	Tella eshwari	Scabies	W
64	*Cucumis sativus* L.	C	Cucurbitaceae	Dosakaya	Throat affections, sun stroke	Fr
65	*Curculigo orchioides* Gaertn.	H	Hypoxidaceae	Nela tadigadda	Polyurea, aphrodi-siac, scropion bite, menstural disorders	W
66	*Datura innoxia* Mill.	H	Solanaceae	Tella ummetha	Diarrhoea, poisonous bites	W
67	*Datura metal* L.	H	Solanaceae	Nala ummetha	Aphrodisiac, insanity	L
68	*Dodonaea viscosa* (L.) Jacq.	Sh	Sapindaceae	Bandarae	Broken bones, wounds	L
69	*Echinops echinatus* Roxb.	H	Asteraceae	Brahma dandi	Nervine tonic, diuretic aphrodisiac	W
70	*Eclipta prostrate* (L.) L.	H	Asteraceae	Gunta galagara	Skin diseases, hepatic tonic, bites	W
71	*Euphorbia nivulia* Buch.-Ham.	T	Euphorbiaceae	Bontajemudu	Rhumatism	Latex
72	*Evolvulus alsinoides* (L.)L.	S	Convolvulaceae	Vishnu kranta	Fevers, dysentery, anthelmintic	W
73	*Ficus benghalensis* L.	T	Moraceae	Marri	Rhematism, toothaches	B
74	*Flacourtia indica* (Burm.f.)Merr.	T	Flacourtiaceae	Porika	Snake-bites, gout, rheumatism	Sd
75	*Gardenia gummifera* L.f.	T	Rubiaceae	Bikki	Antiseptic, authelmintic, bleeding piles	L,Fr,Sd

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
76	*Gisekia pharnaceoides* L.	H	Aizoaceae	Irshi-rashkura	Diuretic	W
77	*Gloriosa superba* L.	H	Liliaceae	Nabi chettu	Abortificient, leprosy, gonorrhoea	W
78	*Gmelina arborea* Roxb.	S	Verbenaceae	Gummadi teku	Galactogogue, gonorrhoea, fevers, indigestion	B
79	*Gymnema sylvestris* (Retz.)Roem. and Schult.	H	Asclepiadaceae	Poda patri	Stomachic, diuretic, diabetes	L
80	*Haldina cordifolia* (Roxb.) Ridsdale	T	Rubiaceae	Battaganepu	Tonic after delivery	B
81	*Oldenlandia umbellata* L.	H	Rubiaceae	Chiruveru	Snake bite, asthama	W
82	*Helictris isora* L.	S	Sterculiaceae	Nul tada	Febrifuge	Sd
83	*Hemidesmus indicus* (L.)R.Br.	H	Asclepiadaceae	Pala sgandhi	Nutritional disorders, leucorrhoea, rhematism	R
84	*Hybanthus enneaspermus* (L.) F. V. Muel	H	Violaceae	Rathnapurusha	Aphrodisiac	W
85	*Holorrhena antidysenterica* (Roth.)DC.	T	Apocynaceae	Kodisha pala	Anthelmintic, carminative	B
86	*Ichnocarpus frutescens* (L.)R.Br.	C	Apocynaceae	Pala teega	Purifies the blood, skin diseases, syphilis, elephantiasis	L
87	*Indigofera tinctoria* L.	H	Papilionaceae	Neeli chettu	Sedative, piles, diuretic, dropsy	W
88	*Lawsonia inermis* L.	S	Lythraceae	Gorintaku	Burning feet, small pox, rheumatism, wounds	L,Sd
89	*Hygrophila auriculata* (Schumach.)Heine	H	Acanthaceae	Neeru golimidi	Aphrodisciac, diuretic, dropsy	Sd
90	*Leucas aspera* (Willd.) Link	H	Lamiaceae	Tummi kura	Insecticide, scabies, snake bite	W
91	*Lepidagathis cristata* Willd.	H	Acanthaceae	Mulla banthi	Fevers	W
92	*Luffa acutangula* (L.) Roem.	C	Cucurbitaceae	Beera	Expectoraut, splenitis, haemorrhoides, leprosy	Fr,Sd
93	*Luffa acutangula var amara* (L.)Roxb.	C	Cucurbitaceae	Chedu beera	Diabetes, dropsy	Fr

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
94	*Luffa cylindrica* (L.) Roem.	C	Cucurbitaceae	Venna beera	Cool, demulcent	Fr
95	*Madhuka longifolia* var. *latifolia* (Roxb.) A. Chiov.	T	Sapotaceae	Ippa	Asthma, epistaxis, gives vigour, vitality	B,L,Fr
96	*Mangifera indica* L.	T	Anacardiaceae	Mamidi	Atonic dyspepsia, constipation, bleeding	Fr
97	*Marsdenia volubilis*	C	Asclepiadaceae	Penujittu	Cooling, alterative, gonorrhoea	L, St
98	**Martynia annua* L.	S	Martyniaceae	Telu gondi	Used in scorpion stings	Fl
99	*Melia azadirach* L.	H	Meliaceae	Gumpana	Anthelintic, nervous headaches	Fl, Fr
100	**Mimosa pudica* L.	H	Mimosaceae	Athi pathi	Piles, fistula, scorpion sting, menstrual disorders	Sd
101	*Mitragyna parvifolia* (Roxb.) Korth.	T	Rubiaceae	Battaganapa	Stomachache, stimulant, emetic	B
102	**Moringa oleifera* Lam.	T	Moringaceae	Munaga	Rheumatism, gout, syphlilis, paralysis	B,Fl,Sd
103	*Moringa concanensis* Nimmo ex Dalz.	T	Moringaceae	Chedu munaga	Blood purifier	Sd
104	*Mucuna pruriens* (L.) DC.	C	Papilionaceae	Duli dundi	Aphrodisiac, leucorrhoae, spermatorrhoea	L
105	**Murraya koengii* (L.) Spreng.	S	Rutaceae	Karivepaku	Stimulant	L
106	**Musa* x *paradisica* L.	S	Musaceae	Arati	Haemoptysis, diabetes	Fr
107	*Momordica charantia* L.	C	Cucurbitaceae	Kakara	Diabetes, leprosy, piles, jaundice	Fr
108	*Momordica dioica* Roxb.	C	Cucurbitaceae	Karkotaki	Diabetics	Fr
109	**Nerium indicum* Miller	S	Apocynaceae	Ganneru	Conjuctivities, syphilis	Fl
110	**Ocimum tenuifloiun* L.	H	Lamiaceae	Tulasi	Expectorant, antiseptic	W
111	**Opuntia dillenii* (Ker-Gawl)Haw.	S	Cactaceae	Naga jamudu	Whooping cough, gonorrhoea	W
112	*Pergularia daemia* (Forssk.)Choiv.	C	Asclepiadaceae	Dishtapu teega	Asthama, leprosy	L,St
113	*Phoenix sylvestris* (L.) Roxb.	T	Araceae	Eetha	Opthalmia, opacity of cornea	Fr

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
114	*Phyllanthus amarus* Schumm.and Thonn.	H	Euphorbiaceae	Nela-usiri	Jaundice, gonorrhoea, bites	Fr
115	*Phyllanthus emblica* L.	T	Euphorbiaceae	Usiri	Asthma, menstrual disorders	Fr
116	*Plumbago zeylanica* L.	S	Plumbaginaceae	Chiramulamu	Piles, skin diseases	W
117	*Pterocarpus marsupium* Roxb.	T	Papilionaceae	Teddagi	Toothace, boils	B
118	*Pongamia pinnata* (L.)Pierre	T	Papilionaceae	Kanugu	Skin diseases, pyorrhea	B
119	**Punica granatum* L.	S	Punicaceae	Danimma	Diarrhoea, anthelmentic	Fr,Sd
120	*Rivea ypocrateriformis* (Desr.)Choisy	C	Convolvulaceae	Teega boddi	Piles, constipation	W
121	*Sapindus emarginatus* Vahl	T	Sapindaceae	Kunkudu	Migrain, abortifacient	B,Fr,Sd
122	*Sarcostemma acidum* (Roxb.)Voigt	S/C	Asclepiadaceae	Atukudu teega	Wounds, cuts, leprosy	W
123	*Ledebourea hyacinthina* Roth	H	Hyacinthaceae	Adavi Ulligadda	Rheumatic pains	W
124	*Sida acuta* Burm.f.	H	Malvaceae	Parasukamp	Gen. Debility, boils, absciss	W
125	*Sida cordifolia* L.	H	Malvaceae	Bhoomibala	Paralysis, anaemia	W
126	**Solanum americanum* Mill.	H	Solanaceae	Kamanchi	Heart diseases, hiccough	Fr,L
127	**Solanum virginianum* L.	H	Solanaceae	Nalavakudu	Cough, urinary tract infections	Fr
128	*Soymida febrifuga* (Roxb.)Juss.	T	Meliaceae	Yegi	Fevers, vaginal infections	B
129	*Sphaeranthus indicus* L.	H	Asteraceae	Boadataram	Eye trouble, tonic, lice killer	W
130	*Strychnos nux-vomica* L.	T	Loganiaceae	Vishmushti	Paralysis, fevers	Fr,L
131	*Strychnos potatorum* L.f.	T	Loganiaceae	Chilla	Urinary treat infections, eye diseases	Fr
132	*Syzigium cumini* (L.) Skeels	T	Myrtaceae	Neredu	Diabetes, Diarrhoea	B,Fr,Sd
133	*Tamarindus indica* L.	T	Caesalpiniaceae	Chintha	Oedema, piles	Fr,L
134	*Tephrosia purpurea* (L.) Pers.	T	Papilionaceae	Vempali	Diabetes, spleen, level disorders	W

Sl. No.	Latin Name	Habit	Family	Vernacular Name	Medicinal Uses	Part Used
135	*Terminalia arjuna* (DC.)Wt.andArn.	T	Combretaceae	Erumaddi	Heart diseases, urinary tract infections	B,Fr,Sd
136	*Terminalia bellerica* (Gaertn.)Roxb.	T	Combretaceae	Tanikya	Urinary calculi, asthma	B
137	*Terminalia catappa* L.	T	Combretaceae	Badam	Diabetes, back pain	B
138	*Terminalia chebula* Retz.	T	Combretaceae	Karakkaya	Piles, jaundice	B
139	*Terminalia alata* Roth	T	Combretaceae	Nalla maddi	Bactericidal, ulcer	B
140	*Tinospora cordifolia* (Willd.)Hook.f.and Thoms.	C	Menispermaceae	Tippa teega	Fevers, gout	W
141	*Trianthema portulacastrum* L.	H	Aizoaceae	Gajeru gadda	Night blindness, urinary disorders	W
142	**Tridax procumbens* L.	H	Asteraceae	Gaddi chamanthi	Antiseptic, cut, wounds, burns	W
143	*Tylophora indica* (Burm.f.)Merr.	C	Asclepiadaceae	Mekameyami aku	Asthma, emetic	B,L
144	*Ventilago denticulate* Willd.	C	Rhamnaceae	Erra sulugudu	Tonic, post delivery treatment	B
145	*Vitex negundo* L.	S	Verbenaceae	Vavilaku	Sciatica, arthritis, eye trouble	W
146	**Withania somnifera* (L.) Dunal	H	Solanaceae	Aswaghanda	Reducing sugar, body strength, aphrodisiac	R,Sd
147	*Wrightia tinctoria* R.Br.	S	Apocynaceae	Doddapala chettu	Diarrhoea, dysentery	B
148	*Ziziphus mauritiana* Lam.	T	Rhamnaceae	Ganga regu	Aphrodisiac, diuretic	B,Fl,L
149	*Ziziphus oenoplia* (L.) Mill.	S	Rhamnaceae	Pariki	Digestive tonic, cut wounds	B, Fr
150	*Ziziphus xylopyrus* (Retz.)Willd.	S	Rhamnaceae	Gotti	Skin diseases	Fr

* **Planted/exotic/running wild;** B=Bark; C=Climber; Fl=Flower; Fr=Fruit, H=Herb; L=Leaves; R=Root; Sd=Seed; P= Parasite; S=Shrub; St=Stem; T=Tree; W=Whole plant

The Papilionaceae are the dominant family (Fig. 4.2) with 10 species followed by Caesalpiniaceae with eight, Apocynaceae, Combretaceae, Cucurbitaceae, Mimosaceae with seven, Euphorbiaceae, Malvaceae and Rubiaceae with five species. The rest of the families contribute one or two species.

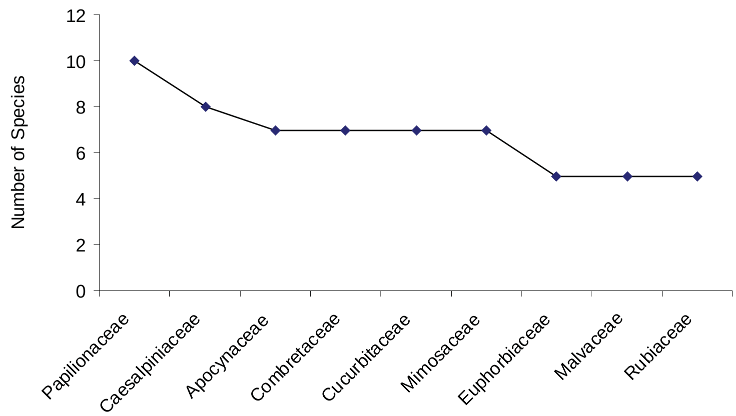

Fig. 4.2 Dominant angiosperm families contributing medicinal plants.

Herbs (57) dominate in their medicinal use followed by trees (50), shrubs (36), twiners (6) and parasites (1) (Fig. 4.3).

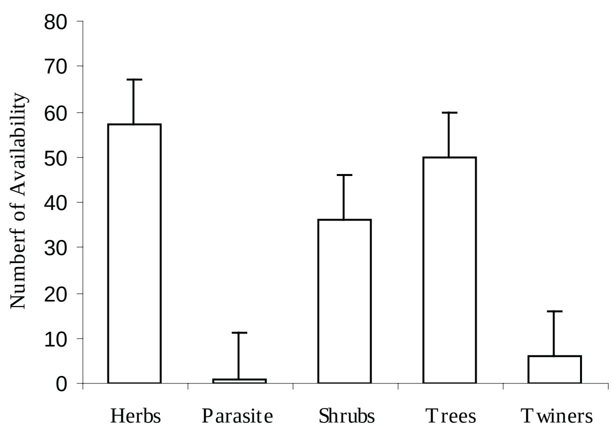

Fig. 4.3 Habit-wise analysis of the medicinal plants.

The local people and the herbal physicians use the following phytodrugs for common human ailments: (i) **Asthama:** Dishtapu teega (*Pergularia daemia*, leaves and stem), Usiri

(*Phyllanthus emblica,* fruits), Tani (*Terminalia bellerica,* stem bark) and Mekameyani aku (*Tylophora indica,* leaves). (ii) **Blood Purifier:** Barre sughandi pala (*Hemidesmus indicus* var. *pubescens,* whole plant), Pala teega (*Ichnocarpus frutescens,*leaves) and Chedu munaga (*Moringa concanensis,* stem bark). (iii) **Bone fracture:** Bandarae (*Dodonaea viscosa,* leaves) and Venna bera kaya (*Luffa cylindrica,* fruit) (iv) **Diabetes:** Tangedu (*Senna auriculata,* leaves and fruits), Rela (*Cassia fistula,* fruits and stem bark), Poda patri (*Gymnema sylvestris,* leaves), Chedu beera (*Luffa acutangula* var. *amara)*. Arati (*Musa paradisica,* fruits), Kakara (*Momordica charantia*, fruits), Boda kakara (*Momordica dioica,* fruits), Neredu (*Syzygium cumini,* seeds, stem bark) and Vempali (*Tephrosia purpurea,* whole plant). (v) **Diarrhoea:** Konda gogu (*Cochlospermum religiosum,* stem bark), Tella ummetta (*Datura innoxia*, whole plant) and Dodda palachettu (*Wrightia tinctoria,* stem bark). (vi) **Eye troubles (**including conjunctivitis and opacity of cornea): Gurija (*Abrus precatorius,* seeds), Brahmadandi (*Argemone mexicana,* whole plant), Tella and Erra jilledu (*Calotropis gigantea, C. procera,* all parts), Eetha (*Phoenix sylvestris,* fruits), Chilla (*Strychnos potatorum,* fruit) and Vavila aku (*Vitex negundo,* leaves) (vii) **Fever:** Nela vemu (*Andrographis paniculata,* whole plant), Vepa (*Azadirachta indica,* all parts), Kalimi (*Carissa spinarum,* fruits), Vishnu kranti (*Evolvulus alsinoides*, whole plant), Jegi (*Soymida febrifuga,* stem bark) and Tippa teega (*Tinospora cordifolia,* whole plant). (viii) **Skin diseases:** Chandra (*Acacia catechu,* bark), Chandra bheda (*Acacia chundra,* bark), Kasintha (*Senna occidentalis,* whole plant), Pachiteega (*Cassytha filiforms,* whole plant), Gunta galagara (*Eclipta prostrata,* whole plant), Pala teega (*Ichnocarpus frutescens,* leaves), Chitramulam (*Plumbago zeylanica,* whole plant), Kanugu (*Pongamia glabra,* bark) and Gotti (*Ziziphus xylopyrus,* fruit), and (ix) **Toothache and gum swelling:** Chandrabheda (*Acacia chundra,* bark), Murki tumma (*Acacia farnesiana,* bark), Kundeti kommu (*Caralluma adscendens* var. *attenuata,* whole plant), Marri (*Ficus benghalensis,* bark) and pedda eggi (*Pterocarpus marsupium,* bark). Photographs of the few medicinal plants (Fig. 4.4) available at Ramagiri hill forest are provided.

Apart from the medicinal plants, beedi leaves, gum karaya, tapsi, chilla, nux-vomica, brooms, ippa and copri are the major non-timber forest produce (NTFPs) collected and sold by the tribal and non-tribals people. Koyas are the main ethnic tribe who are though settled cultivators, depend largely upon the nearby forests for non-timber products. Nayakpods, the other important ethnic tribe, are also primarily agriculturists and podu (shifting) cultivators. They also collect forest produce. Lambadas, a gypsy non-local tribe, are largely workers and, at places, settled agriculturists. An estimate of their dependence on the local forest was made by Reddy (1996) and Rao *et al.* (1998). Most of the local communities are benefited by collection of beedi leaf (*Diospyros melanoxylon*), flower and seeds of Mahua (*Madhuca longifolia*.) and broom grass (*Thysanolaena maxima*).

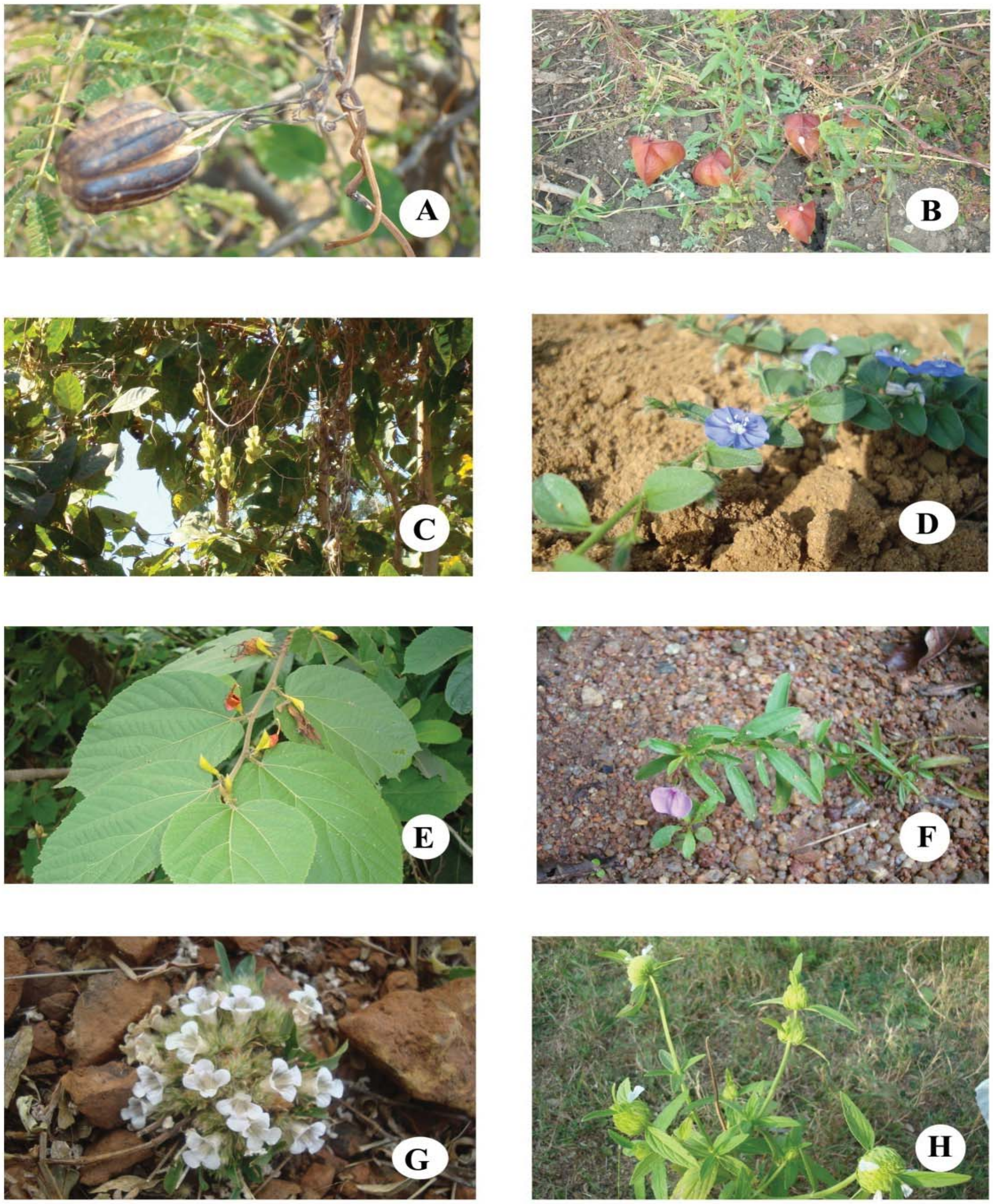

Fig. 4.4 Medicinal plants of Ramagiri hill forest.

A) Aristolochia indica; B) Cardiospermum halicacabum; C) Mucuna pruriens; D) Evolvulus alsinoides; E) Helicteres isora; F) Hybanthus enneaspermus; G) Lepidathis cirstata; H) Lecuas asper

Conclusion

The plants are used to discover bioactive natural products that may serve as leads for the development of new pharmaceuticals of hitherto unmet therapeutic needs. Ramagiri hill forest needs immediate attention from the standpoint of conservation. Karimnagar district is rapidly developing in all spheres through rapid expansion of urban limits, indiscriminate open-cast coal mining, granite mining, agriculture, irrigation dams, thermal power stations and cement industries which have bearing on forest ecosystem, and forest cover in the district. Againt this backdrop, Ramagiri forest should be announced as Medicinal Plants Conservation Center and need to be developed as ecotourism place along with Kondagattu and Singarayakonda hill forests and Mahadevpur reserved forests which are the important sources of medicinal plants in Karimnagar district of Andhra Pradesh, India.

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5

Foundation of Green Marketing; Green Production from Natural Resources; A Classic Case - Amino Acid: Green Technology - India Supremacy

— R. C. Gupta, V. Sharan

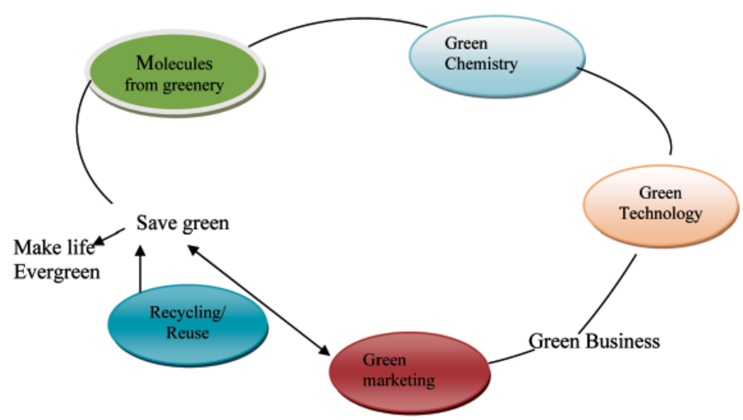
ABSTRACT

The maximum adverse affect on man and Biosphere is from non other than chemicals. Both to some extend can sustain the ill effects of others but when it comes to chemicals their existence became a question leading to uncertainty. To reverse the situation it is necessary to find the causes of such happening and subsequently to find genuine solution. Since problem has arisen due to ill care of nature, hence remedy should be also from that. The well known proverb, "Nature has every thing for need not for greed" should be the principle behind the remedy and nature greenery must be maintained. Any serious subtraction will bound to be counter effective; to overcome such situation it is necessary to have products, commodities available for use or comfort must not be detrimental to nature and its habitat; the man and animals. To maintain the green it is necessary to check the sources which are affecting most; the chemicals. Manufacturing of chemicals is a lengthy process which used large number of toxic substances harmful to men and surrounding. Hence the best way is to avoid such happening, as much as possible. synthesis of such chemicals it is necessary to follow the principle of green chemistry leading to green technology, and the product obtains through such technology will constitute green business ultimately green marketing. Amino acid production through use of natural resources is a good example, with large number of technologist and scientist, further of green technology is bright in India.

Introduction

Chemicals are not single minded, they change their mood in accordance to neighborhood happening and can be foe or friend depending on situation. In a rightful combination they may save the life, and add to enhance the quality of life in other way can be detrimental to life. Thus major harm can be done only by chemical and in practice it is true also, the fossil fuel, notorious form of energy, to ozone depletion are for behind it.

To save the planet it is necessary to save the environment in return there must be equilibrium between subtraction and addition of natural resources. Natural resources are like fix deposit in bank, if someone withdraw premature then likely to have reverse consequence leading to, destabilization and liquidification. To avoid all such happening it is better to care now then to find cure later. Chemical hazards are now very common toxic substances are making life hell and affecting our health and making us disease prone. The core of ours strength vitamins, protein, minerals and amino acids are also get depleted and require regular supply. Productions of such molecules from synthetic sources many further aggravate the situation and there is chances that steps use in synthesis may pollute the environment ever more. Hence there is a need to produce such substances from the natural resources with less/ no harm to nature. While taking an example of amino acid production, perhaps a nature based green technology can be develop while observing a path as below.



Green cycle

Strategy for Green Business:

Any type of business strategy is a combination of choices, scenarios and values and can have short term and long term objective with scope for upside and downside. Such vision must also take in account sustainability when sustainability, combined with environment and ecology is normally known as “Green to Gold”. Sustainability is composite in nature with several steps which include Eco-efficiency, eco-expense reduction, value-chain eco efficiency, ecologic control, eco-design, eco-sales and marketing, eco-define new, market space and intangible value. If these are taken into consideration than it's comes under green business strategy. Green business strategy also addresses pollution. Pollution can be minimizing with follow of pollution, prevention Hierarchy. Prevention of the unnecessary material is good. It is also help to sustain if we reduce the material, we can further add to sustainability by accepting to reuse or recycle the material. If we can able do so then before disposal, proper treatment is must which will reduce the pollution:

Prevention and Reduction

Recycling and Re use

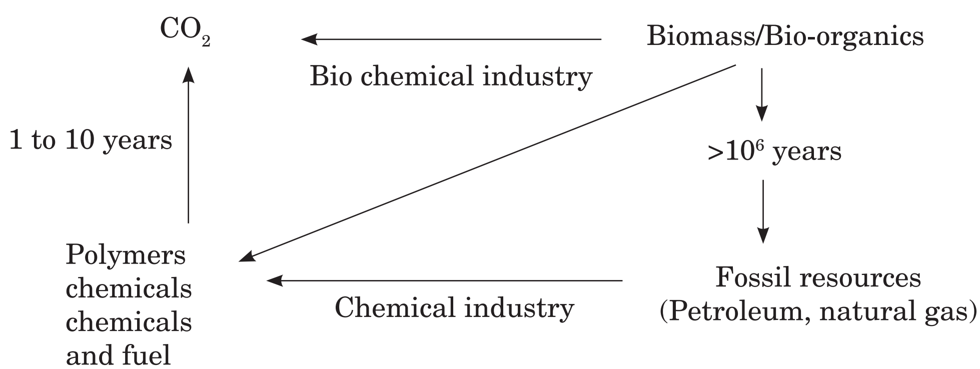
↓

Treatment

↓

Dispose

Balance between carbon used and carbon produced must be maintain, as most of the carbon is used by plant during photosynthesis, hence if number of plants are more, there are chances of more utilization of carbon leading to carbon equilibrium.



Renewable carbon CO_2 and biomass ⟶ New, Bio chemicla industry small entepreneurial business global carbon cycle – the eco drive ⟶ Green polymers and chemical

Hence raw material or feed stock should be renewable rather than depleting where ever technically and economically practical.

Is our society sustainable? If not why and what should be? looking the past and seeing the current one can easily conclude that perhaps our society is not sustainable and bound to face great consequences, just to avoid the extreme 'changes are definitely needed; one can easily observe, the mess created by us; all around us heap of solid waste, evidence of impact of human and industry on air, water and soil, subsequent on human and animal health and plant ecosystem. To avoid all these reuse and recycle is fast option to protect environment.

It is desired that in a sustainable society, science and technologies used for production of human need must not harm the human and environment and resources. Hence a sustainable society must include these elements, environment, human health, a stable economy, an efficient economy, in respect to energy and resource and social and political justice.

A society constantly facing environmental question, pollution of different nature, toxicity of various metals to soil, air, water, phenomena of acid rain, accumulation of natural, artificial as well as nuclear hazardous waste will likely to have question mark on long survival. In addition to this hole in ozone layer, sever climate change and uncertainty, oceanic temperatures are adding much to headache.

In fact majority of all these problems has a "core" molecule-chemistry. Hence solution must come from chemistry, to search and find path ways to minimize the environmental impact of human activity, industry and technology. A possible solution has emerge in the form of Green chemistry – a source for preventing pollution, sustaining Earth with a motto, "It is better to prevent waste than to treat or clean up work after it is formed".

Resource Management and Green Chemistry:

Renewable resources can be made increasingly viable, technologically and economically, through green chemistry using the following:

Biomass
Nano science and Technology
Solar energy
Carbon dioxide
Chitin
Waste utilization.

Energy requirements should be recognized for their environmental impacts and should be minimized. Green chemistry is now well defined and is a establish reality. Through father of Green Chemistry Paul Anastas define it, "The design of chemical products and processes that reduce or eliminate the use, and generation of hazardous substances". Through green chemistry one can have reduced waste, reduce consumption of resources and reduce consumption of energy, hence preventing harm to people and environment.

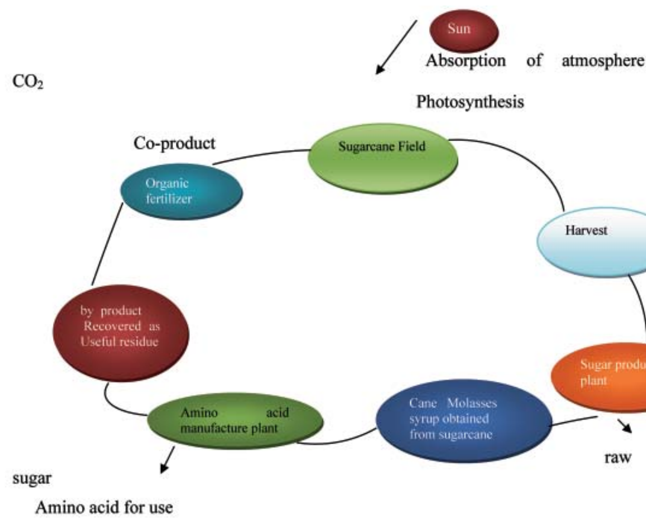
Objective of Green Chemistry

Green chemistry starts work of pollution prevention on the molecule scale. Green chemistry Program planning results into invention of more environmentally friendly chemical processes and route which reduce or even eliminate the generation of hazardous substances. The whole program planning is based on twelve principles of green chemistry which prime motto is human-environment safety. Chemistry plays undeniable a very prominent part in our daily lives, from wake up to sleep knowingly of unknowingly we are chemistry dependent, take example of tooth brush to tooth paste or from pillow to blanket all made from chemical substances but we do not know whether molecule inside it are friend or foe to our health. Chemical developments also bring new environment problems and harmful unexpected side effects hence there is need of green chemical products. In gist one can easily conclude, green chemistry is the utilization of a set of principles that reduces or eliminate the use or generator of minimization hazardous substances in the design, manufacture and application of chemical products and results in the waste minimize at source. Use of catalysis in place of mostly toxic reagents, utilization of renewable resource and improve technology are some of the advantages of Green Chemistry.

Green Production of Amino Acids

Essential molecule of life Amino acids are building block of protein and also have several physiological action their deficiencies are cause of several disease and dysfunction of organ. Amino acids are requiring maintaining good health of man and animals, both. Their production business has profound possibilities. To avoid synthetic route for their production, these amino acids can be produced by fermenting locally available agricultural products like sugarcane, cassava ad corn Amino and production process generate Co-products in amounts that are several times larger than those of the main products, the amino acids. These co-products are also rich in natural nutrients and can be used as feed and fertilizers and they can greatly help to reduce the environment impact. The green technology utilize to produce Amino acids have form main features.

(1). Co-operates with and contributes to the local Agricultural Industry (2) endeavors to achieve zero emission for CO_2, in discharge waste and other waste (3) Make full use of by products and co-products (4) explore the potential of amino acids and the co-products to enhance environment beneficial function are value, thus developing a biocycle.



Bio-cycle production of Amino acids and utilization of co-products

Feed – use Amino Acids and Ecology:

Feed use amino acids, provides the livestock industry with a lot of useful functions. Feed – use lot Amino Acids can effectively participation in attaining less environment load on or soil and water. These useful contributions of feed-use Amino Acids can be elaborated further.

Three Contributions Made by Feed-use Amino Acids

Less Environmental Load on Soil and Water

Reducing nitrogen in the excreta from livestock

When animals are given feeds that are deficient in even one of the amino acids needed, the body cannot effectively use the other amino acids. Thus end up being wasted and excreted as nitrogen compounds. Excessive excretion of these compounds can have the impact on soil and water. Supplementing the deficient amino acids with feed-use amino acids improves the efficiency with the animals' bodies utilize amino acids. This leads to a lower amount of excreted nitrogen and helps reduce environmental load.

Combating Global Warming

Suppressing the generation of N_2O-

Nitrogen compounds from manure and urine are oxidized/reduced by soil and air, with some nitrogen being released into the atmosphere as nitrous oxide (N_2O). The greenhouse effect of N_2O is about 300 times that of CO_2, N_2O has the next largest impact on total global warming after CO_2 and methane. The use of feed-use amino acids can contribute to the prevention of global warming by reducing the amount of nitrogen contained in livestock excrement, which causes the generation of N_2O.

Helping Solve Food Problems

-Effective utilization of farmland-

The use of feed-use amino acids also enables the simultaneous achievement of increased food production and environmental conservation. Common compound feeds for livestock are composed of ingredients such as corn and soybean meal. Nutritionally, 50 tons of soybean meal in 1,000 tons of compound feed can be replaced with 48.5 tons of corn and 1.5 tons of crystalline lysine, since the yield per unit of land for corn, which is also the raw material for lysine, is about three times higher than that of soybeans, about 18 hectares of farmland can be saved by making the switch from soybean to corn production.

Green Technology- India's Supremacy

India is a God gifted land which has every thing for need not for greed. A country with enough water, air, sunlight and vegetation, require sustaining the life. But then why we are in environmental stress condition? Perhaps the reason behind is not to recognize our potential and utilize resource in a proper way. Lack of for lightness and adhacsim are two important draw back. There is a need to follows the principle of care, share, consume and compensate the natural resources. There is no doubt if our natural resources; water, air, greenery and sun when clubbed with sustainable technology; it will provide pillar to India's Green Future and with no doubt India is set to revolutionaries use of green technology is coming decades and in next ten years. India's chance of becoming the global workshop for such technologies is just like, in late eighties and early nineties came with the big boom in communication and information technology, and India quickly moved in at the high end.

Be is the case of energy production to manufactures of Drugs and Pharmaceuticals; it is safe to assume India will employ more energy efficient "Leap Frog" technologies. Incoming decade in energy sector major share of energy production can be through water, air or from solar means. Bio fuel will also contribute in energy production. The pollution free solar energy, through photo voltaic means may be a regular feature of every house hold.

Through India has all to make on live comfortable, yet it require education, infrastructure, innovation, plurality and enlightened, as well as adaptable environmentalism.

Conclusion

Survival and sustainability of a market is linked with good practice of business and business is a collective term of sell and purchase of commodity. Hence longevity of the market is dependent of commodity supply line. If supply line is broken there is possibility that whole market may collapsed thus it is necessary to have sources of commodity for considerable longer duration. As basically all the raw materials to make sellable commodity is extracted from nature directly or indirectly hence it is wise to think and act so that natural resource equilibrium must exist and if this can be achieved then all the relevant term viz, market, business, products will be added with a prefix green and will be the signal of sustainability. There are number of parameter comes under damage to green coverage like energy, fossil fuel and many other but chemicals are on the front for polluting environment, affecting Human and biosphere. As majority of the chemicals are synthesized using toxic substance, hence there is more chance to further aggravate the situation. To minimize this, if green chemistry principles are used it is possible and feasible to minimize the ill effect. Production of bio fuels, bio derange, phyto- remediation with save our planet to greater extent. Future of green technology in India is very bright, and it is likely that in coming decades India will be able to mange sustainability problem. We are an aspiration country. Today we see a commitment at industry, government and people level. This country has a vision and self confidence and now much more is invested in education institutions and developing human resources, I am sure India's world class intellectual and scientific community will definitely able to provide genuine solution to any such problem to keep the country ever green.

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6

Extending the Circle of Agribusiness Management to New Horizons: Functional Foods, Nutraceuticals and Beyond

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ABSTRACT

Though agriculture is an ancient profession ,but in recent time ,it has evolved into agribusiness and has become a vast and complex system .This complex integration covers not only the farm and farmers but also to those who provides inputs (for ex seed, chemicals ,credit etc)as well process the output (for ex milk, grain ,meat etc) to manufactured food products (for ex ice-cream, bread to breakfast cereals etc).In addition to this, linking farm to market and subsequently to consumers also comes under the preview of agribusiness management. With the beginning of this new millennium, agribusiness system has undergone rapid transformation as a new industry with noticeable change in traditional farming system; becoming more specializes to take care of consumers' demands as well as consumers acceptance.

The growing economics and desire to be health and happy make the people more health thinker hence consumers attitude towards life and living is fast changing and because of this changing lifestyle, has also given birth to lifestyle diseases First victim of this life style change is food habit, consumption of junk foods has increased many folds ,resulting occurrence and spreading of several deadly diseases related to nutritional deficiencies .Drug therapy of these diseases often could not provide desire effects even some time exhibit toxic effects/symptoms with series of complications ,since this situation has immerged because of nutrition and food problem hence answer must be obtain from there itself only . In reality to cope such happening, birth of tern nutraceutical in 1989 and functional food in 1993, has found to have great impact in current wellbeing .Nutraceutical and functional food can provide a tool to explore the interface between medical and food science as Chinese saying "Medicine and food have common origin "hence plays a big role in health and happiness of society as well as people linked with it._

Keywords: Management, chemicals, farmers, consumers, new millennium, traditional farming

Introduction

Food as defined by WHO is substance which is consumed by a living organism to meet the energy and nutrients needed for life and growth. Food can be categories in two major group, normal food just food for everyone need, and food stuffs intended for specific nutritional uses. The second categories facilitate the concept of functional food. Thus a normal food can become functional food if a designed component has been added or removed for some specific purpose. The addition or subtraction can be of one component or more to suit the bioavailability for masses or to certain group of population.

The modified component of the food are designed in a such way that it becomes beneficial for cure or the prevention of diseases, leading to restoration and effective modulation of body functions. Such functional food can be a part of infant formula to précised cereal based food, baby food for infants and growing children. It can also be a part of regulating energy need, like restricted diets for weight loss and other symptoms. Food can be for special medical purposes likes diabetes, alleviation of various symptoms associated with ageing and many more. Where as nutraceutical is a substance that is a food or a part of food and provide medical or health benefits ,including prevention and treatment of diseases ,such products may range from isolated nutrients, dietary supplements and specific diets to genetically engineered designer foods and herbal products .thus nutraceuticals are products prepare from food but sold in the form of pills or powders(portions) or in other medicinal forms not usually associated with food .There is little difference between functional food and nutraceuticals ,when food is being cooked or prepared using scientific intelligence with or without knowledge of how or why it is being used ,the food is called functional food includes enriched cereals, breads ,sport drinks, bars, fortified snake foods, baby foods, prepared meals and more, where as a nutraceutical is demonstrated to have a physiological benefit or provide protection against decease .A functional food could be a kind of nutraceutical ,yet nutraceutical is distinct from functional food .Some of the important nutraceuticals from food sources includes ;ascorbic acid, selenium, lignin, glutathione, β carotene, □ tocopherol and many more .There are several nutraceuticals that are found in higher concentration in specific foods or food families .Marketed preparation of nutritional supplements are prepared in relation to a particular object like mineral supplement to hangover supplement and from neurotonic to memory enhancer.

In doing all these; innovation is essential for business and nearly 2/3 of American population takes at least one type of nutraceutical health product. Nutraceutical industry growth since 1995 is 7.1% per year and global nutraceutical market grew to 46.7 billion US dollar in 2002 and expected to reach 24 billion US dollar in 2015 .In Indian scenario, during the past 5 years Indian nutraceutical market has been growing at rapid pace; it is a fastest growing sector among other sectors of food and pharmaceuticals market and likely to sustain the growth rate in coming years and expected to reach 4.2 billion US dollar in 2017.Overall Indian functional food & nutraceutical market is emerging with strong growth potential due to escalating health awareness and with new found achievements in sports, scientific development as well as, desire for weight measurement, suppression of ageing symptoms , to maintainer of blood glucose and cholesterol all these will act as catalysis for promotion of this enlarging and expending agribusiness.

It is very hard to trace the origin of agriculture, but seems to a gift of women who gave the concept of home by taming man and settled agriculture .For many centuries the main purpose of agriculture was to feed the people but with pace of time linkage between communities gave birth for desire for some thing more to cope with need thus exchange of agricultural commodities started initially through batter system where give and take was symbol thus making ground for foundation stone of agribusiness. In couple of past centauries; this concept of agribusiness has changed a lot and has been redefined several time, extended to include several parameters. This transformation did not happen in a day or even in a year ,but came slowly as a response to a varieties of forces .Not much before; farmers used to produce the input require for agriculture ,may be seed ,draft animals ,feed to simple farm equipment and majority of agricultural produce were utilized by farmer and his extended family, a very small portion which was nor consume was sold for cash to cater other needs ,the cash earning by selling the produce catalyzed the farmer to be more concentrate on production only. With this in mind farmer stared to search the way to get input and started to purchase inputs .This new trend enables other to build business that focus to meet the input requirement for agriculture production ,such as seed, fencing, machinery and others thus constituting a new term “ agricultural input sector” During the same period a commodity processing and food manufacturing move off the farm to make the farm produces more useful and convenient to consumers, for ex consumer willing to buy flour than grind the wheat themselves or arrange for gridding and will not mind to pay extra for processed commodity (flour) instead of raw agricultural commodity(wheat) in similar fashion many commodities like rice, milk, livestock were processed for consumers liking .Probably during the same period a new concept of food preservation also came in existence where perishable nature of most agricultural commodities which are available only at harvest ,with the advancement in food technology has made it possible to get those commodities every day round the clock and this latest addition to agriculture comes under” processes and manufacture sector”.

Having all above in mind the definition of agriculture had to be extended to include not only the production but also to care input industries, processes, food manufacturing to chain of food distributors and finally retailers involve in purchase their raw agricultural commodities, ,processes and delver them for sell to consumers .In real sense this extended family of core agriculture has been integrated with new term “agribusiness” first introduced by Davis and Goldberg in 1957 In a principle successes of any business depends how good is inter and intra relation between its different components of business system and success of one component heavily depends on success and functioning of other components ,hence to integrate all the components in right combination the word management come to stand .In short management is art of getting things done through people and it is a multi purpose organ that manage the system or in other words business.

Now agribusiness sector is well defined and covers diverse components; yet still growing and assimilating several new .With growing economy and prosperity consumers are becoming more and more casus about food and its benefits as well as looking for more valuable food items and their role in health and happiness .Consumers are now turning away from concept of “food to feed” but moving towards “food for health and to keep fit.”With this new slogan consumers desire got attention from the academia as well industry and combine efforts of both resulted in the identification, isolation as well as recognition of substances which can help to maintain fit and healthy .These substances were expected to alleviate the symptoms of disease and also to prevent/cure diseased state .The term “functional food” was introduced for such substances with a hope that what a drug does in very short duration same effect can be exhibited by that particular food if it is used for considerably longer duration ,while drug is in form of capsule/ tablet or in some other form, but functional food will be part of normal diet . The new functional foods were much liked by consumers and soon it became the house hold name .During the same period as functional foods are time consuming and one has to wait for long to get noticeable changes another more effective term came in to prominence, ”Nutraceutical “which is still not a drug but in common words concentrate of food actives or natural substances which are found in our body /required for growth and maintainer. Nutraceuticals may be in form of capsule or similar design. Scientifically there is not much difference between functional food and nutraceuticals but technically some differences do occurs. Functional food and nutraceuticals gave a big boost to utility of agriculture produce to earn much higher income and opened a new era for agribusiness.

The world scenario of functional food and nutraceuticals market since their inception is always in ascending order with average 7%increse yearly and is expected to grow 9.9% in current decade crossing 200billion $ by the end of decade. In India also this market is catching up and has shown an increase of 18% in past three years and likely to be 5 billion $ in 2015.This happy growth of functional food and nutraceutical market can provide rich dividend to agribusiness system but it still require an efficient management and regulation to develop faith and trust in consumers.

What we Understand of Functional Foods

Food as defined by WHO is substance which is consumed by a living organism to meet the energy and nutrients needed for life and growth. Food can be categories in two major group, normal food just food for everyone need, and food stuffs intended for specific nutritional uses. The second categories facilitate the concept of functional food. Thus a normal food can become functional food if a designed component has been added or removed for some specific purpose. The addition or subtraction can be of one component or more to suit the bioavailability for masses or to certain group of population.

The modified component of the food are designed in a such way that it becomes beneficial for cure or the prevention of diseases, leading to restoration and effective modulation of body functions. Such functional food can be a part of infant formula to précised cereal based food, baby food for infants and growing children. It can also be a part of regulating energy need like restricted diets for weight loss and other symptoms. Food can be for special medical purposes likes diabetes, alleviation of various symptoms associated with ageing and many more.

There is no doubt that functional food can modulate target- functions but the art of mechanism of functional food-action is different than drug action mechanism; in general functional action is in two ways.

Functional food

Modulation of Target functions	Modulation of diseases conditions
↓	↓
Enhanced functional activities	reduction risk claim
↓	↓
Restoration of normalcy	Restoration of normality

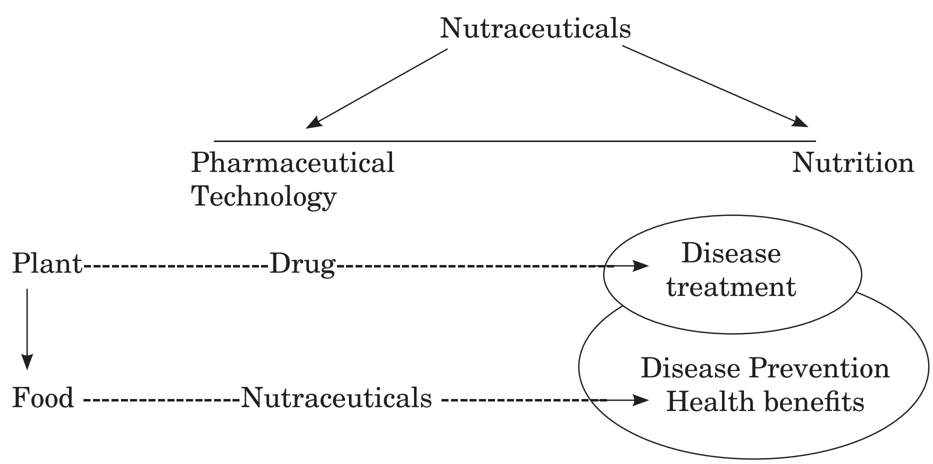
Though the functional food has ability to exhibits reduction of diseases, risk claims with enhanced functional activities but still there are many unsolved questions like safety, scientific verification of claim effects, advisability in diseases related claims, clear differentiation between food and drug, all these need urgent attention. However in spite all these, functional foods have edge over conventional food and deserve expansion, extension and enlargement but with justification.

Factors Behind Functional Activity:

In principle diseased state of health is due to weaken host defense and related activities. Radiation hazards have direct effect on biological safety. Effect of radiation includes cyto-toxicy chromosome aberrations, protein oxidation, muscle injury and may metabolic and biological changes. Agents providing such actions called free radicals. For alleviating their effect and returning to normalcy, it is necessary to monitor their activities to reduce effects. Agents responsible for such actions are commonly called antioxidant. Host defense is mediated through production of inflammatory mediators by macrophage which includes MOP, TNFα, IL-1β, IL-6, IL-8 and many others. Molecules which are responsible for the regulating the production of these agents will participate to strengthen of host defense, resulting reduction of diseases risk.

Nutraceuticals

The term nutraceutical was first introduced by Stephen Defelice in 1989 by amalgamating the words nutrition and pharmaceutical and it can be any substance; that is food or part of food which is/are capable of providing health and or medical benefits including prevention and or cure of disease .A nutraceutical may be an isolated nutrients, dietary supplement, specific diets and even genetically modified/engineered designer foods to herbal products.



Benefits of Nutraceuticals & Functional Foods

From consumers point of view nutraceutical and functional food may offer several benefits:

May increase health value of diet
May help to live longer
May help to alleviate symptoms of ageing
May help to overcome a particular medical condition
May have psychological benefits
May be feeling of more natural and with less toxic as well as side effects

May provide food for certain group of people like people with vascular problem /cancer or some other or even for elderly where more specific food (nutrient rich) is require coping the situation With all these beneficial factors nutraceutical and able to bridge gap between food and medicine and justifying the old saying, “Let food be your medicine and medicine be your food”.

Food and non Food Source of Nutraceuticals

Nutraceutical may be classified on the basic of plant ,animal as well as microbial source(bacteria yeast many nutraceuticals may be found in both plants and in animals and some time even in microbes also for example choline and phosphotidylchloline ,also sphingolipids which is found both in plants and animals.

The non food sources can be obtain by fermentation for example amino acids can be produced by bacteria grown in fermentation systems The emergence of recombinant –genetic techniques has enabled new avenues for obtaining nutraceuticals .production of nutraceutical like eicosapentaenoic acid (EPA) by bacteria is a good example

Common Nutraceutical by Food Source

Food is source of energy which is require to maintain the routine activities as well as to keep fit. It has been suggested that human should consume about 5000 ORAC (Oxygen radical absorbance capacity) units a day for maximum benefits .There are a large number of food items cereals vegetables fruits which contain active ingredients in the form of chemical agents which are known to be beneficial for health,one of the major factor behind ill health is week host defense system which become incapable to fight against harmful agents in the common words oxidants or free radicals which are responsible for diseases state there are several food items which has ability to scavenge such free radical this capacity is measured in form of ORAC higher the ORAC score better to consume however amount of item in each case has been standardized to get such score

Food items	**ORAC Score**
1. Cloves ground	314,446
2. Sumac bran	312,400
3. Cinnamon, ground	267,536
4. Sorghum, bran, raw	240,000
5.Oregano, dried	200,129
6.Parsley, dried	74,349
7. Basil dried	67,553
8. Curry powder	48,504
9. Chocolate ditched powder	40,200
10. Sage	32,004
11. Mustard seed yellow	29,257
12. Ginger ground	28,811
13. Pepper black	27,618
14. Goji berries	25,300

15. Chilli powder	23,636
16. Pecans	17,940
17. Paprika	17,919
18. Elderberries raw	14,697
19. Sorgham, grain red	14,000
20. Peppermint, fresh	13,978
21. Oregano, fresh	13,978
22. Walnuts	13,541
23. Pears, dried	9,496
24. Savory, fresh	9,465
25. Pink beans	8,320
26. Black beans	8,040
27. Pinto beans	7,779
28. Plums	7581
29. Lentils	7,282
30. Apples, dried	6,681
31. Garlic powder	6,665
32. Blueberries	6,552
33. Soybeans	5,764
34. Onion powder	5,735
35. Basil, fresh	4,805
36. Almonds	4,454
37. Cowpeas	4,343
38. Apples, red delicious	4,275
39. Raisins, white	4,188
40. Strawberries	3,577
41. Figs	3,383
42. Gooseberries	3,277
43. Apricots, dried	3,234
44. Peanuts, all types	3,166
45. Cabbage, red	3,145
46. Broccoli	3,083
47. Apples	3,082
48. Guava	2,550
49. Lettuce, red leaf	2,380
50. Concord grape juice	2,377

Market Trend of Nutraceuticals

Nutraceutical industry has three main segments, functional food dietary supplements and herbal/natural products in 1995 natural and organic food market was $80 billion of which functional food was 16 billon but it has grown to 47 billon in 2002 and 75 billion 2009 hence market trend is very encouraging with 7-9% yearly increase .

India Share in Nutraceutical Marketing

Indian nutraceutical market is increasing with much faster rate the world average in past 5 years. The global nutraceutical market in 2008 was estimated to be $ 117 billion, of which Indian's share was only 0.9%. The global market is estimated to reach $177 billion by next year, growing at a healthy CAGR of 7%. With increasing penetration of preventative healthcare products in the Indian market, growing health awareness, higher disposable income and other factors, the Indian nutraceutical industry has shown a promising CAGR of 18% in the last three years. According to one report, the total Indian nutraceutical market in 2015 is expected to be roughly $5 billion. Fast moving consumer goods (FMCG) companies, and pharmaceutical companies are major players in Indian.

When nutraceuticals were introduced in India, most of the industry leaders wondered if nutritional supplements would gain acceptability in the Indian prescription driven health and wellness industry. Contrary to their concern, nutraceuticals were well accepted, particularly by the upper-middle segment of the Indian population. However, the industry is in a nascent stage and holds ample opportunity to grow in future. There is a strong need of developing customized products, affordable pricing and distribution strategy. According to Indian nutraceuticals Market Forecast & Opportunities, 2017, the nutraceuticals market in India is expected to grow tremendously in the next five years. The Indian nutraceuticals market revenues are expected to reach approximately USD 4.2 billion in 2017.

Future Prospects

The enhanced level of awareness about fitness and health in this new millennium supported by media prompting a vast majority of people to lead a HEALTHIER LIFESTYLE, resulting more attention on ; what to eat and what to drink and this has turn the table in favor of new found interest in nutraceuticals and functional foods .hence nutraceuticals industry is expending very fast and global trend to healthy products cannot be reversed. Though the prices of some nutraceutical products may drop as generic products make their way into the market but, people dependence and faith on these products and their increasing availability provides a clue for the growth of the market shall remain stable.

Conclusion

There is no doubt that agribusiness is extending, expending, enlarging and assimilating several new entireties to make it more consumers friendly; creating a new era of agribusiness management. In principle successes of any business depends on consumers faith, utility, goodness .availability, Affordability .In addition to these present day consumers also thinks of contribution of the commodity in term of health and happiness thus designing the products and its marketing is now also linked with this object. In reality good health is precursor of happiness, while changing life style, use of fast food had added significant contribution to development of several new diseases as well early appearance of diseased state and symptoms .The old proverb,"prevention is better than cure" is still a better option .In fact the major reason behind diseased state is defective "host defense" and a weak host defense system will not able to fight against enemies. The modern theories of diseased state blame weak protection against free radicals. Free radicals are born due to several factors and mostly in form of Oxygen but to some extent in Nitrogen also. These free radicals are short lived and generally combine with other agents to produce harmful molecules which in return damage the host .Thus there is urgent need to trap these free radicals in other words to hold these radicals .There are many agents found in nature has such properties and belongs to number of cereals fruits, vegetables, meat, marine products and some more. These agents have power to trap the free radicals thus avoiding diseased state. Power to trap the free radicals is express in term of "OR" higher the OR value better to use. When these agents are used as part of food/diet to provide medical and health benefits then they are term as components of functional food and nutraceuticals. Technically there is little difference between functional food and nutraceuticals where functional food remains as part of food but nutraceuticals can be in form of tablets, syrup or some others. Benefits of nutraceuticals are numerous may increase health value of diet, help to live longer, alleviate symptoms of ageing to psychological benefits. Besides herbs a large numbers of cereals, vegetables especially leafy, and fruits have high power of anti-oxidant values and are classified as nutraceuticals but the real agents in theses items are presence of certain chemical molecules like amino acids, flavonoides ,terpines ,cumarines some other who possess such properties. Similarly meat products also contain such agents hence can be used to prepare nutraceuticals. Nutraceutical industries are now occupying central stage in agribusiness management, business is booming with annual increases of 7-9% creating new jobs the world market is expected to reach 20billion $ by the end of this decade. In India too we are not far behind though we started little late but rate of growth is very fast and in past 3 years we have seen a growth rate of 18%. Indian market is now flooded with functional food and nutraceuticals items making the things complicated; what to accept and what to reject, which is real which is fake; there is an urgent need to check this mess and to develop legislature, regulation to check mushroom growth of this market otherwise Indian consumers is standing on cross road where there is no mile stone and is puzzle where to move.

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Agro Diversification: A Sustainable Approach for Poverty Eradication in India

— Ganesh Kawadia, Sheena Sara Philips

ABSTRACT

Agriculture is the backbone of Indian economy. It contributes around 15 per cent to the GDP of the economy and provides employment to about 60 per cent of the labour force. More than 70 per cent of the population lives in rural areas which are mainly dependent on agriculture for their livelihood. Till 1985, India could enhance its average GDP growth rate to just 3.5 per cent (Hindu Growth Rate) which was later enhanced to more than 8 per cent during XIth Plan period. This growth was mainly due to enhanced performance of service sector which made the country as one of the emerging nations in the global economy. In spite of this remarkable growth in the post liberalized period, the issues of poverty and unemployment could not be resolved. Almost, 29 per cent of the population still lives below poverty line. Majority of the poor population are either dependent on rural economy or on agriculture for their livelihood. The astounding growth performance of the economy and in fact, the planned development efforts of the Government too has failed to improve the condition of rural poor. The Government has launched many programmes for eradication of poverty but the progress of all these programmes is far away from satisfactory. Undeniably, no nation can maintain quality of life or achieve sustainable development without uplifting the population from poverty.

As mentioned above, isolating poverty from Indian agriculture is a daunting task owing to the livelihood dependence of the population on agriculture. And therefore the role of agriculture in the Indian economy cannot be underestimated. The technological improvement of the late 1970s has pushed the growth rate in agriculture. The agricultural sector of the country has grown by about 2.7 per cent per cent per annum during the last fifty years. As a result, the total food grain production has reached from just 50.83 million tonnes in 1950-51 to more than 260 million tonnes in 2011-12. The cereal production comprising of rice, wheat and coarse cereals grew from 42.42 million tonnes in 1950-51 to more than 227 million tonnes in 2010-11. This remarkable growth has made this country self-sufficient in wheat and rice and we now export these crops to many countries.

Keywords: Poverty, Sustainable development, economy, cereal production

Introduction

The shining side of agriculture sector has not helped much in the improvement of the people living below poverty line. Since, majority of these people do not have any other occupation or skill, therefore their condition can only be enhanced by improving or making agriculture more efficient and productive. Increasing pressures on the physical environment like climate change, soil erosion, and other environmental pressures necessitate the need for agricultural producers to tune their production systems in such a manner that they make the most efficient use of the resources available not only in economic terms, but also in social and environmental contexts. This requires better management of natural resources such as land and water which can lead to better diversification of agriculture into more value added products like oilseeds, pulses, fruits and products with higher protein value. This is also essential to fulfill the demand of growing economy and also to ensure food security.

The agricultural diversification can be understood in terms of horizontal (crop diversification) and vertical diversification. Horizontal diversification describes how a farm unit allocates its land and water resources to produce various crops in a particular year. This diversification can also be achieved region wise where different regions are motivated to produce different crops depending upon their specific geographic conditions. Vertical diversification can be understood as shifting from agriculture/farm activities to allied/non-farm activities. Further, it can also mean to create demand downward in the commodity chain by value addition through processing and marketing which can also imply crop specialization in the context of increased demand for processed foods. Examples include dairy farmer who makes butter or cheese or a cotton planter who gins his own cotton takes a step towards diversifying the same crop. As **Ngaruko (2003)** notes that price volatility for processed goods is comparatively lower than their raw counterparts that could prove to be stable source for higher export earnings. Agricultural diversification is also imperative in the context of slow but steady structural transformation of the economy. This in turn, can smash the required agricultural production level which is needed not only for export portfolio but also for domestic consumption. Diversification can help to hold labor in agriculture because of better scope for viable opportunities. **(Timmer, C.P., 1997).**There is thus a need to study the extent of agro diversification and its impact on poverty in India

Review of Literature

The growth trajectory of India precludes a large fraction of poor people leaving them entangled in abject circle of poverty. With declining role of agriculture and increasing contribution of services sector in driving the country's growth momentum when agriculture sector holds the highest employment dependency is a crucial issue from the viewpoint of sustainability. As **Wallack J.S. (2003)** notes that economic growth that is not accompanied by sectoral growth rates implies mere re-allocation of resources to faster growing areas of the economy. He further asserts that the scope of this kind of acceleration is inherently limited since the initial increase in growth peters out once the decreasing returns to scale sets in. On the contrary, if there is faster sectoral growth rate, transformations are not only deeper but promise better prospects for sustainable growth. **Anríquez, G.& Stamoulis, K. (2007**) finds a positive and significant relationship between poverty and rurality wherein 85 per cent of the differences in poverty is explained by the level of rural population whereas **Datt and Ravallion (1996)** show that economic growth in rural sector of India reduced poverty in both rural and urban areas, while economic growth in urban areas did little to reduce rural poverty. **Lewis (1954) and Johnston and Mellor (1961)** highlight following key functions which enable broader economic growth and development in the economy as a result of growth in agriculture sector : **a)** the rise in the size of agriculture based incomes raises demand for goods and services produced outside of the agricultural sector owing to multiplier effects of agricultural sector with increased farm incomes; **b)** savings can be generated for further investment **c)** provision of labor force; **d)** provision of affordable food which allows urban areas to develop and maintain wage rates at competitive levels; **e)** and lastly, the agricultural sector provides for a raw material base to support manufacturing sector.

Ninan K.N., (2000) in a study of fifteen major states found strong negative relationship between agricultural growth, access to the PDS and rural poverty levels in India whereas relative food prices and inequality in rural consumption showed a positive association with rural poverty for all the measured levels of poverty viz. Headcount Ratio(HCR), Poverty Gap Index(PGI) and Squared Poverty Gap Index(SGPI). The author further finds that when Real NDP Per Capita was counted from agriculture sector, it reduces rural poverty levels by 1.4 per cent on a HCR basis and 2.5 per cent and 3.4 per cent in terms of PGI and SPGI respectively whereas a reduction of 0.7 per cent to 1.6 per cent was observed by these three indicators when measuring NDP from non-agricultural sector. But, he further notes that Punjab and Haryana which were successful in reducing poverty in post Green Revolution saw increasing trends of poverty measured by all the three indicators mentioned above although statistically insignificant in the post reform period. The disparities have continued to grow despite major poverty reductions.

But, the economic reforms are accused of being anti-agricultural as sector-specific policies for agriculture were missing in the reformatory measures and hence the link which puts agriculture on a pedestal to alleviate poverty lay untouched. However, **Bhagwati (2001)** argues that the objective of poverty alleviation was very much inherent in economic reforms that aimed at higher growth as this growth would then act as a lever resulting in higher employment. Furthermore, he underscores growth as a strategy to raise the minimum income of people. **Mehta and Shah (2003)** found historically marginalized groups of SCs and STs, women, old age people and the disabled to be more prone to the chronic poverty.

Joshi et al (2006) argue that crop diversification can help in augmenting income and employment in rain fed areas which were neglected during the Green Revolution period so as to act as a potent tool in poverty alleviation. They also talk at length regarding Government administered prices of rice and wheat which although result into higher output prices but are unsustainable. In this price-led growth, farmers gain in proportion to their marke table surplus thereby intensifying the divide between small and large farmers whereas higher prices for fruits and vegetables are primarily caused by their increasing demand and higher quality in the market. **Minot (2003)** in his paper finds higher yield (e.g. rice, wheat) as the main source of crop income growth during 1980s whereas price rise (Minimum Support Prices) and diversification were the governing factors that led to the growth in the agricultural sector during 1990s. He further elaborates that the growth that took place in 1990s displayed regional variation across the country where on one hand rising prices were considered the most important source of growth in northern and eastern regions of the country while crop income growth in western and southern regions was dominated by diversification to high value crops**. Siregar, M. & Suryadi, M. (2006)** in a case study of Indonesia where crop specialization in rice led to diminishing levels of horizontal diversification of food crops found production and trade related policies to be biased towards production of rice that covered 65.6 per cent of the harvested area of food crops. For this study, they undertook five CGPRT (Coarse Grain Pulses Roots Tubers) crops viz. maize, soybean, groundnut, cassava, and potato that are said to have comparative advantage along with rice. The easy availability of credit, technological competence in the cultivation of rice, tendency of risk aversion of farmers and issues with marketing efficiency with alternative crops, lack of institutional and Government support for crop diversification were among other reasons responsible for crop specialization and not diversification. But, still the biased nature did not ensure self-sufficiency in rice. In the same vein, **Hazra, C.R. (2001)** notes the tendency of crop specialization within diversified crop groups like within cereals, a declining share of coarse cereals and increasing share of wheat and rice; similarly for oilseeds, despite the dominant area share of groundnut, area under rapeseed, mustard, sunflower and soybean has substantially grown.

Many empirical evidences acknowledge that agriculture sector can have significant multiplier effects in non-farm economy **(DFID 2005).** Fluctuations in agricultural performance are felt quickly, not only in the agricultural sector, but also in the wider non-farm economy. In an empirical analysis of the Kenyan economy by **Timmer (2003)** shows that between 1987 and 2001, the rate of growth of the non-agricultural sector depended strongly on growth in agriculture.

As **Datt and Ravallion (1996)** notes that in 1980s, the decline in public investment was offset by an increasing private investment in agriculture which further depleted in 1990s and therefore increased public investment in irrigation, water resource management, rural roads and rural electrification will stimulate private investment and act as a key to aid the growth momentum of agriculture sector. This view is further corroborated by **Mehta, A.K., et al. (2011)** to mean that significant allocation of public investment in agriculture is necessary to ensure effective implementation of safety net programmes for poverty eradication.

Changing food preferences with increased incomes is the order of the day. With rising income, growing urbanization and changing food preferences, the demand for HVCs has shot up. **(Rao, P et al 2004, Pingali and Khawaja, 2004).** Learning to adjust to emerging opportunities has significant spillover in terms of technological and managerial skill. In addition, when diversified production promotes dietary diversity or new food processing product, it can enhance the nutritional balance of the diet, which improves earning capacity of labor **(Ali and Farooq, 2003).** The crucial question is how to improve the condition of agriculture in the country. The scope of extension of agriculture is very limited as we have already brought more than fifty percent of the area under agriculture. There is thus a need to study the scope of agro diversification and its impact on poverty in India. This paper is an attempt in this direction.

Objectives

1. To identify the factors of diversification such as Net Area Sown, Net Irrigated Area, Area under Forests, Food grain yield.
2. To study the inter-linkages between poverty levels and various indicators of diversification across different States
3. To identify the factors that can help in reducing the poverty levels.

Research Methodology

Here, we have attempted to examine the impact of agricultural diversification on the poverty level across 28 states for the year 2008-09. Below Poverty Line figures have been taken from NSSO 61st Round Survey under Uniform Recall Period (URP) for the year 2004-05. Uniform Recall Period (also Reference Period) takes into account the consumption of all the items used in last 30-day period. And, then in order to measure the extent of diversification in agriculture, we have used percentage area under Net Sown Area, percentage area under food crops, and percentage area under forest as a source of alternative income to the rural poor. Along with these variables, we have also considered food grain yield as a measure of agricultural strength in the economy. The above data has been collected from Directorate of Economics and Statistics. The higher level of these variables indicates the modernization of agricultural activities.

We have worked out an econometric model where

$\gamma_t = \beta_1 X_1 + \pi_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu_t$

γ_t =Percentage below Poverty Line under Uniform Recall Period

X_1= Percentage area under Net Area Sown

X_2= Percentage Net Area Sown under Non-Food Crops

X_3 = Percentage Net Irrigated Area

X_4 = Percentage Area under Forest Cover

X_5 = Percentage yield of food grains

Status of Agriculture Sector and Poverty

Poverty in India is calculated on the basis of cut-off line between poor and non-poor. Dandekar-Rath poverty line was derived on the basis of minimum requirements expressed in calories for a person wherein individuals who did not meet the calorie intake requirement of 2400 calories in rural areas and 2100 in urban areas were said to fall below the poverty line. The calorie intake measurement approach to poverty measurement was replaced by Cost of Living Index. The Planning Commission defines poverty lines as a Per Capita Monthly Expenditure for rural and urban areas separately. But, then there were differences between Lakdawala and Tendulkar estimates of poverty. Though, the percentage of population living below poverty line came down to 37.2 per cent in 2004-05 from 45.3 per cent in 1993-94 but the absolute number of poor people increased by 3.4 million in these eleven years registering an annual average decline of only 0.74 per cent. This annual average figure of poverty decline rose to 2.18 percentage for the seven year period from 2004-05 to 2011-12 by helping 137.8 million people escape the poverty trap. The drop in the poverty rate may be due to massive poverty alleviation programmes like MGNREGA, PMGSY etc. and many other schemes that have directly catered to rural poverty undertaken in the last seven years. With the majority of population still living in rural areas when rural poverty engulfs 25.7 per cent of the population, its development has received special focus from the initiation of Five Year Plans.

With ever mounting population pressure and increasing fragmentation of land, the marginal productivity of labor has decreased with the shrinking of average size of landholding. The incidence of poverty is greatest in rural areas and is typically severe among small and marginal farmers. Greater incidence of indebtedness based on size of landholding was observed in marginal farm households having land up to 1.0 hectare. **NSSO Survey (59th Round)** reports that about 79.9 per cent farm holdings are below 2 hectares. Tiny and fragmented pieces of landholding leave farmers with limited choices of availing credit. According to **World Development Report (1978),** fragmented holdings reduce the profitability of investing in tube-wells and pumps. Innovative small scale technologies such as shallow tube wells still need to serve a minimum area of three to four hectares to be economic whereas the average landholdings are merely fragments smaller than this. Income from these farms cannot be raised up to the desired level to sufficiently alleviate poverty unless existing crop production systems are diversified through inclusion of high value horticultural and arable crops. The volatility of farm products that persists in the international markets proves gruesome to farmers who depend on one or two major cereal crops (wheat, rice, etc.) as seen in the post green revolution era.

Dynamism in weather is another pertinent issue in India. Incidence of flood in one part of the country and drought in the other part is a very frequent phenomenon in India. Even though India is endowed with a variety of soils, climate, biodiversity, more than two-thirds of its geographical area falls within the dry land ecosystems. Under these aberrant weather conditions, dependence on one or two major cereals (rice, wheat, etc.) is always risky. About 80 per cent of the country's annual rainfall is mainly from the South-West monsoon season of June to September, followed by the North-West monsoon in November-December. Therefore, most of the rainfall is received for a few months in a year. As a matter of fact, high indebtedness and debt trap among farmers and farming community due to the vagaries in the climatic pattern is again a glaring phenomenon.

In light of the above problems, a cross-sectional study of the land-use statistics of 28 states of India has been undertaken to assess the graveness of the situation.

Table 7.1 Cross-Sectional Analysis of Land Use Statistics of Indian States

S. No.	States	BPL (URP)	NIA over NAS (in %)	NAS Over Geographical Area (in %)	NAS Food Crops (in %)	NAS On Non-Food Crops (in %)	Area Under Forests (in %)	Yield under Food grains
1	Andhra Pradesh	15.80	44.40	39.51	65.97	34.03	22.58	2744
2	Arunachal Pradesh	17.60	26.40	2.52	87.32	12.68	61.55	1255
3	Assam	19.70	5.10	35.10	82.33	17.67	23.62	1551
4	Bihar	41.40	62.30	60.13	95.73	4.27	6.61	1766
5	Chhattisgarh	40.90	28.40	34.84	94.46	5.54	46.96	1041
6	Goa	13.80	26.20	36.49	81.93	18.07	33.78	2231
7	Gujarat	16.80	43.20	50.00	42.82	57.18	9.35	1595
8	Haryana	14.00	80.50	80.89	73.52	26.48	0.90	3388
9	Himachal Pradesh	10.00	19.30	9.72	96.90	3.10	19.78	1757
10	Jammu & Kashmir	5.40	42.50	3.33	89.18	10.82	9.10	1851
11	Jharkhand	40.30	7.30	18.87	97.16	2.84	28.09	1720
12	Karnataka	25.00	31.80	53.05	71.62	28.38	16.02	1511
13	Kerala	15.00	18.70	53.76	40.15	59.85	27.84	2440
14	Madhya Pradesh	38.30	43.50	48.47	62.01	37.99	28.21	1168

S. No.	States	BPL (URP)	NIA over NAS (in %)	NAS Over Geographical Area (in %)	NAS Food Crops (in %)	NAS On Non-Food Crops (in %)	Area Under Forests (in %)	Yield under Food grains
15	Maharashtra	30.70	18.20	56.63	62.80	37.20	16.94	1001
16	Manipur	17.30	21.90	10.57	99.58	0.42	75.82	2236
17	Meghalaya	18.50	21.80	12.66	90.50	9.50	42.26	1783
18	Mizoram	12.60	11.70	4.51	95.79	4.21	75.62	898
19	Nagaland	19.00	24.50	19.06	82.59	17.41	52.05	1811
20	Orissa	46.40	39.10	35.99	89.17	10.83	37.33	1363
21	Punjab	8.40	97.80	82.78	84.85	15.15	5.86	4231
22	Rajasthan	22.10	35.60	51.28	61.20	38.80	7.97	1263
23	Sikkim	20.10	8.20	15.07	91.53	8.47	44.93	1351
24	Tamil Nadu	22.50	58.10	38.77	73.30	26.70	16.19	2225
25	Tripura	18.90	21.80	26.69	93.22	6.78	57.77	2526
26	Uttar Pradesh	32.80	79.70	68.14	90.14	9.86	6.88	2365
27	Uttarakhand	39.60	45.10	14.10	94.78	5.22	65.18	1715
28	West Bengal	24.70	59.20	59.65	83.69	16.31	13.23	2493
	Total (All India)	27.50	44.70	43.04	72.96	27.04	21.18	1909

Forests

Forests are both a resource and a habitat for rich flora and fauna found in the country. The role of forests in maintaining water and soil conservation, soil fertility and acting as an aid to regeneration of eco systems in the form of wind breaks and shelterbelts are some of critical aids to agriculture system as a whole. Out of the total geographical area of 328726 thousand hectares, land use statistics are available for 305586 hectares covering roughly around 92.96 per cent. India's 21.18 per cent area is under forest cover; Manipur and Mizoram have the highest percentage of forest cover of more than 75 per cent and Uttarakhand with 65 per cent whereas Haryana boasts of hardly 1 per cent of forest cover followed by 5.85 per cent of Punjab, 6.60 per cent of Bihar. It can be seen that although area under forest is comparatively more in Manipur (75.82 per cent) and Mizoram (75.62 per cent) than Haryana (0.90 per cent), but still poverty figures for these states do not differ very significantly. It may be noted that food grain yield is among the lowest in Mizoram. With a vast plethora of forest resources, Mizoram has immense potential to generate newer source of employment and income by diversifying to non-allied activities so as to generate alternative source of income, boost agricultural growth and combat poverty at the same time.

Irrigation

The role of irrigation as a critical input to agriculture is no exaggeration. Area sowed with crops accounts only for 43.0 per cent of the geographical area in 2008-09 of which 55.30

per cent is rain-fed which signifies the dependence of Indian agriculture on monsoons. The breakthrough in irrigation potential is yet to be explored as Net Irrigated Area has only increased from 40.8 per cent in 1999-2000 to 44.7 per cent in 2008-09. Monsoon dependent agriculture in India is often cited as the single most culprit of the failure of agriculture productivity inducing people deeper into the poverty net. Here, with the help of cross-sectional data, we can see that out of the 82.78 per cent of net sown area of Punjab, 97.8 per cent of NAS is irrigated and the poverty level here is just 8.40per cent followed by Haryana (NAS: 80.88 per cent) of which 80.5 per cent is irrigated, but poverty level being 14 per cent. Assam with only 5.10 per cent of net irrigated area has a poverty level of 19.7 per cent whereas Orissa with 39.10 per cent of net irrigated area has a high 46.40 per cent of population living below poverty line.

There is a huge contention that irrigation acts as a poverty alleviation mechanism whereby access to irrigation facilities can enable farmers to intensify cultivation leading to increased productivity and raising income and employment opportunities thereby reducing poverty levels. But, as it is evident from the table, despite having good percentage of area under irrigated fields, some states are not able to combat the incidence of poverty. This may be due to the fact that the states with high percent of area under irrigation have not bothered much for the diversification of agricultural activities. As a result even the irrigation facilities have not been able to reduce the poverty levels in the country.

Area Under Food Crop

In an endeavor to study how the States have fared in crop diversification, we undertook a study to identify the area allotted to producing food crops and non-food crops in the States. More than 95 per cent of the net sown area is under food crops in states like Manipur, Jharkhand, Himachal Pradesh, Mizoram and Bihar. But, the food grain yield in Punjab is the highest with 4231 kg/hectare wherein 84.85 per cent area is accounted to food crops followed by Haryana and Andhra Pradesh with 73.52 per cent (Yield 3388 kg/hectare) and 65.97 per cent (Yield 2744kg/hectare) area under food crops respectively. Here, it is worth mentioning that on one hand, Jharkhand and Bihar having more than 95 per cent area under food crop production with food grain yield of 1720 kg/hectare and 1766 kg/hectare respectively has a population living below poverty line with 40.30 and 41.40 per cent respectively while on the other hand, Himachal Pradesh with 97 per cent area under food crops has only 10 per cent population living below poverty line, the food grain yield being 1757 kg/hectare. Here, attention should be given to states like Kerala and Gujarat which have 59.85per cent and 57.17 per cent area under non-food crops giving way for diversification curbing down their poverty levels to 15 per cent and 16.8 per cent respectively.

It can be inferred that some agricultural dominated states like Punjab and Haryana could reduce the poverty levels through the expansion of area under agricultural crops by more than seventy percent of their geographical area. This approach cannot be treated as sustainable on environmental grounds and also for quality of life consideration. Such approach cannot ensure the sustainability of agricultural growth. We therefore have to search for alternative strategy of growth of sustainable agricultural sector in the country. The above analysis thus suggests that there are multiple factors affecting poverty. There is thus a need to test the empirical validity of the above facts in order to understand the role of agro diversification in poverty reduction. Therefore, we have undertaken a regression analysis wherein we regress the percentage population under poverty on area under Net Area Sown, Net Area sown under non-food crops, Net Irrigated Area, area under forest and yield under food grains. The estimates of the regression results are shown in the following table:

$$\gamma_t = \beta_1 X_1 + \pi_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu_t$$

Model Summary

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1.	.733	.537	.436	8.337

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	30.732	7.753		3.964	.001
Percent NAS	.400	.131	.826	3.066	.005
Percent NAS Non-Food Crop	-.289	.127	-.411	-2.267	.033
Percent NIA	.092	.118	.191	.781	.443
Percent Area under Forest	.138	.108	.273	1.281	.213
Food grain Yield	-.013	.003	-.837	-4.402	.000

The model explains overall 53.7 per cent of variation in the poverty levels across 28 states. The regression co-efficient of Net Area Sown (in %) is positive and significant. This indicates that the state with higher level of area under cultivation have higher incidence of poverty. The just expansion of area is thus not the viable way to solve the problem of poverty. The regression coefficients of area under non-food crops and food grain yield are found to be negative and significant which implies that with diversification of agriculture to non food crops and resorting to modernized methods of agriculture practices, states were successful in bringing down their poverty levels. Though unexpectedly, but the coefficient of irrigation facilities and forest cover are found to be positive but statistically insignificant. Forest cover presents itself as a reservoir of alternative to farm income generation which means that the opportunities will have to be explored out of this natural resource endowment. Thus, the entire exercise suggests that improvement in agriculture is crucial for poverty reduction. This is possible only through horizontal (from mono-cropping to multiple cropping pattern.) and vertical diversification (from farm to non-farm activities or developing forward linkages). Though, we do not have adequate data on vertical diversification of agriculture but we can very well conclude from our analysis that crop diversification from food crop to non-food crop will not only help in reducing the poverty levels but will also help in fulfilling the food needs of the growing economy.

Conclusion

Indian agriculture needs a major face-lift if it has to become viable and internationally competitive. Barring a few States like Punjab, Haryana, Uttar Pradesh and Bihar, more than 70 per cent of the cultivated areas in Indian States still vehemently depend on vagaries of monsoons. Besides, due to mounting population pressure and absence of major upheavals in farming practices, half the population has to survive on meager and unstable agriculture income making them vulnerable to incidence of chronic poverty. The urgency of coming out with a sustainable attack on poverty through agricultural diversification stems from the fact that agriculture still has the highest labour absorption capacity. And even if surplus labour shifts to industrial sector it would involve a lag period depending on the process of skill formation by the economy. Our analysis of 28 Indian states shows that agricultural diversification of food crops to non-food crops (i.e. crop diversification) is able to alleviate poverty. There exists a lot of scope in diversifying farm activities to non-farm activities (i.e. vertical diversification). It may also take the form of developing the agro- product processing industries to develop a strong forward linkage of agriculture with the rest of the economy. In the absence of such diversification, the growth process will not be able to trickle down to the bottom of the society. At a time of rising fiscal deficits when unproductive expenditures have to be curtailed, providing innovative and sustainable measures through agricultural diversification can augment income and help in employment generation thereby bringing down the poverty levels. The diversification approach to agriculture has the capacity to strengthen the base of rural economy which in fact is also a sustainable approach to uproot poverty. By developing forward linkages in the form of agro-processing, rural industrialization can pave way for an altogether innovative yet sustainable approach towards poverty alleviation. But, bringing in agricultural diversification revolution when majority of Indian farmers possess small and marginal landholdings would require huge level of infrastructure and institutional support with a well-developed network of market structure. Lastly, Government policies again play a very dominant role in encouraging activities related to agricultural production and diversification.

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8

Integrated Natural Resource Management and Ecosystem Service

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ABSTRACT

Integrated natural resource management (INRM) refers to the management of natural resources such as land, water, soil, plants and animals, with focus on the quality of life for both present and future generations and ecosystem services. The services that people obtain from ecosystems are the key factors to understand the human relationships with the environment and to develop the environmental policy. INRM focuses on sustainability and at the same time tries to incorporate all possible stakeholders from the planning level itself to reducing possible future conflicts. The conceptual basis of INRM has evolved in recent years through the convergence of research in diverse areas such as sustainable land use, participatory planning, integrated forest management, integrated watershed management, and adaptive management. The Natural Resources Management (NRM) refers to the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries and wildlife. These resources together provide the ecosystem services to mankind. Ecosystem services are transformations of natural assets (soil, water, air and living organisms) into products that are useful to human. The major ecosystem services are, provision of clean air and water; maintenance of soil fertility; maintenance of liveable climates; pollination; pests control; provision of genetic resources; production of food and fibre; and provision of aesthetic, cultural, spiritual and intellectual experience. Ecosystems generate a number of benefits or "ecosystem services" to human beings. River systems provide freshwater, recreation, power, and food supply. Coastal wetlands help to mitigate against flooding, filter waste, and serve as nurseries for fisheries. Forests provide us a wide variety of ecosystem services, including provisioning, regulating, cultural and supportive services. These ecosystem services not only deliver the basic material needs for survival, but also provide other aspects of well-being, including health, security, good social relations and freedom of choice.

Keywords: Natural Resource Management,ecosystems services, coastal wet lands, nurseries

Introduction

The integrated natural resource management (INRM) is a process of managing natural resources in a sustainable and systematic way for mankind, which includes multiple aspects of natural resource uses (biophysical, socio-political, and economic) to meet goals of the wider community (e.g., food security, profitability, risk aversion, poverty mitigation, welfare of future generations and environmental conservation). INRM is being used extensively and been successful in regional and community based natural resource management.

The roots of integrated natural resource management can be traced back to the early definition of "holisms" (Smuts, 1926 and Clark et al., 1999). There are many definitions of integrated natural resource management, and as many as 36 closely associated terms (Downs and Gregory, 1991). Some of these terms include: integrated environmental management (Margerum and Born, 1995), integrated catchment management (Mitchell and Hollick, 1993), total catchment management (Clark et al.,1999), integrated resource management (Lang, 1990), ecosystem management (Grumbine, 1994), watershed management (Mitchell, 1990), integrated watershed management (Clark et al., 1999), and adaptive management (Bellamy 1999, 2000; Lee, 1999; Lal et al., 2001; McClain and Lee, 1996). Several definitions are given by different authors. Integrated Natural Resources Management (INRM) has been defined as "the responsible and broad-based management of the land, water, forest and biological resources base (including genes) needed to sustain agricultural productivity and avert degradation of potential productivity." (Bilderberg Consensus, 1999).

Land and water are the natural resources, which include: Biological resources, such as flower, trees, birds, wild animals, fish etc.; Mineral resources, such as metals, oil, coal, building stones and sand, and other resources, like air, sunshine and climate (UNEP, 1987). Natural Resources are used to make food, fuel and raw materials for the production of finished goods (Adriaanse, 1993).

The Natural Resources and Ecosystems Services Area conducts strategic research and related activities that aims at the full integration of natural resource management into all aspects of national economic development, and to ensure that natural resource management is adequately resourced for effective implementation at national and sub national levels.

Ecosystem services have been defined by Daily (1997) as the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. Mooney and Ehrlich (1997) trace the development of the concept. Ecosystem function, as it pertains to service delivery for humans, was first described in a report (SCEP, 1970), which coined the term environmental services. Holdren and Ehrlich, (1974) later refined the list of services, using the terminology public service functions of the global environment.

The idea that ecosystems provide a large range of functions and services that can be valued is not new but a real development of this concept was observed during the 1990s (Gosselink et al., 1974; Costanza et al., 1989; Point, 1992; Daily, 1997; Costanza, 2000; Daily et al., 2000). It enables the benefits that flow to humans from well-functioning ecological systems to be included in decision making on an equal footing with more tangible costs and benefits (Costanza et al., 1997; Daily, 1997). There is a debate about how to define ecosystem services and how to distinguish services from the ecological processes that lead to their generation, and the benefits that flow (Binning et al., 2001; Boyd and Banzhaf, 2007; Fisher et al., 2008, 2009; Maynard et al., 2010). The concept of ecosystem services has given a new formalisation to this recognition (Lovett et al., 2004; Postel, 2008). Ecosystem functions are beneficial to human populations, directly or indirectly, through ecosystem goods and services (Costanza et al., 1997; Daily, 1997; MA, 2005; Patterson and Coelho, 2009).

Developing country with the understanding of the ecosystem services is the research on management and governance settings relying on traditions on sustainable management of natural resources. Highly relevant approaches to ecosystem service governance include sustainable development and natural capital (Daly, 1990), collective governance of common pool resources (Ostrom, 1990), ecosystem management (Grumbine, 1994, Imperial, 1999) and adaptive management (Gunderson and Holling, 2002; Olsson et al., 2004) as well as the natural resource specific sustainability analyses on forests, fisheries, agricultural land, wetlands and land-use. These research traditions have developed methods and applications that have been tested in practice and should not be ignored when aiming to operationalise ecosystem services for governance.

Building on ecology-focused frameworks (CBD, 2005) the Millennium Ecosystem Assessment (MA, 2005) articulates the dominant interpretation of ecosystem services and defining it as pertaining to "the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits" (Milder et al., 2010; Norgaard, 2010; Pascual et al., 2010).

Natural Resource

Resource is the means for fulfilling the individual and social welfare of human. Natural components like land, water, minerals, forest, wildlife, energy from different sources and human itself are considered as resources. The global survibility depends on the availability of these resources. It is well known that the human requirement increased significantly with their development from ancient to modern era. Thus there are needs for sustainable use of resources to meet of the ever increasing human requirements. The modern human development and technological innovations helped a lot in solving the problems of resource depletion at a faster rate. The strength of a nation determined by its social, economic and political nature which is chiefly determined by the resources they conquered and their capacity to utilise and conserve these resources. There are different types of resources are available globally, those are: (i) Continuous resources (solar energy, wind, gravity, tidal energy and geothermal energy); (ii) Renewable resources (Surface water, flora, fauna, soil and air); (iii) Non-renewable resources (Minerals and groundwater, etc.); (iv) Extrinsic resources (Human skills, institutions, management abilities etc). Management of natural resources on scientific ways is essential to meet the increasing demand for growing population to prevent environmental degradation and save the future earth.

Land

Land is the most vital resource as it will be used for production of crops and other biological materials needed for food, fodder, medicine and associated materials. The volume of production depends on the extent and yield capacity of the cultivable land, which in term is flexible according to human attitude. India is the 7th largest country in the world, with a total land area of 3,287,263 sq. km. It has a land frontier of 15,200 km. and a coastline of 7,517 km. Out of India's total geographical area of 328.73 Mha., 306 Mha. comprise the reporting area and 146.82 Mha. is degraded land (SER, 2009). The major land use categories of India are: Cultivated land (142 Mha); Forest land (67 Mha); Non-agricultural land (20 Mha); Barren and pasture land (55 Mha) and Fellow land (25 Mha) (NRSA, 1986, 1990).

Water

Water is the important resource for sustain of the life. Approximately 97.2% of water lies in ocean, while 2.15% in ice form and the remaining 0.65% remains as fresh water either on surface or as ground water. The available freshwater resources are very limited. The demand for fresh water has increasing day by day with the rapid growth of population, agriculture and industry. As a result the freshwater reserve depletes with time. The requirement of fresh water per person is about 2.7 lit/day, thus the global requirement is about 5 billion cu.m. for only drinking purpose.

In India, over 3 trillion cu.m. of water received from rainfall, which is perhaps among the highest in the world. Major river systems share 83% of the drainage basin, account for 85% of the surface flow and serve 80% of the total population of the country (Singh, 2006). With respect to ground water reserve in India, the estimated available groundwater to be over 210 billion cu.m. There were a large number of swamps and wetlands present in this country, which are essential for balance the ecosystem. Integrated Water Resource Management (IWRM) is increasingly gaining currency in the contemporary discourse on water. The discourse however, is influenced mainly by the two popular perspectives on water viz; scarcity and crisis management. This is a serious problem in so far as it perpetuates irrigation centric, engineering oriented, and bureaucracy driven approach for water resource development with limited concerns for equitable distribution and sustainability of the use. Some of these features appear glaringly in the Water Policy, 2002 in India (Bandopadhyay, 2006).

Biological resources

The biological recourses are including the floral and faunal diversity of the world. At the end of the nineteenth century, we believe that more than 1.7million species presently known, this is a just fraction of the total number as expected to exit on earth. Major fractions of the organisms are yet to be discovered and clarified. Forests are the major biological resours which play a vital role in regulating climate, water runoff, providing shelter and food for wildlife and purifying the air. Forests are not just trees, but part of an ecosystem that underpins life, economies and societies. Forests are essential for human survival and well-being. Forests are amongst the most biologically-rich terrestrial systems. Together, tropical, temperate and boreal forests offer diverse sets of habitats for plants, animals and micro-organisms, and harbour the vast majority of the world's terrestrial species. Forests provide a wide range of services which include prevention of soil erosion, floods, landslides, maintenance of soil fertility, and fixing carbon from the atmosphere as biomass and soil-organic carbon. There are 6 principal types of forest, viz. cool conifer forest, temperate mixed forest, warm-temperate moist forest, tropical moist evergreen forest, tropical moist deciduous forest and dry forest. The distribution of different forest types primarily depends on the temperature and rainfall regime of the concerned region. The richest and most diverse terrestrial ecosystems on the earth are the tropical forests which contain more than two-thirds of all plant biomass and atleast one-half of all plant, animal and microbial species of the world.

According to NRSA (1989) remote sensing data the average forest cover area is about 19.47 as against non forest area of 78.40%. Among the forest area there are only 11.51% area having dense forest. In India the forest cover area ranging from about 6% to 25% as varies from state to state. The total forest cover of the country, as per the 2005 assessment, is 677,088 sq. km. which constitutes 20.60% of the geographic area of the country (SER, 2009).

Mineral resource

A variety of minerals both metal and non metals were exploited by the mankind over centuries. Most minerals used for industrial purposes, which occurs in the earth's crust. There are three categories of metals exists in the earth i.e. (a) structural metals like Fe, Al (b) scare metals like Cu, Pb, Zn, Mg, Ni, Hg etc. and (c) precious metals like Au, Pt, Ag etc. The most important non metal mineral is the fossil fuel. India is rich in a variety of natural resources. Along with 56% arable land, it has a significant number of sources of coal, iron ore, manganese, mica, bauxite, titanium ore, chromites, natural gas, diamonds, petroleum and limestone. India is self sufficient in thorium, which is mined along the shores of Kerala, comprising 24% of the world's known and economically available thorium. Mining complexes, as estimated recently, occupy around 0.06% of the total land area of the country (SER, 2009).

Energy

The world shares of primary fuels in 1991 was dominated by oil (38.1%) followed by coal and lignite (25.6%) and natural gas (20.9%). The total renewable gross consumption makes upto 8.9% of the total primary energy. There are some 600 sedimentary basins in the world where crude oil is available. About 200 of them are unexplored for petroleum, because they are in the polar regions, deep water, the remote interior of continents or are restricts for political reasons. Another 240 have been explored to some extent without making commercial discoveries and remaining 160 are commercial producers. Coal is another fossil fuel in carboniferous deposits. About 10 major countries have 92% of the currently estimated reserve. The power sector is a major consumer of coal, using about 78% of the country's coal production. Coal-fired thermal units account for around 62.2% of total power generation in the country. Coal is a major energy source catering to India's growing energy needs. It meets about 51% of the country's commercial energy needs, and about 70% of the electricity produced in India comes from coal (SER, 2009).

Ocean

Ocean is the treasure wealth in the globe. It has vast array of biological resources along with minerals and energy resource in form of tides and waves. Ocean space has been used by mankind as a source of food and also as an area of commerce, colonisation and welfare. Its vast living resources have been utilised only fractionally. There is tremendous scope of improvement in exploiting and enhancing these resources on a sustainable way. In India the oceanic resources particularly along the coast line is fairly high, i.e. 46% of the total exploited resource from Indian ocean lies in Indian share. India's coast is 7,517 km (4,671 miles) long; of this distance, 5,423 km (3,370 miles) belongs to peninsular India, and 2,094 km (1,301 miles) to the Andaman, Nicobar, and Lakshadweep Islands.

Integrated Natural Resource Management (INMR)

Integrated natural resource management is a complex and shifting framework for the management of natural resources. It has developed over the last several decades as a response to failures of narrower approaches to resource management. While different definitions are abundant, a comprehensive definition will include varying emphases of each of the following components. INRM must be approached from an ecosystem perspective and based on strong science. It must recognize humans as being part of an ecosystem, incorporate human values into planning, and involve broad stakeholder participation. INRM must work with complexity, avoiding oversimplification and should be goal-oriented. It must approach management from multiple spatial and temporal scales, utilizing biophysical as opposed to arbitrary political boundaries. INRM must utilize the principles of adaptive management, using data collection and monitoring to predict outcomes, and adapting to new situations as conditions and knowledge change. Utilizing this comprehensive approach and finding a balance between these components will be essential to successful integrated natural resource management (Christopher Detwiller, 2006).

Components of INRM

INRM is a complex web of information, ideas and actions that are difficult to tease apart to understand different aspects of INRM. The components of INRM include Ecology/Science, Societal and Cultural inclusion, Stakeholder collaboration, Institutional organization, coping with Complexity, Setting goals, Scope/Scale, and Adaptive management (Fig 8.1).

Ecology/Science

INRM must be approached from an ecosystem perspective, by describing parts, systems, environments and their interactions through concepts such as stability and feedback. Work must be holistic and comprehensive and focus on maintaining ecological integrity. Ecologically sustainable management will be achieved through rigorous data collection and monitoring, with the goal of placing a stronger scientific basis behind governmental policies.

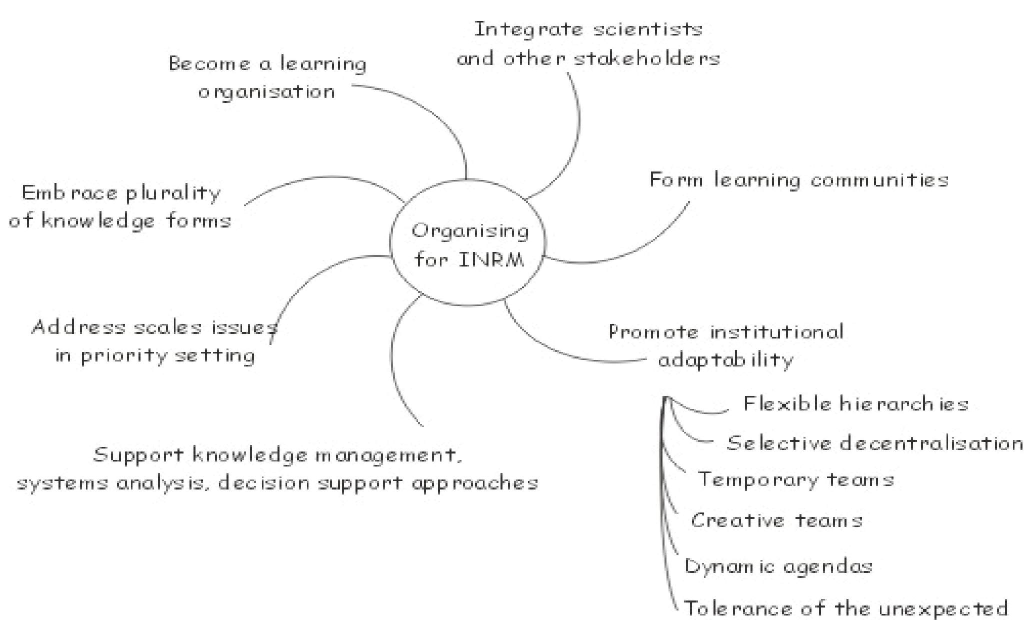

Fig. 8.1 Components of INRM (Sayer and Campbell, 2001)

Societal and Cultural Inclusion

Many ecosystems high in biodiversity are continue to be inhabited by human civilization. Therefore it is essential to include people and their activities in the ecosystem and recognize and incorporate human values into planning. INRM should be explainable and implementable in a consistent way to different people and groups with the goals of social and economic change. It is helpful to think of ecosystem management not as managing the ecosystem, but as managing the people who interact with the system.

Stakeholder Collaboration

INRM must have broad public participation and incorporate stakeholders from the beginning of the planning and decision-making process. The process must be interdisciplinary and depend upon the synthesize information and knowledge from a variety of sources (research, management experience, citizens) that considers a variety of issues. There must be more effective and equitable balancing of stakeholders' interests, values, and uses. This must be achieved through a shared action space that promotes interdependence among stakeholders. The process must be capacity-builiding, and create a sense of ownership in the planning process and results to ensure legitimacy, which will be essential for successful implementation. There must be more and better interagency cooperation between governmental and non-governmental organizations. This interaction must be truly collaborative, and consist of more than individual disciplines independently evaluating and recommending modifications to the results of another discipline's findings.

Institutional Organization

INRM must incorporate institutional factors into the analysis, with the goal of improving institutional performance and integration of government policies. Organizations must be willing to critically evaluate their institutional framework and be open to organizational change. The product of INRM must not be a management plan associated with a dominant land use. Institutions must be willing to share power with other stakeholders. A single organization having the ability to take unilateral action will reduce credibility and the chances of success.

Coping with Complexity

Complexity is an inevitable component of INRM. The INRM must address this and work with, not artificially reduce complexity. Failure to do so may result in inappropriate interest driven simplifications aimed to benefit specific organizational interests or bias for government control.

Setting Goals

INRM must be focus oriented and should be clear about the problem and needs. It must move from an overarching view of the issue to a specific focus on what can actually be done. This can be done by recognizing goals, determining objectives to achieve these goals, and taking active management steps.

Scope/Scale

INRM must mesh subjects and disciplines across boundaries, temporal and spatial scales. It must define a management unit using biophysical criteria, such as a watershed, instead of using arbitrary political boundaries. It must also look at different levels and scales of system structure, process, and function. In a given project timeframe, some phenomena will have been through many cycles, while others may have not even completed a single cycle (Fig 8.2).

Adaptive Management

Adaptive management is grounded in the admission that humans do not know enough to manage ecosystems. It recognizes limits, addresses the dynamic nature of natural systems, accepts and recognizes the inevitability of change. It focuses on monitoring and data collection. It doesn't postpone action until "enough" is known. It recognizes management as flexible, adaptive and as a learning process. It is an ongoing process and is inherently tentative, constantly modifying, evolving and adapting to new situations as conditions and knowledge change.

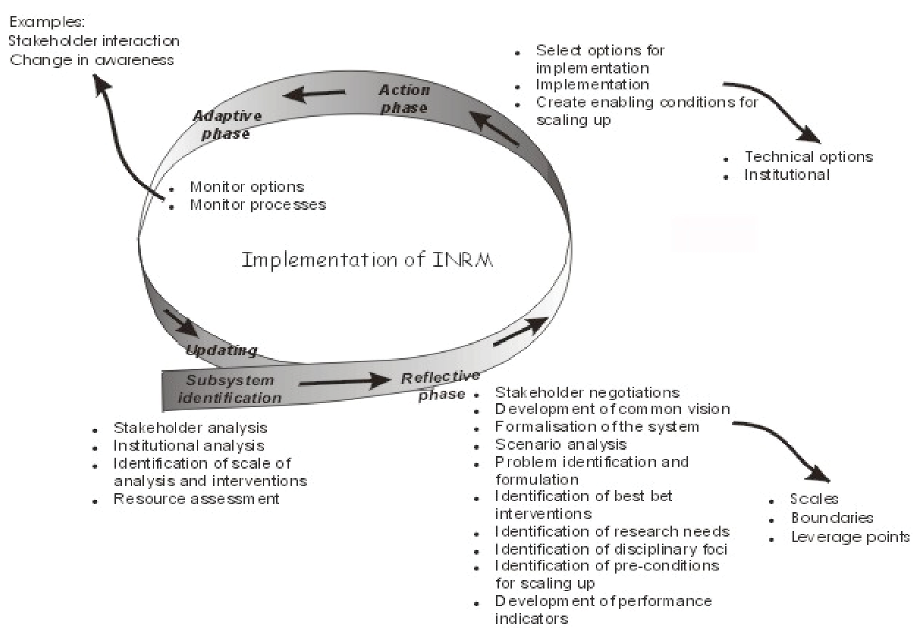

Fig. 8.2 Implementation of Integrated Natural Resource Management (modified after Sayer and Campbell, 2001)

Ecosystem Services (ES)

Why are Ecosystems Declining?

There is mounting evidence that ecosystems around the world are declining in terms of the species that live in them and the services that they provide for humans (Daily, 1997; World Resources Institute, 2000). People generally are not well informed about the benefits that come from ecosystems and the potential to lose those benefits under some management regimes (Daily, 1997). Many of the components of ecosystems are publicly rather than privately owned. The private markets that might give price signals when resources decline do not emerge and that decline of ecosystems due to other economic activity is not factored into costs in those markets (Heal, 2000). The economic systems used in most countries emphasise values and preferences of individuals (consumer sovereignty) more than the values of communities (Costanza and Folke, 1997). There are few mechanisms or incentive for investment in ecosystem services (Heal, 2000). Most of these trends can be addressed through better documentation of what the benefits of ecosystems are to people.

What are Ecosystem Services?

The world's resources are infinite (Mooney and Ehrlich, 1997), but it has taken some time to develop a concept relating the needs of humans to the amounts and types of natural resources that might be needed. Westman (1977) simplified this to nature's services which ware finally refined to ecosystem services. Ecosystem services include: provision of clean air and water; maintenance of soil fertility and structure; maintenance of liveable climates; pollination of crops and other vegetation; control of the vast majority of potential pests, diseases and weeds; provision of genetic resources; production of goods like food and fibre; and provision of cultural, spiritual and intellectual values (Daily, 1997; Binning et al., 2001).

Application of the Concept of Ecosystem Services

Practical applications of the ecosystem service (ES) concept are now becoming widespread (Goldman et al., 2008, Tallis et al., 2008) and include payments-for-ES (PES) schemes (Turpie et al., 2008), spatial planning (Lubchenco and Sutley, 2010), greening of national accounting (Boyd, 2007), and directing strategic arguments in high-level policy and lawmaking (Reducing Emissions from Deforestation and Forest Degradation [REDD]) Miles and Kapos, 2008). The rapid growth in practical applications of the ES concept has illuminated ethical considerations related to its use. The concepts are now widespread and diverse and include its use as a communication tool, for policy guidance and priority setting, and for designing economic instruments for conservation.

Ecological Analyses and Economic Assessments of Ecosystem Services

Economics is essentially the study of how humanity provides for itself (Heilbroner, 1968) by standing on the shoulders of natural systems. Therefore, an economic framework for ecosystem service research is logical. With respect to ecosystem services, the choice of which services to value is in itself a value judgement usually made on the basis of economic and social values (Bingham et al., 1995).

Mechanisms for Investment in Ecosystem Services

Around world develop new markets for environmental goods and services. The essential requirements of such schemes are that investors are given some limited rights over ecosystem goods and services so that they can trade them, and that demand either exists due to rarity or is created by regulations defining acceptable levels of ecosystem goods and services (Binning and Young, 1997; Salzman, 1997; Heal, 2000).

Policies/Laws of INRM

The Government has embarked on a policy of sustainable production and protection through environmentally viable measures and conservation of natural resources. Special effort has been made to generate employment in rural areas. The policy is to put the land to optimum uses according to its capability and to treat the land according to its needs, with top agenda to optimize crop production and to protect arable land by adopting appropriate scientific soil and water conservation measures. The policy acknowledges that optimum uses and judicious management of land and water resources are essential pre-requisite for both primary productions as well as for meeting social priorities. Ultimately, this can lead to healthy environment, enhance the productivity, stabilize people economy and thereby ensure peace, progress and prosperity.

Conclusions

The review of Natural Resources Management (NRM) refers to the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna. The NRM should contribute to poverty alleviation, and that natural resources should be used in a sustainable manner to enhance human welfare. Natural resources (NR) provide fundamental life support, in the form of both consumptive and public-good services. The challenge we face is to make the ecosystem services framework credible, replicable, scalable, and sustainable. Ecological processes maintain soil productivity, nutrient recycling, the cleaning of air and water, and climatic cycles. Together, these resources provide the ecosystem services that underpin human life. At the genetic level, diversity found in natural life forms supports the breeding programs necessary to protect and improve cultivated plants and domesticated animals to safeguard food security. Wild flora and fauna form the basis of traditional medicine and important source of the modern pharmacological industry. All ecosystems deliver goods and services to humankind and therefore have economic value (financial, social, environmental and health) for human welfare. The integrated natural resource management and eco-system service describes the value of natural resource management and ecosystem services from a multi-disciplinary perspective. The NRM should contribute to poverty alleviation, and that natural resources should be used in a sustainable manner to enhance human welfare.

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9

Institutional Reforms in Forest Governance in Odisha: Is There any Impact on Livelihood?

— *Tapas Kumar Sarangi*

ABSTRACT

Institutional theory tells us that social political and economic institutions, both formal and informal, shape behaviour and opportunities; define rights and distribute power. It has major implications for poverty and its alleviation. Historically forest dwelling populations in India have been subjected to a range of deprivations that have affected their livelihood adversely. In the absence of proper institutional mechanism, adequate resource endowment such as land, human capital and access to service sector, forest play a crucial role in the livelihood strategies of many rural household in India. However, the multifaceted deprivations faced by the tribal and other forest dwellers have led to loss of private land, forest land and forest products to these communities. It has severely restricted their access to forest resources. Similarly the people living in un-surveyed areas, and forest villages were also deprived of access to different public services provided by the state. As a result their level of living is at rock bottom. Large scale displacement of tribal on account of development projects including mining activities further eroded their livelihood options.

Decentralisation and devolution have been a major policy theme in Common Property Resources (including forest) governance in developing countries over last few decades. Participatory Forest Management has become one of the key objectives of forest policies and programmes in India including in the state of Odisha since late 1980s. Simultaneously efforts by local communities, which have evolved since early 1960s in different areas of Odisha, have resulted into evolution and development of self initiated forest protection groups in the state. These groups have grown and matured into viable institutions with self governance and they have been protecting and conserving forest of their own. There is provision for incentives for the members which influence them for effective participation in the protection and development of these natural resources. In view of the above, this paper will tries to understand different institutions reform in forest governance and its impact on livelihood in Odisha.

(Keywords: Community, Institution, Livelihood, Governance**)**

Introduction

There has been an increasing worldwide interest in Participatory Forest Management (PFM) as a potential approach for improving forest governance over recent decades. India is among the few countries in the world where such an approach has been implemented on a significant scale, primarily through the Joint Forest Management (JFM) programme, although there has also been widespread self-initiated community-based forest management in some areas. The Government of India has made policy commitments to PFM. Non Government Organisations (NGOs) and Donor agencies are also supporting this implementation.

This paper is an attempt to understand the forest governance in general and in the context of Odisha in particular with a view to understand its working. It also points out the weaknesses present in the institutions. A number of factors including access to resource, organisational efficiency, characteristic of community and its involvement affect governance of natural resource like forest. The evidence (both historical and case studies) provided in the paper shows that forest governance in the state of Odisha lack tenurial rights for long time for forest dwellers which has affected the motivation of them for conservation and proper use of forest resources on long term basis. Eventhough, the forest protection communities, both Joint Forest Management (JFM) and Community Forest Management (CFM) have been working in the state over the years. However these groups are organisationally weak in the decision making due to lack of their rights on the forest they are protecting. Further there is intra group problem. The weaker members (for example women and poor) are excluded in the decision making due to elite capture within the groups. As a result the distribution of benefits is not equitable among the members. This reduces the motivation of these excluded members. Further the policy of sharing the final output between the JFM and the Forest department is also not just for the JFM members. The FRA 2006 has been implemented in the state since 2008. There has been considerable progress in regularising the land under possession under individual rights but the progress in the implementation of conferring community forest right is very low and other provisions of the Act have not been implemented. If the FRA is implemented effectively, it will strengthen the motivation of the forest dwellers in the conservation and development of forest.

The structure of the paper is as follows: The *first* section discusses some analytical issues relating to natural resource governance. The *second* section provides a discussion on the implementation of forest policies in the state that restricted the rights on forest and forest land of forest dwellers and alienating them in the process of decision making relating to governance of forest in pre and post-independent periods. The *third* section anlyses the nature and outcome of participatory forest management as it works in the state of Odisha. The *fourth* section discusses the problems associated with malfunctioning of forest institutions and it is followed by a brief summary of the paper.

The last century has experienced much degradation of forests due to increased biotic pressure in terms of increased population, technological revolution and unsustainable exploitation of natural resources. In India, as in most other developing countries environmental degradation has manifested itself in rapid rates of natural capital depletion exemplified by forest degradation and soil erosion. Nationalisation of forests and other natural resources without due importance to traditional common property institutions has made these resources de facto open access resources and consequently faced the 'tragedy of commons'. Inefficient management of state owned resources, market failure, increasing interdependence between the livelihood system and natural resources and the widespread concern for sustainable development has led to the evolution of the alternative institutions for management of natural resources.

Decentralisation is an increasingly popular theme in management of natural resources in recent times all over the world. Countries have devolved and decentralised their resource use and management system to the users. There has been effort to involve the local people and build participatory institutions to mange the natural resources. In fact, a large body of case studies has demonstrated that local user groups can devise institutions to mange resources sustainably (Baland and Platteau, 1996; and Ostrom, 1990). A large number of countries are currently experimenting with some form of community resource management by transforming some of their power to the community to use and manage such resources. However, empirical outcomes of such devolution of resource use and management are mixed and the reasons for differences in performance of outcomes are not fully understood.

The Crucial role played by institutions in the context of resource governance is increasingly being recognised in development studies. Institutions, viewed as a set of rules actually used (Ostrom et al. 1992) or 'rules of the game in society' (North 1990) are important transaction cost-minimising arrangements. In situations such as those widespread in the developing tropics, where human beings and forests co-exit in an intricately intertwined web of interdependence, the sustainability of resource extraction largely depends upon the existence of, as well as adherence to, rules governing the common property resource (Gibson et al. 2005).

As rule structures, community-based institutions minimisie transaction cost because people themselves develop their rules suitable for particular situations. Realising the shortcomings of traditional top–down state forest and bio-diversity management, developing countries are increasingly embracing participatory approaches to Natural Resource Management (NRM). The goal is to promote local people's active involvement in management of protected areas and other natural resources (Kiss 1990). The same trend has manifested in India with the adoption of Joint Forest Management, which aims to involve user groups on a large scale, marking an important shift in official forest policies. In parallel, the recent literature on Common Property Resource (CPR) management emphasises the ability of user communities to effectively manage collectively owned natural resources through informal institutional arrangements (e.g. Wade 1988; Ostrom 1990). Example of this variety is found in the state of Odisha where local communities have been protecting forest of their own (Sarap 2007).

With the introduction of Joint Forest Management (JFM) in 1990s, a dramatic shift took place in the approach of the government towards the forest dwelling communities. It changed the expectations as well as the relationship between the communities and the Forest Department. Much before JFM become a programme of government, however, communities-initiated, collective action based resource management had emerged sporadically throughout the country[1]. Studies in different parts of the country (Gadgil and Berkes 1991; Gadgil and Guha 1992; Gadgil and Chandran 1992; Ghate 2000, 2003, 2004; Pathak and Gour-Broome 2001) point to the existence of communities that were consciously maintaining and managing the forests within their village boundaries, with or without tenure rights. Thus local community participation in forest management and in forest ownership has been increasing (White and Martin 2002).

It is essential to ensure rule compliance by community members as well as protection from poaching by outsiders in order to ensure effective management of degraded and dense forests. Monitoring is a necessary condition for the long term sustainability of participating CPR regimes in order to guard against conditions that tempt individuals to cheat and gain benefits to the disadvantage of others (Ostrom 2000). When sanctions are strictly enforced they prevent the spread of free-riding behavior, thereby instilling a sense of trust in the community. It is essential to provide conditions that facilitate a sense of justice and fair play in the participants, by ensuring that all individuals who break the rules will be sanctioned irrespective of their position in the community.

A significant fraction of local communities who are dependent on the forest have developed de-facto arrangements for use and management of forest over vary long periods of time (Gadgil and Guha 1992; Gardgil and Chandran 1992). It is only recently, however, that participation of communities in forest management has received de-jure acceptability. Participatory policies are now being considered relevant and consistent with India's overall development strategy of reducing poverty and protecting the environment. But this understanding has come after a prolonged experience of dwindling forest cover under centralised forest management (CSE 1982, World Bank 2006). Now we discuss the evolution of forest policies and governance and how these have alienated the forest dwellers from the forest which is their primary sources of livelihood.

1 See also Bhattachrya et al. 2010

Evolution of Forest Policies and Governance in India

Pre Independence Period

Keeping in view the importance of natural resources and commercial significance of forest resource, certain regulations were formulated and implemented by the colonial administrators to appropriate revenue from the forest based resources. The beginning of a forest policy in the pre-independence India started in 1855 when the then Governor General, Lord Dalhousie, issued a memorandum on forest conservation restricting the customary rights of the forest dwellers on the use of forest resources through a ban on their movement in the forest. Further, the 1865 Act empowered the government to declare authority on such resources for national interests. It was noticed that for all purposes the state seems to have played a dominant role over the right of the individuals and communities. Later during 1878 the Indian forest Act classified all forests of India into three categories, i.e., reserve forest, protected forest and village forest. The first ever forest policy came into existence in 1894. The primary objectives for maintenance of adequate forest cover to assume preservation of climate, physical conditions of the forest was emphasised. Therefore, the policy regulated the rights and put restriction on privileges previously enjoyed by the local inhabitants. Since then this has banned shifting cultivation and protected hill slopes resulting in conflicting situation for the forest dwellers with the forest department. The Indian Forest Act 1927 and Government of India Act 1935 consolidated the power of the Government on forest, emphasised on the revenue yield aspects and resource requirement of British economy.

Post Independence Period

The national forest policy formulated during 1952 mainly focused on forest as the source of timber but neglected the village commons (see Appendix 1 for details). The state restricted the common people to have agricultural operations within forest land and also in the periphery areas of reserved forest. The free grazing of forest and free enjoyment of private forests were controlled whereas tribal people were denied from practicing shifting cultivation (Sarap and Sarangi 2010a). Due to the abolition of *Zamindari system* in 1952, the government of Odisha took over the management of forests and formulated a number of legislations to reduce freedom of tribals over the use of forest and its resources. Apart from this, cultivation, hunting and fishing were also prohibited inside the reserved and protected forests. These measures increased the deprivation of people from forest resources while assuming greater use of forest produce by the neighboring communities. The emphasis was laid more on national interest, often, interpreted as commercial interest by reducing the access of forest dwellers on forest resources.

Subsequently, during 1976 the Government of India formulated the National Commission on Agriculture and the Social Forestry was recommended for creation of Forest Corporation to improve the commercial feasibility. According to the recommendations, many conservation oriented production forestry programmes were implemented[2]. More restrictions were made for entry tribals into forest. In addition to this, the culture, tradition and ethos of the forest dwellers were also not given proper attention by the commission. Again, no special programmes were implemented for enhancing the economy of the tribals. Instead, programmes were essentially drawn for developing forest resources benefiting tribals indirectly through wage earnings[3].

Deprivation of tribals along with degradation of forests influenced the policy makers to look forward to a new forest law. The Government of India enacted the Forest Conservation Act, 1980. It further restricted the rights of the state Governments on forests. However, the law expanded the definition of 'non forest purposes' which included the cultivation of cash crops like tea, coffee, spices, rubber plants, oil bearing plants, horticultural crops and medicinal plants. This law bill initiated a debate with respect to policies, legislations and also on the role of different stakeholders including activists, scientists, forest department contractors and industrialists. Consequently, it resulted in creating a Forest department by separating it from Agriculture department and named it as Ministry of Environment and Forest (MoEF). The new department deals with forestry issues with a kind of pragmatic approach, so that the forest related issues, both for the benefit of government and people, could be dealt with properly. Accordingly various forest issues and related matters concerning people participation, forest revenue, deforestation, ecology, etc., could be taken care of by this ministry as and when necessary.

Forest Management in the Context of Odisha

Odisha Forest Act 1972 is based on the Indian Forest Act 1927. Formulation of this act has been the first major attempt to bring uniformity in forest administration and management in the state. The objectives of this act include revenue maximisation and meeting industrial and commercial demands considering forest as a 'state property'. In a sense, the act only formalised the process, which the state was following since independence. The rights and access of local communities on forest and forest products further got restricted with the enactment of policies such as Wildlife Protection Act (1972).

National Forest Policy, 1988: A Paradigm Shift

A wide discussion at national and international level forums suggested various ways and means to formulate a package of programmes to ensure sustainable forest development

2 However the commission hardly focused on conservation- it said the only purpose of forests was to generate revenue and setup forest development corporations to cut down natural forests to replace them with commercial, fast growing plantations.

3 There was less to do with tribals than with commercial exploitation of forests, including replacing mixed natural forests with fast growing mono-cultural plantations- three million denced forests were felled for the purpose.

and ensuring livelihood of forest dependent population. Similarly, there was a lot of criticism of many provisions of the Forest Conservation Act 1980. These provided inputs to the government of India's National Forest Policy, 1988 which modified a number of provisions of earlier acts for the benefit of the poor. For the first time recognition of non-market and ecological benefits was emphasised in the Seventh Plan Document (1985–90). It was made clear that raw materials for forest based industries would be provided only after meeting the needs of the local people. The Central Board of Forestry recommended a ban on commercial exploitation of degraded forests and regeneration of national forest, in order to reduce the growing pressure on forest resources.

Thus, the new forest Policy seems to have planned for protection, conservation and management of the forest and its resources. It also honoured the customary rights of the people; replaced the contractors with tribal co-operatives, co-operative government undertakings and corporations. It suggested suitable alternatives for shifting cultivators such as engagement of these people in forest based industries. With the adoption of National Forest Policy 1988, the colonial forest Policy establishing straight control over forest by the Forest Department was relatively weakened in comparison with earlier years.

Changes in the Policy and Legal Framework: Governance Issues

The policy and legal regime in the forestry sector will keep focus on poverty alleviation through forestry, increasing productivity, enabling environment for private sector to grow more trees, ecological security of the nation, empowerment of communities along with their capacity building and biodiversity conservation in 2000.

The ecological security became the prime objective and was given importance providing livelihood to the forest dependent communities in the country. JFM mode was chosen in the country including in the state of Odisha by the state to encourage the support of the forest dwellers along with the forest department for growth and conservation of forest. There was rapid growth of JFM throughout the country[4]. The Environment Protection Act was enacted in 1986 for improving the environment in the country. There has been some progress during last two decades for enhancing contribution of forests towards poverty alleviation through empowering people with the ownership of NTFP, participation in decision making relating to use of forest (PESA, 1996). The traditional lifestyles of tribes and their recorded rights have been respected and embedded in the forest management practices as well as in subsequent policies to some extent.

Implementation of PESA

The provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996 was passed by the Indian parliament to extend the provisions of the 73rd Constitutional Amendment 1993 to

4 This programme has covered more than 22 million hectares of forests with the involvement of approximately 21 million people by the end of 1990s. In case of Odisha it has cover about 14 per cent of the total forest area involving nearly 17 million families by the end of 2010-11.

the Schedule fifth areas of the country. The PESA Act specifies that State Governments will endow *panchayats* in the scheduled areas with such powers and authorities as considered necessary to enable them to function as institutions of self governance[5].

The PESA inter-alia empowers the *Gram Sabhas* and *Gram Panchayats* in scheduled areas to safeguard and preserve the traditions and customs of the people, their cultural identity, community resources, and customary methods of dispute resolution and more specifically to provide for endowing *Panchayats* with appropriate ownership of minor forest produce. By and large, the PESA provides a lot of useful guidelines, directives to the state government for formulation of appropriate Forest Laws and Acts for the larger benefit of the forest dwellers living in and around the forests. Decentralised management of resources by the people would not only provide incentive to them for the development and management of resources, but also suppose to solve some of the problems faced by them through participation in the decision making.

Following the Central guidelines Odisha has amended its *Panchayati Raj* Act in December 1997. However, practically, the state Government has not transferred the power as per the provision of the central Act, 1996. The PESA Act devolved power to the local self-government to preserve, protect and manage the forest resources in regards to traditional rights of the forest dwelling communities. The Act also empowered the *Gram Sabha* to preserve and protect the traditional rights and ownership of Minor Forest Produce at the village level. But it is to be noted that the Odisha state Act does not give any power to *Gram Sabha* on matters relating to Land Acquisition, minor minerals, planning and management of minor water bodies. Instead it has entrusted all these power to *Zilla Parisad*, which is not required to consult *Gram Sabha* while exercising all these power. Over the years it has been found that the *panchayat,* because of adhering to a particular mode of functioning, could not grow as units of self-governance, as per the provisions of the PESA Act.

In the management of Minor Forest Products, there have been various short comings in the state Act as well as in the function of *Gram Panchayat*. In Odisha the *Gram Panchyats* are now empowered to register the traders in their territorial jurisdiction for trading of 68 items. However, they have not been legally empowered to take any penal measures against traders who do not pay fair prices (prices fixed at the regional level) to primary collectors. In case they want to take penal action they have to approach the Divisional Forest Officer for further action.

Further, contradiction has emerged between the Odisha Forest Policy and the PESA Act. The Odisha Forest Act 1972-Section 77 invests the powers with the Divisional

5 Under this provision of the Constitution of India, the Governor is empowered to administer in the Fifth Schedule Area and also he can make, repeal or amend any act of Parliament or of the state legislature or any existing law, if he thinks them to be detrimental to the interests of the tribals. The Governor may make regulations for the good government in the Scheduled Area, he can prohibit or restrict the transfer of land of the tribal people and regulate the carrying on of business of money lending in this area.

Forest Officers to enter upon any land to survey, demarcate and prepare a map of the same; power to hold an inquiry into forest offences and in the course of such inquiry to receive and record evidence. The criminal procedure authority has been lying under the jurisdiction of Forest officials (Odisha Forest Manual 2005). Taking the advantage of the 1972 Act, the local level forest officials assert their power to control over forest and forest products. As a result the traditional rights of the tribal people over forest have been eroded.

The *Panchyati Raj* institutions in the present forms have neither any capacity to control the traders, who misuse their power nor have funds to buy Minor Forest Produce MFPs from the primary collectors. Further they also have any capacity to store the procured products and to sell the same to buyers at reasonable prices[6].

Participatory Forest Management (Pfm) in Odisha

This section provides a discussion on the development of PFM in the state of Odisha. It is noteworthy that the Self-initiated Forest Protection Committees took the initiative well before the forest department, and it has spread widely across the state since the 1960s. The forest department took the initiative in the formation of *Van Samrakhyan Samitee (VSS)*, during 1993 and after.

Participatory Forest Management approach, in its present form, i.e., Joint Forest Management came as an outcome of the National Forest Policy in the year 1993 in Odisha. Theoretically, JFM resolution looked upon the local communities as equal partners with Forest Department for protection and management of forests.

From 1993 to 1997 the process of formation of JFM was slow but later its' picked up. As a result, 11,915 *Vana Samrakhyan Samities* (VSSs) and 398 Eco-Development Committees (EDC) have been formed by the end of 2010-11. These VSSs have been managing around 14 per cent of total forest area in the state and nearly 17 million families were involved in this programme of which around 0.7 million families belonged to tribal communities (Government of Odisha 2011-12). Similarly, it has been estimated that about 10 thousand self-initiated forest protection committees have been functioning in the state. These groups are also protecting the forest, of course, without the support of the Forest Department. But it has been found that many of the JFM and CFM Committees are dormant in the sense that the committees have been formed, but they are not active in activities relating to protection or management of forests.

About 29 thousand villages have forest as recorded land. The number of forest protection committees, both, JFM and Self-initiated forest protection groups (SIFPGs) constitute more than 20 thousand villages. In any case some of the committees of both JFM and CFM are dormant. In any case more than three fourths of the villages have some sort of forest protection committees to look after the forest.

6 However, in the administrative perspective, no effective coordination was found between PRIs and Forestry institution over controlling forest resources.

Forest Development Agency (FDA)

With the introduction of FDA scheme during the year 2002–03, a renewed drive for formation of VSS was started by Forest Department in the state. The scheme was launched in 2002–03 by Ministry of Environment and Forest (MoEF) to implement the National Afforestation Programme (NAP). The NAP was introduced during the Tenth Five Year Plan and has been formulated by merging four centrally sponsored afforestation schemes of MoEF.[7] The National Afforestation and Eco-Development Board (NAEB) of the MoEF is in-charge of operation of this 100% centrally sponsored scheme and its tenure has been kept till the end of the 10th plan period.

Progress under FDA in Odisha

FDA was formulated for the regeneration of the depleted forest. However, the objective of FDA formation has limited success. Up to 2006–07, 1565 VSSs constituting 16% of the total VSS (9776) have been covered under FDA. These VSSs are protecting 55 thousand hectares of forest area, which constituted hardly 6.15% of area protected by VSSs in the state during this period. Clearly very few VSSs have been included under FDA and the selection is often based on subjective judgment of Forest Department officials. The structure of General Body and Executive Body is designed to favour the government officials, who control the decision making of the FDA. Active participation by VSS representatives is rarely found. Major decisions are taken by the forest department officials.

Though some developmental works have been undertaken in the entry point phase of NAP, transparency has not been maintained in the use of funds. Further activities are selected mainly by the forester and the president. People participation in the micro planning is found to be marginal. People are used as labourers in nurseries and other forestry activities. The performance of FDA has not been satisfactory and participatory (see Sarap 2007, Sarap and Springate Baginski 2013).

Though FDA has provided few days of employment to the poorer sections of the society, it has left out communities depending on timber, fuelwood, bamboo and charcoal trade for their livelihood. National Afforestation Programme has left problems like encroachments, salinity, desertification, vulnerability of members, etc. In some VSSs, plantation has been done without micro plan. Cooperation between the villagers and the forest officials has not been encouraging (RCDC 2004). Clearly the working of FDA has discriminated many weaker communities from its operations and the decision making process has become centralised.

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7 i.e., Integrated Afforestation and Eco-Development Projects Scheme (IAEPS), Area Oriented Fuel Wood and Fodder Projects scheme (AOFPS), Development of Non-Timber Forest Produce including Medicinal Plants Scheme and Association of Scheduled Tribes and Rural poor in regeneration of Degraded Forests (ASTRP).

Odisha Forestry Sector Development Project (OFSDP)

The Odisha Forestry Sector Development Project (OFSDP) aims at promoting sustainable forest management in the state with a larger goal of supporting rural livelihoods. Supported by Japan International Cooperation Agency (JICA), OFSDP is a seven year project (2006-13) and is executed by an autonomous society under Forest and Environment Department, Government of Odisha. The project is being implemented at selected project villages in 14 Forest Divisions of the State, through active participation of the village community organised as *Vana Sarakshana Samiti* (VSS) or Eco Development Committee (EDC). The project targets to cover 2,275 VSSs/EDCs in the forest fringe villages in the targeted forest divisions. Local level evidence show that working of this programme is similar to that of the JFM programme working in the state and beset with several problems relating to management of FPCs. Local level evidence show that working of this programme is similar to that of the JFM progress during in the state.

Forest Right Acts 2006: A new hope for the Tribals and Forest Dwellers

The Central Government has passed the Forest Right Act during 2006. It provides the legislative basis to redress historical injustice meted out to forest dwellers in the country for long years and thus has major implications to them, both in promising a more secured form of livelihoods as well as the legal provisions necessary to defend them in the future. This Law recognises the rights of occupation of forests by tribes and other forest dwellers and empowers them for management of forests used by them as common property resources. It conforms to the policy prescription of participatory forest management, accepted principles of biodiversity conservation. The land title will be given to those forest dwellers that are under the possession of the forest land upto December 2005. It is to be noted that the vested forest rights are heritable, but not alienable or transferable (Government of India, 2006).

By the end of March 2013 about three lakh of individual land titles (including hardly 879 community forest titles) constituting 5.39 lakh acres of forest land have been given to the claimants (Government of India 2013). The average area of land give per claimant was 1.62 acre and it was 64.25 acre in case of community forest title.[8] Effective and comprehensive implementation of the FRA will have significant impact on the livelihood of forest dwellers and conservation of forest (Sarap, Sarangi & Naik 2013). It will reduce the tenure insecurity and provide a number of benefits under the anti-poverty programmes. It will also increase the bargaining power of the tribals vis-à-vis the others in the decision making process leading to better governance of forest (Sarangi 2013).

8 At the all India level (as on 31st March 2013) 32,45,369 number of claims have been filed. Out of this 12,81,926 titles (39.5 per cent) have been issued to the claimant.

Problems in the Participatory Forest Management

This section discusses the problems associated with the PFM institutions. Though both the CFM & JFM institutions serve the same purpose of involving the local communities and their concerns in the management of forest, there are several cases of conflict between these institutions. At administrative level JFM is patronised by the Forest Department where as CFM initiatives do not get the official recognition from any government authority and often treated as illegal. There are several instances of conflicts between the forest department and CFM groups in many forest divisions of the state. This is mostly due to difference in the approach and perspective of the stakeholders. It has been observed that CFM institutions are characterised with higher level of participation as compared to JFM. But JFM institutions have certain advantages due to the patronisation of the government (ibid). In view of this many self-initiated CFM groups have converted them into JFM to avail the benefits given under JFM programme and to seek the government recognition (Sarap 2005).

Even though local forest institutions have been working in the state for the last several years, they are besieged with a number of problems in their functioning. The Participatory Forest Management (PFM) in the state of Odisha has been a haphazard affair reflecting the weakness of the Odisha Forest Department as well as Forest Protection Committees as an institution. There has been lack of proper participatory process, either at the outset or post-formation: local people's participation in the preparation of the 'micro-plan' is generally marginal, as the forester exerts major control over this. In VSS executive committee and general body meetings, important decisions are being taken by elites, including the forester (who is the secretary). Self-initiated groups were found to be relatively more participatory than the VSS, although few women are involved in either type of management. Further, women have little power in decision-making (see Sarap 2007).

The study of Sarap and Springate Baginski (2013) reveals that the organisational structure of JFM has several type of lacuna. These include exclusion of poorer members including women in the decision making process resulting in weak bargaining power of these members vis-à-vis the elites in the FPCs. It has lead to capture of elites in the governance of the organisation. This has also led to weakening of FPCs in elimination of several types of conflicts faced by them.

Organisational Setup

There are many reasons for failure of JFM, the foremost being the emphasis on a formal and uniform organisational structure. JFM framework prescribes for constitution of a committee termed as *Vana Samrakshyan Samitees* (VSSs) with defined membership. The recently enacted JFM resolution 2000 by Government of India talks about facilitating a uniform structure for JFM committees i.e. Society in all the states and registration of all

JFM committees under the Society Registration Act, 1860. This is in contrast to diverse institutions and organisational arrangements under CFM, which undergo changes in response to internal dynamics, local situations and context. Though their organisational structures differ, they are essentially democratic bodies reflecting the ground realities of the area. On the other hand, appointment of Local Forester in the position of Secretary replacing the natural leadership virtually puts the power on the hands of forest officials in JFM. Since the forester had responsibilities of number of committees at the same time fails to perform the duty of a functional leader and is unable to give adequate time to the affairs of the committee.

Benefit Sharing

The 1993 resolution of JFM by Government of Odisha provides for 50% share in major or final harvest and a 100% share of intermediate produce to the VSS members. There is a feeling among the community that 50% of the benefits are taken away from it. As such there is problem of incentive for hard work to the members of PFM. The Non Timber Forest Produce (NTFP) policy in the State is regressive in comparison with policies of other neighboring states. Upto late 1990s most of the marketable items (28 items) were leased out to private traders, alias a joint sector company. Thus, even on supposedly jointly managed forest land, the co-managers are treated as mere labourers who are to gather NTFPs and handover to state appointed agents at the prices fixed by the state (Sarap and Sarangi 2009, 2010b).

Financial Transparency

There is no robust organisation structure among the forest protection committees both JFM and CFM for management of finance is concerned, even though the scale of finance available to the CFM is low as compare to the JFM. Evidence shows that, there is lack of financial transparency in most of the FPC. Complain of mis-utilisation of funds by president/secretary in some of the JFM/CFM studied villages reported by the members of the FPCs. Further, there is no regular external auditing of financial account in especially the CFM and in the case of JFM secretary (forester) is doing the audit (see Sarap and Springate Baginski 2013).

Issue of Tenure Security

Under the existing JFM framework villagers have hardly any secure rights over forest. As such the incentive to the members to ensure the growth of forest products on long terms basis is minimal. The Forest Department has been the senior partner in the control of forest and powers over forests as well as systems of management. Provision of community forest rights over the forest would likely to change the power structure of the forest dwellers in future. But this is yet to happen in the state.

Inter and Intra Conflicts

Much of the conflicts around PFM were concerned with the local institutional level and the nature and functioning of institutions (Sundar 2012). Conflicts of various natures, including intra-village and inter-village are found in the forest area. For instance, Sarap (2007) study revealed several types of conflicts present in the study area. These includes sharing benefits, usufruct rights, illegal felling, forest boundaries and with forest mafias. Mining, mostly located in forest areas, has led to conflict between forest-fringe communities and mining leaseholders. The VSS or the CFM institutions are unable to resolve such conflicts and when the conflicts are resolved, it is temporary in nature and occurs again after a point of time (see Sarap 2005). The recent industrialisation policies in the state, which are mostly based on mining, and generally located in forest areas, have aggravated the conflicts between the forest dependent communities and mine contractors significantly due to displacement of local people from the forest area. As the traditional livelihood options of local people are affected because of this policy the conflict is becoming recurrent (see Mishra, 1998, Sundar 2012)[9].

Further there is no coordination between PRI and other local institutions in the states. This has weakened the conflict management present in forest fringe villages (World Bank 2006).

Equity Issues

Equity in the distribution of benefits from the PFM between different sections of participant households within a community is another important issue that is likely to affect household participation in the PFM activities as well as the sustainability of PFM institutions. It has been found that poorer members in the group, whether in JFM or CFM, are unable to realise fully the benefits accruing from the forest. The participation of women is also weak. Such situations lead to exclusion of many poor from benefit sharing and forest management efforts[10].

These forest management systems were meant to include and empower the community, but the nature of empowerment remained very limited (Saxena, 2003). Joint Forest Management has been working in the state for since last two decades, but the progress in terms of institutional development as well as impact on livelihood

9 As per the JFM plan the VSS, through its executive committee, is to execute an MoU with the concerned DFO for protecting, regenerating and management of forest area, VSSs constituted prior to 1993 have not been registered as VSS in full. Further, VSS institutions, in the absence of legal authority, have failed to resolve many interpersonal conflicts prevalent in the groups. In such situations VSS committee find it difficult to take strong action against erring individuals or the state for non- compliance. It also becomes difficult to ensure equitable distribution of usufructs given the prevailing socio economic inequalities in the rural communities

10 See also Baland and Platteau 1999, pp-774

of local people is marginal[11]. Furthermore, JFM has been used as a strategy to co-opt CFM and to enable the forest department to establish and expand its control over the forest areas, which are under 'de-facto-control' of local communities.

Local communities find the VSS institution uncomfortable since it tends to erode the decision-making authority at the community level. It also disregards the traditional knowledge system of the community and instead has introduced a situation where the Forest Department plays an important role in decision-making relating to forest.

Clearly the functioning of PFM in the state has not satisfactory. As a result these institutions are unable to perform their role properly in the distribution of benefits to the members and in resolving the conflicts present in the forest fringe villages.

Conclusion

On the Whole it is clear that a number of factors including clear tennurial rights and provisions of incentives to the people dependent on natural resources and protecting them are important for proper functioning and governance of forest institutions. There have been systematic efforts on the part of the state, both in pre-independent and post-independent period, to curtail the participation of forest dwellers in the process of decision making in the forest institutions, thereby alienating them from not only conservation efforts but also on livelihood supports.

The participatory forest management through state efforts has led to some improvement in forest dwellers' participation in the process of governance. But the forest institutions are characterised by several types of problems which constraint effective participation of weaker members. This affects equitable distribution of benefits of forest products. Proper functioning of PFM and effective implementation of FRA in its wider perspective and especially through Community forest rights will go a long way in providing incentives to the forest dwellers for proper governance of forest institutions and distribution of benefits.

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Appendix 1. Phases of Forest Governance during Post Independence Period

Phases	Major Policies	Highlights Points
Phase- I 1947-1970	National Forest Policy (1952)	• Commercial Exploitation of Forest for Industrial Development.
Phase- II 1971- 1988	National Commission on Agriculture (1976); Forest Conservation Act (1980)	• Conservation through powerful legislation such as Wildlife Conservation Act & Forest Conservation Act. • No Place for Forest Dwellers and Tribals in protection and management of local forest resources.
Phase- III 1988 Onwards	National Forest Policy (1988)	Based on three major components: • Emphasis on Participation of forest dwellers. • Increasing access to forest products. • Enhancing Livelihoods.

10

Urban Avifauna of Udaipur and its Importance to the Local Population (Udaipur, Rajasthan, India)

— Satya Prakash Mehra, Sarita Mehra, Parul Sen

ABSTRACT

The beginning of the 21st century can be characterized by tremendous growth of urban areas and associated process of globalization and unification of urban environments. Urban environment as new ecosystems is of great interest all over the world. Urban ecosystems are complex social-ecological systems with important functions. These man-made ecosystems have certain areas with high biological diversity, including both remnant species and species purposefully or unintentionally introduced by human actions. There can be important habitats and valuable corridors for both common and less common species within the urban sprawl.

As per our preliminary studies in the urban areas of southern parts of Rajasthan, local people were interested in local biodiversity, especially on phenological events, and benefited from it by getting aesthetic pleasure, and information on seasonal changes. The cities such as Udaipur have the artificially developed diversified habitat within the urban limits which provide shelter and protection to many floral and faunal species. Urban areas are rich in species particularly vascular plants and many groups of animals especially birds. The artificially managed parks such as Sajjan Niwas have the diversity of flora whereas artificial lakes are the sites of great wetland avifauna. The diversity of avifauna is taken for identifying the importance of biodiversity for Udaipur which is among the top ten tourism sites of world. The role of urban areas in functions such as provision of ecosystem services will largely be determined by patterns of biodiversity within that area.

This paper aims to respond to the call for integrative research by studying relationships between the anthropogenic activities and urban biodiversity of the cities from the southern part of Rajasthan.

To support an integrative approach in urban green planning, both ecological and social research has to be incorporated to the planning process.

Keywords: urban, avifauna, conservation, Udaipur, Rajasthan

Introduction

Worldwide, urban areas are expanding both in size and number. Rapid urbanization is expected to continue. The beginning of the 21st century can be characterised by tremendous growth of urban areas and associated process of globalisation and unification of urban environments. Although cities occupy just 2% of the Earth's surface, their inhabitants use 75% of the planet's natural resources (UNEP 2008). As a result of urban expansion, native vegetation is reduced and fragmented over a landscape mosaic in which both the amount of impervious surface is increased, and the structure and composition of the remaining vegetation is progressively altered (Beissinger and Osborne 1982, Arnold and Gibbons 1996, Vitousek *et al*. 1997, Germain *et al.* 1998, Marzluff *et al.* 1998). Urbanization—the increase in the urban share of total population—is inevitable, but it can also be positive. Despite the significant destruction and degradation of habitats, urban areas have the capacity to support a wide diversity of vertebrate and invertebrate fauna species, perhaps due to the range of diverse natural and artificial habitat niches and conditions that occur in urban areas (Niemelä 1999a,b, Collins *et al*. 2000). Green spaces in form of parks, reserves, private gardens, wetland, lakes etc. in the urban areas contribute towards the formation of diversified ecosystems (Schaefer 1994, Argel-de-Oliveira 1996) and the heterogeneity of natural environments is one of the most important factors that contribute to an increase in biodiversity (Karr 1976). Such characteristics of the urbanized areas enhanced the approach of the Conservation Science workers to get involved in the studies related to urban biodiversity (McDonell and Pickett 1990, Alvey 2006, Garden *et al.* 2006) and their dynamics especially avifauna which were otherwise overlooked before 1990s (Botkin and Beveridge 1997, McDonnell *et al*. 1997, Savard *et al*. 2000).

The Cartesian dichotomy or paradigm has reinforced many ancient western cultural expressions of nature domination by placing 'humans' above 'nature', as if we were neither interconnected nor interdependent. For centuries, western society has controlled and dominated nature and become more and more disconnected from it. The human-nature dualism has proven to be one of the most important modern causes of human degradation of the biosphere. Urban ecological conservation is the ideal cultural milieu in which to force this confrontation with our current relationship with nature. In the City, many of us humans are living in close proximity to our fellow members of the universe. We have to share our living space, our natural resources.

Owing to wide ranges of climatic variations, edaphic characters, physiography, topography and geology, Rajasthan has a diversity of habitats. These habitats harbor rich variety of fauna especially avifauna. Out of 500 bird species reported from the state (Islam and Rahmani 2004), habitats of the eastern and southern parts of the state are the shelter of more than 80% of the reported bird species (Sharma 2002). The State of Rajasthan is one of the driest state of the country and the total surface water resources in the State is only about 1% of the total surface water resources of the country. Nevertheless there are thousands of temporary freshwater and salt aquatic bodies in the region, varying enormously in size. 52 wetlands, including three natural, have been identified in state which expands in approx. 34% of the geographic area of state (Anon. 1990). The surface water play major role in providing the breeding and resting ground to aquatic birds depending on its characteristics with respect to the food availability and protection. The surface water resources in Rajasthan are mainly confined to south and southeastern part of the State. Known for the wetland ecosystem, "City of Lakes" or 'Venice of the East", Udaipur is one of the dreamt destinations of the international tourists. The water bodies of the 'lake city' play an important role in several spheres of human interest: culturally, socially, scientifically and economically. After fish, birds are probably the most important faunal group that attracts people to wetlands.

Alike all over the world birds especially water birds attracted the attention of ornithologists, specialists on hunting management and hunters from the very past time in the princely state of Rajasthan (Adam 1873, Barnes 1891, Oates 1899, Messurier 1904, Impey 1909, Whistler 1938, Prakash 1960, Kushlan 1986). Many species of the waterbirds are migratory, undertaking annual migrations along different flyways spanning the length and breadth of the globe between their breeding and non-breeding grounds (Ali 1959, Alerstam 1990).

The ornithological studies in Southern Rajasthan were mainly confined to the Abu Hills in the Sirohi district (Butler 1875-1876) and parts of the Udaipur district (Hume 1878) in pre-independence era. In Udaipur it was followed by the work of Sharma and Tehsin (1994), Sharma (1998), Sharma (2002), Mehra (2005) and Mehra *et al.* (2010). Monitoring of waterbirds can provide valuable information on the status of wetlands (Custer *et al.* 1991, Kushlan 1993), and can be a key tool for increasing the awareness of importance of wetlands and conservation values. There is growing concern of the need to conserve waterbirds and wetlands and recognition that birds can serve as indicators of the health of our surroundings (Anon 2001). Cities are dependent on the ecosystems beyond the city limits, but also benefit from internal urban ecosystems (Bolund and Hunhammar 1999).

The purpose of this contribution is to present a preliminary analysis of the avifaunal composition in the terrestrial and aquatic habitats of the urban areas of Udaipur (Rajasthan, India) and its value for the community with respect to socio-ecological aspects. The study assesses the avifaunal diversity found in urban areas of Udaipur and suggests the measures to safeguard and enhance the biodiversity of the area, and doing so to improve the quality of peoples' lives through contact with, appreciation of, and involvement in nature conservation.

Material and Methods

Avifaunal Surveys and Field Methods

Seasonal field surveys were conducted for a period of five years from July 2004 to Jun 2009 for the collection of data. Three seasons namely, winter, monsoon and summers were considered for monitoring and collecting data. Urban habitats were broadly divided into – urban terrestrial and urban aquatic habitats. They were further categorized into sub-habitats for the ease of data collection and interpretation.

1. Urban Terrestrial (T) habitats: These habitats were categorized into following six sub-habitats:
   a. Protected Area (TPA) – Sajjangarh Wildlife Sanctuary
   b. Public Park (TPP) – Sajjan Niwas Garden
   c. Forest Fragments (TFF) – Baghdara, Khas Odhi and Moti Magri
   d. Agricultural Field (TAF) – fields of MPAUT and those present on the borders of Udaipur partially representing rural
   e. Institutional Green Spaces (TIGS) – Administrative campuses of universities (Mohanlal Sukhadia University and Maharana Pratap University of Agriculture & Technology)
   f. Constructed Areas (TCA) – denotes selected roads, buildings within city

2. Urban Aquatic (W) Habitats: These habitats were categorized into following three sub-habitats:
   a. Urban Lakes (WUL) – Pichola, Saroop Sagar, Fatehsagar
   b. Peri-urban Lake (WPUL) – Udaisagar, Baghdarrah Lake
   c. Other Aquatic bodies (WOA) – Govardhan Sagar, Connecting Links (Ahar), Small temporary pools within terrestrial habitats of Khas Odhi, Sajjan Niwas, constructed areas etc.

Seasonal surveys were conducted in the morning (6.00-12.00) and late afternoon or evening (15.00-18.00) hours. Different sampling methods were employed as per the requirement. Bird species were assessed in representative plots using the Line Transect Method (LTM) and or modified Transect Method (RTM) (see Bibby *et al.* 2000, Javed and Kaul 2002, Urfi *et al.* 2005) and Point Count Method (PCM) for farmland, forest hills, gardens, groves, plantations and protected areas (Hutto *et al.*1986), and Total Count

Method (TCM) for wetland habitats with less than 5 km perimeter (Burnham *et al.* 1980, Hoves and Bakewell 1989). The common and scientific names of the bird species are after Manakadan and Pittie (2001). All birds seen or heard within a 100-m radius during a 5-min period were recorded to species at each sampling location using the PCM (Hutto *et al.*1986). The resource guides used for the identification and description were Ali and Ripley (1968 – 1999), Grimmett *et al.* (1999) and Grimmett *et al.* (2004).

Status of the bird species recorded from the urban habitats was assigned as:

R: Resident; R/LM: Resident with Local Movement; LM: Local Movement; R/WM: Resident with Winter Movement; R/WM/LM: Resident with Winter as well as Local Movement; WM: Winter Migrant; WM/PM: Winter Migrant with Passage Migration; WM/R: Winter Migrant with Resident; SM: Summer Migrant.

Assessment of Urban Sub-habitats

Yearlong observations (July 2005- Jun 2006) on the human accessibility were made on the different points for particular site for assessment of the sub-habitats.

Disturbance Level

The disturbance levels of the sub-habitats were rated as according to presence of human or other anthropogenic activities with relation to peak bird activities in morning hours from ½h before sunrise to 4h after sunrise):

1. High Disturbance (Rating - 3) – activities or movements of humans for all the observing points or transect at particular site in peak bird activity hours;
2. Moderate Disturbance (Rating - 2) – activities or movements of humans for/or near about half period at all the observing points or transect at particular site in peak bird activity hours;
3. Low Disturbance (Rating - 1) – activities or movements of humans for/or near about one-fourth period at all the observing points or transect at particular site in peak bird activity hours;

Accessibility Level

The accessibility level of human denotes the approach of the sub-habitats for a common man. The assessment included three points – a) Nearness from residential area, b) Frequency of use by local residents; and c) Ownership - public property and/or permitted site for common man. Based on these three criteria, rating on human accessibility was given:

1. All the sites of sub-habitat fulfills all the three points (Rating - 1)

2. All the sites of sub-habitat fulfills either points ‘a’ and ‘c’ or ‘b’ and ‘c’ (Rating - 2)
3. All the sites of sub-habitat does not fulfills point ‘c’ (Rating - 3)

Importance Level

The assessment of the importance of the sub-habitats was made through interactions with at least 50 people per season found at particular site of observation on the issues of direct or indirect benefits related to residence, education, recreation, economic and other:

A. *based on the use of local community*

1. Frequently used (Rating - 1)
2. Occasionally used (Rating - 2)
3. Rarely used (Rating - 3)

B. *based on the use of global community*

1. Frequently used (Rating - 1)
2. Occasionally used (Rating - 2)
3. Rarely used (Rating - 3)

Potential and Scope of Eco-tourism

Through the analysis of the views of the locals and other parameters of characteristics required for developing tourism site, potential and scope of the urban habitats for developing site as eco-tourism especially related to birding site were interpreted. Site was rated as accordingly:

1. Could be developed as hotspot for eco-tourism (Rating - 1)
2. Could be used alternative site for ecotourism (Rating - 2)
3. Least important for eco-tourism (Rating - 3)

Results and Discussions

In total, 242 species of birds belonging to 68 families were recorded from the urban habitats of Udaipur during the period of five years from July 2004 to Jun 2009 (Tables 10.1, 10.2A, 10.2B). Out of the total, 140 bird species representing 42 families were recorded from the terrestrial habitats whereas 102 bird species representing 26 families were recorded from aquatic habitats. Five species of global importance, namely, Indian White-backed Vulture; Long-billed Vulture; Green Munia from terrestrial habitats and Spot-billed Pelican; Indian Skimmer from aquatic habitats, recorded in the past from the study area were also enlisted in the checklist but not sighted during the course of study (Table 10.1, 10.2A).

Table 10.1 Terrestrial bird species recorded during study period (2004-2009) from urban habitats of Udaipur

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
1	**Hawks, Eagles, Buzzards, Old World Vultures, Kites, Harriers Accipitridae**										
1	Oriental Honey-Buzzard (129-130) *Pernis ptilorhynchus* (Temminck, 1821)	R/LM	x	-	x	-	x	-	-	-	-
2	Black-shouldered Kite (124) *Elanus caeruleus* (Desfontaines, 1789)	R/LM	x	x	x	x	x	x	-	-	-
3	Black Kite (132-134) *Milvus migrans* (Boddaert, 1783)	R	x	x	x	x	x	x	-	-	-
4	Egyptian Vulture (186-187) *Neophron percnopterus* (Linnaeus, 1758)	R	x	-	x	x	x	x	-	-	-
5	Indian White-backed Vulture (185) *Gyps bengalensis* (Gmelin, 1788)	?	-	-	-	-	-	-	-	-	-
6	Long-billed Vulture (182) *Gyps indicus* (Scopoli, 1786)	?	-	-	-	-	-	-	-	-	-
7	Red-headed Vulture (178) *Sarcogyps calvus* (Scopoli, 1786)	LM	x	-	x	-	-	-	-	-	-
8	Short-toed Snake-Eagle (195) *Circaetus gallicus* (Gmelin, 1788)	R/LM	x	-	x	-	-	-	-	-	-
9	Crested Serpent-Eagle (196-200) *Spilornis cheela* (Latham, 1790)	R/LM	x	-	x	-	-	-	-	-	-
10	Pallid Harrier (190) *Circus macrourus* (S.G. Gmelin, 1770)	WM	-	-	-	x	-	-	-	-	-
11	Shikra (137-140) *Accipiter badius* (Gmelin, 1788)	R	x	x	x	x	x	x	-	-	-
12	White-eyed Buzzard (157) *Butastur teesa* (Franklin, 1832)	R/LM	x	-	x	-	-	-	-	-	-
13	Tawny Eagle (168) *Aquila rapax* (Temminck, 1828)	R/LM	-	-	x	-	-	-	-	-	-
14	Changeable Hawk-Eagle (160-162) *Spizaetus cirrhatus* (Gmelin, 1788)	R/LM	-	-	x	-	-	-	-	-	-
2	**Falcons Falconidae**										
15	Lesser Kestrel (221) *Falco naumanni* Fleischer, 1818	WM/PM	-	-	x	-	-	-	-	-	-
3	**Pheasants, Partridges, Quails Phasianidae**										
16	Grey Francolin (244-246) *Francolinus pondicerianus* (Gmelin, 1789)	R	x	x	x	x	x	x	-	-	-
17	Common Quail (250) *Coturnix coturnix* (Linnaeus, 1758)	WM	x	-	x	x	-	-	-	-	-
18	Rain Quail (252) *Coturnix coromandelica* (Gmelin, 1789)	R/LM	x	x	x	x	x	-	-	-	-
19	Jungle Bush-Quail (255-258) *Perdicula asiatica* (Latham, 1790)	R/LM	x	x	x	-	-	-	-	-	-
20	Rock Bush-Quail (259-261) *Perdicula argoondah* (Sykes, 1832)	R	x	x	x	x	x	-	-	-	-
21	Indian Peafowl (311) *Pavo cristatus* Linnaeus, 1758	R	x	x	x	x	x	x	-	-	-
4	**Stone-Curlew & Stone-Plovers/Thick-knees Burhinidae**										
22	Stone-Curlew (435-436) *Burhinus oedicnemus* (Linnaeus, 1758)	R	x	-	x	x	x	-	-	-	-
5	**Coursers & Pratincoles Glareolidae**										
23	Indian Courser (440) *Cursorius coromandelicus* (Gmelin, 1789)	R/LM	-	-	x	-	-	-	-	-	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
6	**Pigeons & Doves Columbidae**										
24	Blue Rock Pigeon (516-517) *Columba livia* Gmelin, 1789	R	x	x	x	x	x	x	-	-	-
25	Oriental Turtle-Dove (530-533) *Streptopelia orientalis* (Latham, 1790)	WM	x	x	x	-	x	-	-	-	-
26	Little Brown Dove (541) *Streptopelia senegalensis* (Linnaeus, 1766)	R	x	x	x	x	x	x	-	-	-
27	Spotted Dove (537-540) *Streptopelia chinensis* (Scopoli, 1786)	R	x	x	x	x	x	x	-	-	-
28	Red Collared-Dove (535-536) *Streptopelia tranquebarica* (Hermann, 1804)	R	x	x	x	x	x	x	-	-	-
29	Eurasian Collared-Dove (534) *Streptopelia decaocto* (Frivaldszky, 1838)	R	x	x	x	x	x	x	-	-	-
30	Yellow-legged Green-Pigeon (503-505) *Treron phoenicoptera* (Latham, 1790)	R/LM	x	x	x	-	x	-	-	-	-
7	**Parakeets Psittacidae**										
31	Alexandrine Parakeet (545-548) *Psittacula eupatria* (Linnaeus, 1766)	R/LM	x	-	x	-	-	-	-	-	-
32	Rose-ringed Parakeet (549-550) *Psittacula krameri* (Scopoli, 1769)	R	x	x	x	x	x	x	-	-	-
33	Plum-headed Parakeet (557-558) *Psittacula cyanocephala* (Linnaeus, 1766)	R/LM	x	x	x	x	x	x	-	-	-
8	**Cuckoos, Malkohas & Coucals Cuculidae**										
34	Pied Crested Cuckoo (570-571) *Clamator jacobinus* (Boddaert, 1783)	SM	x	x	x	x	x	-	-	-	-
35	Brainfever Bird (573-574) *Hierococcyx varius* (Vahl, 1797)	R/LM	x	x	x	x	x	x	-	-	-
36	Indian Plaintive Cuckoo (584) *Cacomantis passerinus* (Vahl, 1797)	R/LM	x	-	x	-	-	-	-	-	-
37	Asian Koel (590-592) *Eudynamys scolopacea* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
38	Sirkeer Malkoha (596-598) *Phaenicophaeus leschenaultii* (Lesson, 1830)	R	x	-	x	-	-	-	-	-	-
39	Greater Coucal (600-602) *Centropus sinensis* (Stephens, 1815)	R	x	x	x	x	x	x	-	-	-
9	**Owls Strigidae**										
40	Collared Scops-Owl (619-624) *Otus bakkamoena* Pennant, 1769	R	x	x	x	x	x	x	-	-	-
41	Eurasian Eagle-Owl (625-627) *Bubo bubo* (Linnaeus, 1758)	R/LM	x	-	x	-	-	-	-	-	-
42	Dusky Eagle-Owl (630) *Bubo coromandus* (Latham, 1790)	R/LM	-	-	x	-	-	-	-	-	-
43	Spotted Owlet (650-652) *Athene brama* (Temminck, 1821)	R	x	x	x	x	x	x	-	-	-
44	Short-eared Owl (664) *Asio flammeus* (Pontoppidan, 1763)	WM	-	-	-	x	x	-	-	-	-
10	**Nightjars Caprimulgidae**										
45	Indian Jungle Nightjar (670-672a) *Caprimulgus indicus* Latham, 1790	R	x	-	x	x	x	-	-	-	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
46	Common Indian Nightjar (680-681) *Caprimulgus asiaticus* Latham, 1790	R	x	-	x	x	x	-	-	-	-
47	Franklin's Nightjar (682) *Caprimulgus affinis* Horsfield, 1821	R	x	-	x	x	x	-	-	-	-
11	**Swifts Apodidae**										
48	Asian Palm-Swift (707-708) *Cypsiurus balasiensis* (J.E. Gray, 1829)	R	-	-	x	-	-	-	-	-	-
49	House Swift (702-706) *Apus affinis* (J.E. Gray, 1830)	R	x	x	x	x	x	x	-	-	-
12	**Bee-eaters Meropidae**										
50	Small Bee-eater (749-752) *Merops orientalis* Latham, 1801	R	x	x	x	x	x	x	-	-	-
13	**Rollers Coraciidae**										
51	European Roller (754) *Coracias garrulus* Linnaeus, 1758	WM/PM	-	-	x	x	x	-	-	-	-
52	Indian Roller (755-757) *Coracias benghalensis* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
14	**Hoopoes Upupidae**										
53	Common Hoopoe (763-766) *Upupa epops* Linnaeus, 1758	R/WM	x	x	x	x	x	x	-	-	-
15	**Hornbills Bucerotidae**										
54	Indian Grey Hornbill (767) *Ocyceros birostris* (Scopoli, 1786)	R	x	x	x	x	x	x	-	-	-
16	**Barbets Capitonidae**										
55	Brown-headed Barbet (780-782) *Megalaima zeylanica* (Gmelin, 1788)	R	x	x	x	x	-	-	-	-	-
56	Coppersmith Barbet (792) *Megalaima haemacephala* (P.L.S. Müller, 1776)	R	x	x	x	x	x	x	-	-	-
17	**Woodpeckers Picidae**										
57	Eurasian Wryneck (796) *Jynx torquilla* Linnaeus, 1758	WM	x	x	x	x	x	-	-	-	-
58	Brown-capped Pygmy Woodpecker (851-854) *Dendrocopos nanus* (Vigors, 1832)	R	x	x	x	x	x	-	-	-	-
59	Yellow-fronted Pied Woodpecker (847) *Dendrocopos mahrattensis* (Latham, 1801)	R	x	x	x	x	x	-	-	-	-
60	Lesser Golden-backed Woodpecker (818-823) *Dinopium benghalense* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
61	Black-shouldered Woodpecker (858-859) *Chrysocolaptes festivus* (Boddaert, 1783)	R	x	x	x	x	x	-	-	-	-
18	**Larks Alaudidae**										
62	Singing Bush-Lark (872) *Mirafra cantillans* Blyth, 1845	R	x	-	x	-	-	-	-	-	-
63	Red-winged Bush-Lark (875-877) *Mirafra erythroptera* Blyth, 1845	R	x	-	x	-	x	-	-	-	-
64	Ashy-crowned Sparrow-Lark (878) *Eremopterix grisea* (Scopoli, 1786)	R	x	-	x	-	x	-	-	-	-
65	Greater Short-toed Lark (885-886) *Calandrella brachydactyla* (Leisler, 1814)	WM	x	-	x	-	-	-	-	-	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
66	Common Crested Lark (898-900) *Galerida cristata* (Linnaeus, 1758)	R	x	-	x	-	-	-	-	-	-
67	Eastern Skylark or Oriental Skylark (904-909) *Alauda gulgula* Franklin, 1831	R	x	-	x	-	-	-	-	-	-
19	**Cuckoo-Shrikes, Minivets, Woodshrikes Campephagidae**										
68	Large Cuckoo-Shrike (1072-1075) *Coracina macei* (Lesson, 1830)	R/LM	x	x	x	x	x	-	-	-	-
69	Black-headed Cuckoo-Shrike (1078-1079) *Coracina melanoptera* (Rüppell, 1839)	R/LM	-	-	x	-	-	-	-	-	-
70	Small Minivet (1090-1095) *Pericrocotus cinnamomeus* (Linnaeus, 1766)	R	x	-	x	-	-	-	-	-	-
71	White-bellied Minivet (1096) *Pericrocotus erythropygius* (Jerdon, 1840)	R/LM	x	-	x	-	x	-	-	-	-
72	Common Woodshrike (1069-1071) *Tephrodornis pondicerianus* (Gmelin, 1789)	R	x	x	x	x	x	-	-	-	-
20	**Bulbuls Pycnonotidae**										
73	Red-vented Bulbul (1126-1132) *Pycnonotus cafer* (Linnaeus, 1766)	R	x	x	x	x	x	x	-	-	-
21	**Ioras Irenidae**										
74	Common Iora (1097-1101) *Aegithina tiphia* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
75	Marshall's Iora (1102) *Aegithina nigrolutea* (Marshall, 1876)	R	x	x	x	-	-	-	-	-	-
22	**Shrikes Laniidae**										
76	Rufous-tailed Shrike (942-943) *Lanius isabellinus* Hemprich & Ehrenberg, 1833	WM	x	-	x	-	-	-	-	-	-
77	Brown Shrike (949-950a) *Lanius cristatus* Linnaeus, 1758	WM	x	-	x	-	-	-	-	-	-
78	Bay-backed Shrike (939-940) *Lanius vittatus* Valenciennes, 1826	R	x	x	x	-	-	-	-	-	-
79	Rufous-backed Shrike (946-948) *Lanius schach* Linnaeus, 1758	R	x	x	x	x	x	x	-	-	-
23	**Thrushes, Robins, Wheaters Turdinae**										
80	Blue Rock-Thrush (1725-1726) *Monticola solitarius* (Linnaeus, 1758)	WM	-	-	x	-	x	-	-	-	-
81	Siberian Rubythroat (1643) *Luscinia calliope* (Pallas, 1776)	WM	x	-	x	-	-	-	-	-	-
82	Bluethroat (1644-1646a) *Luscinia svecica* (Linnaeus, 1758)	WM	x	x	x	x	x	-	-	-	-
83	Oriental Magpie-Robin (1661-1664) *Copsychus saularis* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
84	Indian Robin (1717-1721) *Saxicoloides fulicata* (Linnaeus, 1776)	R	x	x	x	x	x	x	-	-	-
85	Black Redstart (1671-1672) *Phoenicurus ochruros* (Gmelin, 1774)	WM	x	x	x	x	x	x	-	-	-
86	Common Stonechat (1695-1698) *Saxicola torquata* (Linnaeus, 1766)	WM	x	-	x	x	x	-	-	-	-
87	Pied Bushchat (1700-1703) *Saxicola caprata* (Linnaeus, 1766)	WM	x	-	x	x	x	-	-	-	-
88	Variable Wheatear (1712) *Oenanthe picata* (Blyth, 1847)	WM	x	-	x	x	x	-	-	-	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
89	Desert Wheatear (1709-1710) *Oenanthe deserti* (Temminck, 1825)	WM	x	-	x	x	x	-	-	-	-
90	Isabelline Wheatear (1706) *Oenanthe isabellina* (Temminck, 1829)	WM	x	-	x	x	x	-	-	-	-
91	Indian Chat (1692) *Cercomela fusca* (Blyth, 1851)	R	x	x	x	x	x	x	-	-	-
24	**Babblers Timaliinae**										
92	Rufous-bellied Babbler (1219-1223) *Dumetia hyperythra* (Franklin, 1831)	R	-	x	x	-	-	-	-	-	-
93	Yellow-eyed Babbler (1230-1232) *Chrysomma sinense* (Gmelin, 1789)	R	x	x	x	x	x	x	-	-	-
94	Common Babbler (1253-1254) *Turdoides caudatus* (Dumont, 1823)	R	-	-	x	x	x	-	-	-	-
95	Large Grey Babbler (1258) *Turdoides malcolmi* (Sykes, 1832)	R	x	x	x	x	x	x	-	-	-
96	Jungle Babbler (1261-1265) *Turdoides striatus* (Dumont, 1823)	R	x	x	x	x	x	-	-	-	-
25	**Prinias, Warblers Sylviinae**										
97	Streaked Fantail-Warbler (1498-1500a) *Cisticola juncidis* (Rafinesque, 1810)	R	-	-	-	x	-	x	-	-	-
98	Franklin's Prinia (1502-1505) *Prinia hodgsonii* Blyth, 1844	R	x	-	-	x	-	x	-	-	-
99	Ashy Prinia (1515-1518) *Prinia socialis* Sykes, 1832	R	x	x	x	x	x	x	-	-	-
100	Indian Great Reed-Warbler (1550-1552) *Acrocephalus stentoreus* (Hemprich & Ehrenberg, 1833)	WM	-	-	x	-	-	-	-	-	-
101	Common Tailorbird (1535-1539) *Orthotomus sutorius* (Pennant, 1769)	R	x	x	x	x	x	x	-	-	-
102	Common Chiffchaff (1574-1575) *Phylloscopus collybita* (Vieillot, 1817)	WM	x	x	x	x	x	x	-	-	-
103	Olivaceous Leaf-Warbler (1581) *Phylloscopus griseolus* Blyth, 1847	WM	x	-	x	x	-	-	-	-	-
104	Hume's Warbler (1590-1591) *Phylloscopus humei* (Brooks, 1878)	WM	x	-	x	x	-	-	-	-	-
105	Greenish Leaf-Warbler (1602-1605) *Phylloscopus trochiloides* (Sundevall, 1837)	WM	x	-	x	x	-	-	-	-	-
106	Common Lesser Whitethroat (1567-1568) *Sylvia curruca* (Linnaeus, 1758)	WM	x	x	x	x	x	x	-	-	-
26	**Flycatchers Muscicapinae**										
107	Red-throated Flycatcher (1411-1412) *Ficedula parva* (Bechstein, 1792)	WM	x	x	x	x	x	x	-	-	-
108	Ultramarine Flycatcher (1421-1422) *Ficedula superciliaris* (Jerdon, 1840)	WM	x	x	x	-	-	-	-	-	-
109	Verditer Flycatcher (1445) *Eumyias thalassina* (Swainson, 1838)	WM	-	x	x	-	-	-	-	-	-
110	Tickell's Blue-Flycatcher (1442-1443) *Cyornis tickelliae* Blyth, 1843	WM	x	x	x	x	x	x	-	-	-
111	Grey-headed Flycatcher (1448-1449) *Culicicapa ceylonensis* (Swainson, 1820)	WM	x	x	x	x	x	x	-	-	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
27	**Monarch-Flycatchers & Paradise-Flycatchers Monarchinae**										
112	Asian Paradise-Flycatcher (1460-1464) *Terpsiphone paradisi* (Linnaeus, 1758)	SM	x	x	x	-	x	-	-	-	-
28	**Fantail-Flycatchers Rhipidurinae**										
113	White-throated Fantail-Flycatcher (1454-1459) *Rhipidura albicollis* (Vieillot, 1818)	R	x	x	x	x	x	x	-	-	-
114	White-browed Fantail-Flycatcher (1451-1453) *Rhipidura aureola* Lesson, 1830	R	x	x	x	x	x	x	-	-	-
29	**Tits Paridae**										
115	Great Tit (1790-1797) *Parus major* Linnaeus, 1758	R	x	x	x	-	x	-	-	-	-
116	Pied Tit or White-naped Tit (1798) *Parus nuchalis* Jerdon, 1844	R	x	-	x	-	-	-	-	-	-
117	Black-lored Yellow Tit (1809-1811) *Parus xanthogenys* Vigors, 1831	R	-	x	x	-	-	-	-	-	-
30	**Creepers Certhiidae**										
118	Spotted Creeper (1840-1841) *Salpornis spilonotus* (Franklin, 1831)	R	-	x	x	-	-	-	-	-	-
31	**Sunbirds Nectariniidae**										
119	Purple Sunbird (1916-1918) *Nectarinia asiatica* (Latham, 1790)	R	x	x	x	x	x	x	-	-	-
32	**White-eyes Zosteropidae**										
120	Oriental White-eye (1933-1936) *Zosterops palpebrosus* (Temminck, 1824)	R	x	x	x	x	x	x	-	-	-
33	**Buntings Emberizinae**										
121	Crested Bunting (2060) *Melophus lathami* (Gray, 1831)	R/LM	x	x	x	-	-	-	-	-	-
34	**Finches Fringillidae**										
122	Common Rosefinch (2010-2013) *Carpodacus erythrinus* (Pallas, 1770)	WM/R	-	-	x	-	-	-	-	-	-
35	**Munias (Estrildid Finches) Estrildidae**										
123	Red Munia (1964) *Amandava amandava* (Linnaeus, 1758)	R	-	-	x	-	-	-	-	-	-
124	Green Munia (1965) *Amandava formosa* (Latham, 1790)	?	-	-	-	-	-	-	-	-	-
125	White-throated Munia (1966) *Lonchura malabarica* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
126	Spotted Munia (1974-1975) *Lonchura punctulata* (Linnaeus, 1758)	R	-	-	x	x	x	-	-	-	-
36	**Sparrows Passerinae**										
127	House Sparrow (1938-1939a) *Passer domesticus* (Linnaeus, 1758)	R	x	x	x	x	x	x	-	-	-
128	Yellow-throated Sparrow (1948-1949) *Petronia xanthocollis* (Burton, 1838)	R	x	x	x	x	x	-	-	-	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
37	**Weavers Ploceinae**										
129	Baya Weaver (1957-1959) *Ploceus philippinus* (Linnaeus, 1766)	R	x	x	x	x	x	x	-	-	-
38	**Starlings & Mynas Sturnidae**										
130	Grey-headed Starling (987-989) *Sturnus malabaricus* (Gmelin, 1789)	WM/PM	-	x	x	-	-	-	-	-	-
131	Brahminy Starling (994) *Sturnus pagodarum* (Gmelin, 1789)	R	x	x	x	x	x	x	-	-	-
132	Rosy Starling (996) *Sturnus roseus* (Linnaeus, 1758)	WM/PM	x	x	x	x	x	x	-	-	-
133	Asian Pied Starling (1002-1004) *Sturnus contra* Linnaeus, 1758	R	x	x	x	x	x	x	-	-	-
134	Common Myna (1006-1007) *Acridotheres tristis* (Linnaeus, 1766)	R	x	x	x	x	x	x	-	-	-
135	Bank Myna (1008) *Acridotheres ginginianus* (Latham, 1790)	R	x	x	x	x	x	x	-	-	-
39	**Orioles Oriolidae**										
136	Eurasian Golden Oriole (952-953) *Oriolus oriolus* (Linnaeus, 1758)	R/LM	x	x	x	-	x	-	-	-	-
40	**Drongos Dicruridae**										
137	Black Drongo (962-964) *Dicrurus macrocercus* Vieillot, 1817	R	x	x	x	x	x	x	-	-	-
138	Ashy Drongo (965-966b) *Dicrurus leucophaeus* Vieillot, 1817	WM	x	-	x	-	-	-	-	-	-
139	White-bellied Drongo (967-969) *Dicrurus caerulescens* (Linnaeus, 1758)	R	x	-	x	x	-	-	-	-	-
41	**Woodswallows Artamidae**										
140	Ashy Woodswallow (982) *Artamus fuscus* Vieillot, 1817	R/LM	x	-	x	-	-	-	-	-	-
42	**Crows, Treepies Corvidae**										
141	Indian Treepie (1030a-1034) *Dendrocitta vagabunda* (Latham, 1790)	R	x	x	x	x	x	x	-	-	-
142	House Crow (1048-1051) *Corvus splendens* Vieillot, 1817	R	x	x	x	x	x	x	-	-	-
143	Jungle Crow (1054-1057) *Corvus macrorhynchos* Wagler, 1827	R	x	x	x	x	x	x	-	-	-
	Total		**118**	**84**	**136**	**91**	**92**	**59**	**0**	**0**	**0**

(225-256): Numbers within brackets after the common names are the numbers given to species in Ripley's (1982) Synopsis, which was also followed in Ali & Ripley's Handbook

(?) denotes the records of species from the site before the 2004 or reported by other workers at same site during same period

UR: Unrecorded; R: Resident; R/LM: Resident with Local Movement; R/WM: Resident with Winter Movement; R/WM/LM: Resident with Winter as well as Local Movement; WM: Winter Migrant; WM/PM: Winter Migrant with Passage Migration; SM: Summer Migrant

Table 10.2A Aquatic bird species (Wetland) recorded during study period (2004-2009) from urban habitats of Udaipur

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
1	**Grebes Podicipedidae**										
1	Little Grebe (5) *Tachybaptus ruficollis* (Pallas, 1764)	R/LM	-	-	-	-	-	-	x	x	x
2	Great Crested Grebe (3) *Podiceps cristatus* (Linnaeus, 1758)	WM	-	-	-	-	-	-	-	x	-
2	**Pelicans Pelecanidae**										
3	Great White Pelican (20) *Pelecanus onocrotalus* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
4	Spot-billed Pelican (21) *Pelecanus philippensis* Gmelin, 1789	?	-	-	-	-	-	-	-	-	-
5	Dalmatian Pelican (22) *Pelecanus crispus* Bruch, 1832	WM	-	-	-	-	-	-	x	x	-
3	**Cormorants/Shags Phalacrocoracidae**										
6	Little Cormorant (28) *Phalacrocorax niger* (Vieillot, 1817)	R/LM	-	-	-	-	-	-	x	x	x
7	Indian Shag (27) *Phalacrocorax fuscicollis* Stephens, 1826	R/LM	-	-	-	-	-	-	x	x	-
8	Great Cormorant (26) *Phalacrocorax carbo* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	x
4	**Darters Anhingidae**										
9	Darter (29) *Anhinga melanogaster* Pennant, 1769	R/LM	-	-	-	-	-	-	x	x	-
5	**Herons, Egrets & Bitterns Ardeidae**										
10	Little Egret (49) *Egretta garzetta* (Linnaeus, 1766)	R	-	-	-	-	-	-	x	x	x
11	Grey Heron (35-36) *Ardea cinerea* Linnaeus, 1758	R/WM	-	-	-	-	-	-	x	x	-
12	Purple Heron (37-37a) *Ardea purpurea* Linnaeus, 1766	R/LM	-	-	-	-	-	-	x	x	-
13	Large Egret (45-46) *Casmerodius albus* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	x
14	Median Egret (47, 48) *Mesophoyx intermedia* (Wagler, 1829)	R/LM	-	-	-	-	-	-	x	x	x
15	Cattle Egret (44) *Bubulcus ibis* (Linnaeus, 1758)	R	-	-	-	-	-	-	x	x	x
16	Indian Pond-Heron (42-42a) *Ardeola grayii* (Sykes, 1832)	R/LM	-	-	-	-	-	-	x	x	x
17	Little Green Heron (38-41) *Butorides striatus* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	-
18	Black-crowned Night-Heron (52) *Nycticorax nycticorax* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	-
6	**Storks Ciconiidae**										
19	Painted Stork (60) *Mycteria leucocephala* (Pennant, 1769)	R/LM	-	-	-	-	-	-	x	x	-
20	Asian Openbill-Stork (61) *Anastomus oscitans* (Boddaert, 1783)	R/LM	-	-	-	-	-	-	x	x	-
21	White-necked Stork (62) *Ciconia episcopus* (Boddaert, 1783)	R/LM	-	-	-	-	-	-	x	x	-
22	Black-necked Stork (66) *Ephippiorhynchus asiaticus* (Latham, 1790)	R/LM	-	-	-	-	-	-	-	x	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
7	**Ibises & Spoonbills Threskiornithidae**										
23	Glossy Ibis (71) *Plegadis falcinellus* (Linnaeus, 1766)	R/WM/ LM	-	-	-	x	-	-	x	x	x
24	Oriental White Ibis (69) *Threskiornis melanocephalus* (Latham, 1790)	R/LM	-	-	-	x	-	-	x	x	x
25	Black Ibis (70) *Pseudibis papillosa* (Temminck, 1824)	R	-	-	-	x	-	-	x	x	x
26	Eurasian Spoonbill (72) *Platalea leucorodia* Linnaeus, 1758	R/LM	-	-	-	-	-	-	x	x	x
8	**Flamingos Phoenicopteridae**										
27	Greater Flamingo (73) *Phoenicopterus ruber* Linnaeus, 1758	R/WM	-	-	-	-	-	-	x	x	-
28	Lesser Flamingo (74) *Phoenicopterus minor* (Geoffroy, 1798)	WM	-	-	-	-	-	-	-	x	-
9	**Geese & Ducks Anatidae**										
29	Lesser Whistling-Duck (88) *Dendrocygna javanica* (Horsfield, 1821)	R/LM	-	-	-	-	-	-	x	x	x
30	Bar-headed Goose (82) *Anser indicus* (Latham, 1790)	WM	-	-	-	-	-	-	x	x	-
31	Brahminy Shelduck (90) *Tadorna ferruginea* (Pallas, 1764)	WM	-	-	-	-	-	-	x	x	x
32	Comb Duck (115) *Sarkidiornis melanotos* (Pennant, 1769)	R/LM	-	-	-	-	-	-	x	x	x
33	Cotton Teal (114) *Nettapus coromandelianus* (Gmelin, 1789)	R/LM	-	-	-	-	-	-	x	x	x
34	Gadwall (101) *Anas strepera* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
35	Eurasian Wigeon (103) *Anas penelope* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
36	Mallard (100) *Anas platyrhynchos* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
37	Spot-billed Duck (97-99) *Anas poecilorhyncha* J.R. Forester, 1781	R/LM	-	-	-	-	-	-	x	x	x
38	Northern Shoveller (105) *Anas clypeata* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	x
39	Northern Pintail (93) *Anas acuta* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
40	Garganey (104) *Anas querquedula* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
41	Common Teal (94) *Anas crecca* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	x
42	Red-crested Pochard (107) *Rhodonessa rufina* (Pallas, 1773)	WM	-	-	-	-	-	-	-	x	-
43	Common Pochard (108) *Aythya ferina* (Linnaeus, 1758)	WM	-	-	-	-	-	-	x	x	-
44	Ferruginous Pochard (109) *Aythya nyroca* (Guldenstadt, 1770)	WM	-	-	-	-	-	-	x	x	-
45	Tufted Pochard (111) *Aythya fuligula* (Linnaeus, 1758)	WM	-	-	-	-	-	-	x	x	-
10	**Cranes Gruidae**										
46	Sarus Crane (323-324) *Grus antigone* (Linnaeus, 1758)	R/LM	-	-	-	x	-	-	-	x	-
47	Demoiselle Crane (326) *Grus virgo* (Linnaeus, 1758)	WM	-	-	-	-	-	-	-	x	-
48	Common Crane (320) *Grus grus* (Linnaeus, 1758)	WM	-	-	-	-	-	-	-	x	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
11	**Rails, Crakes, Moorhens, Coots Rallidae**										
49	Brown Crake (342) *Amaurornis akool* (Sykes, 1832)	R/LM	-	-	-	-	-	-	x	x	-
50	White-breasted Waterhen (343-345) *Amaurornis phoenicurus* (Pennant, 1769)	R	-	-	-	-	-	-	x	x	x
51	Purple Moorhen (348-349) *Porphyrio porphyrio* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	x
52	Common Moorhen (347-347a) *Gallinula chloropus* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	x
53	Common Coot (350) *Fulica atra* Linnaeus, 1758	R/WM	-	-	-	-	-	-	x	x	x
12	**Jacanas Jacanidae**										
54	Pheasant-tailed Jacana (358) *Hydrophasianus chirurgus* (Scopoli, 1786)	R/LM	-	-	-	-	-	-	x	x	x
55	Bronze-winged Jacana (359) *Metopidius indicus* (Latham, 1790)	R/LM	-	-	-	-	-	-	x	x	-
13	**Painted-Snipes Rostratulidae**										
56	Greater Painted-Snipe (429) *Rostratula benghalensis* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	-	x	-
14	**Plovers, Lapwings Charadriidae**										
57	Little Ringed Plover (379-380) *Charadrius dubius* Scopoli, 1786	R/WM	-	-	-	-	-	-	x	x	x
58	Kentish Plover (381-382) *Charadrius alexandrinus* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
59	Yellow-wattled Lapwing (370) *Vanellus malabaricus* (Boddaert, 1783)	R/LM	-	-	-	x	-	-	-	x	-
60	Red-wattled Lapwing (366-368) *Vanellus indicus* (Boddaert, 1783)	R	x	x	x	x	x	x	x	x	x
61	White-tailed Lapwing (362) *Vanellus leucurus* (Lichtenstein, 1823)	WM	-	-	-	-	-	-	x	x	-
15	**Sandpipers, Stints, Snipes, Godwits & Curlews Scolopacidae**										
62	Pintail Snipe (406) *Gallinago stenura* (Bonaparte, 1830)	WM	-	-	-	-	-	-	-	x	-
63	Common Snipe (409) Gallinago gallinago (Linnaeus, 1758)	R/WM	-	-	-	-	-	-	x	x	-
64	Jack Snipe (410) *Lymnocryptes minimus* (Brünnich, 1764)	WM	-	-	-	-	-	-	-	x	-
65	Black-tailed Godwit (389-390) *Limosa limosa* (Linnaeus, 1758)	WM	-	-	-	-	-	-	x	x	x
66	Bar-tailed Godwit (391-391a) *Limosa lapponica* (Linnaeus, 1758)	WM	-	-	-	-	-	-	x	x	-
67	Spotted Redshank (392) *Tringa erythropus* (Pallas, 1764)	WM	-	-	-	-	-	-	x	x	x
68	Common Redshank (393, 394) *Tringa totanus* (Linnaeus, 1758)	WM	-	-	-	-	-	-	x	x	x
69	Marsh Sandpiper (395) *Tringa stagnatilis* (Bechstein, 1803)	WM	-	-	-	-	-	-	x	x	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
70	Common Greenshank (396) *Tringa nebularia* (Gunner, 1767)	WM	-	-	-	-	-	-	x	x	-
71	Green Sandpiper (397) *Tringa ochropus* Linnaeus, 1758	WM	-	-	-	-	-	-	-	x	-
72	Wood Sandpiper (398) *Tringa glareola* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
73	Common Sandpiper (401) *Actitis hypoleucos* Linnaeus, 1758	R/WM	-	-	-	-	-	-	x	x	x
74	Little Stint (416) *Calidris minuta* (Leisler, 1812)	WM	-	-	-	-	-	-	x	x	-
75	Temminck's Stint (417) *Calidris temminckii* (Leisler, 1812)	WM	-	-	-	-	-	-	x	x	-
76	Ruff (426) *Philomachus pugnax* (Linnaeus, 1758)	WM	-	-	-	-	-	-	x	x	x
16	**Avocets & Stilts Recurvirostridae**										
77	Black-winged Stilt (430-431) *Himantopus himantopus* (Linnaeus, 1758)	R	-	-	-	-	-	-	x	x	x
78	Pied Avocet (432) *Recurvirostra avosetta* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	-
17	**Stone-Curlew & Stone-Plovers/Thick-knees Burhinidae**										
79	Great Stone-Plover (437) *Esacus recurvirostris* (Cuvier, 1829)	R/LM	-	-	x	-	-	-	x	x	x
18	**Coursers & Pratincoles Glareolidae**										
80	Small Pratincole (444) *Glareola lactea* Temminck, 1820	R/LM	-	-	-	-	-	-	x	x	-
19	**Gulls, Terns Laridae**										
81	Black-headed Gull (455) *Larus ridibundus* Linnaeus, 1766	WM	-	-	-	-	-	-	x	x	-
82	Gull-billed Tern (460-461) *Gelochelidon nilotica* (Gmelin, 1789)	WM	-	-	-	-	-	-	x	x	-
83	River Tern (463) *Sterna aurantia* J.E. Gray, 1831	R	-	-	-	-	-	-	x	x	x
84	Black-bellied Tern (470) *Sterna acuticauda* J.E. Gray, 1831	R/WM	-	-	-	-	-	-	x	x	-
85	Whiskered Tern (458) *Chlidonias hybridus* (Pallas, 1811)	WM	-	-	-	-	-	-	x	x	-
20	**Skimmers Rynchopidae**										
86	Indian Skimmer (484) *Rynchops albicollis* Swainson, 1838	?	-	-	-	-	-	-	-	-	-
	Total		**1**	**1**	**2**	**6**	**1**	**1**	**72**	**84**	**34**

Table 10.2B. Aquatic (Wetland dependent) bird species recorded during study period (2004-2009) from Udaipur

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
1	**Hawks, Eagles, Buzzards, Old World Vultures, Kites, Harriers Accipitridae**										
1	Brahminy Kite (135) *Haliastur indus* (Boddaert, 1783)	R/LM	-	-	x	-	-	-	x	x	-
2	Western Marsh-Harrier (193) *Circus aeruginosus* (Linnaeus, 1758)	WM	-	-	x	x	-	-	x	x	-

Sr. No.	Common Name Scientific Name	Status	Terrestrial Habitats						Aquatic Habitats		
			TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
3	Steppe Eagle (169) *Aquila nipalensis* Hodgson, 1833	WM	-	-	x	-	-	-	-	x	-
2	**Osprey Pandionidae**										
4	Osprey (203) *Pandion haliaetus* (Linnaeus, 1758)	WM	-	-	x	-	-	-	x	x	-
3	**Owls Strigidae**										
5	Brown Fish-Owl (631-632) *Ketupa zeylonensis* (Gmelin, 1788)	R/LM	-	-	x	-	-	-	-	x	-
4	**Kingfishers Alcedinidae**										
6	Small Blue Kingfisher (722-724) *Alcedo atthis* (Linnaeus, 1758)	R	-	-	-	-	-	-	x	x	x
7	White-breasted Kingfisher (735-738) *Halcyon smyrnensis* (Linnaeus, 1758)	R	-	-	-	-	-	-	x	x	x
8	Lesser Pied Kingfisher (719-720) *Ceryle rudis* (Linnaeus, 1758)	R/LM	-	-	-	-	-	-	x	x	x
5	**Bee-eaters Meropidae**										
9	Blue-tailed Bee-eater (748) *Merops philippinus* Linnaeus, 1766	WM	-	-	-	-	-	-	x	x	x
6	**Swallows & Martins Hirundinidae**										
10	Common Swallow (916-918) *Hirundo rustica* Linnaeus, 1758	WM	-	-	-	-	-	-	-	x	-
11	Wire-tailed Swallow (921) *Hirundo smithii* Leach, 1818	R	-	-	-	-	-	-	x	x	x
12	Red-rumped Swallow (923-928) *Hirundo daurica* Linnaeus, 1771	R	-	-	-	-	-	-	x	x	x
13	Streak-throated Swallow (922) *Hirundo fluvicola* Blyth, 1855	R	-	-	-	-	-	-	x	x	x
7	**Wagtails & Pipits Motacillidae**										
14	White Wagtail (1885-1890) *Motacilla alba* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	x
15	Large Pied Wagtail (1891) *Motacilla maderaspatensis* Gmelin, 1789	R/WM	-	-	-	-	-	-	x	x	x
16	Citrine Wagtail (1881-1883) *Motacilla citreola* Pallas, 1776	WM	-	-	-	-	-	-	x	x	x
17	Yellow Wagtail (1875-1880) *Motacilla flava* Linnaeus, 1758	WM	-	-	-	-	-	-	x	x	x
18	Grey Wagtail (1884) *Motacilla cinerea* Tunstall, 1771	WM	-	-	-	-	-	-	x	x	x
	Total		**0**	**0**	**5**	**1**	**0**	**0**	**15**	**18**	**12**

(225-256): Numbers within brackets after the common names are the numbers given to species in Ripley's (1982) Synopsis, which was also followed in Ali & Ripley's Handbook

(?) denotes the records of species from the site before the 2004 or reported by other workers at same site during same period

R: Resident; R/LM: Resident with Local Movement; LM: Local Movement; R/WM: Resident with Winter Movement; R/WM/LM: Resident with Winter as well as Local Movement; WM: Winter Migrant; WM/PM: Winter Migrant with Passage Migration; WM/R: Winter Migrant with Resident; SM: Summer Migrant

Terrestrial habitats

Urban terrestrial habitats were surveyed into six heads, namely, Protected Area (TPA), Public Park (TPP), Forest Fragments (TFF), Agricultural Field (TAF), Institutional Green Spaces (TIGS) and Constructed Areas (TCA).

Terrestrial bird species - Occurrence

Around 140 species were recorded from different terrestrial habitats of the urban areas of Udaipur. Highest number of species was 136, recorded from the fragmented forest (TFF) areas lying in and around Udaipur. This was followed by the terrestrial habitats of the protected area (TPA), which harbored 118 species. Interestingly, over 90 bird species were recorded from the institutional campuses (TAF and TIGS). Habitat of the green space within city, viz. Sajjan Niwas Park (TPP) was home for only 84 bird species. Almost 60 species found shelter in the close proximity of huma settlements, i.e., constructed structures (TCA). Fig. 10.1 present species recorded from the urban terrestrial habitats.

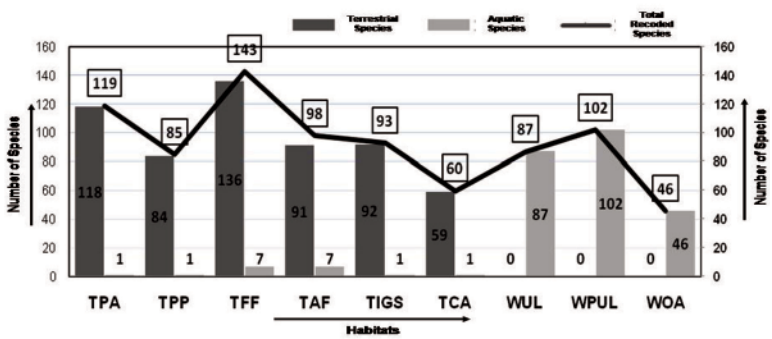

Fig. 10.1 Occurrence of Bird Species in urban habitats of Udaipur

Terrestrial bird species – Status

Maximum species (approximately 56%) of the total recorded terrestrial bird species were local residents (R) of the study area whereas 16% were resident with local movement (R/LM). Approx. 20% of the total terrestrial species were winter migratory (WM). They were mainly from the three families, namely, Turdinae, Sylvinae and Muscicapinae. One species of each was showing local movement (LM), resident with winter movement (R/WM) and winter migration with resident (WM/R). Four species were winter migrant with passage migration (WM/PM) and two species were summer migrants (SM) recorded from the study area. Fig 10.2 is the graphic presentation showing status of the terrestrial bird species recorded from the study area whereas Figure 3A is the pie diagram presenting the proportion of the recorded terrestrial bird species according to their status.

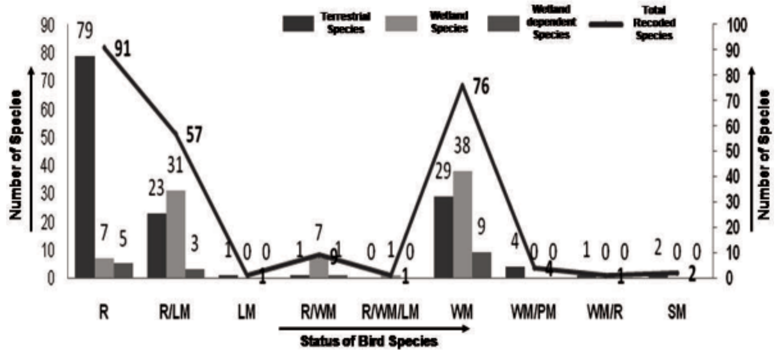

Fig. 10.2 Status of Bird Species recorded from urban habitats of Udaipur

Aquatic Habitats

Urban aquatic habitats were surveyed into three heads, namely, Urban Lakes (WUL), Peri-urban Lake (WPUL) and Other Aquatic bodies (WOA).

Aquatic Bird Species - Occurrence

Aquatic bird species, categorized into wetland species and wetland dependent species, accounted 102 from the study area. 84 species were wetland species whereas 18 species were wetland dependent. Aquatic habitats from the peri-urban areas (WPUL) harbored all the 102 aquatic species whereas 87 species were recorded from urban lakes (WUL). Surprisingly, small aquatic bodies and linking canals (WOA) were home for 46 aquatic species. Fig. 10.1 presents a picture of the number of species in different aquatic habitats. 12 aquatic species were also sighted from the terrestrial habitats of the study area.

Aquatic Bird Species – Status

Maximum species (approximately 46%) of the total recorded aquatic bird species were winter migrants (WM) which showed their presence in the winter season. Approx. 33% were resident showing local movement (R/LM) due to decrease or absence of water in main aquatic bodies in summer seasons. Proportion of aquatic resident (R) species was only about 11% of the total. Eight species were resident showed winter movement (R/WM) and one species was resident showing both winter and local movement (R/WM/LM). Fig. 10.2 is the graphic presentation showing status of the aquatic bird species recorded from the study area whereas Figure 10.3B is the pie diagram presenting the proportion of the recorded aquatic bird species according to their status.

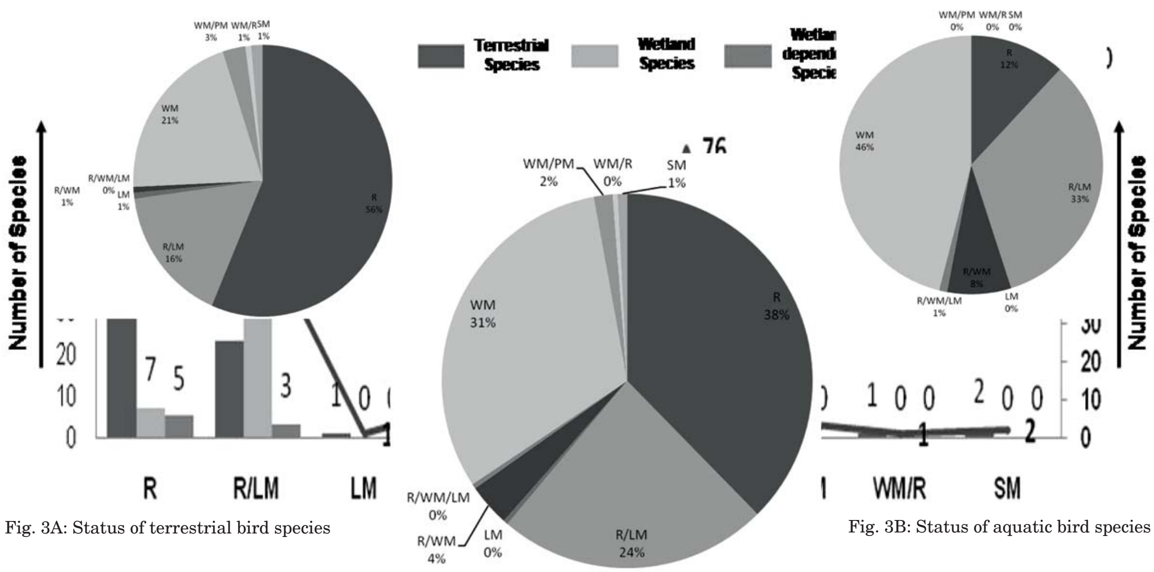

Fig. 3A: Status of terrestrial bird species

Fig. 3B: Status of aquatic bird species

Fig. 3C: Status of recorded bird species

Fig. 10.3 Status of Bird Species in urban habitats of Udaipur

Species of Global Interest

Fifteen bird species enlisted in the globally threatened species, were recorded during the period of study from investigated habitats (Table 10.3). Out of these one each from the list of Critical Endangered (Red-headed Vulture) and Endangered (Egyptian Vulture) , four categorized from the list of Vulnerable, namely Dalmatian Pelican, Lesser Kestrel, Sarus Crane and Pied Tit, showed their presence in the study area. Remaining nine species were the Near Threatened species, namely Darter, Painted Stork, Black-necked Stork, Oriental White Ibis, Lesser Flamingo, Ferruginous Pochard, Black-tailed Godwit, Black-bellied Tern and European Roller.

Four of the 15 globally threatened species were terrestrial whereas 11 were aquatic species. All the four terrestrial globally threatened species were recorded from the urban terrestrial habitats categorized as forest fragments (TFF) and agricultural fields (TAF). Similarly, maximum of the aquatic threatened species were sighted from the urban aquatic habitats categorized as peri-urban lakes (WPUL) which harbored ten globally threatened species whereas only seven aquatic threatened species were sighted in urban lakes (WUL).

Table 10.3 Bird species of global importance recorded during study period (2004-2009) from urban habitats of Udaipur

Sr. No.	Common Name Scientific Name	Terrestrial Habitats						Aquatic Habitats		
		TPA	**TPP**	**TFF**	**TAF**	**TIGS**	**TCA**	**WUL**	**WPUL**	**WOA**
	Critically Endangered									
1	Red-headed Vulture (178) *Sarcogyps calvus* (Scopoli, 1786)	x	-	x	-	-	-	-	-	-
	Endangered									
2	Egyptian Vulture (186-187) *Neophron percnopterus* (Linnaeus, 1758)	x	-	x	x	x	x	-	-	-
	Vulnerable									
3	Dalmatian Pelican (22) *Pelecanus crispus* Bruch, 1832	-	-	-	-	-	-	x	x	-
4	Lesser Kestrel (221) *Falco naumanni* Fleischer, 1818	-	-	x	-	-	-	-	-	-
5	Sarus Crane (323-324) *Grus antigone* (Linnaeus, 1758)	-	-	-	x	-	-	-	x	-
6	Pied Tit or White-naped Tit (1798) *Parus nuchalis* Jerdon, 1844	x	-	x	-	-	-	-	-	-
	Near Threatened									
7	Darter (29) *Anhinga melanogaster* Pennant, 1769	-	-	-	-	-	-	x	x	-
8	Painted Stork (60) *Mycteria leucocephala* (Pennant, 1769)	-	-	-	-	-	-	x	x	-
9	Black-necked Stork (66) *Ephippiorhynchus asiaticus* (Latham, 1790)	-	-	-	-	-	-	-	x	-
10	Oriental White Ibis (69) *Threskiornis melanocephalus* (Latham, 1790)	-	-	-	x	-	-	x	x	x
11	Lesser Flamingo (74) *Phoenicopterus minor* (Geoffroy, 1798)	-	-	-	-	-	-	-	x	-
12	Ferruginous Pochard (109) *Aythya nyroca* (Guldenstadt, 1770)	-	-	-	-	-	-	x	x	-
13	Black-tailed Godwit (389-390) *Limosa limosa* (Linnaeus, 1758)	-	-	-	-	-	-	x	x	x
14	Black-bellied Tern (470) *Sterna acuticauda* J.E. Gray, 1831	-	-	-	-	-	-	x	x	-
15	European Roller (754) *Coracias garrulus* Linnaeus, 1758	-	-	x	x	x	-	-	-	-
	Total	**3**	**-**	**5**	**4**	**2**	**1**	**7**	**10**	**2**

Characteristics of Urban Habitats

Least disturbed urban habitats include protected areas (TPA), forest fragments (TFF) and peri-urban lakes (WPUL) which were rated one. Only habitats of main human settlements (TCA) were found highly disturbed whereas public park (TPP), agriculture field (TAF), institutional green spaces (TIGS) and other aquatic habitats (WUL and WOA) where moderately disturbed.

The habitats TPA, TPP TCA, WUL and partly TFF were maximum accessible for any visitors, therefore, rated one. On the other hand, TAF, TIGS and partly TFF (Khas Odhi) were least accessible in terms of visiting the sites, hence rated three whereas, aquatic habitats WPUL and WOA were having moderate accessibility.

On the local scale, the habitats which are maximally used by residents were TPP, TCA and WUL whereas site TPA WPUL and WOA were least used by local public, hence of low importance. On the global reach, TPA, WUL and WPUL were maximally accessed and TPP, TFF, TAF, TIGS, TCA and WOA were of least importance for the visitors or are overlooked due to low concern.

Thus, as according to potential and scope for developing eco-tourism sites which could be of great interest for both the local and global community include habitats TPA, TFF, WUL and WPUL. Out of these TPA and WPUL were already visited by the global community with the point of view of its beauty rather than natural heritage. These habitats have the potential to develop sites for birding and involve local community for employment. This would be helpful in achieving the aims and objectives of Conservation Sciences also.

Table 10.4 is summary of the assessment of the terrestrial habitats of the Udaipur which could be a source of socio-ecological aspects of research and its implementation. Still there is much need of analysis of the inclination of the local community to step ahead for the new global responsibility of employment generation through conservation.

Conclusion

Conservation through Community Participation: There is always a conflict between protection of habitats and human involvement. Uncontrolled urbanization has forced both wetland habitats and biodiversity in a situation that both are struggling for their existence. There is need to bring the concept of conserving these habitats as well as biodiversity. Community based nature conservation that is coming up very successful in many parts of the globe could be used in Udaipur. This could be income generating source providing employment to the local residents and the mass involvement to conserve the diversity from ecological point of view.

Table 10.4 Assessment and rating of urban habitats of Udaipur

Habitats → / ↓ Characteristics		Terrestrial Habitats						Aquatic Habitats		
		TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
Bird Species	Terrestrial	**118**	**84**	**136**	**91**	**92**	**59**	**0**	**0**	**0**
	Aquatic	**1**	**1**	**7**	**7**	**1**	**1**	**87**	**102**	**46**
	Total	**119**	**85**	**143**	**98**	**93**	**60**	**87**	**102**	**46**
	Globally Threatened	**3**	**0**	**5**	**4**	**2**	**1**	**7**	**10**	**2**
Disturbance Level		1	2	1	2	2	3	2	1	2
Accessibility Level		1	1	1/3*	3	3	1	1	2	2
Importance Level	Local	3	1	2	2	2	1	1	3	3
	Global	1	3	3	3	3	3	1	1	3
Potential & Scope		1	2	1	2	3	3	1	1	2

(*) represents one of the sites, Khas Odhi, which is private property rich in terrestrial avifauna

Table 4B. Bird species recorded during study period (2004-2009) from urban habitats of Udaipur

Habitats →		Terrestrial Habitats						Aquatic Habitats		
		TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA
Bird Species (Number)	Terrestrial	118	84	136	91	92	59	0	0	0
	Aquatic	1	1	7	7	1	1	87	102	46
	Total Recorded	**119**	**85**	**143**	**98**	**93**	**60**	**87**	**102**	**46**
	Threatened	**3**	**0**	**5**	**4**	**2**	**1**	**7**	**10**	**2**

Udaipur is already on World Tourism Map due to its scenic beauty and Historical importance, the natural heritage of the place is still unexploited source of income generation in the urban areas. The coordinated and integrated approach of different government departments as well as academic research is required for the site to achieve its importance regarding potential of Nature Tourism.

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11

Anuran Diversity of Southern Rajasthan, India

— *Satya Prakash Mehra*

ABSTRACT

Amphibians are among the faunal group of major concern due to continual decline in their population. In general, efforts are required at every level with the widespread approach of surveys and checklist preparations for the conservation measures. The paper deals with the study of anuran diversity of the southern parts of the Rajasthan State (India) in general and elevations of Aravallis in particular.

Using visual encounter method and call detection for the monitoring of species and population, seasonal surveys of the study area and periodic transect sampling of the sites - Abu Hills and Kumbhalgarh Hills, were undertaken for the observations for the period from 2006 to 2009.

Ten anuran species were recorded from the study area whereas only seven species showed their presence on the elevations of Arravallis. Three species were distributed throughout the study area along with the higher altitudinal ranges. The species richness decreased with the elevation. The altitudinal range of 800-1000msl of Abu Hills and 600-800msl of Kumbhalgarh Hills were found as important range for the anuran diversity.

Habitat alteration was found to be major cause of concern for the regular decline in the population of anurans in the study area.

Keywords: Abu, Anuran, Aravallis, Kumbhalgarh, Rajasthan

Introduction

Due to the important role of amphibians in food webs at different tropic levels such as herbivores (at the larval stages they feed upon vegetation); predators (prey upon small animals); and prey (serve as food for larger predators), they are particularly sensitive to environmental changes. Even than they are systematically underrepresented in international conservation plans (Hedges 2006, Pawar *et al.* 2007). Declining amphibian populations have been observed around the world in the last 20 years. Potential causes of the world-wide amphibian decline are still embroiled in controversy (Alford and Richards 1999, Houlahan *et al.* 2000). In spite of being at high risk of extinction, amphibians are the terrestrial vertebrate groups least studied in the world, with only 5% of the total number of studies conducted on vertebrates and the effects of habitat loss (Lawler *et al.* 2006). There is also a very little information available on the consequences of anthropogenic effects and land use changes for amphibian fauna. Anuran represents the largest proportion among amphibians (Frost 2009), hence largely taken for the representation of group.

From many parts of India information on the current status of amphibian fauna is lacking especially from Rajasthan (Sharma and Mehra 2007, Mehra 2010). There is need of widespread approach of surveys and preparation of checklists along with quantitative estimates so as to devise potential conservation measures (Padhye and Ghate 2002).

In Rajasthan, southern part is provided with transects of Aravallis with discrete wetlands and unique habitat characteristics of high altitudinal water bodies. This study describes current trends of knowledge regarding the status and distribution of amphibian fauna from Aravallis particularly anuran species.

Material and Methods Study Area

The State of Rajasthan lies between 23°30’ - 30°11’ North latitude and 69°29’ - 78°17’ East longitude, occupying 342,239 km2 which accounts 10.41% of the geographic land area of the country. In general, six districts of Udaipur Division, viz., Banswara, Chittorgarh (Pratapgarh), Dungarpur, Rajsamand and Udaipur; and three districts of Jodhpur Division, viz., Jalore, Pali and Sirohi were explored for assessing the status and distribution of anurans. Thus, nine districts were explored in general and the high altitudes in particular for the amphibian fauna in the present investigation (Fig. 11.1). Pratapgarh is newly formed district in 2008, therefore, during the data collection it was observed within Chittorgarh throughout the study. This southern part of the state under present investigation constitutes approximately 21% of the total geographic area of state (DoF, 2009).

The study area consisted of plain desert at about sea level af Jalore (Hathigaon village approximately 20 msl) to the highest elevations of Sirohi (Guru Shikhar, Mount Abu approximately 1,722 msl). The western part of the study area was under arid and semi-arid zones with plainer terrains of Thar Desert. Similarly, the southern parts of the study area in the Dungarpur and Banswara were on the lower altitudes comprising of variety of wetlands in the plainer and plateau terrains. The central parts (parts of Sirohi, Pali and Udaipur) of the study area comprised of the hilly terrains of Aravallis with all the higher altitudes particularly the range of 800msl and above. The northern and eastern parts (parts of Rajsamand, Udaipur, Chittorgarh and Pratapgarh) were also hilly terrain with the lower altitudes ranging between 300 to 600 msl. The altitudinal cross section of the study area is shown in Fig. 11.2. The two sampling sites (high altitudes) of Aravallis were Abu Hills and Kumbhalgarh Hills.

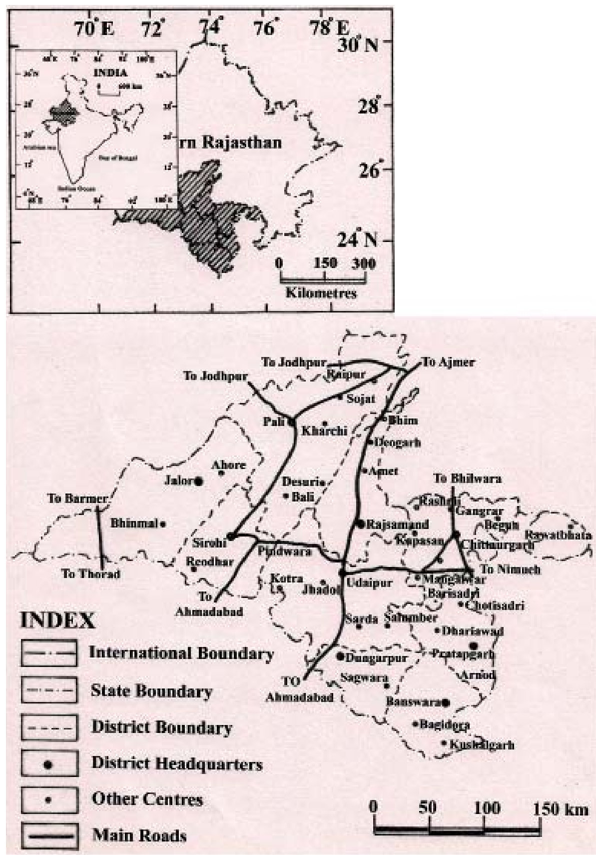

Fig. 11.1 Location Map of the Study area

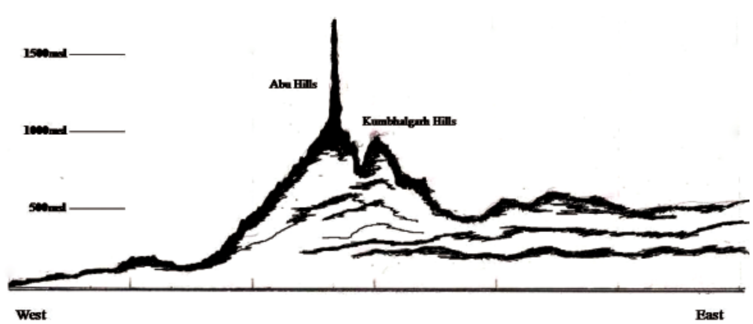

Fig. 11.2 Cross section of the study area of Rajasthan

Method

The present study was carried out during 2006 to 2009. Seasonal surveys (day and night) were carried out in different habitat types of the study area. Observed species were examined carefully. The diagnostic keys given by Boulenger (1890), Dutta (1992), Chanda (2002), Daniel (2002) and Daniels (2005) were used for species identification. Other than morphological identification, advertisement calls were used for identification and differentiation among individuals (Sharma, 2005 a,b). Night sampling (1900 hrs to 2100 hrs for hilly terrains and 1900 hrs to 2400 hrs for plains) was carried out with the aid of a spotlight.

The Visual Encounter Method and Visual Observation were used to survey the anurans in each site during the day and night (Heyer *et al.* 1994). Transects sampling were conducted for selected sites in the study area in different directions. Two replicates for each transect was done in an analogous habitat. All individuals encountered on the transect line were only identified to the species level and the mean number of live and trampled individuals was recorded for analysis of the characteristics of the population and diversity.

Results and Discussions

Anuran species are already showing a fast rate of extinction throughout the globe (Blaustein and Wake 1990, Stuart *et al.* 2004). Biologists have approached unaltered habitats, such as the tops of mountains etc. to document the anuran species before extinction. In this study the investigation has been carried out in the habitats of southern Rajasthan with main focus on the distribution pattern of anurans in higher elevations of Aravallis. Very few studies have been carried out on the related aspects of anuran diversity of higher altitudes (McCann 1942a,b, Waltner 1974, Ravichandran 1998, Krishnamurthy *et al.* 2001, Naniwadekar and Vasudevan 2007) especially in Aravallis (Sharma and Mehra 2007). McCann (1942a,b) had been the pioneer for Aravallis but that was merely a firsthand documentation of anurans at the table land of Abu Hills. No work has been done so far on the species distribution and attributes of anuran from high altitude from Aravallis. Thus, it is the first of the kind of scientific work carried in the Aravallis specifically for the anurans.

Among the current list of 13 anurans, presence of *Bufo viridis* has not been reported by any worker in the last three decades other than the author (Saxena, 1999). This was also not observed from the study sites in the present research. Thus, 12 anuran species of four families and ten genera have been documented time to time by different investigators (Sharma and Mehra 2007). These are *Euphlyctis cyanophlyctis*, *E. hexadactylus*, *Hoplobatrachus tigerinus*, *Fejervarya limnocharis*, *Sphaerotheca breviceps*, *S. rolandae*, *Duttaphrynus melanostictus*, *Bufo stomaticus*, *Microhyla ornata*, *Uperodon systoma*, *Kaloula taprobanica* and *Polypedates maculatus*.

Ten anuran species, out of the twelve, were recorded from the study area of southern Rajasthan in the present study namely *E. cyanophlyctis*, *H. tigerinus*, *F. limnocharis*, *S. breviceps*, *D. melanostictus*, *B. stomaticus*, *M. ornata*, *U. systoma*, *K. taprobanica* and *P. maculates* (Table 1). Among the ten species from southern Rajasthan, only seven species namely, *E. cyanophlyctis*, *H. tigerinus*, *F. limnocharis*, *S. breviceps*, *D. melanostictus*, *B. stomaticus* and *M. ornata*, were encountered on the higher altitude (above 800msl) whereas one species *U. systoma* was recorded from the foothills of Abu Hills (Table 11.1). McCann (1942a,b) also observed seven species from plateau regions of Abu Hills which is about 29 sq. km. at the average altitude of 800msl. It is quite possible that *U. systoma* which show its occurrence in the foothill areas of Abu Hills could not be recorded by McCann (1942a,b) because he covered only table land of Abu Hills whereas the area of about 326 sq. km. including the foothills was covered in the present study. This species was not observed by McCann (1942a,b) as well as by us from the high altitudes.

Table 11.1 Distribution of the anuran species in Study Area

Sr. No.	**Scientific Name (Common Name)**	**Distribution**			
		Study Area	**Altitudinal Range**		
			Study Area	**Sampling Sites**	
				Abu Hills	**Kumbhalgarh Hills**
	Family Ranidae				
1	*Euphlyctis cyanophlyctis* (Indian Skipping Frog)	Whole study region	All the ranges	All the ranges	All the ranges
2	*Hoplobatrachus tigerinus* (Indian Bull Frog)	Whole study region	Below 900m	Below 900m	All the ranges
3	*Fejervarya limnocharis* (Cricket Frog)	Whole study region	All the ranges	All the ranges	All the ranges
4	*Sphaerotheca breviceps* (Short-headed Burrowing Frog)	Pali, Sirohi, Chittorgarh, Pratapgarh, Udaipur	Below 900m	Below 900m	Below 900m
	Family Bufonidae				
5	*Duttaphrynus melanostictus* (Common Asian Toad)	Pali, Sirohi, Chittorgarh, Pratapgarh, Udaipur	Below 900m	Below 900m	All the ranges
6	*Bufo stomaticus* (Marbled Toad)	Sirohi, Chittorgarh, Pratapgarh, Udaipur	Below 900m	800-1,000m	600-800m
	Family Microhylidae				
7	*Microhyla ornata* (Ornate Narrow-mouthed Frog)	Whole study region	All the ranges	All the ranges	All the ranges

Sr. No.	Scientific Name (Common Name)	Distribution			
		Study Area	Altitudinal Range		
			Study Area	Sampling Sites	
				Abu Hills	Kumbhalgarh Hills
8	*Uperodon systoma* (Marbled Balloon Frog)	Jalore, Sirohi, Udaipur, Chittorgarh, Pratapgarh	Below 600m	Foothills	-
9**	*Kaloula taprobanica* (Indian Painted Frog)	Chittorgarh, Pratapgarh	Below 600m	-	-
	Family Rhacophoridae				
10	*Polypedates maculatus* (Indian Tree Frog)	Chittorgarh, Udaipur	Below 600m	-	-

** First Record from Rajasthan (Mehra 2010)

The altitudinal distribution pattern on Aravallis, in general, showed ubiquitous presence of *E. cyanophlyctis*, *F. limnocharis* and *M. ornata* on all the ranges from lower elevations or foothills to the highest elevations or peaks whereas *U. systoma* was observed from the foothills of the study areas only. *K. taprobanica* and *P. maculatus* are two other species which are not found in either of the sampling sites. Although, these two species are present in the lower elevations, below 600msl, in other sites of Aravallis in districts Chittorgarh and Pratapgarh districts. Rest four species out of ten namely *H. tigerinus*, *S. breviceps*, *D. melanostictus* and *B. stomaticus* showed their presence only below 900msl.

The altitudinal distribution pattern on Sampling Sites, in particular, showed distribution of *E. cyanophlyctis*, *F. limnocharis* and *M. ornata* on all the ranges very common followed by the presence of *H. tigerinus*, *D. melanostictus* and *B. stomaticus* which were commonly distributed. Presence of *S. breviceps* was occasional (Table 11.2 and 11.4). It could be due to its burrowing nature.

Table 11.2 Species abundance in different altitudinal ranges of Abu Hills

Sr. No.	Scientific Name	Distribution
	>800msl (Higher altitudes)	
	Family Ranidae	
1	*Euphlyctis cyanophlyctis*	Very Common
2	*Hoplobatrachus tigerinus*	Common
3	*Fejervarya limnocharis*	Very Common
4	*Sphaerotheca breviceps*	Occasional
	Family Bufonidae	
5	*Duttaphrynus melanostictus*	Common
6	*Bufo stomaticus*	Common
	Family Microhylidae	
7	*Microhyla ornata*	Very Common

Table 11.3 Species attributes for different altitudinal ranges of Abu Hills

Species Attributes	2006-07	2007-08	2008-09
<600msl (Foothills)			
Species Richness (S)	7	7	6
Total Abundance	3010	3237	4059
Simpson Diversity Index (D)	0.227	0.209	0.212
1-D	0.77	0.791	0.788
1/D	4.398	4.775	4.717
Shannon-Weiner Diversity Index (H')	1.563	1.654	1.617
Evenness (E)	0.803	0.85	0.903
600-800msl (Middle altitudes)			
Species Richness (S)	5	6	6
Total Abundance	2479	2410	3279
Simpson Diversity Index (D)	0.271	0.279	0.253
1-D	0.729	0.721	0.747
1/D	3.695	3.589	3.95
Shannon-Weiner Diversity Index (H')	1.41	1.422	1.478
Evenness (E)	0.876	0.794	0.825
800-1000msl (Higher altitudes)			
Species Richness (S)	7	7	7
Total Abundance	5338	4573	4413
Simpson Diversity Index (D)	0.321	0.203	0.206
1-D	0.679	0.797	0.794
1/D	3.117	4.934	4.855
Shannon-Weiner Diversity Index (H')	1.455	1.7	1.684
Evenness (E)	0.748	0.873	0.865
>1,000msl (Higher altitudes)			
Species Richness (S)	3	3	3
Total Abundance	396	420	485
Simpson Diversity Index (D)	0.385	0.355	0.347
1-D	0.615	0.646	0.653
1/D	2.599	2.821	2.88
Shannon-Weiner Diversity Index (H')	1.022	1.065	1.079
Evenness (E)	0.931	0.97	0.982

This is in accordance of the earlier studies made to assess similar species attributes (Navas, 2006). Species such as *E. cyanophlyctis* has been reported very common from high altitudes 2,000 and 3,000 above msl in Western Ghats (Daniels 1999, Ravichandran 1998) and Himalayas (Waltner 1974). The altitudinal range of 800 to 1000msl of Sampling Site 1 (Abu Hills) was important for the diversity of anuran species. Whereas at Sampling Site 2 (Kumbhalgarh Hills), the middle altitudinal range (600-800msl) was important for the anuran diversity.

Relative abundance of species was more on the rainfed sides of Aravallis. The eastern and southern parts in case of Sampling Site 1 whereas central and eastern parts of Sampling Site 2. There may be several reasons for the abundance and anuran diversity in particular sections of the sampling sites. Ovaska (1997) and Donnelly and Crump (1998) described about the changes in temperature and precipitation regimes could result in changes in the distribution and abundance of amphibian populations. The distribution of any species of organism is limited by the distribution of suitable environments. The combination of precipitation and temperature is fundamentally important in determining the distribution of general vegetation, which, in turn, determines the distribution of animal life.

Table 11.4 Species abundance at higher altitudes (>800msl) of Kumbhalgarh Hills

Sr. No.	Scientific Name	Distribution
	Family Ranidae	
1	*Euphlyctis cyanophlyctis*	Very Common
2	*Hoplobatrachus tigerinus*	Common
3	*Fejervarya limnocharis*	Very Common
4	*Sphaerotheca breviceps*	Occasional
	Family Bufonidae	
5	*Duttaphrynus melanostictus*	Common
6	*Bufo stomaticus*	Common
	Family Microhylidae	
7	*Microhyla ornata*	Very Common

The landscape characteristics decide vegetation of any habitat which in turn affects the abundance of particular anuran species (Buskirk 2005, Piha *et al.* 2007, Pillsbury and Miller 2008). There are some species which are evidenced from its habitat site and the surrounding environs (Radhakrishnan *et al.* 2007). The vegetation of the area mainly comprises of plant species of arid and semi-arid region. Though, the deep valleys in the Aravallis, which have perennial streams, have riverine forests of semi-evergreen species. The anurans were mainly found distributed nearby the aquatic environment. In the sandy tracts of western parts especially Jalore and Pali, the agricultural fields were most important site of occurrence of the *E. cyanophlyctis*, *F. limnocharis* and *M. ornata*. Agricultural ponds formed were occupied by these anuran species all over the study area. In Sirohi and Pali, *U. systoma* was another species found nearby the agricultural fields in abundance. *B. stomaticus* was another species found abundant near the farm lands in districts of Udaipur region. The waterlogged paddy fields of the Banswara and Dungarpur districts were preferred site of all the commonly distributed anuran species mentioned above. Knutson *et al.* (2004) also conclude that small farm ponds may sustain amphibian populations in landscapes where natural wetland habitat is rare.

The species richness decreases with the elevational gradient at both the sampling sites in the present investigation (Tables 11.3 and 11.5). At Sampling Site 1, seven species were encountered in the foothills whereas only three species were recorded from the high altitudes. Though, seven species were also encountered on the central plateau region of average altitude 800msl. Similarly, only five species were encountered on the high altitudes of the Sampling Site 2 whereas six and seven species were recorded from the lower elevational gradients. The results are in accordance with the patterns of species richness at elevational gradients with that of earlier work (Rahbek 1995, 1997). Inger *et al.* (1987) found associations between species richness and forest types at low and middle elevations in the southern Western Ghats.

Table 11.5 Species attributes for different altitudinal ranges of Kumbhalgarh Hills

Species	2006-07	2007-08	2008-09
<600msl (Foothills)			
Species Richness (S)	6	6	6
Total Abundance	2970	2767	3144
Simpson Diversity Index (D)	0.262	0.252	0.253
1-D	0.738	0.748	0.748
1/D	3.812	3.966	3.961
Shannon-Weiner Diversity Index (H')	1.46	1.496	1.505
Evenness (E)	0.815	0.8351	0.84
600-800msl (Middle altitudes)			
Species Richness (S)	7	7	7
Total Abundance	2290	2277	2524
Simpson Diversity Index (D)	0.304	0.305	0.295
1-D	0.696	0.695	0.705
1/D	3.292	3.278	3.388
Shannon-Weiner Diversity Index (H')	1.324	1.319	1.366
Evenness (E)	0.68	0.678	0.702
>800msl (Higher altitudes)			
Species Richness (S)	5	5	5
Total Abundance	1366	1194	1419
Simpson Diversity Index (D)	0.346	0.306	0.311
1-D	0.654	0.694	0.689
1/D	2.893	3.267	3.214
Shannon-Weiner Diversity Index (H')	1.177	1.297	1.284
Evenness (E)	0.731	0.806	0.798

At Sampling Site 1 (Abu Hills) (Tables 3), highest diversity (1.56) in year 2007 was found at the foothill areas followed by plateau table at altitudinal range of 800-1000 msl which was 1.7. The case was reverse for the consecutive years 2008 and 2009 where highest diversity 1.65 and 1.62 respectively, accounted for plateau region. The diversity index for higher altitude above 1000 msl was lowest for all the study years, 1.02 in 2007, 1.05 in 2008 to 1.08 in 2009.

At Sampling Site 2 (Kumbhalgarh Hills) (Tables 5), highest diversity (1.46) in year 2007 was found at the foothill areas followed by middle altitudinal range of 600-800msl and than higher altitudes which was 1.5. The same pattern was followed for all the study years where highest diversity indices were calculated for foothills followed by the middle altitudes. The diversity indices for the highest altitudes were lowest for all the study years, 1.17 in 2007, 1.3 in 2008 and 1.29 in 2009.

In the present study, low diversity was found on the highest altitudinal ranges at both the sampling sites which is contrary to that of Ravichandran (1998) who concluded that Tamil Nadu owes its rich amphibian diversity to its forests in higher elevations along the eastern slopes of the Western Ghats. This may be because the pattern of forest and related habitats in Aravallis particularly the Abu Hills, Kumbhalgarh, Parshuramji and Jarghaji are different from the other high altitude habitats such as Western Ghats. Aravallis have the climax forest types (Mathur 1960) with the dry deciduous vegetation. Thus, due to absence of dense moist habitats on the high elevations of the Aravallis, low diversity of the amphibians was observed. It is evident from the fact that the high diversity of anurans observed for the ranges of the two Sampling Sites, viz. 800-1000msl range of Site 1 and 600-800msl range of Site 2, were having dense and moist habitats in form of perennial streams, ponds etc.

Using the remarks on the habitat use of the amphibians by Srinivasulu and Das (2008), the eight species of amphibian of southern Rajasthan could be categorized as human commensals or tolerant of disturbed habitats. These are *B. stomaticus, D. melanostictus, M. ornata, U. systoma, E. cyanophlyctis, F. limnocharis, H. tigerinus* and *S. breviceps*. The two species which were mentioned human commensals, namely *K. taprobanica* and *P. maculatus* were only found in the forest patches. As the sightings of these two were rare during the course of work, therefore, it would be not justifiable to comment on their habitat use. In terms of gross habitat usage are the fossorial (*K. taprobanica, M. ornata* and *U. systoma*), terrestrial (*D. melanostictus* and *B. stomaticus*), aquatic or aquatic-margin (*E. cyanophlyctis, E. hexadactylus, F. limnocharis* and *H. tigerinus*) and arboreal (*P. maculatus)*. Skittering on the water surface is known for one species (*E. cyanophlyctis*).

In the present investigation, it was found that habitat loss is major cause of concern. The study area falls in the semi-arid tract but the sampling sites were among the areas of high rainfall. Abu Hills receive highest average annual rainfall than any other parts of the state. Similarly, Kumbhalgarh Hills have riverine pocket in its central parts along with dense forest patches with relatively rich sources of water to maintain the wetland habitats. Despite of these conditions, the investigated areas are receiving low rainfall from past few years and the anthropogenic interferences are increasing. In such conditions it is necessary to check the further exploitation through strict implementation of the rules and regulation.

Recommendations were made by Mehra (2006) for the fragile ecosystem of Abu Hills in year 2006 which resulted in the notification of Eco-Sensitive Zone for the human habituated area of the Abu Hills in year 2009. This is welcome step to protect the ecosystem of the Abu Hills. The notification will check further alteration of the aquatic habitats. The anuran diversity was found high for this range due to presence of aquatic bodies, drainage, agricultural farms and many other water logged areas which are of great importance for the anurans.

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12

Managing Natural Resources for Sustainable Livelihoods: Threats to the Future of Sustainable Wild Collection and Field Experience with Implementation of the FairWild Standardfor Medicinal Plants

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ABSTRACT

The majorities of medicinal and aromatic plant (MAP) species in international trade are not grown on farms but rather are collected from wild populations by local, rural or indigenous people, a practice that will continue for agronomic, ecologic, and economic reasons.

While there is a finite inventory of wild plants available for trade, albeit dwindling due to encroachment from development and conversion of biodiversity to cropland, global demand is increasing due to growing interest in natural health care. The number of people willing to collect wild plants for household income is steadily declining because more can be earned from other activities. At the same time, countries are implementing export promotion programs to commercialize and globalize their systems of traditionalmedicine that employ plant-based drugs, i.e. Ayurvedic medicine from India and traditional Chinese medicine (TCM) from China.

Part of the solution is found in the recent development and implementation of rigorous sustainability standards that link local producer communitieswith product companies that require sustainable wild harvested ingredients with independent certification. The FairWild Standard (FWS) combines fair trade principles supporting economic and social sustainability with sustainable resource management plans that support ecological sustainability. Compliance with the FWS for the selected managed species can be certified through independent inspection and certification organizations.

Based on the authors' experience in collaborative implementation of sustainability standards with communities that make their livelihoods from wild harvesting of medicinal plants, this article describes experiences from different regions and the pioneering companies and organizations that are investing in sustainable harvesting, trade and use.

Keywords: Biodiversity, FairWild, Herbal medicine, Medicinal and aromatic plants, Natural resource management, Sustainability.

Abbreviations: CBD, Convention on Biological Diversity; CITES, Convention on International Trade in Endangered Species of Wild Fauna and Flora;FWF, Fair Wild Foundation; FWS, Fair Wild Standard; IMO, Institute for Market Ecology; ISSC-MAP, International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants; LIK, local and indigenous knowledge; MAP, medicinal and aromatic plants; NGO, non-governmental organization; TEK, traditional ecological knowledge; TMK, traditional medical knowledge.

Introduction

Through careful observation of the natural world over many generations, local, rural and indigenous communities developed and implemented natural resource management systems and strategies for sustainable use necessary for their own long-term survival. Traditional resource management systems contain the local knowledge of precisely how, when and where to collect and process plant parts for dye, fiber, food, and medicine uses, as well as for ritual and religious uses, providing a foundation for cultural security, food security, and local medicine security. Such traditional management systems are now considered within concepts including local and indigenous knowledge (LIK), traditional ecological knowledge (TEK) and traditional medical knowledge (TMK). TEK has been defined as "a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes, F., et al. 2000). Reddy (2006) states "TMK includes ethnobotanical knowledge on plant and genetic resources as well as folkloristic oral traditions that deal with medicinal applications of these resources," and asserts that "ownership and control over TMK and biodiversity have become the new realities and tropes of medical globalization" (Reddy, S. 2006). While traditional systems exist for management of natural resources for sustainable local production of traditional foods and herbal medicines, the push towards commercialization and globalization of traditional herbal medicines creates new demand for extraordinary quantities for the export market that test the limits of local resource management systems.

There are an estimated 50,000 to 70,000 medicinal and aromatic plant (MAP) species used in local and traditional systems of medicine but only about 3,000 occur in the global import/export trade. Of the approximately 3,000 species in international trade, about two-thirds are wild collected and are likely to continue to be wild collected for agronomic, ecologic, and economic reasons (Medicinal Plant Specialist Group 2007). Some medicinal plants take several years to reach maturity, many medicinal roots requiringat least four to five years before a first harvest is indicated and tree barks obtained from branches or trunks even longer. Farmers would need to plan a crop rotation system spanning over decades before determining feasibility and profitability, with no return on investment during the first several years of experimental cultivation. Small- to medium-sized farming enterprises cannot generally afford such long-term speculation (Brinckmann, J. 2009).Additionally, the cultivation of formerly wild-only species generally requires conversion of natural ecosystems of biodiversity into cropland. A study funded by the United Nations Environment Programme (UNEP) reports that expansion of cropland in tropical countries is now one of the principal causes of biodiversity loss (Phalan, B., et al. 2013).

While there is a finite inventory of wild plants available for local use and international trade, the available quantities of certain economic plant species are decreasing due to development encroaching on wild lands, conversion of natural ecosystems to cropland, and non-sustainable harvesting practices associated with the loss of TEK, among other factors. At the same time, global demand continues to increase due to growing interest in natural health care and correspondingly herbal medicinal products and natural health products.

Contributing to loss of TEK is a worldwide mass migration of young people from rural to urban areas. Internal migration appears as a massive phenomenon, exceeding international migration with young people being 40 per cent more likely to move from rural to urban areas than older individuals (Decent Rural Employment Team 2013). In the People's Republic of China, the world's largest producer, user and exporter of MAPs (Brinckmann, J. 2011), 700 million people now live in cities compared to 200 million in 1980. At the current rate of migration nearly 1 billion Chinese will live in cities by 2030 (Miller, T. 2013).India, the world's second largest producer, user and exporter of MAPs, also faces rapid urbanization, with an estimated 590 million living in cities by 2030 (Planning Commission Government of India 2013).

The number of people willing to collect wild plants as their source of household income is steadily dropping mainly because more can be earned from other activities. As an example, the European Union (EU) funded project "Traditional and Wild" aims to preserve the TEK on wild collection that is being lost rapidly in eastern European countries. The flow of TEK from previous generations has been disrupted largely due to weak economic incentives of wild collection for household income and increasing urbanization of society. Other disincentives for the next generations to choose wild collection as their source of income include uncertain legal access to natural resources (land tenure) and legal requirements to register as collectorswhilethere is still only a limited number of forward-thinking ethical companies willing to pay a sustainability price mark-upand social premium for botanical raw materials with organic and fairtrade certifications (TRAFFIC International 2013).

Part of the solution to these significant problemsthat indeed challenge biodiversity conservation can be observed in the recent development and implementation of rigorous standards for sustainable wild collection and resource management applying ecological, economic and social criteria within a whole ecosystem approach, i.e. the long-term survival of the people, plants and animals are taken into consideration.

The preservation of TEK and TMK, respectively, as it pertains to wild collection of medicinal plants, traditional post-harvest processing methods, and preparation of traditional medicines may be intrinsically linked to biodiversity conservation and the local economies that are dependent on produce of sensitive ecosystems. Furthermore there is data demonstrating the co-occurrence of high biological diversity with high linguistic and cultural diversity. It has been suggested that indigenous economies and management practices essentially enable high biological diversity to persist. Biodiversity and linguistic diversity are, however, experiencing an extinction crisis with an estimated annual loss of species at 1,000 times or more greater than historic rates and 50-90% of languages disappearing by end of this century (Gorenflo, L.J., et al. 2012). Thus, the conservation of sensitive ecosystems, which provide essential raw materials for herbal medicines and natural products, may not be possible without incorporating endemic languages and traditional cultures into biodiversity conservation strategies.

Since the early 2000'sselected local wild harvesting communities have been participating in the test implementation of newly established sustainability standards with the support of buyer/importer companies that require procurement of sustainably wild harvested ingredients with independent certification. Initial implementation in some cases has also occurred in collaboration with non-governmental organizations (NGOs) and governmental agencies charged with nature conservation activities. The FairWild Standard (FWS) is one such standard having been test implemented in several countries of Africa, Asia, Europe and South America in the 9 years thus far from 2005 through 2013.

1. The Fair Wild Standard (FWS)

The purpose of the FWS is to ensure the continued use and long-term survival of wild species and populations in their habitats, while respecting the traditions and cultures, and supporting the livelihoods of all stakeholders, in particular collectors and workers (FairWild Foundation 2010a). Implementation of the FWS can also contribute to fulfilling regulatory requirements of national resource management systems as well as compliance with international conventions such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD).

The development of the ecological module of the FWS, originally called the "*International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants*" (ISSC-MAP), was supported in part by the German Federal Agency for Nature Conservation (BfN), TRAFFIC International, the World Wide Fund for Nature (WWF), and the International Union for Conservation of Nature (IUCN). The development of the social module of the standard was initiated by the Swiss Import Promotion Programme (SIPPO) (operating under the Swiss State Secretariat for Economic Affairs (SECO)) in cooperation with Forum Essenzia e.V. (Kempten, Germany) and the Institute for Market Ecology (IMO) (Weinfelden, Switzerland).

In October 2008, during the IUCN IV World Conservation Congress, an agreement was signed between the four founding institutions of the ISSC-MAP to endorse global implementation of the standard through the newly established FairWild Foundation.

The FWS Version 2.0 is comprised of 11 principles and 29 criteria addressing ecological, social and economic requirements for sustainable wild collection, which are outlined in Table 12.1. The FWS couples fair trade principles with sustainable resource management plans to ensure social and ecological sustainability of wild harvested plants. In fulfilling the resource assessment and management plan requirements of the FWS, local botanical experts are generally contracted to conduct species-specific and region-specific research on sustainable collection rates for each botanical to be collected. Harvest methods and practices for each site must be based on this research and may be modified (adaptive management) as new research becomes available. Incorporating fair trade principles, collectors are paid a steady and fair price for collected botanicals. In addition to the fair price, a premium is paid to the collectors and is kept in a separate account that is used to improve the quality of life for the collectors. Use of the premium funds are decided by the collectors, funds may not be taken in cash but rather used to purchase goods that will be of benefit to collectors or to the communities in which they live. Additional principles of the FWS include other social requirements and responsible business practices.

Table 12.1 FairWild Principles and Criteria for Collection Operations

SECTION I: WILD COLLECTION AND CONSERVATION REQUIREMENTS
Principle 1. Maintaining Wild Plant Resources: Wild collection of plant resources shall be conducted at a scale and rate and in a manner that maintains populations and species over the long term.
Principle 2. Preventing Negative Environmental Impacts: Negative impacts caused by collection activities on other wild species, the collection area and neighboring areas shall be prevented.
SECTION II: LEGAL AND ETHICAL REQUIREMENTS
Principle 3. Complying with Laws, Regulations and Agreements: Collection and management activities shall be carried out under legitimate tenure arrangements and comply with relevant laws, regulations and agreements.

Principle 4. Respecting Customary Rights and Benefit-Sharing: Local communities' and indigenous peoples' customary rights to use and manage collection areas and wild-collected target resources shall be recognized, respected and protected.
SECTION III: SOCIAL AND FAIR TRADE REQUIREMENTS
Principle 5. Promoting Fair Contractual Relationships between Operators and Collectors: Collectors have the structures and access to information needed to represent their interests and participate in FairWild Premium decisions. There is no discrimination against particular groups as collectors.
Principle 6. Limiting Participation of Children in Wild-Collection Activities: Collection and processing by collectors is done without substantial work contribution of children.
Principle 7. Ensuring Benefits for Collectors and their Communities: Trade intermediaries are minimized, collectors are ensured a fair price for the collected goods, and community social development is supported through means of a FairWild Premium fund.
Principle 8. Ensuring Fair Working Conditions for all Workers of Wild-Collection Operations: The collection operation ensures good working conditions for all workers of the wild-collection operation.
SECTION IV: MANAGEMENT AND BUSINESS REQUIREMENTS
Principle 9. Applying Responsible Management Practices: Wild collection of target species shall be based on adaptive, practical, participatory and transparent management practices.
Principle 10. Applying Responsible Business Practices: Collection of wild resources shall be undertaken to support quality, financial and traceability requirements of the market without sacrificing sustainability of the resource.
Principle 11. **Promoting Buyer Commitment**: The buyer of wild-collected products (e.g. importer) strives for mutually beneficial long-term trade relations with the wild-collection operation based on respect, transparency and support for the supplier in quality aspects.

Source: (FairWild Foundation 2010a).

1.1. Fair Wild Standard Development and Test Implementation

During the mid-2000's, early versions of both the FWS and the ISSC-MAP were developed, test implemented and refined through a multi-stakeholder process directly engaging wild MAP producer organizations in several countries, particularly in central- and eastern- European countries (e.g. Bosnia & Herzegovina, Croatia, France, Hungary, Macedonia, Poland, and Romania) and Asian countries (e.g. Afghanistan, Cambodia, India, Kazakhstan, Nepal, Uzbekistan, and Siberian Federal District of Russian Federation) but also in some African countries (e.g. Lesotho and Namibia) and South American countries (e.g. Brazil and Peru).

The first companies to attain FairWild certification for certain wild harvested plant materials within their wild resource management plan areas were situated in republics of the former Yugoslavia including three companies in Bosnia &Herzegovina (BiH), namely Boletus d.o.o. (Hadžići, BiH), Elmar d.o.o. (Trebinje, BiH), and Smrčak d.o.o. (Zvornik, BiH)), one company in Croatia, Terra Magnifica (Donji Stupnik), and another in Macedonia, Alkaloid A.D. Skopje (Skopje).Implementation of the FWS at many sites has been made possible by partnerships between producers (those who collect the plants), processors and distributors (those who process and resellto manufacturers), and manufacturers of finished products. Such partnerships help to ensure that the costs of implementation and maintaining annual certification will be offset by companies willing to pay the full costs of sustainable resource management.

One of the first high volume MAPs to be prioritized by companies and government-funded country projects was licorice (root and stolon of *Glycyrrhiza glabra* L. and/or of *G. inflata* Bat. and/or *G. uralensis* Fischer; Fabaceae). Chinese licorice (*G. uralensis*) is an endangered and nationally-protected medicinal plant species within China where it is one of the most widely used botanicals in the traditional Chinese system of medicine (Zhang, J.T. 2010). Indeed, licorice is among the most widely utilized of allMAP species for domestic consumption in its various countries of origin as well as being one of the highest volume MAPs in the global export trade.

In 2005, implementation of the standards for sustainable wild licorice began in the Almaty Region of Kazakhstan through the financial and technical support of an EUcompany Martin Bauer GmbH & Co. KG (Vestenbergsgreuth, Germany). Also in 2005 implementation began in the Badakshan, Baghlan, Bamyan, and Herat Provinces of Afghanistan as part of a program funded by the Dutch development organization Oxfam-Novib with trade support of another EU company, Organic Herb Trading Company (Somerset, UK). First audits were carried out in both Afghanistan and Kazakhstan in 2006 by the Swiss inspection and certification body, Institute for Market Ecology (IMO). In 2007, implementation began in the Amur Darya delta region of Uzbekistan with support of the German Agency for Technical Cooperation (GTZ) and a Swiss trading company W. Kündig & CIE AG (Zurich, Switzerland). More recently the Organic Herb Trading Companymandated implementation of the FWS for wild licorice with a producer group in Spain. Among other potential sustainable licorice projects under consideration, the Georgian Ministry of Economy and Sustainable Development is discussing the possibility of implementing the FWS for wild licorice harvesting in eastern Georgia near the border with Dagestan.

Table 12.2 provides information on the companies, governmental agencies and NGOs who have played a significant role thus far in the implementation of the FairWild Standard for sustainable licorice root and thereby protecting the sensitive ecosystems where licorice occurs in the wild. Table 12.3 provides the list of producer groups, brokers, processors and traders, and finished product manufacturing companies presently committed and invested in the FairWild system.

Table 12.2 Partners for the sustainable harvesting of wild licorice root

ISSC-MAP and FairWild® implementation projects for sustainable wild licorice root		
Producer group	**Governmental and/or NGO supporting institutions**	**Trading companies supporting implementation**
Various tribal groups involved with licorice collection (Afghanistan)	Oxfam-Novib (Netherlands); UKAID Department For International Development (DFID) Research in Alternative Livelihoods Fund (RALF)	Organic Herb Trading Company (UK)
Herbes del Moli (Spain)	None	Organic Herb Trading Company (UK)
Shirin Mukhid (Uzbekistan)	German Agency for Technical Cooperation (GTZ)	W. Kündig & CIE AG (Switzerland)
A licorice harvesting firm (Kazakhstan) supported by Martin Bauer (Germany)	None	Martin Bauer GmbH & Co. KG (Germany)

Table 12.3 FairWild Operations as of October 2013

Companies	Countries
FairWild-certified Operators (Producers)	
Alkaloid A.D. Skopje	Macedonia
Amin Organic Farm	Azerbaijan
Arid Land Resources (supported by Arbor Oils Kenya)	Kenya
Asociacion de Recolectores de Cacao Silvestre Yuracare	Bolivia
Asva-Raf LLC	Armenia
Boletus d.o.o.	Bosnia & Herzegovina
Herbes del Moli (supported by Organic Herb Trading Co.)	Spain
Martin Bauer GmbH (Germany) supported producer group	Bulgaria
Martin Bauer GmbH (Germany) supported producer group	Kazakhstan
Runo Spólka z.o.o.	Poland
Schmidt und Co. Kft.	Hungary
Viola Ltd. (supported by Organic Herb Trading Company)	Bulgaria
Brokers for FairWild-certified Operators	
Inproplant GmbH	Germany
Josef Weber & C.L. Meyer GmbH	Germany
Processors and Distributors of FairWild-certified Ingredients	

Companies	**Countries**
Agrimed Hessen w.V.	Germany
High Quality Organics	United States
Martin Bauer GmbH & Co. KG	Germany
Organic Herb Trading Company Ltd.	United Kingdom
W. Kündig & CIE AG	Switzerland
Manufacturers and Marketers of Finished Products with FairWild-certified Ingredients	
Alkaloid AD Skopje	Macedonia
Neal's Yard Remedies	United Kingdom
Pukka Herbs Ltd.	United Kingdom
Traditional Medicinals®, Inc.	United States, Canada

1.2. Wild Plant Populations Managed Under the FairWild System

Presently there are 29 plant species occurring in 11 countries that are being managed under sustainable resource management plans according toFWS requirements for certification. The wild collection sites are subject to annual inspections by an independent third-party inspection and certification organization, the Institute for Market Ecology (IMO) or other organizations authorized to make FWS inspections under agreement with IMO for example Austria Bio Garantie (ABG). Table 12.4 shows the wild harvested medicinal plants that are commercially available with FairWild® certification as of October 2013.

There are also funded country projects where the FWS is presently being implemented within a national strategy as well as company-driven implementations that are in their early stages with certification anticipated in the coming years. For example, the Applied Environmental Research Foundation (AERF) of Pune, Maharashtra has signed an MOU with an EUherbal product company Pukka Herbs (Bristol, UK) who, in collaboration with the Durrell Institute of Conservation and Ecology (DICE) at University of Kent, aim to establish a sustainable supply chain of selected wild medicinal plants from the North-western Ghats with a goal of FairWild certification by 2015 for "bibhitaki" or belleric myrobalan fruit (*Terminalia bellerica* (Gaertn.) Roxb.; Combretaceae) and "haritaki" or chebulic myrobalan fruit (*Terminalia chebula* Retz.; Combretaceae). This partnership between AERF, DICE and Pukka Herbs is part of a three-year (2013-2016) project, "*Socio-ecological landscapes for biodiversity conservation and climate change adaptation*," funded under the Darwin Initiative by the UK Department for Environment, Food and Rural Affairs (DEFRA) (University of Kent 2013).

Similarly, the US herbal product company Traditional Medicinals®, Inc. (Sebastopol, California) signed an MOU with the Shuijing Traditional Chinese Medicine Materials Cooperative (Shuijing Town, Pingwu County, Sichuan Province, China) for the long-term sustainable supply of "nanwuweizi" or southern schisandra fruit (*Schisandra sphenanthera* Rehder & E.H. Wilson; Schisandraceae), with project goals of FairWild, Organic Wild, and Panda Friendly certifications. The MOU between the US company and the cooperative was signed as an outcome of a five-year (2007–2011) project, "*Sustainable Management of Traditional Medicinal Plants in the High-Biodiversity Landscapes of Upper Yangtze Eco-region*," which was a field project within the EU-China Biodiversity Programme (ECBP), funded by the EU and implemented by the United Nations Development Programme (UNDP) in cooperation with China's Ministry of Environmental Protection. One of the very positive lessons learned in this project was through the early identification and targeting of socially responsible herbal product companies nearly at the start of the five-year project. The inviting ofinterested companies to participate as stakeholders contributed significantly to the successful implementation of sustainability standards, meeting the goal of achieving third-party certification, and resource management continuity through establishing a long-term fairtrade relationship between the cooperative and two companies (a Chinese extraction company and a US herbal product company). Experience has shown that it is more common for similar sustainable development projects to come to an endafter government funding and technical cooperation stops, particularly in cases where reliable buyers for certified botanicals have not been invited into the project. This case demonstrated that responsible companies can play a useful role towards biodiversity conservation through trade agreements based on the FWS (Brinckmann, J., and Morgan, B. 2012).

Country projects where the FWS is presently being implemented but where linkages to buyers of the eventually FairWild certified ingredients has not yet been established include a UNDP country project for Morocco, "*Mainstreaming Biodiversity into Value Chains for Medicinal and Aromatic Plants in Morocco*," funded by the Global Environment Facility (GEF) involving sustainable resource management plans for Moroccan wild oregano aerial parts (*Origanum compactum* Benth,; Lamiaceae), Moroccan wild thyme flowering aerial parts (*Thymus saturejoides* Coss.; Lamiaceae), and wild rosemary leaf (*Rosmarinus officinalis* L.; Lamiaceae), possibly among other MAPs (Global Environment Facility 2010).

The "Traditional and Wild" project, a Central Europe Programme co-financed by the European Regional Development Fund (ERDF), is implementing the FWS in several eastern European countries including Czech Republic, Hungary, Poland, and Slovenia. The project has already carried out and published resource assessments for several MAP species (Central Europe Programme 2013). Table 12.5 provides a list of the assessed wild species and the collection regions where the FWS is being applied.

Additionally, a number of EU and US botanical ingredient processing and distributing companies plan to invest further in FairWild implementation at selected sites within their own networks of wild harvesting enterprises, including the companies High Quality Organics (US), Martin Bauer GmbH & Co. KG (Germany), Organic Herb Trading Company (UK), W. Kündig & CIE AG (Switzerland), and Worlée Naturprodukte GmbH (Germany).

Table 12.4 Wild Plants with FairWild® Certification as of October 2013

Botanical name	**Common name**	**Plant parts**	**Countries**
Althaea officinalis L. [Malvaceae]	Marshmallow	Leaf, Root	Hungary
Betula pendula Roth. [Betulaceae]	Birch	Leaf	Macedonia
Boswellia neglecta S. Moore [Burseraceae]	Frankincense	Gum-resin exudate	Kenya
Commiphora confusa Vollesen [Burseraceae]	Myrrh	Gum-resin exudate	Kenya
Cornus mas L. [Cornaceae]	Cornelian cherry	Fruit	Azerbaijan
Crataegus monogyna Jacq. [Rosaceae]	Hawthorn	Flower-bearing branches with leaves	Bulgaria
Equisetum arvense L. [Equisetaceae]	Horsetail	Sterile aerial parts	Macedonia
Foeniculum vulgare Miller [Apiaceae]	Fennel	Cremocarps and mericarps	Macedonia
Gallium aparine L. [Rubiaceae]	Cleavers	Flowering aerial parts	Hungary
Glycyrrhiza glabra L. [Fabaceae]	Licorice	Root and stolon	Spain
Glycyrrhiza uralensis Fisch. [Fabaceae]	Chinese licorice	Root and stolon	Kazakhstan
Hypericum perforatum L. [Clusiaceae]	St. John's wort	Flowering tops	Macedonia
Juniperus communis L. [Cupressaceae]	Juniper	Ripe cone berry	Bulgaria, Macedonia
Matricaria recutita L.[Asteraceae]	Chamomile	Capitula	Macedonia
Melissa officinalis L. [Lamiaceae]	Lemon balm	Leaf	Bulgaria, Macedonia
Myrtus communis L. [Myrtaceae]	Myrtle	Leaf	Macedonia
Robinia pseudoacacia L. [Fabaceae]	Black locust	Flower	Macedonia
Rosa canina L. [Rosaceae]	Dog rose	Receptacle and remains of the dried sepals	Armenia, Bulgaria, Hungary, Macedonia
Rubus caesius L. [Rosaceae]	European dewberry	Leaf	Hungary

Botanical name	**Common name**	**Plant parts**	**Countries**
Rubus fruticosus L. [Rosaceae]	Blackberry	Leaf	Bosnia & Herzegovina, Bulgaria
Rubus idaeus L. [Rosaceae]	Raspberry	Leaf	Bosnia & Herzegovina, Bulgaria
Sambucus nigra L. [Caprifoliaceae]	European elder	Flower	Bosnia & Herzegovina, Bulgaria, Hungary, Macedonia
Taraxacum officinale F.W. Wigg. [Asteraceae]	Dandelion	Leaf; Underground parts	Bulgaria, Hungary, Poland
Theobroma cacao L. [Sterculiaceae]	Cacao	Kernels of the ripe seed	Bolivia
Tilia cordata Miller [Tiliaceae]	Linden	Inflorescence	Bosnia & Herzegovina, Hungary, Macedonia
Tilia platyphyllos Scop. [Tiliaceae]	Linden	Inflorescence	Bosnia & Herzegovina, Hungary, Macedonia
Tilia tomentosa Moench [Tiliaceae]	Silver lime	Inflorescence	Bulgaria
Urtica dioica L. [Urticaceae]	Stinging nettle	Leaf	Bosnia & Herzegovina, Bulgaria, Hungary, Macedonia, Poland
Urtica dioica L. [Urticaceae]	Stinging nettle	Rhizome and root	Bosnia & Herzegovina, Poland

Source: (FairWild Foundation 2013).

Table 5. Resource Assessments for MAP species in Traditional and Wild Project

Botanical name	Common name	Plant parts	Countries
Betula pendula Roth. [Betulaceae]	*European white birch (silver birch)*	*Leaf*	*Region of Rzeszow, Poland*
Equisetum arvense L. [Equisetaceae]	*Horsetail*	*Sterile aerial parts*	*Rzeszow's Region, Poland*
Juglans regia L. [Juglandaceae]	*English walnut*	*Leaf*	*Šentjur's region, Slovenia*
Juniperus communis L. [Cupressaceae]	*Juniper*	*Ripe cone berry*	*Region of Kiskunság, Hungary*

Botanical name	Common name	Plant parts	Countries
Rosa canina L. [Rosaceae]	*Dog rose*	*Receptacle and remains of the dried sepals (hip)*	*Czech Republic*
Rubus idaeus L.; Rosaceae	*Raspberry*	*Leaf*	*Lokve's region, Slovenia*
Sambucus nigra L. [Caprifoliaceae]	*European elder*	*Flower, Fruit*	*Czech Republic; Ormánság Region, Hungary; Šentjur's Region, Slovenia*
Urtica dioica L. [Urticaceae]	*Stinging nettle*	*Aerial parts, Leaf*	*Czech Republic; Lokve's Region, Slovenia*
Vaccinium myrtillus L. [Ericaceae]	*Bilberry*	*Fruit, Leaf*	*Rzeszow's region, Poland*

Source: (Central Europe Programme 2013)

1.3. How Collectors are Deciding to use the Fair Wild Premium Fund and the Difficulties faced

An unanticipated difficulty with implementing certain parts of Principles 5 and 7 of the FWS has been reported similarly by many of the certified producer operations. Principle 5.1 requires that an economic relationship exist between the wild collection enterprise and its registered collectors that is fair and transparent, thus allowing the collectors to be involved in important decisions such as FairWIld premium fund use or pricing agreements. Principle 7.2 deals with the actual administration and use of the premium fund for community social development purposes, i.e. collectors should form a representative committee or democratically elect a stakeholder board that is accountable for the receipt, administration and decisions on appropriate use of the premium fund monies.

The problems faced thus far with the premium fund requirements of the FWS vary from country to country. In some countries it has not been possible for the collectors to establish a separate bank account for the receipt and administration of premium fund monies due to complicated national regulations. Buyers have had to experiment with different ways to transfer these funds without putting the producer enterprise at risk of violating a regulation. In several countries, we have learned that each collector is required to pay income tax on a proportional share of the overall premium fund (as though it was income, which it is not) which diminishes the amount made available for community social development purposes.

In certain cases, making a democratic decision on equitable use of the premium fund has been complicated in that some communities have stated that they would prefer to not have the money usedtowards an expenditure that would benefit the entire community. Issues of fairness are raised, in that some households include collectors who are working full-time, while other households may include collectors working only part-time and some villagers are not participating in the collection at all. Thus, the registered collectors may not view it as "fair" if non-collectors in their village benefit from the community development fund. In most cases, the individual collectors state that they would prefer to instead receive additional cash and be allowed to make their own personal decisions on how best to spend it towards improving the quality of life for their family. The latter suggestion could be problematic for FWS requirements that the funds are used to improve quality of life depending on the cultural context and who in the household is actually empowered to make decisions on how money is spent for the family.

In wild collection operations where there are only a few collectors working together in a brigade, the establishment of a democratic framework for deciding on how best to use the social premium fund each year has worked rather well. However, in collection operations where there may be hundreds of collectors, not all living in the same community or village, this aspect of the standard for supporting social sustainability remains a complicated issue to sort out.

2. Consumer's Willingness to Pay the Price for Biodiversity Conservation

While there are certainly other relevant sustainable harvesting practice standards for MAPs being implemented around the world, the FWS is presently the most visible standard that is specifically linked to management of wild plant populations in context of biodiversity conservation. Popular branded herbal products, now bearing the FairWild® certification mark on their labels, are found on retail store shelves in several EU and non-EU European countries, throughout Canada and the United States, and in several Asian and Oceanic regions, in particular Australia, Hong Kong, Japan, New Zealand, the Philippines, and Taiwan. The website address of the FairWild Foundation is presented on labels which enables consumers to learn more about biodiversity conservation and how they are play a role by choosing to purchase and use products from responsible companieswho are investing in natural resource management, sustainable production, trade and use.

Other sustainability standards being implemented that are playing a positive role in biodiversity conservation and sustainable harvestingof MAPs include, among others, the Fair for Life Social and Fairtrade Programme for Wild Collection Operations (Bio-Stiftung Schweiz 2011) and the STD01-Ethical BioTrade Standard (Union for Ethical BioTrade 2012).

For labelling and marketing of sustainable herbal and natural products at the retail level, especially in the North American market, compliance with multiple standards is becoming more commonplace and product labels from ethical companies are beginning to display a range of several relevant certification marks that communicate different aspects of sustainability, not only for the product's wild-collected botanical ingredients but also for plant-based packaging components. For example, there are finished products labelled with the FairWild certification mark that are also labelled with the United States Department of Agriculture (USDA) organic certification mark which shows compliance with the USDA National Organic Program (NOP) Wild-crop Harvesting Practice Standard (United States Department of Agriculture 2011) as well as with the Non-GMO-Project verification mark which shows compliance with the Non-GMO Project Standard for product ingredients and plant-based packaging components (Non-GMO Project 2013).

1.4. Discussion

The theory asserting that biodiversity conservation can be facilitated through sustainable management, use and ethical trade of economic plants is still being tested. In this new social business model, the local, rural or indigenous people, who earn some or all of their household income from wild collection of plants, are to be paid fairerprices that not only cover the costs of resource management activities in the long term, including required conservation investments, annual inspections and certification, but also provide for a reliable annual income leading to local economic security with funds also available for community social development (FairWild Foundation 2010b). The hypothesis is that wild collection communities will be incentivized and empowered to become stewards of the ecosystems that they themselves are a part of - so long as the certified sustainably harvested producethat they bring to market will commandan appropriate price premium. The incentive needs to be high enough to ensure long-term economic viability of wild collection enterprises in rural areas so that the transmission of TEK from generation to generation can continue and so that the dwindling number of young people interested in carrying on the ancient tradition of wild collection will reverse and start to increase.

For the FWS and other sustainability standards to have measurable positive impact for the long-term survival of MAP species in healthy ecosystems there also needs to be a large enough public willing to pay premium prices for sustainably produced products of biodiversity. That theory is also being tested, mainly in the North American and Western European countries where the largest markets for certified organic, non-GMO and fairtrade products exist and continue to grow year after year. For example, in the US market, sales of natural products featuring third party certifications surged in 2012 with non-GMO verified products increasing 18% over the previous year, fair trade certified product increased 17%, and certified organic products increased by 12% (Watson, E. 2013).

Approaching the end of the first decade of FWS implementation, the number of certified producers, registered processors and traders, and finished product licensees continues to grow steadily but many more companies need to join and invest in the FairWild system and/or other comparable resource management systems before we'll reach a significant global impact on biodiversity conservation.

A growing number of product companies are indeed becoming interested in the implementation of sustainability standards in collaboration with their producers and suppliers because it appears to economic sense in the long term. Businesses that invest in the independent certification of sustainable resource management for their botanical ingredients find that it complements and supports their overall quality assurance system, reduces supply chain risk and uncertainty, supports compliance with food safety regulations by offering full traceability and transparency, and most of all enables a sustainable supply of raw materials based on long-term planning and equitable trade agreements between the sellers and buyers as required under the FWS. The ongoing monitoring and adaptive management requirements for FWS compliance should protect at least the mapped and controlled wild collection areas subject to inspection and certification. And in some cases we have seen a positive influence made on neighboring or nearby resource managers who may consider joining the FairWild system once they observe the economic and social benefits to their local community.

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Water Governance and Climate Change Policy in Delhi

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ABSTRACT

Climate change is likely to increase the frequency, intensity, and duration of extreme events in unpredictable ways and will require cities to develop adaptation strategies that enable them to manage this variability and uncertainty (ACCCRN, 2009). The affect of climate change in relation to water availability is a debated issue. The impacts of climate change on urban water systems are not always direct. However the water in urban may suffer from scarcity of water due to drought, sudden high intensity precipitation will create flood in urban area, reduce permeable surface will not allow water to recharge ground water which is a major source of water in urban area or water lines may be destroyed in such flood or storm.

Delhi is experiencing population increase from 0.4 million in 1911 to 16.75 million in 2011 and the population is expected to become 23 million by 2021. The growth of population exerts severe stress on the water supply system in Delhi. Delhi urban area has highest per capita supply of water in India. The estimated demand of water is 1140 million gallon per day (mgd) in 2011 where as the supply has been only around 830 mgd. It is predicted that with existing pressures on water availability and use, the impacts of climate change on water will be strongly felt by water managers. In this context, municipal water systems and water governance need a strategy to enact and follow a more sustainable, resilient and equitable water management approach.

National Action Plan for Climate Change and Climate Change Agenda for Delhi have a separate Water Mission. New National Water Policy 2012 has also integrated climate change issues as a part of its policy. Integration of water management and climate change policy had been attempted in Delhi. This paper tries to analyze the water governance and current methodology adopted in Delhi for climate change action plan and water management. Finally this paper also explores the possibilities of better integration of water management and Climate Change Agenda for Delhi.

Key word: Urban, Climate Change Action Plan, Water Management, Water Mission

Introduction

Water is a natural resource available in atmosphere, on ground and underground. The availability of water is finite but renewable. The per capita water availability in the country is reducing progressively due to increase in population. The average annual per capita availability of water in the country was 1816 cubic meter in 2001 which reduced to 1545 cubic meter as per the 2011 census. According to the UNDP, if per capita annual water availability is below 1700 cubic meter per person the area is considered as water stressed. So for the present situation of availability of water India is a water stressed country. Limited availability of water and growing demand of water due to increasing population, urbanization and industrialization is a serious concerned. In addition due to the contamination of water sources and poor water treatment facility it is often difficult to have safe drinking water in urban area. On the other hand the level of urbanization increased from 27.81% in 2001 to 31.16% in 2011 (Census 2011). To provide drinking water to the increased urban area is becoming critical because the absence of new sources near these urban areas, existing fresh water sources are becoming polluted, per capita water consumption is increasing and because of the high wastage of water due to extended large network of water supply system without proper maintenance.

Climate change refers to changes in averages in temperature and extremes in the weather of a region or of the planet as a whole over time. It can be measured by changes in temperature, precipitation, wind, storms and other weather indicators. These changes sometimes lead to extreme events, which creates disasters. Urban areas witness high concentration of population, industries and infrastructure making them more susceptible to these effects of climate change. Climate change is likely to increase the frequency, intensity, and duration of extreme events in unpredictable ways and will require cities to develop adaptation strategies that enable them to manage this variability and uncertainty. The affect of climate change in relation to water availability is a debated issue. The impacts of climate change on urban water systems are not always direct. However the water in urban may suffer from scarcity of water due to drought, sudden high intensity precipitation will create flood in urban area, reduce permeable surface will not allow water to recharge ground water or water lines may be destroyed in sudden flood or storm. In this context judicious planning for water resources is necessary for urban area. The municipal water systems and water governance need a strategy to enact and follow a more sustainable, resilient and equitable water management approach with effective integration of climate change adaptation and mitigation policies at city level.

Delhi is experiencing population increase from 0.4 million in 1911 to 16.75 million in 2011 and the population is expected to become 23 million by 2021(Mater Plan of Delhi, 2021). The growth of population exerts severe stress on the water supply system in Delhi. Delhi urban area has highest per capita supply of water in India. The estimated demand of water is 1140 million gallon per day (mgd) in 2011 where as the supply has been only around 830 mgd. It is predicted that with existing pressures on water availability and use, the impacts of climate change on water will be strongly felt by water managers. Therefore Delhi also needs efficient water governance with more sustainable, resilient and equitable water management approach.

The integration of water management and climate change policy had been attempted in Delhi through Climate Change Agenda for Delhi (2009-2012) with a separate Water Mission. This paper tries to analyze the water governance and current methodology adopted in Delhi for climate change action plan and water management.

Water Governance in Delhi

Delhi is situated on the banks of river Yamuna, located at 28.38° N and 77.13° E on the northern part of India and stretched over an area of 1483 sq. km. Delhi is experiencing population increase from 0.4 million in 1911 to 16.75 million in 2011 and the population is expected to become 23 million by 2021 (Table 13.1). The growth of population exerts severe stress on the water supply system in Delhi.

Table 13.1 Population growth and estimated population of Delhi

Year	Population (million)	Growth rate (%)
1971	4.06	52.93
1981	6.22	53.00
1991	9.42	51.45
2001	13.85	47.02
2011	16.75	20.94
2021(estimated)	23.00	37.31

Source: www.delhiplanning.nic.in and Mater Plan of Delhi, 2021 and Census 2011(Provisional).

The Delhi Jal Board (DJB) is responsible for the production and distribution of potable water after treating raw water from various sources and also provides treatment and disposal of wastewater. DJB supplies treated water in bulk to the New Delhi Municipal Council (NDMC) and to the Delhi Cantonment Board (DCB) areas both of which are responsible for the distribution of water within their own territories. The provision of water in the areas under three Municipal Corporations of Delhi (MCD) is the responsibility of DJB. There are several authorities engaged in the provision, development and maintenance of water supply in Delhi. The Delhi Development Authority (DDA), MCD, DCB and NDMC are directly responsible for provision of water and plan for new development activities. Besides these, Ministry of Water Resource in the National Level and Central Ground Water Authority (CGWA), Central Ground Water Board (CGWB), Central Public Works Department (CPWD), State Public Works department (PWD) and other government and non-governmental organizations are engaged in preparations of policy and technological implementation and other aspects of water management in Delhi. Because of the presence of a large numbers of organizations involved directly and indirectly for the development and related water provisions in Delhi it is necessary to involve these organization in the climate change action plan formulation for Delhi and the responsibilities are to be clearly defined for the proper implementation of the plan.

Climate Change and Water Issue in Delhi

The climate change projection for Delhi (Fig. 13.1) portrays that an increase in temperature and increase in the precipitation with high fluctuation may cause water logging, flooding and water availability for a limited period of time. The significant changes are expected due to climate change in the river morphology that will influence the water availability and increase water scarcity for Delhi because water sources of Delhi depends on rivers and distant dams. Climate change has enhanced the concerns for rising risks from extremes climate and particularly those influencing water related hazards. The water related hazards in Delhi might include water scarcity, river flooding, flash flooding, ground water depletion, lack of supply and no supply to the slum and poorer areas, which are more vulnerable. All of these hazards are likely to be intensified with rising temperature, declining or sudden high intensity precipitation. The uncertainty associated with monsoon is further likely to amplify the problems of flash flooding and less ground water recharge in Delhi.

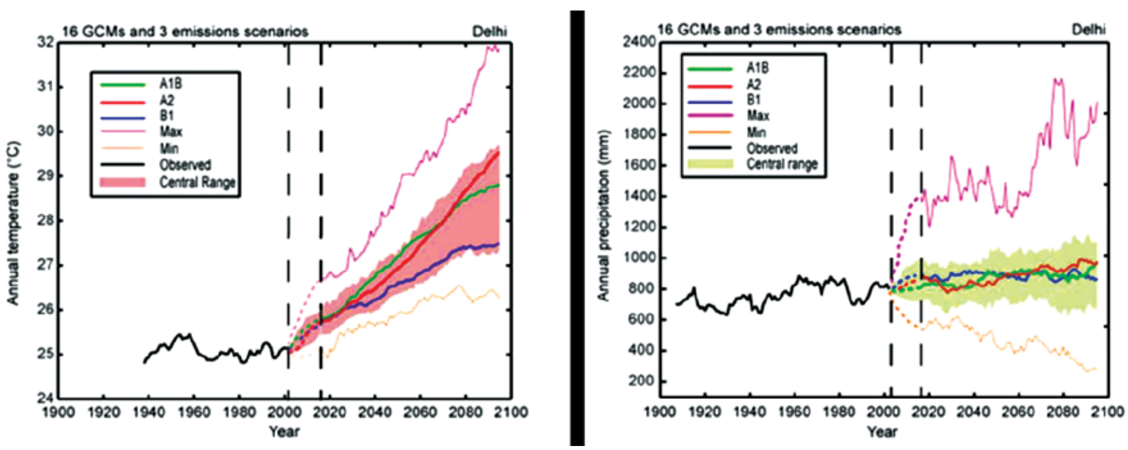

Fig. 13.1 Climate change prediction for Delhi (Mehrotra, 2009)

The following section briefly looks at the water problems associated with Delhi, which are likely to exacerbate as a result of climate change. The water related vulnerability in Indian cities as established in the case of other Indian city by ISET and Pacific Institute, 2011 are

- Demand-supply gap in water and dependence on a single distant surface water source,
- Lack of access to water by the poor,
- Poor management of water utility: finances, infrastructure, complaints,
- Lack of groundwater management,
- Lack of water quality monitoring and regulation,
- Lack of information and understanding of climate change impacts,
- Lack of networking and information flow between different water managers.

Some of these issues were discussed in Climate Change Action Plan (2009-2012) for Delhi but vulnerability analysis or assessments for any of these aspects were not done. The issue of risk reduction and adaptation to climate change has received little attention (Sharma, et al, 2010) in the climate change action plan for Delhi. Some of these aspects of risk and vulnerability issues are discussed in this report in detail.

National Action Plan on Climate Change (Napcc)

It is predicted that India may face a major threat in the sectors such as water, agriculture and forestry because of the projected climate change as its economy closely tied to the natural resource base. It has been realized that India needs a national strategy to adapt to climate change and to further enhance the ecological sustainability in all its development. In order to address the climate change in the country, the National Action Plan on Climate Change (NAPCC) outlining policies and programs addressing climate mitigation and adaptation was released in June 2008.

The NAPCC identifies key sectors that are likely to get affected as a result of climate change. Each of these sectors has been discussed in the form of missions, wherein policy interventions have been carved out to address climate change at that sector level. The NAPCC identifies eight missions representing multi pronged, long-term and integrated strategies for achieving key goals in the context of climate change. These missions are (1) National Solar Mission, (2) National Mission for Enhanced Energy Efficiency, (3) National Mission on Sustainable Habitat, (4) National Water Mission, (5) National Mission for Sustaining the Himalayan Ecosystem, (6) National Mission for a Green India, (7) National Mission for Sustainable Agriculture, (8) National Mission on Strategic Knowledge for Climate Change. As this paper is discussing the water governance and policy in light of climate change, the description on National Water Mission is important.

National Water Mission

The National Water Mission was formulated and envisaged to ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states. The water mission considered the provisions of the National Water Policy. Optimisation of water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing was encouraged. It also emphasised that the urban water need to be met through recycling of waste water and the water requirements of coastal cities with inadequate alternative sources of water to be met through adoption of new and appropriate technologies such as low temperature desalination technologies.

Delhi Action Plan on Climate Change (Dapcc)

Different ministries were directed to submit detailed implementation plans to the Prime Minister's Council on Climate Change. Following this, the Ministry of Environment and Forests (MoEF) has also asked Delhi government to submit state level action plan on climate change on the lines of the NAPCC. To respect the climate change initiative for Delhi government wanted to integrate the agenda for climate change into policy framework and wanted to make these agenda operational through the action plans of different departments and organizations. The Department of Environment and Forests, Government of National Capital Territory of Delhi prepared the Delhi Action Plan on Climate Change and assigned targets to the individual departments and government bodies. It also regulates and monitors the implementation of the targets under DAPCC.

The Climate Change Agenda for Delhi comprises of the six missions (1) Solar mission, (2) Enhance energy efficiency, (3) Sustainable Habitats, (4) Green Delhi, (5) Water mission, (6) Strategic Knowledge. The agenda primarily aims to reduce Delhi's carbon footprint by identifying a set of 65 action points that each department within the Delhi government would have to follow. Out of these six missions, the Water Mission formulated the policy and action plan for addressing the water problems in Delhi.

Water Mission for Delhi

The Water Mission specifies different ways through which water problems shall be addressed in the case of Delhi. These have been identified as targets that should be achieved. These include water efficiency, installation of water recharge systems, re-use of wastewater, treatment of wastewater through interceptor sewers, wastewater treatment by connecting all houses to the sewer system, wastewater treatment for industries by improving the work of the Effluent Treatment Plants (ETPs), water recharging by restoring water bodies, treatment of all the wastewater by setting up Sewage Treatment Plants (STPs) in villages, collecting storm water from villages and providing proper drainage system and enhancing the water availability for Delhi by constructing Renuka Dam. In order to address these targets, the agenda also specifies the respective authorities, which shall be responsible for the implementation of the same. There is a long list of departments and organizations identified for implementations of the action plans these are DJB, MCD, DDA, Public Works Department (PWD), Engineers India Limited (EIL), Delhi State Industrial and Infrastructure Development Corporation (DSIIDC), Department of Industries (DI), Department of Urban Development, Department of Environment, Department of Irrigation and Flood Control, etc.

The Department of Environment and Forests himself is responsible for restoring water bodies in Delhi to ensure ground water recharge. The DJB was assigned to take action to construct ground water recharge system, waste water treatment through interceptor system, connecting all houses with sewer system, setting up STPs in all villages, waste water reuse, water recharging by restoring water bodies. The MCD to construct the systems of collection of storm water from villages and proper drainage, waste water collection and treatment from unauthorised colonies, waste water reuse, ground water recharging by restoring water bodies. The DDA should do waste water reuse and ground water recharge by restoring water bodies. The DSIIDC to construct waste water treatment at industrial level, installation of Effluent Treatment Plants (ETPs) and ground water recharge by restoring water bodies. Analysis of these action plans and achievements are discussed in following sections.

Water Source and Interstate Dependency

One of the targets of the Climate Change Action Plan for Delhi was for enhancing the water availability for Delhi by constructing Renuka Dam. The Yamuna River is the main source of water for Delhi. Delhi gets 83% of its raw water from surface water sources and 17% from ground water sources. The surface water sources in Delhi basically comprise of the river Yamuna, canals, drains and the lakes or ponds. The surface sources of water supply of Delhi are through different interstate arrangements. Delhi is presently sourcing major part of its water from long distance. Dependence on such distance source for Delhi is a major concerned in the perspective of climate change. This also adds in the cost of transport and treatment.

All planning for future water supply in Delhi is based on anticipated raw water inflow from three large dams under construction in the Himalayas, which may not be able to supply water for near future due to the environmental controversies associated with these projects and climate change effects on these sources are also major concern for the availability of water for Delhi. The approach of sourcing water from distance source is against the principle of climate adaptation. It also discourages the search for the use of local potential sources and maintaining these for sustainable water use.

The DJB's approach is basically a supply side approach by exploiting additional water resources to meet the increasing water demand of Delhi. The Central Ground Water Board also has provided details of fresh water sources in the city to the DJB but DJB has not exploited the potentials of those sources. The Central Ground Water Board (CGWB) also assessed 215 billion cubic meters surplus monsoon runoff that can be stored and utilized for future but DJB has not utilized the potential yet and DJB did not consider it as an alternative source. In the present water mission there is no role provided to CGWB which is responsible to ensure sustenance of ground water in Delhi. The surface water source of Delhi depends on many interstate treaty and understanding. Representation of these states and central government organizations related to water governance should have been included as stakeholders in the action plan.

Water Efficiency

As per the climate change action plan the DJB is to ensure water efficiency by power reduction (10%) in Sewage Pumping Stations and in the water supply system and a detailed plan for 20% efficiency needed to be prepared. The National Water Mission also proposed increase in water use efficiency of 20% through better regulatory mechanisms with differential entitlements and pricing. The enhancement of water efficiency through water saving appliances is one of the important steps. This has not been encouraged or policy has not regulated to ensure that the people should use such appliance to reduce water demand and increase water use efficiency. About 3.99 lakh connections are unmetered and 4.00 lakh are defective meters (Economic Survey of Delhi 2012-13). This leads to a lump some water tariff for the consumer. As the tariff is not based on actual consumption people do not practice water conservation. This issue also has not been considered in climate change action plan for Delhi. Whether it is rich or poor all pay the same cost and while the distribution system in rich areas is better and hence the availability is also better but the same is not true for poorer areas of Delhi. New strategies need to be tried out to conserve water and increase the efficiency of water use and equitable supply to all.

The National Water Policy 2012 has the objective of increasing water use efficiency and cover wide range of actions such as adequate provision for operation and maintenance of water resources projects, promotion of water efficient techniques and technologies, improving efficiency of water supply systems, efficiency labeling of water appliances and fixtures, equitable distribution of water and rational charges for water facilities and promotion of mandatory water audits, including those for drinking water purposes. All these probable actions were not considered as a part of the Water Mission in Delhi.

Demand and Supply Coverage

The water mission also asks to ensure 100 % connection (3% per year) by DJB, but as per the Census 2011 it is seen that only 81% of the total households in Delhi have piped water connection. This also does not include slum and unauthorized area of Delhi. Water scarcity is rather a more common hazard in Delhi. Due to constant population growth and increasing temperature that water scarcity has become more frequent. Recently Delhi experienced some major water scarcity in the year 2002, 2011 and 2012. South Delhi areas are affected regularly in such water scarcity incidents. The water treatment and supply capacity was 66 million gallons per day (mgd) in 1965 and rose to 855 mgd in 2012 (Economic Survey of Delhi 2012-13) where as the estimated demand of water was 1140 mgd in 2011 with almost 25% demand supply gap and this will continue to increase because there is less possibility of getting water from new distance sources. There is also an alarming transmission loss of 48 percent (Basil, 2004), which reduces the actual treated water available to consumer. The Master Plan of Delhi, 2021 (MPD, 2012) has given the water requirement 80 gpcd (360 lpcd) with breakup of domestic and non-domestic as 50 gpcd (225 lpcd) and 30 gpcd (135 lpcd) respectively. The MPD-2021 provided a water requirement of 1380 MGD by DJB estimation and 1840 by DDA estimation for 2021 (Table 13.2), whereas the maximum water augmentation capacity by DJB is around 940 MGD by 2021. Therefore the supply and demand gap will continue to increase and people will depend more to the unsustainable arrangement of water to reduce the gap.

Table 13.2 Estimated water demand in Delhi

Year	Populations in million	DJB estimation (MGD) (@60 gpcd)	DDA estimation (MGD) (@80 gpcd)
2006	16.5	990	
2007	17.5	1050	
2011	19	1140	1520
2021	23	1380	1840

Source: DJB and MPD 2021

The proposed steps to meet the shortfall as per MPD, 2021 is to expedite the construction of more dams and increase the height of dam and transfer of large volume of water through interstate agreement but there is no proposal for reducing the water demand through demand management. As a general principle the sustainable sources of water responds more to the climate change adaptation, which is missing in water management plan for Delhi.

The standards on which the DJB and DDA is working are very high as compared to other Indian Cities (Mumbai 135 lpcd, Chennai 80 lpcd, etc.). Moreover standards set by two organizations are different show the lack of understanding between the two organizations for water provision in Delhi. The DJB is unable to provide continuous supply of water which leads to water wastage, water contamination and responsible for reducing the life of the system. Most of the European, Asian and African cities able to manage 24 hour supplies with much less water than Delhi (Lal, 2005). The present water supply standard appears to be unrealistic, which also need to be reconsidered for the perspective of climate change affect.

The estimated breakup of the per capita demand as given in Table 13.3 (Khare, et al, 2006) clearly shows that the other demand except domestic demand need not to be the potable water, recycled water or water from other sources can be used for the same. It is necessary to classify the quality of water required for different activity in our day-to-day life, like for drinking and cooking, for washing, for toilet flushing, for industries, for recreation, for maintaining garden and urban green etc. The dual supply (water for drinking and cooking and water for other uses) needs to be seriously considered for Delhi to reduce the demand of treated water so that the GHG emission on the treatment of potable water can be reduced.

Table 13.3 Break up of water usage for 50 gallon per capita per day (gpcd)

Purpose	**Potable @30gpcd (135 lpcd)**	**Non-potable@ gpcd (90lpcd)**
Drinking	05	
Cooking	10	
Washing clothes	30	
Washing utensil	20	
Washing hand and faces	10	
Bathing	60	
Floor washing		30
Flushing of toilets		60
Total @225 lpcd	135 lpcd	90lpcd

Source: Khare et al, 2006

The per capita demand can be reduced through policy measures and with appropriate technology. DJB has initiated a water saving programme through media to educate people, but these efforts are not sufficient. More over DJB or any other organizations in this context are not encouraging the use of water saving devices in the system. Presently the market doesn't provide water appliances and water use devices with information on water saving whereas the National Water Policy 2002 and 2012 has given emphasis on water efficiency.

However to improve the situation the MPD-2021 has given emphasis on the following guide lines

- To promote water conservation through an integrated and community driven model.
- Recycling of treated wastewater with separate lines for potable water and recycled water.
- Groundwater recharging through rain water harvesting, conserving water bodies and controlling encroachments.
- Focused planning and action to be taken to prepare and implement rain water as roof water harvesting schemes both with the aim of optimizing water use and ground water recharge.

The above issues have been addressed in MPD 2021 but not considered in Water Mission and no action plan is properly formulated for the same. There is a need for proper technical, physical and economical investigation to offer consumers the appropriate options for efficient water management. The benefit in terms of reduction of Green House Gas (GNG) and options to climate change adaptation should be demonstrated and proper policy and institutional arrangement should be made for implementation. There is no consideration for water use efficiencies and use of water saving devices to reduce the demand. With the increase of the water demand in Delhi and due to prevalent supply gap, the dependency groundwater, packaged water, tanker water supply etc. will multiply the cost of health and environment in Delhi if there is no alternative approach initiated.

Wastewater Management

Installation of water recharge systems, re-use of waste water, treatment of wastewater through interceptor sewers, wastewater treatment by connecting housing at all levels to the sewer system, wastewater treatment for industries by improving the work of the Effluent Treatment Plants (ETP), water recharging by restoring water bodies, treatment of all the waste water by setting up Sewage Treatment Plants (STP) in villages, collecting storm water from villages and providing proper drainage are considered to be the action plan for water mission in Delhi. MCD has to provide drainage, wastewater treatment by mini STPs facilities to all villages in Delhi, water reuse to be started (50MGD) by DJB, interceptor wastewater treatment facilities to be installed (JnNURM) by DJB.

Wastewater treatment capacity of Delhi is about 515 MGD as in 2012. The actual quantity of wastewater treated is much below around 63% of the installed capacity due to incomplete sewer connectivity and chocking of sewer lines. A proper inventory of existing sewer system and network plan is necessary to find out actual area coverage and missing link. As per the Economic Survey of Delhi report 2012-2013 the sewage treatment plants are not functioning up to their optimal level due to various reason such as low flow of sewage to STPs, trunk and peripheral sewer still to be connected to the STPs, rehabilitation of silted and settled trunk sewer lines yet to be completed. The total sewage generation is about 670 MGD and treatment is around 322 MGD and untreated sewage around 348MGD falling in river Yamuna. Cleaning of the river Yamuna had been given top priority. Measures for treatment of industrial wastewater in Effluent Treatment Plants, decentralized wastewater treatment facility had also been given priority. About 200 villages were considered for connecting with sewer line with proper drainage system. But the improvement in this regards is hardly visible. The treated wastewater is hardly being used and the horticulture water needs are not met. The result is all the public parks and their lawns and gardens are not maintained and remain parched (www.vigyanvijay.org).

The untreated sewage is released directly into the 14 open drains in Delhi, which finally discharge in to Yamuna. The officials have not properly considered how the treated effluent would be disposed and if indeed it could be reused. A city will be more efficient if it collects water locally, supplies it locally and disposes waste locally (Narayan, 2006). So the decentralized system of waste water treatment can ensure effective use of recycled waste water and can help to achieve the target set by the water mission. A new management strategy needs to be devised for this with an effective regulatory mechanism (Mehta, 2009).

Floods

The floods in Delhi are due to the mismanagement of the situations by concerned authorities and it is clear from the recurring phenomenon of floods in the river Yamuna and flash floods caused by rains due to choked drains of Delhi. Delhi experiences also floods from the river Yamuna and the Sahibi River via the Najafgarh drain. In last thirty-three years, the Yamuna River crossed its danger level for twenty five times (DDMA, 2010). However, the major events of flooding have been less. The major floods of the last century were flooding in 1924, 1947, 1976, 1978, 1988 and 1995. One common aspect of all floods was that the poorer areas located near the floodplain of Yamuna were most affected. Studies also note that the risks from flooding in Delhi have increased over time. In 2010 the river Yamuna flowed two meters above its danger mark (fixed at 204.83m), which caused an evacuation of over 2000 people from North and East Delhi (DDMA, 2010). The flood affected the low-income group colonies worst than other areas. Vulnerability mapping and adaptation strategies for such risk has not been identified and initiated in the Water Mission of Climate Change Action Plan for Delhi. Delhi Disaster Management Authority (DDMA) is responsible for preparation of vulnerability map. Action Plan for climate change does not include DDMA as a stakeholder of climate change action plan and vulnerability due to climate change is not considered for mitigation and adaptation.

Local Flooding

Local flooding is a significant phenomenon, which has been increasing during recent years in Delhi. There are more impervious surfaces (roads, pavements, houses etc) in Delhi. High rates of development along with the resultant loss of soft landscape have led to high surface water run-off rates. This results in flash floods in the low-lying areas even after moderate precipitation. Another factor adding to this effect is that of river because the river is already flowing at a higher level within its embankments. Thus, the water gets logged in the city areas and it takes several days to mechanically pump it out and bring the situation under control. Similarly, during the past few years, flooding due to the city's 18 major drains has also become a common phenomenon. Already under the pressure of the city's effluent discharge, these drains experience reverse flow from the Yamuna and cause flooding the neighboring colonies (DDMA, 2010). These are the area where the effect of the climate change will be more and needs to be mapped for preparation of mitigation and adaptation strategies.

Ground Water Depletion

Ground water is another major source of water in Delhi. As per the report release by CGWB, 2008, the dynamic ground water resources in Delhi have been assessed as 292 Million Cubic Meter (MCM) in 2003 (withdrawal equals to 312 MCM) as compared to 428 MCM in 1983 showing an overdraft and reduction of around 130 MCM over past 20 years and about 75% of area of Delhi ground water levels are declining at an alarming rate of 0.20 m per annum. It is a matter of serious concern. Total volumes of ground water extraction by private tube wells are very high where the natural recharge of ground water in the Delhi found to be lower than five per cent in most of the area (Datta, et al, 1996). According to a study done by the CGWB it will take just 2,600 additional tube wells running at an average of ten hours per day to exhaust the entire reserve of underground water in Delhi (Jha, 2006). The net result is the alarming depletion of ground water and deterioration of ground water quality. The change in the rainfall pattern with more intense precipitation for limited period due to climate change will farther reduce the recharge of ground water, if serious efforts on artificial recharge are not enhanced and abstraction of ground water illegally totally stopped. The Climate Change Agenda for Delhi does not talk about this issue at all.

Conservation of Water Bodies

The water recharging by restoring water bodies also one of the action plan of the Water Mission of the Climate Change Agenda for Delhi. The Mission identifies 620 water bodies that shall be restored and used for water recharging and also mentions which organization and bodies shall do the same, however, it does not outline in detail the manner in which this is to be achieved and how the role of each organization will differ in this. The deepening of old lakes and other water bodies, preserving and developing the forest area in Delhi, construction of check dams at Asola Wild Life Sanctuary and plantation of trees, some of the steps being taken to improve ground water resources in Delhi (Economic Survey of Delhi 2012-13). But the traditional water bodies like ponds in Delhi are either defunct or encroached upon. The excess water, causing flooding in some areas, can be used as the potential recharge water to reduce the flooding. The 36000 sq. ft. Mayapuri Lake is one such example. This water body is partially filled up for a common effluent treatment plant. A park has come up on the 31000 m^2 water body in Vinod Nagar. A hospital is to come up on an 8400 m^2 water body in Jilmil Tahirpur (Lalchandani, 2008a). An independent body set up by the court has identified 794 water bodies, out of which 629 water bodies exist officially in Delhi (Lalchandani, 2008b). There are also numbers of micro watersheds present in Delhi, which prove excellent topographical formation to conserve monsoon runoff through simple recharge structure. New tanks, reservoir can be created in low-lying areas where there is a natural slope in the terrain and runoff water can be harnessed managed and administered. The Yamuna flood plain (area 97 km^2) in Delhi offers a good scope for development of groundwater resources for storage monsoon water. Out of 580 MCM of monsoon flow allocated to Delhi about 280 MCM goes unutilized due to lack of storages. There is a need to prepare a plan to conserve these resources. Though 620 water bodies were identified under the Water Mission for conservation no significant improvement is seen in these regards.

Conclusion

The Energy Research Institute in Delhi interviewed 1,114 people from across Delhi. The survey highlighted that majority of the respondents in Delhi were not aware that government policies exist for climate change in Delhi (IANS, 2013). Even officials from concerned organizations responsible for water management in Delhi are not clear about the climate change action plan for Delhi. It has been observed that in spite of this role allocation that the mission did, there are certain areas, where more than one authority is responsible for fulfilling the target. In such cases, it is essential to demarcate the exact role to be played by each of the authority to achieve that single target. Also, it is important to raise awareness about this mission to all stakeholders and key actors of water governance in Delhi so that these targets can be integrated with the implementation policies and action plan.

Climate change and water problems shall not be seen in isolation. The present policy sees its own targets in isolation without proper integration at the institutional policy and action plan level. The water mission for Delhi does provide some opportunity for this but it needs to be more focused.

The Water Mission for Delhi does not identify vulnerability areas for water risk due to climate change. The vulnerability of the poor population in the city due to climate change has not been considered in the context of Delhi. It did not directly talked about the climate change mitigation and adaptation approaches. The NWP 2012 talks about mitigation at micro level by enhancing the capabilities of community to adopt climate resilient technological options, which is absent in the Delhi Climate Change Agenda can be integrated in the next action plan.

One of the Climate change adaptation strategy in National Water Policy 2012 is increasing water storage through revival of traditional water harvesting structures and water bodies and through efficient water use. Increasing water storage in its various forms (soil moisture, ponds, ground water, small and large reservoirs and their combination) will provide a mechanism for dealing with increased variability because of climate change. Delhi also has given importance in revival of water bodies but implementation of such programme is not up to the mark. This needs to be given more importance with a clear responsibility to different organisations. Also, it is imperative for the authorities to develop coordination mechanism especially for targets assigned to multiple authorities, to avoid any confusion or overlap and help achieve the target within the time period.

NWP's adaptation strategies also include better demand management approaches to enhance the water use efficiency and the capability for dealing with increased variability because of climate change. Water demand management approaches are missing in Climate Change Agenda for Delhi. This also is to be included with water efficiency rating in water devices and in all developments.

It is seen that there was a lack of monitoring mechanism which has lead to the delay in the overall implementation of action plan in Delhi. Thus there is a need of a monitoring mechanism and needs to be mandatory as a part of the action plan of climate change for Delhi.

Another significant area of concern is funding, since at present the plan does not have provisions for target wise funding allocation along with the sources that could ensure smooth implementation. This should be also part of action plan. There should be integration of Clean Development Mechanism for different water projects at the target level and this can be regulated by the local authorities itself. The authorities also need to outline exact manners through which the community, the people could be actively involved in achieving these targets and combating climate change, since their role as stakeholders and as victims of climate change events is also equally important.

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Biodiversity Conservation for Sustainable Use: Challenges for Future

— *Pranab Pal*

ABSTRACT

Biodiversity in its holistic sagacity encompasses every stages of natural variety ecological and evolutionary progression including normal ecosystems, wild species and diversity undeveloped ecosystems, domesticated and varieties. It is not consistently dispersed lying on the soil. According to a few experts 5.50 million class of living forms on our earth and of these merely 1.7 million contain been recognized and comprise 3,20,000 kind of green plants and fungi, 75,00,000 species of insects, 45,000 species of vertebrates and 3,50,000 species of micro creatures newly it have predictable so as to the figure of insects unaccompanied might live because elevated as million. Biodiversity is vital to the mitigation of scarcity, owing to the essential merchandise and bionetwork armed forces it provides. Biological diversity is basic to the completion of human requirements. It is important to input development divisions such while cultivation, forestry, fisheries and going to places of interest, resting on which extra than 1.3 billion populace depend on intended for their livelihoods. The rough country is currently quickly vanishing and merely minute wreckage stay. The rising human population and the speedy augment of farming and manufacturing split the liability designed for the obliteration of come again is gone of the wilderness. Protection of natural assortment determination exists on top of main concern plan intended for the world's professional in the 21st century. India seeing that solitary of the mega-biodiversity centers. India's Biodiversity is one of the majority noteworthy within the planet and have its customary knowledge for conserving the reserve in usual systems. The varied climate regions of the country- with unique floristic and faunal richness, their vastness, endemism, heterogeneity, and also inaccessibility of large area. The Indian sub-continent is recognized intended for its varied bioclimatic regions behind solitary of the richest floras and fauna. Rising human being interventions resting on the ecosystems contain accelerated the procedure of biodiversity loss. The skills of the precedent hardly any decades contain exposed so as to since industrialization in addition to fiscal growth obtain put, the outlines of expenditure, manufacture and requires alter, damage, modify in addition to still obliterate ecology. Global Biodiversity Assessmen, approximation the whole figure of animal and plant species to live flanked by 13 and 14 million. It auxiliary records so as to distant merely 1.75 million species encompass been described plus deliberate. A number of scientist express that by 2100 merely 20-50 % of the plants and animals creation awake ecosystems inside worldwide, moist steamy forests might stay because we identify them nowadays. The modify in the climate situation be already felt through the biodiversity and wildlife habitats crosswise the earth. A lot of plant and animal species be ultimately flattering extinct while a consequence of the climate changes. Some of the plant and animal class are not capable to become accustomed to the changing weather.

Keywords:- Biodiversity, Conservation, Human Intervention , Strategies for Changes

Introduction

There are more than 1.8 million species within the planet which are recognized in the direction of science, the predictable whole figure is probable toward subsist stuck between 30 to 50 million. It have been probable so as to the destruction of class might be happening by the side of the pace 10 to 20 thousand per year. Further 95% of species with the intention of more *(Heywood, 1995)* continue living are at this time vanished. The usual living thing species within the oceans have a period of about 4 million year. This is an amazingly extensive instance through creature edifying average but amazingly petite in contrast towards the almost 4000Ma times gone by the existence resting on soil. Approximately 25% of oceanic species turn into wiped out all million years. Resting on pinnacle of normal, two three species wide-reaching ought to turn into extinct every year on or after usual courses. In a developing nation such as India, where a burgeoning population, intense agriculture and urbanization expand at great rate, the task of preserving creatures that represent the diversity of life in wild places presents a variety of challenges. India is the Seventh main country in the world, by means of ropes populace (million) plus 18% of the live stock population. The Himalayan heap variety in India is one of the nearly all gorgeous environmental speculates within the world. On the identical instance it is solitary of the majority in danger rising *(Parmer. A, 2012)* facts of walker, trekkers and scenery fans contain been creation the yearly pilgrimage of these peaks within such amount so as to the environment's normal symmetry is in danger. More then 5,80,000 villages within the nation almost 35% exist in and about woodland region. Forest and Tree wrap *(FSI-2011)* of the country is 78.29 mha which be 23.81% of the geographical area. It have 2.76% of the World's wood wrap. Consist of there is decrease is of 367 km^2 in the wooded area cover up. Ground area dilapidation happening owing in the direction of the usual and human induced causes, similar to storm wearing absent and water logging, is solitary of the main concern in India. Some experts dwelling Sapiens contain been causing extermination of additional species intended for at smallest amount 50,000 years and almost certainly longer. For the duration of the precedent 500 years the pace of human caused extinctions has augmented exponentially. The unreliable degrees in addition to types of dreadful conditions stalk mostly as of indefensible make use of and unsuitable land management practices. Loss of plants happens since a consequence of deforestation, hurtful further than the silviculturally acceptable restrictions indefensible fuel-wood in addition to provisions taking out, irregular farming, infringement within wood lands, forest fires in surplus of grazing, each solitary of which area under discussion the earth to degradation forces. In India 60% of country's cattle 700 million graze in forest area. The disappearance of variety is a indication of such indefensible enlargement, in addition to destroys the option of their make use of intended for the betterment of humanity within the prospect. Unless we expand a new-fangled prototype of sustainable lifestyles the earth's restricted bio-resources have to inexorably exist worn out. According in the direction of some scientists, overgrazing which inside occasion be able to alter grassland to desert ,The villagers stay great numeral of livestock to get together their agriculture and domestic prerequisite. Our possess nation's extended expression goals of monetary growth are to be content, the conservation of its only one of its kind biodiversity have to take its put in programmes of resonance environment management. In India grave require of grass for thatching and for fodder, consequently for the duration of shortage land area have changed in forest area. On the subject of 50% of the forest area 70 mha is prone toward forest fire. Owing to shortage huge fraction of the wooded area periphery population is dependent on forest property resulting in its unsustainable exercise. Illicit felling of precious timber also poses a grave threat to defense of forest. In the vicinity of the end of the 20th century and the beginning of the 21st century a lot of types of human activities *(Bill devall, 2006)* are creating a increasing consequence so as to experts describe the "catastrophe of destruction". The earth is losing its steamy forests next to the disturbing pace of roughly 45 million acres per year. This resources with the intention of virtually 1.3 acres of humid forest fade away each second. Green houses gasses are the major cause intended for the type of weather change which in revolve posses the danger to the enormous biodiversity. This determination shift the great fraction of inhabitants in addition to strength others to wander. The hotness modify in the weather circumstances be able to be most excellent felt at mountains. The altering type of weather situation are as well the harsh danger on the coastal areas, which have led on the way to the main area of wooded area loss. Seeing that a great deal earth because probable have to be place aside as wilderness to defend this precious livelihood prosperity. The reduction of type is consequently a immense fiscal beating to humanity. Since wilderness is gradually more transformed to agricultural, countrified and lastly manufacturing and urban land, the numeral of extinctions quickly increases. A good number variety of plants and animals be able to merely stay alive in quite whole natural ecosystems. Normal landscapes as well carry out more than a few armed forces for humankind. A number of these landscapes are ecologically vigorous in addition to be able to endure a pale quantity of commotion with no a grave defeat of biological diversity. While humid evergreen were known to be enormously affluent in class, this became a major cause of anxiety in the 1070s and 1980s. Mangroves are surrounded by the oldest in addition to mainly creative marshland forests of our earth. They are perfect environment against tempest rush and coastal wearing away. In India's biodiversity is mirrored within its human being enriching assortment. By means of 615 recognized cultural societies and 1652 speech clusters, India status second into the planet in human edifying miscellany. In India, nearby 34 variety (*Teri,2012*) accurate Mangroves. Bhitarkanika Orissa has 31 species. The Sundarban include 27 and Andaman & Nicobar Islands contain 24 species. Mangroves make available precious overhaul but contain been declining universal as a consequence anthropogenic and further pressure. Tropical forests immobile have quite widespread tracts, the swampland of the preceding century were disappearance still extra quickly. The enclosed space of these failing habitats was at the present emphasized because a main matter in preventing the destruction of species. The confront for forest and wildlife management stay behind intimidating. India evidently is next to the intersection. On top of the solitary give in attendance is a required designed for quick fiscal growth and alleviation in the direction of defend environment, forest and wildlife and make sure glowing organism of its inhabitants. In India medicinal plants countenance a variety of pressure on the way to their continued existence. Appropriate toward elevated insist triggering far above the ground quantity extraction, which strength too engage destructive methods of harvesting , on the way to create up and about the manufacture within the *(Survey of the Environment,2012)* slightest obtainable instance, such unhelpful harvesting procedures, determination habitually harm the populace and subsequently the usual renewal of the class gets exaggerated. Bearing in mind the big figure of medicinal plants variety and more than a few mammals are under threat, the challenge is how in the direction of the conservation priorities.

Anthropogenic Pressure and Habitat Loss

Unluckily biodiversity loss is rising by the side of an unparalleled pace, intimidating the incredibly base of sustainable expansion. A lot of species are fading earlier than they are still exposed or described. Further than 12,200 species of plants and animals (State of environment Assam, 2004) are incorporated within the IUCN Red List of in danger species. Other than this integer is considered to be the angles of the iceberg, since merely a portion of recognized class contain been assessed. The most important pressure are environment loss, over-exploitation, invasive species and type of weather change. The snowballing result of all one these feature strength demonstrate the technique to accretion disappearance. The natural fruition has shaped an astonishing choice of flora and fauna including microbes, which are essentially related with myriad continued existence and livelihood desires of human being the social order. Put aside intended for owing to still growing number of dangers and pressures, biodiversity have turn out to be

Photo: 1 Source :- PA

Photo: 2 Source:- Tehri Dam

not merely an issue of nationwide apprehension other than as well as matter of worldwide apprehension. Deforestation is exacting concern within (Photo:-1,2) the western Himalayas wherever augmented insist, intended for firewood, widespread tree trimming during arrange to give food to domestic animals and edifice of roads in the annihilation pace of forests and the integer of avalanche fast enlargement of population has accelerated pollution. In this method the ecosystem of Himalayans has been concerned within a variety of parts owing to together man made activities and usual calamities. Dreadful conditions in addition to destruction of the environment causing harsh man-animal conflict, insist of tiger parts within the worldwide marketplace, contain compulsory the tigers rear to the barrier. The addiction resting on woodlands owing on the way to rising human*(Jain.P,2001)* as well as livestock inhabitants within about tiger territory are causing enormous force on top of the tigers since the expansion schemes contain not reached them as well as consequently their nourishment stay put resting on the forests. Human being activities contain led to stern changes in natural ecosystems so as to have resulted in destruction of a lot of plant and animal species, and are pressure a lot of additional. According to 1997 IUCN Red List of Threatened Plants, worldwide 33,418 species are *(Current Science,2009)* incorporated beneath endangered group. Of this, 4070 species are beneath the category of undefined. India is one of the mega diversity nations in the planet. It has concerning 17,000 species of flowering plants and 5400 widespread species. Of the 1236 threatened species in India,690 species are placed beneath undetermined condition. So as to is 12.2% of species on universal level. Damage of normal environment coupled through profitable felling of trees, infringement of forests for settlements and farming, Jhum (shifting) cultivation surrounded by the hill predispose in addition to a variety of additional infrastructural expansion activities have emerged as solemn threat to the biodiversity of India. By means of pressures as of the increase in population and a ensuing add to require of forest land designed for agriculture, there has been a reduce in the alternation of the jhuming sequence, causing reduction of forest wrap at an disturbing level. Thus patches of forest are currently burnt extra repeatedly at gaps of five to six years – an instance stage so as to is disgustingly insufficient designed for a tainted forest to get better. Jhuming is solitary of the main sources of livelihood intended for numerous tribal communities inhabiting the North-eastern states of India. Arranging of railways lines as well as construction of four line roads all the way through forests, large-scale bamboo harvesting different parts of the country, searching of oil and natural gas in India pose conservation threats. Forest Land converted for open cast coal mining in India (Jharkhand, Assam, Meghalaya etc) mineral excavation, brick manufacturing in the main lands, cement and manure plants, etc are some of the economic activities of the state which are answerable intended for the damage of environment. While Coal be on fire, the Carbon so as to was accumulate contained by the coal is released reverse into the atmosphere as $C0_{2.}$ More then 70% of the world's energy comes as of burning fossil fuels. In India Traditional and substantial reliance on biodiversity resources used for fodder, firewood and minor forest produce has been an accepted system of existence designed for the rural population that accounts for virtually 75% of India's population. By means of fundamental demographic modify, the land to man ratio and forest to man ratio has quickly declined. The lifestyles and the biomass resource necessitate having remained unaffected, the relic forest have move about in the direction of underneath persistent pressure of infringement for cultivation, and unsustainable resource removal depiction the very resource pedestal infertile and exhausted of its biodiversity. At present, hydropower has led in the direction of the construction of over 4000 dams across India. The conception of valley underneath reservoirs within wilderness areas has brought on top of the annihilation of a number of the optimum forests in(*State of Environment Report India,2009*) addition to biodiversity –wealthy exclusive ecosystems. Deforestation owing toward hydropower as well as mining projects are maybe the maximum pressure to biodiversity in India. India have human population compactness more than 800 populace per square mile, additional than double that of China and in excess of ten times so as to of the USA. It is no revelation that a great deal of the biological affluence of India is endangered. By means of hundreds of threatened and endangered species, India position fifth in the world into its information of birds *(WWF, 2000)* in danger by means of destruction, in addition to third in the earth in endangered mammals. At present half of India's primate species are put in danger. Appropriate in the direction of the pressure in India on forests and further normal habitats, numerous species of primates encompass exposed on the way out populations and some are endangered through disappearance.

In excess of over grazing : Unrestrained grazing through domestic stockpile is too a main difficulty, particularly within the grasslands, While the majority of the grassland are restricted toward a small number of pockets of Pas, of course the pressure is serve. Grasslands contain in history been solitary of the nearly all derelict ecology within India, in spite of their marvelous biodiversity in addition to serious function while grazing (Shahabuddin.G, 2012) lands intended for rural populace. Within the shade as well as snivel in excess of the desertion dilapidation of forests, the fortune of grasslands has been totally hided. According to Satellite imagery used by (FSI ,2011) presently Geographical area of India is Total Forest Cover 21.05%,Scrub 1.28%, Non-Forest 77.67% consequently of grassland of ecosystem is in grave problem. Grassland holds up livelihoods of pastoralists as well as play crowd to a number of the nearly all endangered species in India.

Photo: 3

Photo: 4

Grazing also reduces probability of trees imminent up which sporadically colonies and sprout on their own. So far, in excess of grazing (Photo:-3,4) through farm animals be able to evenly fine contribute to single species ascendancy and extend of invasive weeds so as to can obliterate grasses. Overgrazing by domestic animals has unfavorable effects on the vegetation in the container of together alpine grasslands and forests. Overgrazing can increase soil erosion. In India, Ranthambhore National Park the human and livestock populance of 91 villages and three townships (Singh. D.P, 1994) are totally dependent on forest resources for meeting their biomass requirements and thus countless species of fauna and flora are disappearing fast. Grazing by livestock has stermly threatened our wildlife and their habitats in various ways? The noticeable effect is the decline of wild herbivore populations as they have to compete with livestock for their food source. Because more cattle graze and nibble the natural vegetation there is less palatable biomass for wild herbivores. Since livestock supperimer palatable population indigene plant species every so habitually unpalatable species of plants occupy the area. Overgrazing occurs at what time plants are exposed to livestock grazing for extended periods of time, or not have adequate enhancement periods. It's through there reduces the usefulness of the work on the land and is one cause of desertification and erosion. Sustainable lowland production is based on grass management, animal under this management, conjunction livestock marketing, grazing management is the groundwork of grassland–based livestock creation since it affects both of them animal and plant health and productively. Grazing decreases plant life shelter, soil loss and compaction augment, water infiltration decreases and runoff increases, cover up decreases remain at rest more, and so kind onward. In the severest cases, it is difficult for vegetation to reestablish at rest when grazing strength is reduced. The initial plant obliteration leads to effects that create it more difficult for plants to reinstate, which go in front to better losses of vegetation consequently onward. Overgrazing causes animals to run short of meadow. Overgrazing can also have (The Beehive-India, 2012) an effect on livestock performance and situation. Owing to this, the forests and the grasslands turn into nude and afterward prone to soil erosion. By pounding the soil with their hooves, livestock press the subsoil into fine soil which can be carried easily by wind and water. Reduced earth depth, soil organic matter, and soil fertility hurt the land's future productivity.

Grazing Protected Area and Mount Area

Poaching Crisis

Poaching is the against the law pursue, killing or capturing of mammals. Populace poach since animal manufactured goods , such seeing that conceal, ivory, horn, teeth, hair, bone, are sold to traders who create garments, trinkets in addition to additional cloths from them. The poaching causes an assortment of belongings, its nearly all straight collision is disappearance, also worldwide or surrounded by a specified area. As the create of the poaching plague in 2008 South Africa have mislaid in excess of 1600 Rhinos. Rhino populations opposite genuine dilemma beneath the danger of huge augments and poachers take life Rhinos intended for their horns. Even though they are complete awake mostly of keratin, the identical substance that's in your hair and fingernails, might populace in Asia consider so as to crushed Rhino be able to heal whatever thing as of headaches to gout, fevers to rheumatism. Consequently rhino horn is used seeing that a constituent for customary medicines. According to prominent Vietnamese Rhino horn could be cure of cancer. Consequently it has led to a enormous augment in insist for Rhino horn foodstuffs in Vietnam. India Rhino (*Rhinoceros unicornis)* usually have a preference the alluvial unadorned grasslands of the Terai and Brahmaputra sink. It is underneath threat of floods, human intrusion, grazing, hunting, contract passageway thrashing, near to the ground propagation rate, communication *(Venkataraman.K 2012)* of base in adding up to lips diseases as of domestic cattle etc. Its horn, tail, corpse parts, hooves, urine, blood etc are demand in the International market. India while one of the mega diverse countries of this planet**,** the stage an significant *(Sinha.Samir, 2010)* universal function in the deal of wildlife, which comprise every one varied existence forms originate untamed in nature. According to expert environment thrashing was consideration to be the main solitary risk to the outlook of wild tiger (*Panthera Tigris*) in India. It has at the present recognized so as to operate in tiger skeleton, intended for utilize in oriental drug exterior the nation, is pretentiousness an even big risk. Tiger has (Fig: 14.1) been *(WPSI,2012)* killed 965 numbers since1994 -2012 in India. Tiger are under attack since their parts particularly their bones, which Chinese texts utter assist endorse curative in addition to have anti-inflammatory properties are award-winning in customary Chinese medicine as well as twist great proceeds on top of the black marketplace, other than they are barely the merely animals poachers go away behind.

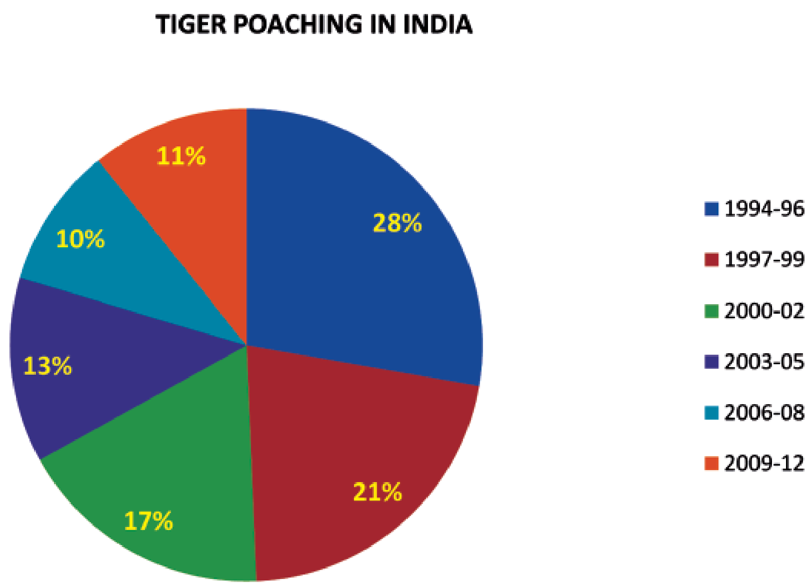

Fig. 14.1

Source: WPSI

Snares are successfully used intended for hunting spotted deer, sambar, barkingdeer, wildpigs *(http://conservationthreats.org/understandthreats/poaching)* in addition to additional herbivores. Frequently great, gravely in danger of extinction animals like tigers and leopards as well obtain trapped along with die within snares. The poaching of Elephants intended for ivory, meat, hide and additional parts mostly designed for make use of in conventional medicine is motionless widespread in numerous countries crossways Asia. Expert analysis of elephant (*Elephas maximus*) Poaching and deliberately killed in India 175 numbers since 2006 to 2012. In spite of universal defense from side to side the Convention on International Trade in endangered Species (CITES) agreement, the worth located on elephant habitat resources so as to present are those that immobile kill elephants meant for proceeds. Elephant ivory have been worn through humans seeing as the initial period. It is vital toward condition so as to Asian elephants are distant fewer flat to poaching than African elephants as merely a number of Asia males contain tusks and together sexes are tusk attitude in African elephants. According to expert of Africa during 2012 Poacher have killed 633 Rhinos in South Africa and thousands of elephant. Elephant hide though does encompass worth in addition to elevated excellence clothing as well as furnishings of elephant skin are sold in boutiques crossways Asia. Against the law killing, thrashing of habitat as well as additional forms of disagreement by means of humans are every one main threats in the direction of Asia's elephants as well as these pressure are rising as the continent's human populace continues toward grow. All through Asia, hunters carry on to aim elephants, capitalizing on top of sustained demand meant for their ivory tusks. The population of Asia elephants have declined appreciably in current decades, in addition to the species is measured in danger of extinction, which resources in attendance is a extremely far above the ground danger of this animal's disappearance within the in their natural habitat.

Poaching Method for Killing of Animal in India

Sl. No.	Poaching method	Reason for Poaching
1.	Poisoning	This method generally positioned within the carcasses of domestic buffaloes and cows. For the duration of the dry, hot summer months small woodland pools are too disillusioned by poachers, otherwise depressions dug and filled by means of water intended for this reason.
2.	Shooting	Most common, specially 60% Rhino has been killed by using of Shooting
3.	Pit Poaching	More then 35% Rhino has been killed by using digging of pit.
4.	Steel Traps	Which are complete through nomadic blacksmiths? These traps are hugely strong.
5.	Electrocution	Poacher use through tapping 230 volts -11KV in the clouds electrical wires and laying a live rope on top of mammal tracts.
6.	Use of noose	This method very common in Africa.

Leopard poaching in addition to smuggling in India in the primary decade of the 21st century, judgment so as to in excess of with the intention (Table 14.1) of epoch an normal of four leopards encompass been killed every week, by means of their corpse parts toward inside the black souk. According to geometric study toward effort to approximation hidden smuggling, the information says with the purpose of now beneath 3000 leopards were *(* http://www.treehugger.com/endangered-species/4-leopards-killed-poaching *)* killed through poachers as of 2001-2010. Leopard solitary lived crossways a huge swath of ground from Siberia to South Africa, other than environment loss and hunting contain radically abridged their variety. IUCN classifies leopards because creature close to–in danger, single pace underneath living being measured on top of the in danger of extinction range in addition to solitary on top of creature of slightest apprehension. In India poachers use the following different methods for killing of animals. The Worlds Conservation Union gathers information gathers in sequence as of Scientists every a small number of years to estimate the figure of in danger species. We are losing species on sandwiched flanked by 100 and 1,000 times the (Glenn. Murphy, 2008) normal charge, in addition to approximately every one of this augment is caused through humans. While poaching as well as habitation annihilation engages in recreation a main element. Because as many as 1 in 3 amphibians and 1 in 4 mammals are at this time underneath threat. Most important pressure is thrashing situation corridors, anthropogenic pressures, environment disintegration, hunting, rail accident, contamination, inter-specific rivalry, woodland fire etc. Body parts, meat, bones, tusks contain elevated insist within international marketplace. Large mammals are much in danger of extinction species.

Table 14.1 Leopard Mortality In India

Sl.No	Mortality	2009	2010	2011
1.	Poaching	24	48	48
2.	Seizure	137	132	139
3.	Found Dead	52	78	65
4.	Killed by Villagers	28	24	32
5.	Shot by deptt.	21	13	9
6.	Killed in Road Accidents	17	22	30
7.	Died in Rescue Operation	6	7	14
8.	Electrocuted	3	2	---
9.	Killed by Tiger/Lion	3	2	12
10.	Infighting	---	---	9
	Total	**291**	**328**	**358**

Source: WPSI

Stipulation the killing does not conclusion, after that a number of living thing countenance disappearance otherwise gone on top of world.

Erosion Problem

Enduringly tainted lands are rising by the side of a yearly rate of 6Mha. Globally, moving the livelihoods of millions of populace coupled with land degradation seriously undermines the livelihood opportunities, consequently most important in the direction of scarcity, relocation in addition to foodstuff uncertainty. Earth is solitary of our valuable possessions. The defeat of this resource, from side to side soil dreadful conditions processes such since blustery weather as well as water erosion, is single of the the majority solemn environmental problems. We are faced by means of seeing that it is destroying the resources of producing our foodstuff. Top soil erosion is a usual procedure in addition to have occurred all through geological history**.** Human being behavior, mainly cultivation and deforestation, though, contain augmented erosion rates, since they be inclined toward take away the defensive plant life in addition to decrease the constancy of the soil. This human prejudiced procedure be termed accelerated erosion. In view of the fact that 1950 accelerated erosion has resulted within the defeat of 1/5 of the topsoil as of the earth undeveloped land and 1/5 of the topsoil on or after steamy forests. Erosion be a solemn crisis within the United States in addition to in the region of the planet. According toward the Federal Emergency Management Agency (FEMA), U.S. coastlines be unable to find 1to 4 feet every year owing in the direction of erosion. The possessions contain ecological as well as fiscal outlay**.** Intended for ecosystems, Erosion translates keen on environment beating since coastal wetlands get worse. The plants and wildlife so as to depend on top of these ecosystems are unenthusiastically impacted through the possessions of erosions. Soil erosion within India is surrounded by the foremost areas of apprehension designed for the Government of India. It affects farming and undeveloped within the country in unpleasant and adverse habits. Soil erosion away leads to deficiency of corporeal individuality of soils and compensation plant and crops. In India approximately 1.30 million hectares of land, so as to is 45% of whole geographic and ditch, variable farming, cultivated wastelands, covered in dust areas, deserts and water cataloguing. Indian Forests contain been exaggerated by means of soil erosion at diverse levels. The forests within the Southern zone be slightest precious from beginning to end soil erosion, while the rest of the areas are almost consistently exaggerated. The southern Zones hold the finest preserved forests in the country. The uppermost plane of erosion is seen going on within the Central zone. The Eastern Zone is the most horrible. Floods encompass turn into an annual attribute of Assam. Owing to serious siltation, the river-bed of the Brahmaputra (Photo-5,6) is going up and as a result its water-baring ability is deteriorating. Still a slight rainfall inundates extensive are other than a associated of floods is the trouble of land erosion.

Photo: 5

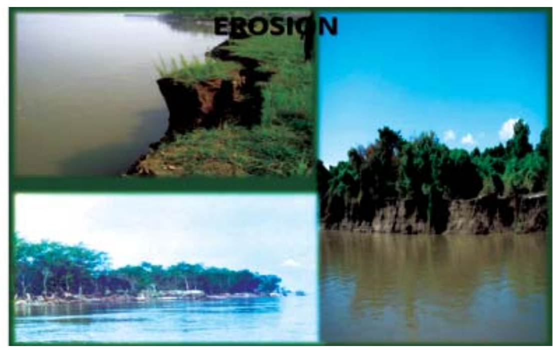

Photo: 6 P.Pal

Erosion of Brahmaputra

The exceedingly creative in addition to prolific soil of Assam is facing a risk from erosion**.** According to study erosion is consumption gone eight thousand acres of land every year, Since 1954 the circumstances have lost about 4.25 lakh hectares of land accumulation owing to river bank erosion. Supplementary then 1.5 lakh populace contain missing their hearths and homes and the precious land so as to twisted crops and constant them. Soil erosion cruelly affects agriculture which is the nearly everyone imperative and extensive work of the state. Corporeal smash up is the nearly all observable as of soil thrashing and the majority probable in the direction of remedied. Tainted lands are regularly mislaid of erosion, desertification, and nutrient exhaustion. Environment damage is not the merely danger in front of wildlife, other than it is rather probable the most threat. Stipulation the exhaustion of normal habitat about the sphere does not slow, accumulation extinctions are convinced to go after.

Conclusion

Biological diversity is a precious usual resource intended for the continued existence of mankind, a slow decrease of which might consequence inside vanishing of class economic worth in the direction of the person contest. Surroundings challenges is consequently in the direction of make out the policies, institutions and technologies which will enhance the positive and mitigate the unenthusiastic property of grazing, poaching etc atmosphere challenges, matter and alternative be different considerably according to type of weather and earth capabilities. The imperfect protection resources obtainable have to be listening carefully tactically on top of opportunities probable toward give way the most conservation advantage. Conserving Biodiversities nowadays are vital not merely intended for the continued existence of the class that continue living in that, other than too intended for human belongs seeing that we are reliant designed for our endurance resting on them. Conserving biodiversity is concerning restoring the equilibrium sandwiched between humans and atmosphere. This resolve assists us in the direction of not get in the way with the bio-diversities there by minimizing our actions in that area. This method, biodiversity of this region is gone un-tampered by means of as well as protected. Sustainable development requires entities toward redefine their policies resting on earth use, food, water, energy, growth, protection, economics and deal. Protection and sustainable use of biodiversity requires the contribution of accountable organization designed for such areas because farming, forestry, fisheries, power, visiting the attractions, trade etc, energy safety, land issues, water issues in addition to type of weather be the challenges in front of India, the length of with biodiversity conservation, as well as medicinal plants in the age old Ayurvedic scheme of medicine. Corporates in India require in the direction of learn their carbon footprint and alleviate it. Conserving resources, recycling, reducing carbon footprint in addition to inventing cleaner processes in addition to comprehensive enlargement are significant. Protection of biodiversity as well as its make use of in sustainable development contain been impeded through a lot of obstacles. The require to normal the conservation in addition to sustainable make use of natural resources crossways every one segment. Consciousness in addition to acquaintance concerning biodiversities is a input to guard the identical. It would go away of extended method to put aside biodiversities. Natural habitats require being sheltered. The apprehension organization requires to be made sure and manage the management of the species present. A great deal of defeat of biodiversities is since of the thrashing of habitats, which in fact is the put, wherever they exist**.** Biodiversity conservation be alive addressed inside the circumstance of sustainable development. Biological Diversity is as well a basis intended for new-fangled crops and livestock, given that the majority harvest plants in addition to ranch animals stalk as of wild relatives. Natural compounds from animal, plants as well as microorganisms are the source designed for new-fangled drugs meant for treating human diseases. The beginning of biological scarcity decrease inside diversity of life forms is bound contain serious consequences intended for the whole livelihood earth.

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15

Ecological Resources and Tribal Livelihood: An Odishan Overview

— Nilakantha Panigrahi, C.R.Das

ABSTRACT

The planners, academicians and implementers have witnessed a visible shift in the development planning during last decade of 20^{th} Century. This includes production of goods and services, growth in per capita income and human wellbeing. The human well being is considered more broadly which has encompassed the consumption of goods and services. It also talked of accessibility of all people particularly of Scheduled Tribes (STs), Scheduled Castes (SCs), women and other deprived sections of the population to the welfare services. Such approaches in the development planning primarily aimed at removing those conditions of social deprivation and discriminations that restrict capabilities of, and deny opportunities for participating in normal economic and social activities. A few of them include attending school at the primary level, having access to quality health care, safe drinking water, sanitation, and gainful employment of an assured nature which connotes the processes of widening people's choices as well as various levels of their well being.

With this premise the present paper covers couple of objectives. The first section of the paper provides a theoretical understanding of the concept of ecological anthropology which deals with the ecological resources and the symbiotic relationships with the tribal communities and vice versa. The second section briefly explains the distribution of tribal people in Odisha and their changing life and livelihood. The third section gives an overview of Kenduleaf one of the most important ecological resources of Odisha with respect to the production and revenue potential. The fourth section from an empirical study finding first gives a profile of the scheduled tribe kenduleaf binder households, and secondly, the extent of their dependency on kenduleaf with respect to the extent of family labour engagement, creation of employment, income and expenditure of the KL binders and alternative livelihood they need to strengthen their economy. While concluding, the paper suggests couple of required development interventions for the livelihood improvement of the tribal KL binders and the maintenance of symbiotic relationships of the tribal people with their ecological resources.

Keywords: Livelihood, Health care, sanitation, gainful employment, discrimination

Introduction

During last couple of decades one finds plethora of materials in social sciences relating to ethno-ecology, environmental economics, human ecology, and political ecology and ecological anthropology. Such areas of specialization describes a type of research that is interested in deepening our understanding of how human have been affected by their natural environment through time and conversely how they have influenced their natural environment (Worster, 1988a, 290-91). The term ecological anthropology which deals with the ecological resources came during 1960s by the thinkers like Alfred Kroeber and Julian Steward. The concept of cultural ecology influenced the concept of ecological anthropology, but one finds a shift from the concept of 'cultural population' to the 'ecological population'. The ecological anthropology is known for its functionalism and systems theory. For anthropologists role of cultural practices and beliefs in enabling human population to optimize their adaptations to their environments and in maintaining undegraded local and regional eco-systems are important. Rappaport (1971) used the word 'ecological population' as an 'aggregate of organisms having a common pattern of distinctive means by which they maintain a common set of material relations within the eco-system in which they participate'.

The native landscapes are created through human actions, including environmental features as legacies of past action both intended and unintended. Whether these are patches of highly fertile soil, islands of distinct vegetation types or areas of land degradation, an understanding of land use histories and the intersection of social, institutional, political, and economic processes over time are essential. Crumeley (1994:6-7) defined landscapes as the material manifestation of the relations between humans and the environment, which 'represent another means of introducing geographical space into anthropological analysis, where it can serve as the laboratory of past human choice and response in which the effects of environmental changes can be palpably understood. An ecological understanding of landscapes involves analysis of the knowledge systems, productive practices, and religious rites that natives have developed over the course of centuries as a means of interacting with and gaining sustenance from their biophysical environments.

The 'cultural materialism' of Harris and the 'ethno-science' of Berlin ConKlin explained that the indigenous groups have traditional ways of categorizing resources, regulating their use and preserving the environment. Ethno-ecology is the traditional set of environmental perceptions i.e its cultural mode of the environment and its relation to people and society. Vayda and Walters (1999) maintain that ecological research should not make prior judgments concerning the causes of environmental change, but must be willing and able to assess all possible factors of biological and social origin. In anthropological and ecological research different kinds of generalizations are obtained from different levels of analysis (Bennett, 1976). In biological term the distinction are made between 'eco-system people' whose subsistence is tied with particular local eco-systems and 'bio-sphere people', who drew their support from resources obtained at a planetary level (Dasmann, 1988).

The changing scope of ecological anthropology finds that the earlier ecological anthropology was based on cultural relativism, while the new ecological or environmental anthropology blends theory and analysis with political awareness and policy concerns. This led to the new field of applied ecological anthropology and political ecology (Greenberg and Park, 1994). Orlove (1980) while reviewing the literature on ecological anthropology noted the processual ecological anthropology as a stage gradually supplementing neo-functionalist approach. Within the processual ecology human system ecology (Bennett, Ibid) emphasized on human ecology as human behavior. Anthropological political ecology established relation with geography and political economy in which concepts such as claims, rights, power and conflicts predominant. However, ecological anthropology many time face methodological difficulties to understand geological, biological and cultural temporalities developed over millions of years. In new ecological anthropology everything is on a larger scale. The focus is no longer the local eco-system. The outsiders are the key players in local ecology. With the changing scope of the subject ecological anthropologist need to pay attention to study the importance of external organizations and forces like government, NGO and the market that are now playing claims to local and in the regional eco-systems throughout the world.

The serious threats to natural resources in post-independent era came through the establishment of development projects basically in tribal inhabited inland areas. These development projects might be multi-purpose irrigation dams, mines, roads, railways, new townships, refugee settlements and big industries. A few such development projects so far established in tribal inhabited forest areas of Odisha which have tremendous impact on the natural resource base of the tribal people are Hydroelectric-cum-Irrigation projects like; Hirakud, Balimela, Machakund, Upper Kolab, Upper Indrabati, Mandira, Rengali; mineral based industries, like Rourkela Steel Plant, National Aluminum Company, Hindustan Aeronautics Limited; and mining projects on cement, iron, dolomite and limestone (Fernades,1994; Mohapatra,1999; Behura and Panigrahi, 2002).).

The impact of massive deforestation has been observed in the life way processes of the rural people including tribal people in particular, which can be categorized as environment effects, social effects and economic effects. The social effects of deforestation restricted the access of tribal people into the forest and encroached the availability of forest produces (Mallik and Panigrahi, 1998; Roy Burmen, 1982). It affected the religious activities, life cycle rituals, customs, practices and the habits of the tribal people. Similarly, the economic effects of deforestation, due to development projects as observed, have drastically influenced the traditional livelihood resources of the tribal people, which were the produces of the forest. Tribal people for their survival largely depend on forest resources. Since the tribal people more or less live in the forest which are terrines with hills and mountains, under this situation for agricultural purpose they clean the land patches on the slopes of the hills and practice shifting cultivation, which of course is pernicious because it causes deforestation. Since tribal people do not have much alternative sources of livelihood and Government provisions for them to earn their livelihood are inadequate, so they by and large depend on hill slopes, foothills and forest products to make their day to day survival.

Study Design

The present study has covered 161 ST binder HHs of which 24.22 per cent are from Bolangir, 8.07 per cent are from Kalahandi, 37.27 per cent are from Rourkela and 30.44 per cent are from Sambalpur. Number of tribal Kl binders from 161 households accounts for 290 persons which is highest in case of Sambalpur district (104), followed by Balangir (85), Rourkela (81) and Kalahandi (20). On an average 1.8 persons of KL binders are reported across the study regions, which is highrest in Balangir (2.18), followed by Sambal pur (2.12), Kalahandi (1.53) and Rourkela (1.35). The gender wise composition of all the binders in four Kl Divisions consists of 290 persons of which male accounts for 136 (46.90%) while females accounts 154 (53.10%). More female binders are observed in Rourkela (62.03&), followed by Balangir (51.76%), while in Kalahandi they tune to 40.91 per cent. The Study tools included structured interview schedule for KL binders to catch both qualitative and quantitative responses. In addition, case studies and photographs were also collected to enrich the data pool of the study. The data is analysed according to the Kl Divisions.. The data was collected during the year 2009-10.

Tribal Communities in Odisha: A Digression on their Regional Geography

The scheduled tribe communities of Odisha contribute substantially to the demographic structure and social fabric of the state. There are 62 tribal communities, with a total population of 8.14 million (Census of India 2001), who belong to Austro-Asiatic, Dravidian and Indo-Aryan language families. Out of them, 13 tribal groups have been identified as primitive who are recently known as particularly vulnerable groups. Almost 44.21 per cent of the total land area in Odisha has been constitutionally declared as scheduled area. Except for the coastal belt, most of the districts of the State are either partially or fully declared as scheduled area. The present scheduled area of the State includes six districts that are fully and five districts that are partially within it. The districts of Mayurbhanj and Sundargarh are the full scheduled districts while Keonjhar is the partially scheduled district in the northern zone of the state. Similarly, Koraput (undivided) is a full scheduled district, while Kandhamal and Kalahandi are partial scheduled districts in the southern zone of the state. Out of 314 Community Development Blocks of Odisha, 118 (37.3 per cent) blocks are covered under the Tribal Sub-Plan (TSP). The tribal population of Odisha constitutes 22.08 per cent of the total State population (2001). The major tribes in the northern zone of the state, based on their numerical strength, are, *Santhal, Munda, Ho, Juanga, Bhuyan, Bathudi, Kharia, Kolha, Kol Lahara, Kisan, Oraon, Gond, Lodha* and *Mirdha*. The major tribal communities of southern zone include *Khond, Koya, Gadaba, Paraja, Omanatya, Pentia, Saora, Bonda, Didayi* and *Shabar*. There are 15 tribal groups distributed in different parts of Odisha each having more than one lakh population. The tribal communities like *Santhal, Gond, Munda, Ho, Birhor, Bhumija, Kharia, Lodha, Oraons* and *Kissan* in the northern zone of the state cut across the State boundaries and are also found in the neighbouring States of Jharkhand, Chhatishgarh and West Bengal. Similarly, *Koya, Khond, Saora, Shabara, Paraja* and *Gadaba* tribal communities of the southern zone are also found in Andhra Pradesh and Chhatishgarh.

The tribal economies are still primitive from the point of view of resource utilization, technology adoption and diversification of cropping pattern. A study of the tribal economy requires an understanding of the concept of community, common property, meaning of land and the role of non-tribals, particularly scheduled caste groups, such as *Panas* and *Damos* who significantly influence the tribal economy. Land is the pivotal property and tribal people retain strong emotional attachment to it even though they do not enjoy legal rights over land. Apart from land based resources, Minor Forest Produce (MFP) popularly known as Non-Timber Forest Produces (NTFP) play a vital role in their economic life, sustenance and labour processes. The Roy Burman Committee (1982) pointed out the commercial viability of MFPs starting from family level to the national level. The Task Force on Development of Tribal Areas (1983) of the Planning Commission since then has also highlighted the importance of forest resources and the role of tribal communities for its management. More specifically, the tribal communities namely *Santhal, Munda, Ho, Bhuiyans* and *Oraons* of northern zone are more or less exposed to the mining and industrial operations in Mayurbhanj, Keonjhar, and Sundargarh districts. Quite a sizeable segment of them have been migrating from their native area to different urban and industrial pockets of Odisha and Jharkhand in search of wage labour. A look into the level of literacy among these tribal communities also reflects a distinct variation between these two zones. As per the 2001 Census the literacy rate among the *Kissan* was 50.19 per cent, while it was 50.88, 39.69, 54.20, 40.43 and 46.96 per cent among *Bhuyan, Munda, Oraon, Santhals* and *Gonds* of the northern zone respectively. The level of literacy among the major tribal communities of Southern zone is much less, namely, 11.73, 12.62, 14.69, 17.96, 21.21, 31.87 and 41.13 per cent respectively among *Koya, Didayi, Bondo, Paraja, Gadaba, Kondh* and *Saora* of the southern zone. The impact of these processes has been quite varied for the different tribal communities and the penetration of exogenous forces has generated aspirations among the tribal communities. In such a situation the influence of traditional institutions in the management of natural and social capital of these communities also varies. There is a need to understand the regional development and diversities and the overall framework of development intervention in these regions.

Tribal Livelihood and Natural Resources

From time immemorial tribal communities eke out their livelihood from forest resources. The economic, social and cultural life of these communities is fully inter-twined with the natural resources. They are using forest resources as totems, which reflect their collective sentiments and solidarity. The use of these resources has been always guided by their cultural practices, festive occasions and taboos. In pre-Independent period the Forest Act 1865, which came into force during the British period empowered the Government to declare any land covered with trees as forestland. As a result, rights of the tribal people were restricted in the name of ‘national interest. Later on the Indian Forest Act 1878-divided forest into three categories, such as reserve forest, protected forest and village forest. This strengthened government control over forest and forest resources. This not only restricted tribal communities as regards free entry, but also accessing certain forest areas for the people in the name of forest classification. The National Forest Policy 1894 laid emphasis on the regulation of community rights and restrictions on the privileges previously enjoyed by the villagers in the immediate neighbouring forest, and brought out a formal relation of forest dwellers particularly tribals with that of Forest Department as a crucial issue in forest management by protecting hill slopes and imposing ban on shifting cultivation. The Indian Forest Act 1935 consolidated the power of the State on forest so as to meet the requirements of British industry, military and commerce.

In the post- independent period the first National Forest Policy of 1952 attempted to redefine the forest policy and the traditional rights of the forest dwelling tribes which converted certain concessions (enjoyed by tribals for long) by withdrawing the release of forest land for cultivation, controlling free grazing, discouraging tribals to do away with the practice of shifting cultivation. The National Commission on Agriculture (NCA) 1976 revised the National Forest Policy which recommended that forests be managed efficiently for commercial purposes and for the minimization of forest productivity but NCA remained silent about the traditional rights of the tribals. Gaining over experiences the Government of India under 42nd Amendment of the Indian Constitution deleted forest from State list and entered it under concurrent list in 1976. The Indian Forest Bill 1980 again vested powers with forest officers to arrest and for the seizure of goods. This policy also reflected the colonial legacy which did not treat *adivasis* as the friend of forest, rather, empowered State Government to declare any reserve forest as non-reserved and also allotted forest land for non- forest purposes. The National Forest Policy 1988 emphasized more on environmental stability through the preservation of forest by replacing contractors by tribal co-operatives, gave concessions to the ethnic minorities, provided suitable alternatives for the shifting cultivators. But, in practice the official draft did not follow the letter and spirit made in the resolution.

Much before the introduction of Joint Forest Management in Odisha it was seen that around 3 to 10 percent of all reserved and protected forest lands of Odisha were under informal community protection (Ghosh, 1996). Tribal people of Odisha seem to have shown remarkable performance in managing their land resources. Perhaps for this reason Government of Odisha has felt that for successful forest preservation the local community should be fully involved and made responsible for the prevention of illicit felling, theft of forest produces and encroachment in reserve forest (GOl, 1997).

Roy Burman Committee (1982) had pointed out the commercial viability of around 300 NTFPs, explained the close linkages between the tribals and forest; and the potential of prosperity of different traders to trade forest produces at various levels. With the 73rd Amendment of Indian Constitution, which gave power and revitalized the Panchayati Raj Institutions, Government of India extended this special power through the Panchayats (Extension to the Scheduled Areas) Act 1996. Following this Government of Odisha has announced and formed the Odisha Panchayati Raj (Amendment) Act of 1997 and extended the Central Act 40 to the Scheduled Areas of the State. Recently (2000) GoO have considered these special provisions and involved the local communities as partners in the management of degraded forests and the members of the Vana Samrakshyan Samiti (VSS) are entitled to share the use of forests. Considering this GoO have handed over 68 NTFP items during 2000 to Gram Panchayats as regards its procurement and marketing at local level.

Factors of Chronic Poverty: Towards an Inclusive Explanation of the North-South divide in Odisha

It can be argued that large differences in the density and extent of concentration of tribal population between the northern and southern regions lead to the observed differences in the extent of aggregate/chronic poverty between these regions of Odisha. On the contrary, while the density of tribal population is very nearly the same in the north and south NSS regions, there is much greater concentration of tribal population in the north as compared to the southern region. In fact, the northern region has more than a proportionate share of the state's tribal population (53.66 per cent) relative to the share of tribals in the state's total population (34.69 per cent). Thus the higher incidence of aggregate/ chronic poverty in the southern region cannot be explained in terms of a higher density and/or concentration of tribal population. This perhaps means that economic conditions of the tribal people vary from context to context. This needs to be studied to examine the efficacy of existing policies and programmes, and for drawing out implications for policy reforms and interventions.

A study of factors that contribute to a relatively stronger impact on aggregate/chronic poverty in the northern NSS region could be useful for understanding the presence of different kinds of constraints operating in the southern NSS region. Available evidences relating to some of these factors are discussed below. However, these factors are indicative and call for more detailed research as well as identification of other relevant variables. We present below an account of some of these differentiating factors.

Level of Wage Rates

The available data suggests that wage rates are relatively higher in the northern as compared to the southern region of Odisha in all segments of the daily wage market. The most striking difference in wage rates is in the case of agricultural labourers. It may be seen that average weeKly wages of tribal agricultural labourers in the north are about 34 per cent higher than they are in the south (and about equal to that in the coastal NSS region of Odisha). It needs to be mentioned here that the observed difference in the incidence of chronic poverty between the northern and southern regions is not fully explained by labour market conditions, but perhaps more importantly, by the relatively lower ratio of prices received to prices paid by the small producers (who constitute a sizeable proportion of the poor) in the southern region (*World Bank, 'Odisha Policy Notes 2005)..*

Relatively Favourable Agro-Ecological Conditions

Relatively higher proportion of high land, and lower proportion of low land, in the southern as compared to the northern region, perhaps suggests the following: lower agricultural productivity in general in the south (because of lower moisture retention capacity of high land soil) in the short run and in the long run, possibly a higher rate of soil erosion in the southern region, in case there has been a greater extent of degradation of forest (*Directorate of Agriculture and Food Production, Bhubaneswar, 1997).*

The data on closed forest area as per cent of total forest area (which is the reciprocal of the extent of degradation of forests), and closed forest area as per cent of total geographical area (a measure of effective forest cover), for the northern and southern regions, show that the extent of degradation of forests is relatively less in the northern region and the effective forest cover is also relatively higher. In addition, there is a much greater concentration of closed forest area in the northern as compared to the southern region. In fact, it is more than proportionate to the share in total population of the state for the northern region (which is much larger than the south. There is some micro level evidence to the effect that JFM is functioning better in the northern region. A good indicator of this is the extent of institutional and community-based management of forests under JFM. We thus find that the extent of forest area protected by Vana Samrakhyana Samiti (VSS) is much higher in the north compared to the south relative to the total forest area in the two regions (*PCCF, Odisha, Aranya Bhawan, Bhubaneswar, 2005).*

Overview of Kenduleaf Resources in Odisha

Kenduleaf (*Diospyros melanoxylon*) is one of the precious naturally renewable livelihood resources in the tribal dominated regions of the state used commercially. It is popularly known as "Green Gold". The quality of kenduleaf (Thus known as KL) in Odisha is known for its unmatchable flavour, texture and workability (Forest and Environment Department, 2008). Due to its flavour, flexibility, feature, texture and resistance to early decay, KL is used as wrapper for preparation of *beedi*. *Beedi* is the popular cigarette for the Indians and for many Asian nations. The quality of KL in Odisha divides it into two types. The first one is little large, thinner, and more pliable with prominent nerves found in bushes, while the second type of KL is shorter, thicker and brittle collected from mature trees.

Management of Kenduleaf

The management of Kl in Odisha is divided into three administrative circles i.e. Conservator of Forest, Cuttack (Kl) Circle which includes 5 Kl Divisions and 44 Kl Ranges; Conservator of Forest, Sambalpur (Kl) Circle covers 6 Kl Divisions and 50 Kl Ranges; whereas, Conservator of Forest, Bolangir (Kl) Circle covers 8 KL Divisions covering 59 Kl Ranges. Thus, the KL organization in Odisha covers 153 Kl Ranges distributed in 19 Kl Divisions which are divided into 3 Kl Circles. Looking at the revenue potential generated out of Kl trading, the state government took a decision to nationalize kenduleaf in the year 1973. The Forest and Environment Department, Government of Odisha does the collection, processing, packaging and storage, of Kenduleafs while the Odisha Forest Development Corporations Ltd. (thus known as OFDC Ltd) sells them on behalf of the State Government on commission basis. The whole range of Kl trade offers employment opportunities to the rural poor of Odisha. The Kl organization includes 7,601 Collection Centre Popularly known as Phadis, spread over 23 western and central districts of the state. During the year 2006-07 (2006 KL crop year) the achievement of Kl production was 3.84 lakhs quintals which have benefited 7,57,123 lakh pluckers (Forest and Environment Dept, 2006-07). The study of NCDS (Mallik, 1997) on the "Procurement and Marketing of Kenduleaves in Odisha: A study on economic deprivation and benefits to primary collectors" assessed the degree of dependency of Kl pluckers on the collection of Kl, employment opportunity of Kl, and the impact of forest depletion on the Kl pluckers.

Registered Kenduleaf Binders and Binding Rates

Kenduleaf binding is another area of raising income for the tribal people of the state. Binding rate of the Kenduleaf is the only determinant of income benefit to the Kl binder households. Attempt made to find out the status of Kl binding parties distributed in different parts of Odisha, total number of *khuntis* in different Kl divisions and number of Kl binders who are engaged in binding operation in the state. The data indicate that there were a total of 962 number of binding parties, 10054 number of *khuntis* and 20108 number of binders engaged in Kl binding in the state. Of the total binding parties operating in the state, only 5.50 per cent are functioning in Sambalpur Kl FD, followed by 6.34 per cent in case of Rourkela Kl FD, 6.30 per cent in case of Bolangir Kl FD and 6.02 per cent in case of Bhawanipatana Kl FD. Similarly, as regards the number of *khuntis* are concerned Sambalpur Kl FD shares 6.53 per cent of the total *khuntis*, while Rourkela has 4.34 per cent of the *khuntis*, Bolangir has 8.06 per cent of *khuntis* and

Bhawanipatana has 5.31 per cent *khuntis* for the binding of the Kl. Out of 20108 number of Kl binders, 6.53 percent of binders were functioning in Sambalpur Kl FD, while 4.34 per cent binders were working in Rourkela Kl FD, 8.06 per cent of binders were working in Bolangir Kl FD, and 5.32 per cent binders were working in Bhawanipatana Kl FD.

The payment of different rates per each Kl bundles of different grades of Kl, for the year 1990 to 2009 was assessed to find out the growth rate in Kl binding rate per bundle. For the base year for all grades of Kl the price was fixed at Rs.5.00 per bundle. However, this price was increased from Rs.3.00 per bundle. There were no variations in the rates as per the quality of the Kl. Uniformity in the binding rate was found for all grades of the KL during the year 1999. When compared with the year 1990 one finds there is a growth of 70.00 per cent in the Kl binding rate during the year 1999. Price variations in the payment of wage rates for different grades of Kl were distinctly observed from the year 2005. During 2009 the growth in the Kl binding rate when compared with 1999 observes 213.95 per cent for grade-1 kenduleraf, 179.01 per cent for grade-II kenduleaf, 173.26 per cent for all other grades. The rates of different grade of Kls are by and large influenced by the quality of the kenduleaves (Forest and Environment Department, 2010).

Production of Kenduleaf

Production of Kl is one of the important indicators of assessing its economic potentiality. Looking at various constraints of managing Kl resources and for better economic return the state of Odisha in the year 1973 has nationalized Kl and entrusted the Forest Department the task of procurement, while Odisha Forest Development Corporation Ltd has been entrusted with the responsibility of marketing the Kl through periodic auction within state and at some place outside the state. All Kls are of not equal quality and thus have differential market value.

The quenqunial classification of data was made for the period 1973 to 2010 to assess the growth of production of Kl in Odisha. The data on the average percentage of growth rate of the Kl production in Odisha reflect that there was a fall in the production of Kl during the period 1978-82 to the extent of -5.83, and -4.66 per cent during the period 2003-2007. In rest of the periods the average percentage growth rate of Kl production in Odisha was always in upward trend. The above similar trends in the production of Kl during the period were observed in case of Sambalpur and Rourkela KL FDs. In case of Bhawanipatana KL FD fluctuation in the net production of Kl was observed since 1993, while in case of Bolangir KL FD the net production of Kl was reported as constant from 1988 to 2002 which again receded in subsequent period (PCCF Office (Kl), Bhubaneswar 2010).

Revenue Potential of Kenduleaf:

There are two types of Kl produced in Odisha viz Processed and Phal. Processed Kl is generally more in Odisha for which services of binders with skill and efficiency is required where as '*Phal*' leaves sold even before production without classification and processing. The average sale price per quintal of processed and *phal* leaves in Odisha effectively fixed and marketed by OFDC. Processing of Kl in Odisha is undertaken by the government headed by the PCCF (Kl), which is not found in any other Kl growing states in India. In Odisha, two Kl Divisions namely Jeypur and Nawarangapur are harvesting Kls which are not processed, known as *"phal"* or unprocessed Kl collected in a "*Kerry*" containing 40 leaves. The average sale price per quintal of processed leaves, therefore, fetched 2.29, 1.38, 1.98, 1.71 and 1.59 times more than the price of '*phal"* leaves during the crop year of 2006, 2007, 2008, 2009 and 2010 respectively. It is basically due to the fact that the better and assured quality of processed leaves fetches more prices. Value addition by undertaking processing, binding and bagging not only contributes to state exchequer by way of royalty, but also generation of additional person days of employment and income ensure a group of people to sustain their livelihood.

An assessment of the decadal variations in the revenue generation from different major forest resources like timber, firewood, bamboo, kenduleaf, and other NTFPs was made by taking into account the achievements during last 57 financial years spread over the period 1953-54 to 2009-10. During the year 1953-54 to 1962-63, of the total revenue collected from different forest resources Kl had contributed to the extent of 0.46 crores i.e 18.85 per cent, while during the decade 1963-64 to 1972-73 this contribution went to the extent of 1.72 crore and in next decade (1973-74 to 1982-83) the contribution of Kl raised to 6.15 crores i.e 24.67 per cent of the total forest revenue. In subsequent decades the contribution of Kl increased to the tune of 55.17 per cent (1983-84 to 1992-93), 70.90 percent (1993-94 to 2002-03) and 74.49 pe cent in the rest seven years periods (from 2003-04 2009-10). This shows that Kl has been a major source of generating income for both government at higher level and households living in rural areas of the state at lower level who are engaged in Kl related operations like bush cutting, plucking and binding of Kls. For the rural households in inland region of the state KL is of the very important naturally gifted source of livelihood.

Kenduleaf trading is a promising source for providing employment to the rural population of Odisha. Opportunities for employment are created during bush cutting, plucking, drying, storing, and processing of kenduleaves. All these activities have differential impact on rural household economies. In addition, the '*Beedi (Green cigarate)* rolling' also creates a lot of employment opportunities for the rural villagers. However, the people engaged in all these arduous activities are exposed to various hazardous effects like underemployment, migration, deprivation from all social sector services like ration under PDS, education and health inputs provided by the line departments. Migration seems to have multiple effects on both adult and young generations of Kl pluckers and the binders. One of the basic objectives of Kl nationalization was to safeguard the welfare interest of the rural people engaged in various stages of Kl trade. In order to achieve this, various organizational and operational strategies have been made for implementation at various stages of production, procurement and processing of kenduleaves. The distinct achievements of all these interventions are reflected in the increasing production of Kl rise in the profit, increase of wage rates of the laborers engaged in various Kl related activities. Sometime it is felt that these growths are not percolating down to the people on a sustainable basis. As a result, very little change is observed in the socio-economic status and economic opportunities at local level, which leads to the continuation of their abject poverty of the Kl binders households.

Livelihood Potential of Kenduleaf: An Empirical Finding
Profile of the Study-

The gender composition of the Kl Binders indicates that of the total population of 619, females constitute 52.50 per cent and male constitute 47.50 per cent. Share of female among the Kl Binder population is more in all the Kl FDs. The age group composition of the KL Binders is analysed according to different age group categories. Among the Kl Binders the data indicate that out of 619 people, around 11.07 and 17.97 per cent were belonging to the age group of 0-6 and 7-15 years respectively. Around 66.64 per cent people were belonging to the productive age group of 16 to 59 years. The marital status of the head of the Kl Binder families shows that out of total 161 Kl binders, 81.25 per cent were married, 13.44 per cent were widow/widower, and only 4.69 per cent were un-married. The female shares only 12.50 per cent among the binders interviewed by the team. Similarly, a look into the marital population of all 619 members of the Kl binder shows that around 48.04 per cent were married and 46.55 per cent were unmarried. The average family size per family among the Kl binders was reported as 3.98 or say 4, which range from highest 4.17 per family in case of Sambalpur Kl FD and minimum of 3.53 per family in case of Bolangir. The educational distribution of the head of the Kl binders and their family members is separately calculated. The data indicate that out of total 161 Kl binders family head, 57.81 per cent were illiterates, 15.00 per cent were just literates, 17.50 per cent were having education up to primary level and 2.81 per cent were having HSC pass. Most of the females (92.50%) were reported as illiterate. The educational achievements of all family members of the Kl binders were also calculated. Out of 619 members of the Kl binders, 44.13 per cent were reported as illiterates. This shows that low education might be another determinant of adopting Kl binding as a source of living.

Kenduleaf and Employment opportunity for Tribal Binders

The person days generated by Kl tribal binders were collected as per different activities like bush cutting, Kl Plucking, and Kl binding. More number of persons engaged in different activities are in the age group of 16 to 29 years (45.33%), followed by 30 to 45 years (33.92%). The field data collected with respect to employment generated in different Kl operations, such as bush cutting, plucking, binding reveal that tribal binders employed in binding work for 95.31 percent, 4.03 percent of days in plucking and 0.67 percent days in bush cutting. Gender-wise distribution of KL work show that males are engaged in binding activities for 96.47 per cent of days, in plucking 2.36 percent and in bush cutting 1.17 percent of total Kl activities. So far as female are concerned they are engaged in binding activities for 94.30 per cent of days, in plucking 5.49 per cent of days and in bush cutting accounted for only 0.21 percent of days. It is obvious that women are engaged more in plucking of Kl than males and in bush cutting males are engaged more number of days than female.

With respect to the number of days engaged in Kl binding activity by each Kl binder across the Kl region is 135.74 days. Total number of days engaged in Kl binding activity is highest per binder in Kalahandi (164.65 days), followed by Balangir (137.65 days), Sambalpur (134.66 days) and in Rourkela (128.08 days). So far as the number of Kl bundles produced per binder it is reported to the tune of 563.32 in all regions, while it is highest in Kalahandi (725.25) and lowest in Sambalpur (527.88 bundles). As regards the income raised from Kl binding the data explain that on an average a Kl binder has generated Rs.12,956.53/-per one Kl season. The highest income from Kl binding is accrued by a binder in case of Kalahandi (Rs.16,692.25/-), while the lowest income is observed in case of Sambalpur (Rs 12,141.34/-).

Distribution of total days of employment, Kl bundles produced, and income raised by tribal Kl binder households the data show that on an average 244.50 days of work engaged by one household produced 1014.69 Kl bundles which have generated an income of Rs.23337.86 during one Kl season. The highest income generated per household out of Kl binding is Rs27942.05 in case of Balangir Kl Division and the lowest is in case of Rourkela (Rs.17851.83). The highest number of person days of employment generated in Kl binding work is in Bolangir (300 Days) and the lowest number of days engaged in Kl binding activities is in Rourkela i.e.172.91 days. Similarly, the data on producing number of Kl bundles per tribal binder HH is highest in Bolangir i.e. 1214.87 and lowest in Rourkela i.e. 776.16 bundles.

Income and Expenditure of Kenduleaf Tribal Binder Households

Annual income of the tribal Kl binder households was collected according to various sources, contribution of Kl binding to the total household income, average income from Kl binding per each household and per Kl binder. The data with regards to the income of Kl binders from various sources raised during the year 2009-10 observes that Kl binding contributed to the extent of 61.05 per cent of the household income followed by wages and remittance (19.07%) and agriculture (10.10%). In case of Sambalpur Kl FD it contributes to the extent of 65.88 per cent of the total income of the household, followed by agro-production to the tune of 16.53 per cent and wage and remittance (15.09%). In case of Balangir income from Kl bindings constitute 62.58 per cent of total household income is the highest among the other sources of income. In case of Bhawanipatana Kl binding work contributed 61.31 per cent of total household followed by wages and remittances (22.82%). The income from Kl binding in Rourkela Kl Division constitutes 59.77 per cent followed by wages and remittances (16.06%).

Generating income from various sources in order to meet the requirements of livelihood basket is the prime concern of the Kl binder households. In addition to Kl binding activity, binder households are also reported engaged in other livelihood sources. The study tried to find out the extent of engagement by a binder household for purposes other than Kl binding and Kl related activities during the year 2009-10. The collection and analysis of data was made with respect to the average number of days worked and earning made by each binder household. The study found out that on an average a Kl binder household has worked 66.05 days during the period 2009-10 and earned an amount of Rs.4503.26. Number of days of engagement by a binder household varies from one Kl FD to another, so also income from other sources. However, number of days engaged by a binder household seems to be highest in case of Bhawanipatana Kl FD (81.71 days), followed by Rourkela Kl FD (58.67 days), Bolangir Kl FD (62.71 days) and Sambalpur Kl FD (62.30 days).

Expenditure of Kenduleaf Tribal Binder Households

The data on monthly expenditure relating to the financial year 2009-10 was collected during primary survey. As per the National Sample Survey (NSS) data from Odisha estimated on the basis of poverty line of the Lakdawala Committee during the year 2009-10 at Rs. 505 & Rs. 804 for rural & urban areas respectively. But the Tendulkar Committee (Headed by Professor S.D. Tendulkar) expert committee appointed by Planning Commission revised methodology for poverty estimations. The Tendulkar Committee has recommended, among other things, two main departures from the previous methodologies. First, the Tendulkar Committee has enlarged the consumption basket and, thus increased the poverty lines for both rural and urban areas for which different consumption baskets have been suggested. For example, the poverty line of the Tendulkar Committee for the Year 2009-10 would be Rs.632 for rural Odisha in comparison to Rs.505 for rural Odisha as per the Lakdawala Committee methodology. This implies that the proportion of the rural poor estimated by using the poverty lines suggested by the Tendulkar Committee would be higher than those estimated by using the previous methodologies. Second, the Tendulkar Committee recommended the use of the “Mixed Recall Period (MRP)” methodology over the “Uniform Recall Period (URP)” methodology for estimation of poverty.

Based on the above estimation, it is an attempt to estimate the number of ST binder HHs below poverty line as per Tendulkar estimation of Rs. 632 per month per capita expenditure on consumption basket. In order to further analyse how many HHs are unable to afford even 50 per cent of prescribed amount i.e. Rs 316 are under distress condition. So it was attempted to find out to know how many HHs are spending below Rs. 316, Rs 317 to Rs632 and above Rs.632. The percentage of ST binder HHs under distress condition in Bolangir, Kalahandi, Rourkela and Sambalpur are 15.38, 40.00, 35.90 and 42.86 respectively. In all Divisions 37.89 percent ST binder HHs are unable to spend even 50 per cent of expenditure recommended for consumption basket to be above the poverty. The percent of HHs who are in a position to spent Rs.317 to Rs.632 in Bolangir, Kalahandi, Rourkela and Sambalpur constitute 62.23, 45.00, 35.90 and 36.73 respectively. In case of total sample of ST binder HHs across all Kl divisions, 42.24 per cent have afforded Rs. 317 to Rs. 632 and have crossed poverty line as per the Tendulkar Committee estimates and their per capita consumption basket constitutes 15.39, 15.00, 28.20 and 20.41 per cent in Bolangir, Kalahandi, Rourkela and Sambalpur Kl divisions. It is revealed from the above estimation that only 19.87 percent of HHs crossed poverty line in all Kl division, whereas, rest 80.13 per cent of tribal binder HHs is languishing under the clutches of poverty.

Conclusion

During last three decades Odisha has witnessed repeated protest by poor tribal people against state encroachment on their age-old land rights. Incidences since 1990s in Maikanch in Koraput district, Raigardh and Mandrabaju in Kandhamal district and Kaling Nagar in Jajpur district may be linked to the impact of globalisation on the poor tribal people of Odisha. Yet incidents involving the subjugation of tribals in Odisha and the deprivation of their natural rights over resources are not new. In post-British India, as a result of deprivation, the tribal people of Odisha have taken part in many movements and revolts. These include uprisings of the Kondhs of Ghumasar (1835–37), the Gonds of Sambalpur (1857–64), and the Bhuiyans of Keonjhar (1867–68). These regional anti-feudal and anti-British agitations and movements gave birth to a class of regional leader, including women, in Odisha in general and in ethnic minority-dominated areas of the state in particular to fight against the British during India's independence struggle. (Bailey,1963) in his village study among the Kondhs of Odisha, rightly pointed out that land alienation, money lending, killing of marginalised groups, burning of crop fields and huts of the poor and imposition of collective fines were some of the major causes of such uprisings. Pathy (1987) opines that this milieu of underdevelopment, destitution and disunity seems to be being reproduced even after more then six decades of the formation of the state and more then five decades of independence.

From the above discussion one can say that the ethno-ecologies of the natives still plays a very important role in their livelihood basket and should not be challenged, transformed, and replaced. Imported values often conflict with native values. In the context of population growth, migration, commercial expansion, national and international incentives to degrade the environment, ethno-ecological systems that have preserved local and regional environments for centuries in many contexts are adversely affected.

In such a situation anthropologists are to make use of various modern methodologies like satellites and other remote sensing devices, including geographic Information Systems (GIS) and a host of new possibilities for anthropological and ecological research particularly in the areas of land use patterns and ecological context. Anthropologists with the changing nature of global-local equations have to think globally and act locally. As new environments emerge and grow in importance, new types of ecological analysis will be needed to understand the interrelations that human groups maintain with them. The establishment of new environmental problems that arises out of such situations results in new problem of environment that can and are to be studied ethnographically popularly dealt by anthropology of environmentalism. The combination of ecological and ethnographic approaches has expanded anthropological research resulting in new possibilities of contributing to solve the larger problems of the natives. This is an important issue with regards to the indigenous people since the paradigm shift in ecological anthropology incorporates new trends, priorities and audiences from both applied and advocacy point of view.

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Natural Resource Management and Sustainable Development V/s Disaster Management

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ABSTRACT

The branch of physical geography deals with the science of natural resource management. The basis of this branch of science is the theory of the geographic landscape where primary element is earth. This also deals with the origin, structure, and dynamics of landscapes, the laws of the development and arrangement of landscapes, along with the transformation of landscapes for the economic activities of man.

The science of land resource management has always been basically an applied science. As it developed, its practical applications became considerably broader. Several special fields have developed in contemporary applied resource management science: agricultural production, land system engineering, land reclamation, land health use, architectural planning, recreation and also land disaster. The principal materials offered by the scientists for use in the various sectors of the national economy are applied/thematic maps, and charts with corresponding texts and in recent time's data base system along with digital maps.

Keywords: Physical geography, landscapes, economic, land health use

Introduction

Natural Resource Management refers to the management of natural resources such as land, water, soil, plants and animals, with a particular focus on sustainable development of quality of life especially for future generations. Thus natural resource management, sustainable development and environmental governance are all co related. Natural resource management specifically focuses on a scientific and technical understanding of resources and ecology and the life-supporting capacity of those resources. In order to have a sustainable environment, understanding and using appropriate management strategies is important in terms of conservation and development. Using appropriate and adapting management systems is dependent on local ecological situations and cooperation between scientists and local people who have knowledge and skill about the resources.

Land resource forms the most important wealth of any region. Its potential, proper utilization and management and role in the development are a matter of utmost concern to the people living in the region concerned. Improper use of land creates problems like land degradation, creation of waste land, decline in productivity due to soil erosion, encroachment on arable land and increase in the frequency of natural disaster.

Therefore, utilization and management of soil, natural vegetation and other land resources, according to their capability is very important. It should be ensured, that land resource must be utilized to the best advantage in an enduring manner. Land resources management, in a broader sense, is the implementation of land use planning, as agreed between and with the direct participation of the actual stakeholders.

Development & Management of Natural Resources in India

The management of land and natural resources is one of the most critical challenges facing by the developing countries today. The exploitation of valuable natural resources, including oil, gas, minerals and timber has often been principal causes in triggering, natural and manmade disasters around the globe. Furthermore, increasing demand and conflict for diminishing renewable resources, such as land and water, is on the rise. This is being further aggravated by environmental degradation, population growth and climate change etc. The mismanagement of land and natural resources is responsible for various types of disasters in so many ways.

Inter-relationship and inter-dependence among water, land, vegetation and animal resources determine the nature and kind of livelihood support systems especially in the rural areas. Depletion of the natural resource-base and increasing biomass-demand of the humans and livestock population are also very much responsible for such types of imbalances. However, the degeneration of natural resources has assumed alarming proportions during last few decades. It is, therefore, pertinent to evolve strategies for sustainable natural resource management systems. It is also imperative to observe the changes taken place in the land-use pattern in general and in the agricultural sector in particular, which generally have implications on local bio-diversity and the ecosystem, which again determine the sustainable food and nutritional security of the local people and country as a whole.

India constitutes about 18 per cent of the world's population, 15 per cent of the live stock population and only 2 per cent of the geographic area; one per cent of the forest area and 0.5 per cent of pasture lands. The per capita availability of forests in India is only 0.08 per ha as against the world average of 0.8 per cent, which reflects the extent of pressure on land and forests resources of the country. According to the National Remote Sensing Agency's (NRSA) there are 75.5 million ha of wastelands in the country. In has been estimated that out of these around 58 million ha may be regenerated and may be brought back to original productive levels through appropriate techniques and measures. But the percentage of such treated land is negligible only because the absence proper and scientific management planning.

Again due to lack of proper watershed management planning in India there is threats of livelihood of millions of people which has become a major constraint to develop a healthy agricultural and natural resource base. Increasing population and livestock are rapidly depleting the existing natural resource base because the soil and vegetation system cannot support present level of use. As population continues to rise, the pressure on forests, community lands and marginal agricultural lands lead to unscientific cultivation practices, depletion of forests. Also increasing grazing practices create more wastelands.

As a matter of fact watershed is a complete geo-hydrological unit which drains at a common point. Rains falling on the mountain start flowing down into small rivulets. The small streams form bigger streams and then finally the bigger streams join to form a big channel to drain out of a village. The entire area that supplies water to a stream or river, i.e. the drainage basin or catchment area, is actually termed as the watershed of that particular stream or river. Thus, management of watershed entails the rational utilization of land and water resources for optimum production but with minimum hazard to natural and human resources. The main objectives of watershed management are to protect the natural resources such as soil, water and vegetation from degradation. In general sense, it is equilibrium in between elements of natural resources on the one hand and man's activities on the other. In managing or developing a watershed it is very important to have people's participation. In this regard, the key issue is how far the people can be motivated, involved and organized to drive the movement. No significant improvement can be expected without the people being motivated or brought to the core of the project.

The Ministry of Rural Development, Government of India, has recently created a Department of Land Resources to act as a nodal department in the field of watershed management and development. This has the mandate of developing the valuable land resources of India, which are presently under degradation and it also endeavors to prevent further degradation of these resources through appropriate management and necessary measures. The Department of Land Resources, being the nodal department has taken up certain new initiatives to play a more active role in the Land Resource management in the country. At the conceptual level it has been realized that the management rather than the mere use of land is the central theme. There is no dearth of land; the real issue is management and utilization techniques which should also include the methods of conservation, sustainable development and equitable access to the benefits of intervention.

It is a known fact that man and his environment are interdependent. Any change in the surrounding environment directly affects the people living therein. A degraded environment results in a degraded quality of life for the people. Thus, any programme to reduce poverty and improve the standard of living of the people must be aimed at the sustainable improvement of the environment. But for this, people's participation is very necessary. There is a close relationship between the environment and the human community living within a certain ecological unit for its livelihood. When the economic condition of a community deteriorates, it leads to over all exploitation and degradation of natural resources. Thus, it is necessary for people to understand the relationship between their economy and the reasons behind their poverty and the degraded environment where they live in. Because the environmental regeneration is possible only when the concerned people realize a need for it and are empowered and trained to have control over the process of resource utilization, management and conservation.

To do so sustainable development of the resources is necessary. Promoting sustainable development is among the top priorities for every government. It is seen as one of the most crucial factors in governance in general, economic prosperity and improvement of quality-of-life for citizens, including improved health services, education, and shelter. Now it is an acceptable fact that everyone should be educated to realize the impacts of natural and manmade disasters, and the need for proper planning, preparation, response, recovery and ever-improved resilience.

India shares 18% of the world population, while its land is only 2% of the total geographical area of the world. Naturally, the pressure on the land is often beyond its carrying capacity. Therefore, the productive lands, especially the farmlands in the India are in the constant process of various degrees of degradation and are fast turning into wastelands. At present, approximately 75.5 million hectare area of the land is lying as wastelands in India. Out of these lands, approximately 50% lands are such non-forest lands, which can be made fertile again if treated properly. In the last 50 years it is India's lush green village forests and woodlots have been deforested to the maximum.

Government of India had created the Department of Wasteland Development during July, 1992 under the Ministry of Rural Development, which has been subsequently reorganized and renamed Department of Land Resources, with a broader mandate. National Wasteland Development Board was established in 1985 under the Ministry of Forests and Environment mainly to tackle the problem of degradation of lands, restoration of ecology and to meet the growing demands of fuel wood and fodder of the local people. During the Seventh Five Year Plan, the strategy adopted by the National Wasteland Development Board emphasized more on tree planting activities rather than Community Participation for wasteland development. In the year 1992, the new Department under the Ministry Of Rural Development (now Ministry of Rural Areas and Employment) was created and the National Wasteland Development Board was placed under it. The Board was reconstituted in August 1992 and was made responsible for mainly development of wastelands in non forest areas in totality by involving local people at every stage of development. It aims at creating a scenario where the Government acts as a facilitator and the people at the grass root level become the real executioner of the programme. Major programme were implemented for improving the productivity of waste & degraded lands keeping in view the poverty, backwardness, gender & equity.

Sometimes many of the long-term development programmes is often disrupted and discontinued due to some unforeseen events. Many of them come in the form of natural or manmade disasters, which can put enormous stresses and set backs on social and political systems. Today, disasters are widely recognized as among the most disruptive forces impeding sustainable development, especially in developing nations, where disasters divert much-needed and scarce resources away from the strategic infrastructure development and toward response and recovery. Appropriate safeguards against these negative effects are needed, including promotion of national disaster management strategies and implementation of sound disaster management practices. However, the greatest emphasis of disaster management continues to be placed on response and recovery activities, while little attention is given to proactive measures that would reduce risk and prepare people, communities and economies to better withstand and survive disasters. In recent memory, for instance, the Indian Ocean Tsunami of December 2004 demonstrated the human cost of not having an early warning platform in place. Similarly, Hurricane Katrina in the United States Gulf Coast demonstrated the high price to be paid for not having a proper understanding of effective plans to counter the risks. Again due to proper warning system and timely evacuation human lives could be saved from cyclone Phailin in Orissa, India on 12th October 2013. On the other hand thousands of pilgrimages died in Uttarakhnad due to incessant rain and flash flood only because of lack of proper and timely information in August 2013.

Disaster Scenario in India and Around the World

India has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquake, landslides etc. are recurring features. About 60% of the landmass is prone to earthquake of various intensities, over 40 million hectares is prone to floods, about 8% of the total area is prone to cyclones and about 60% is susceptible to drought. The Disaster Management cell, Government of India has identified that 8 cities in India are situated in seismic zone V with very damage risk 14 cities are within seismic zone IV with high dame risk, another 24 cities neither seismic zone III, 17 cities are with seismic zone II.The Super cyclone in Orissa in October 1999, and Bhuj earth quake in January 2001, Aila in May 2009 and Phailin in 2013 or Uttarakhand disaster are the examples of such type of devastated natural disaster in India when environmental impact were felt for long time. 7 out of the 63 cities are located along the coastal belt and are vulnerable to cyclonic hazards. 10 out of total cities are located in severe to high landslide hazard prone areas in the hilly regions. Therefore, urban authorities are highly responsible for providing opportunity for the safety of the cities which includes, proper building planning, sewage clearing, and preservation of water bodies.

The picture of the other countries of the world does not have many differences to that of India. In recent past the summer heat waves are likely to become more common in Europe and by 2030. Most of the Europeans and Australians countries may have 10 – 15% more summer days over 350C and 20 - 80% fewer frosts. Most climate models indicate that in many places global warming is likely to increase the frequency and duration of extreme events such as heavy rains, droughts and floods. It has been forecasted by the scientific communities of world that the summer heat waves are likely to become more common in Europe and by 2030, most of Australia may have 10-50% more summer days over 35°C, and 20-80% fewer frosts. Tropical cyclone frequency may change in some regions and peak winds and rainfall rates may increase.

Tropical cyclone rainfall rates may increase, but there is also uncertainty about location changes. Flooding at present is, overall, and costliest form of natural disaster with average losses estimated at $400 million a year and it may increase in near future in many countries of world even heat waves may account for more deaths in Australia than any other climatic events. The average annual number of disasters reported during 2000-04 was 55% higher than during 1995-99. With 719 reported disasters, 2004 was the third worst year of the decade (1994-2004).

The occurrence of natural or manmade disaster is now a daily phenomena and the impact of it is huge in respect of economic and social point of view. In Southeast Asia that includes roughly 31 million people – 13.2 million in the Philippines; 4.9 million in Vietnam; 4.8 million in Thailand; 3.4 million in Indonesia; and 1.5 million in Cambodia. In South Asia, the numbers are even higher: 126.5 million people in India; 57.5 million in Pakistan and 20.9 million in Bangladesh. South and South East Asia have witnessed major disasters in recent times, including devastating earthquakes in China, the quake-triggered tsunami in Japan, the most recent Cyclone Phailin, in India, one of the largest cyclones to ever hit the region and above all the strongest ever typhoon Haiyan, that slams the Philippines island. Typhoon Haiyan, known locally as Yolanda, was historic in its scope, NASA concluding it may be the most powerful tropical cyclone to ever make landfall. According to Weather Channel lead meteorologist Michael Palmer "It is the most powerful storm ever to make landfall".

That width of the Typhoon Haiyan was 370 miles. It surged through the Philippines with sustained winds of 195 mph, and gusts reaching 235 mph. According to the Philippines government, the typhoon made its first landfall over Guiuan in Eastern Samar before moving over Tolosa, Leyte at 7 a.m. local time and Daanbantayan, Cebu at 9:40 a.m. Haiyan then made its fourth landfall over Bantayan Island, Cebu and later made its last at Concepcion, Iloilo and Busuanga, Palawan. Apart from ferocious winds, storm surges up to 10 feet high that blown away coastal towns and deep inland destroying countless human lives and property. The Philippine government says 9.8 million have been affected in 44 provinces, 539 municipalities and 56 cities. Of those affected, 4.9 million are children; 1.5 million are children under the age of five who are at risk of Global Acute Malnutrition (GAM), a measurement of nutritional status used to assess the severity of a humanitarian crisis.

Again, Phailin a very severe cyclonic storm originated from a remnant cyclonic circulation from the South China Sea. From 8th-12th October the depression turned into a giant cyclonic storm and six satellites and 70 weather experts tracked its evolution and movement. By far it is one of the most disastrous cyclone after 1999 Super Cyclone. At the time of landfall on 12th Oct, maximum sustained surface wind speed in association with the cyclone was about 115 knots (215 kmph) Maximum rainfall occurred over northeast sector of the system centre at the time of landfall. Maximum 24 hr cumulative rainfall of 38 cm has been reported over Banki in Cuttack district of Odisha.

Although the nature of the Phailin was devastating but it could not able to use its paw over human being as compare to the super cyclone of 1999. One of the most important reasons behind it proactive pre-disaster management by the central and state Government, and awareness of the local people. In 1999 super cyclone, 460 people were died whereas 28 people lost their lives by Phailin. After the disaster telecommunication, transport system, water supply, medical assistance, food supply were taken care of and restored immediately. Effective decisions from all sectors, accurate weather monitoring, resource mobilization and community based participation were the key factor in reducing the impact of disaster.

To mitigate any type of disaster 'Natural disaster Management Authority' was formed by the Government of India. The authority is a multi disciplinary body which includes various departments like; health, relief, environment & forest, water resources, agriculture, railways, defense, science & technologies, Indian meteorological department. Such type of authority has also been formed in the state, district and block levels which are coordinated by the respective administrative chiefs.

The main objectives are; hazard mitigation, preparedness & capacity building, relief & rehabilitation. The Sustainable Mitigation Planning in some specified cases as adopted by the Government of India are;

- Construction of the buildings as per BSI rules, as has been done in Bhuj Gujarat, after January 2001 earth quake
- Various Government and non Government organizations like Indira Awas Yojana etc have various projects for construction of appropriate buildings to mitigate earth quake hazards
- The long coast line of India also falls under seismic zones III, some parts of Gujarat, entire Andaman, Nicobar islands are under active seismic zone

- Along with earthquake, landslide is another disaster in the hilly areas; October 8th 2005 earth quake with 7.4 Richter Magnitude in Jammu & Kashmir caused large scale destruction

Some Case Studies

Landslides are major threats to life and property in the mountainous terrains around the world. Due to the growing urbanization and uncontrolled land use of the limitedly-available mountainous areas, on global scale, there is an increasing trend of landslide hazard and associated risk. A recent global risk assessment study undertaken by Nadim indicates that the regions with the highest risk of such danger can be found in Colombia, Tajikistan, India, and Nepal. Historical record indicates that the greatest number of loss of life due to a single landslide event was the earthquake-triggered landslide disaster in Kansu Province, in China in 1920, where 100,000 people lost their life (Schuster and Fleming, 1986).

At present the prevention of loss of life and property due to natural calamities is being viewed very seriously by the Government of India. In the past, the main role played by the Government in the case of various disasters was confined mainly to post-disaster activities that included providing relief and organizing rehabilitation. The Uttarkashi Earthquake of 1991, Killari Earthquake of 1993 and the devastating Malpa landslide along the Kailash-Mansarovar route in 1998 acted as an eye-opener for the Government. The need was felt for a proactive approach rather than waiting for a disaster to occur. As a part of this strategy, the Government decided to institute task forces for landslide hazard zonation Mapping and geotechnical investigations along with land use zonation mapping and regulations. It was however the Bhuj Earthquake of 26 January 2001 that led to a paradigm shift in the policies of the Government of India.

Due to the 18th September 2011 Sikkim earthquake of 6.8 Richter scale, several new and a few reactivated landslides have occurred right from the Himalayan foot-hill region (e.g., Dudhia in Kurseong Sub-division, Darjeeling District, West Bengal) up to the higher Himalayan range in the higher reaches of Sikkim-Darjeeling Himalayas, parts of the country as well as in the relatively stable domains of the Meghalaya Plateau, Western Ghats and Nilgiri Hills. In all, 22 states and parts of the Union Territory of Pudducherry and Andaman & Nicobar Islands are affected by this hazard. The new landslides that occurred in the lower elevations are mostly concentrated within the terrace deposits of main streams like Tista, Rangit and Balason etc. 4 landslides reactivated within the old colluvial deposits on the lower reaches of slope adjacent to the streams near Jorethang-Rishi-Legship section along the right bank of Rangit River.

Landslides are one of the natural hazards that affect at least 15 per cent of the land area of our country—an area which exceeds 0.49 million km2. Landslides of different types are frequent in geodynamically active domains in the Himalayan and Arakan-Yoma belt of the North-Eastern of landslides is pronounced during the monsoon period. In order to reduce the enormous destructive potential of landslides and to minimize the consequential losses, the National Disaster Management Authority initiated a series of guidelines. The Guidelines include regulatory and non-regulatory frameworks with defined time schedules for all activities. Investigations of landslide risk assessment involve a multidisciplinary approach where engineering geologists and geotechnical engineers, gemorphologist are an integral part of the investigating team. The investigations include preliminary stage geological and geomorphological investigations, detailed and geotechnical investigations.

Building up and maintenance of the roadway linkages in the Sikkim & Darjeeling Himalayan regions have been a major problem for the engineers and Planners. During the incessant rains in monsoon period, these roadways sometimes get blocked due to landslides for indefinite period affecting the natural mobility of the hill people. Due to limited number of roadways in the region and absence of alternate route, people as well as essential commodities get stranded on the road during such natural calamities.

The main causes responsible for landslide hazards along the roads in the hill areas are;

- Large scale deforestation especially along the jhora banks and road stretch,
- Lack of proper and controlled drainage system,
- Jhora blocking due to non disposable garbage dumping, lack of proper building rules,
- Excessive heavy vehicular movements etc.
- Illegal mining & stone quarrying.

All these reasons have made this geologically unstable region to a vulnerable one. The roads in this region have never been examined with its carrying capacity in respect of geologic structure, soil profile and extent of erosion, geomorphologic analysis along with the evaluation of existing natural vegetation and their importance in the maintenance of the road. Also the steep slopes, heavy rainfall and high altitude characterize the Darjeeling Hill area. Here natural vegetation plays an important role in protecting the hill slopes from erosion. As is said earlier, the forest land in the hill areas are encroached upon for different purposes, as it is done in almost all hilly areas in the country and world as a whole. But, in Darjeeling Hill area, this has created some vulnerable patches, which have become susceptible to frequent landslide hazards. In Kurseong subdivision about 5 percent of the forest cover has been depleted in areas like Sukna, Bagdogra, Pankhabari ranges. In Kalimpong subdivision maximum deforestation is noticed, i.e., 26 percent. The most noted deforested areas are Kalimpong, Chel, Jaldhaka, etc. Due to increasing population pressure, agricultural land has been expanded since last few decades, as a result of which per capita forest coverage has been reduced considerably. The Table below explains the increase of arable land and depletion of forest coverage in the region since 1901.

Table 16.1 Changes in Arable and Forest Areas – 1901 – 1991

Year	Increase in Arable Land (%)	Decrease in Forest Area (%)
1901	19.76	51.54
1911	23.45	55.55
1921	21.3	49.14
1931	20.38	45.46
1941	24.50	45.01
1951	36.67	46.01
1961	31.92	46.07
1971	44.51	40.73
1981	53.61	38.23
1991	56.40	34.12

Source: Dept. of Forests, Government of West Bengal

Due to the 18th September 2011 Sikkim earthquake (M: 6.8), several new and a few reactivated landslides have occurred right from the Himalayan foot-hill region (e.g., Dudhia in Kurseong Sub-division, Darjeeling District, West Bengal) up to the higher Himalayan range in the higher reaches of Sikkim-Darjeeling Himalayas. The new landslides that occurred in the lower elevations are mostly concentrated within the terrace deposits of main streams like Tista, Rangit and Balason etc. 4 landslides reactivated within the old colluvial deposits on the lower reaches of slope adjacent to the streams near Jorethang-Rishi-Legship section along the right bank of Rangit River. Landslides are one of the natural hazards that affect at least 15 per cent of the land area of our country—an area which exceeds 0.49 million km2. Landslides of different types are frequent in geodynamically active domains in the Himalayan and Arakan-Yoma belt of the North-Eastern parts of the country as well as in the relatively stable domains of the Meghalaya Plateau, Western Ghats and Nilgiri Hills. In all, 22 states and parts of the Union Territory of Pudducherry and Andaman & Nicobar Islands are affected by this hazard. The phenomenon of landslides is pronounced during the monsoon period. In order to reduce the enormous destructive potential of landslides and to minimize the consequential losses, the National Disaster Management Authority initiated a series of guidelines. The Guidelines include regulatory and non-regulatory frameworks with defined time schedules for all activities.

Amongst them landslide zonation mapping is important. The major evaluating parameters for such mapping are;

Soil magnitude & length,

Soil thickness analysis,

Relative Relief analysis,

Land use mapping and analysis,

Drainage pattern & density,

Impact analysis of landslides,

The Table below will explain the major landslide occurances in the Darjeeling-Sikkim Himalayas since 1897 till date.

Table 16.2 Major landslide occurrences in Darjeeling – Sikkim Himalayas Since 1897 to till date

Year	Area	Causes	Damages
1897	Tindharia and adjoining areas	Earthquake	Infrastructural failures
1899 (23rd & 25th Sept)	Darjeeling town and adjoining areas	Excessive Rainfall (1065.55mm)	Loss of properties and lives(about72 persons)
1934 (15th Jan)	Tindharia, Kalimpong, Darjeeling town, Kurseong	Bihar-Nepal earth quake	Heavy loss of properties
1950 (14th June)	Kalimpong, Kurseong, Tindharia(Siliguri-Kalimpong railway line was closed forever)	Excessive rainfall (834.10mm)	Heavy loss of properties and lives(127 persons)
1968 (5th & 6th Oct)	Tindharia, Darjeeling, Kalimpong, Kurseong, NH 31 was severely damaged, Coronation bridge was washed away, Hill cart road especially near Giddah Pahar was badly damaged	Excessive rainfall (about 640mm in Kurseong)	Heavy loss of property and lives (677 persons) About 15% of total tea garden areas in Darjeeling was badly affected.
1980 (3rd & 4th Oct)	Darjeeling, Bijonbari, Sukhiapokhri, Tindharia, Kurseong	Excessive rainfall (about 300 mm in Kurseong)	Huge loss of properties and lives(250 persons)
1983	Darjeeling town and adjoining areas, Kueseong, Hill Cart road)	Heavy rainfall	Death:05, House damaged: 345, Heavy loss of property
1987	Darjeeling, Kurseong, Hill Cart Road	Heavy rainfall	Population affected:795, Death: 17, House damaged: 765
1997	Darjeeling, Kurseong, Hill Cart Road	Heavy rainfall	Heavy loss of property and lives(death:17)
1998 (7th July)	Darjeeling, Kurseong subdivision and municipality areas (Sherpa busty)	Heavy rainfall	Heavy loss of property and lives(21 persons, more than 3000 houses were damaged)
1999	Darjeeling-Pulbazar, Rangli Rangliot, Simbong division, Kurseong, NH 55, Kalimpong	Heavy rainfall	heavy loss of property and lives(11 in Sherpa busty, Kurseong)
2000	Darjeeling-Pulbazar, Kurseong, NH 55	Heavy rainfall	Heavy loss of property and lives but there was no such casualties were reported
2002	Darjeeling-Pulbazar, Kurseong, Tista Bazar areas	Heavy rainfall	Heavy loss of property. Total death 7

Year	Area	Causes	Damages
2003	Rangli-Rangliot, Tista Valley, Kalimpong-II, Kurseong, NH 55, Mirik (Gheyabari)	Heavy rainfall	NH 55 near Pagla Jhora was badly damaged, only Gheyabari (Mirik) 23 death was reported
2004	Rangli-Rangliot, Kalimpong II	Heavy rainfall	Heavy loss of property, more than 1,00,000 people were affected, total death 25
2006	Rangli-Rangliot, Kurseong, NH 55	Heavy rainfall	Heavy loss of property, More than 3000 people were affected and total death 13
2007	Darjeeling-Pulbazar Kalimpong-I, Kurseong, NH55	Heavy rainfall	Heavy loss of property especially in tea garden areas like Margaret Hope, Rangli Rangliot, Sukhiapokhri, Garubathan
2008	Darjeeling-Pulbazar, Rangli-Rangliot, Kalimpong-I, Singringtam, Rangli, Bagogra, Mirik- Karshing municipal areas	Heavy rainfall	More than 1,00,000 population were affected but total death reported were 3
2009	Sukhiapokri, Kalimpong-I Kalimpong Municipality	Heavy rainfall	About 555 villages were affected, near about 1,50,000 population affected , total death reported were about 40
2010	Bijonbari, Sukhiapokhri, Darjeeling, Takdah Kurseong, Mirik, Kalimpong – I & II, NH55	Heavy rainfall	Total failure of road & rail link in between Siliguri – Darjeeling due to massive landslides near Pagla jhora and 14th Mile
2011	Darjeeling, Kurseong, NH55, Kalimpong	Earth quake and heavy rainfall	Population affected more than 3,50,000; Death reported 0ver 90 and houses damaged more than 4, 50,000, Massive landslides occurred on NH 55 near Tindharia

Uttarakhand Disaster in August 2013

Cloudbursts, landslides and flash floods are an annual affair in Uttarakhand. The monsoon of 2010 brought with it such massive losses of lives, property, crops and infrastructure that the state said its development clock had been set back by a decade. Things are much, much worse this year in August 2013, when due to incessant rain fall many highways damaged, bridges washed away, electricity and phone networks down, several ravaged places continue to be marooned. The horrifying picture came after the disaster. After all, the speediest monsoon in over 50 years has just dumped over 400% more than average rainfall over Uttarakhand and neighboring Himachal Pradesh.

Himachal chief minister Virbhadra Singh blames nature's fury against which all disaster management must, presumably, fail. India's premier disaster management body neither has implemented any project successfully nor has much information over progress at the state level. Even if local administration had understood the implications of meteorological data, it didn't have much time to put out effective warnings across a state where 65% of the area is under forests.

The Reason Behind Kedarnath Flood as has been said that on GLOF (Glacial Lake Outburst Flood) could be one of the reason behind the flash flood in Kedarnath township, that washed away almost 200 houses and affected thousands of local inhabitants and tourists. The Gandhi Sarovar lake, also known as Chorabari lake, is one of the well known Glacial lake in the higher Himalayan region of India. The Chorabari glacier lies between latitudes 30°44′50″N and 30°45′30″N, and longitudes 79°1′16″E and 79°5′20″E, from an altitude of approximately 6,000 metres (20,000 ft) at the slopes of Kedarnath peak, to 3,800 metres (12,500 ft).

The glacier is around 7 kilometres (4.3 mi) in length, while the basin area of the glacier is approximately 38 square kilometres (15 sq mi) and the glacier ice cover is 5.9 square kilometres (2.3 sq mi). The glacier slope is around 11 degrees and faces south.The glacier has two snouts. It is said that an original single glacier covered the area, which while receding, split into two snouts. One of the snouts is the source of the Mandakini River at 3,865 metres (12,680 ft). The other snout, at 3,835 metres (12,582 ft), drains into the Chorabari Tal.

On 17th morning between 7.30 a huge flash flood that originated from Chorabari lake devastated the Hindu pilgrimage city Kedarnath, that was housed by over 3000 people. The debris flow was such that it had huge boulders and mud that washed away almost 150-200 houses and other were under rubble of 10-12 feet high.

During last flood in 2012 many scientists from various organizations warned about the possibilities of such calamities in future, but, things were not taken seriously by planners and policy makers at state and central government. No early warning systems were placed in this highly sensitive state Uttarakhand. The situation seems not in control of the government in terms of rescue operation and covering huge number of affected people.

Conclusion

The Himalaya is vast mountain system extending in to eight developing countries in south Asia: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. The fact that India is recognized as a mega diversity country and as one of the 10 most extensively forested areas in the world is due mainly to the Himalayas.

Although it covers only 18% of the India's geographical area and accounts for more than 50% of the country's forest cover and 40% of the species endemic to the Indian subcontinent. Losses of forest cover, biodiversity, agricultural productivity and ecosystem services are interlinked problems in the region that threaten the sustainable livelihoods of not only millions of mountain people but also much larger population inhibiting the adjoining Indo-gangetic plains.

Owing to its relatively recent geological origin, the Himalayan ecosystem once rich in biodiversity of elusive plant and animal species is under threat of destruction, expanding agricultural land and rural population resulted in diminishing forest area. Expanding economic activity and population growth are the two basic factors behind increases in energy consumption.

In a state like J&K, where economic growth is necessary and population growth is increasing, energy demand will continue to rise in the years to come. Again, energy consumption patterns and the rise in demand, their sources, and ways in which they are harnessed and utilized have implications for the environment and natural resources, which ultimately affect overall development. Progress in environmental management has been slow and natural resource degradation remains at the core of many problems. Climate change will add a new stress to ecosystems and socio-economic systems already affected by poverty and natural resources depletion and unsustainable management practices needs an immediate attention of the scientific community.

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Status of Saracaasoca : An Endangered medicinal plant species of Conservation Concern from northern Western Ghats Biodiversity Hotspot

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ABSTRACT

Saraca asoca (Roxb.) de Wilde is an economically important medicinal tree species that has been identified as one of the flagship species for conservation and cultivation in India. Scanty information regarding its population structure is available as the demand from pharmaceutical industry is catered by substitute species. Natural populations from northern Western Ghats have been studied at various protection levels ranging from informally protected areas (Sacred groves) to Wild Life Sanctuary. Data on spatial distribution and age structure including regeneration status of this species were presented and discussed.

Key Words: *Saraca asoca,* Sita-ashok, Trade, Population, Regeneration, Distribution map, northern Western Ghats.

Introduction

Biological resources are viewed as 'resource capital' of a nation (Ganeshaiah et al. 2012). Among the 34 global biodiversity hot spots, Western Ghats of India occupies the fifth position according to the economic potential of its biological resources (Natesh, 2000). It is also one of the eco regions of the world with high levels of endemism and houses over

4000 plant species that have medicinal uses. Of the 960 traded medicinal plant species from India, 178 species are consumed in volumes exceeding 100 Metric Tons per year, with their consolidated consumption accounting for about 80% of the total industrial demand of all botanicals in the country (Ved and Goraya, 2007). From the Western Ghats in particular, in the last decade, there is a 50% population decline of medicinal plants in RET (Rare, Endangered and Threatened) category. Modern medicine is dependent on several high-value metabolite-yielding plant resources as major raw material. For instance, natural populations of *Salaciachinensis*L., are being exploited for salacinol and kotalanol to be used against diabetes (Muraoka et al. 2010), *Nothapodytesnimmoniana*(J. Graham) Mabb. forcamptothecin for the cancer cure (Lorence and Nessler, 2004) and *Saraca asoca* (Roxb.) de Wilde for epicatechin and procyanidinintreatment of uterine and menstrual disorders (Pradhan et al. 2009). Unsustainable, unscientific harvesting of these resources in large volumes by forest contractors through local tribal people was found to be one of the reasons for the rapid depletion of natural populations. Recent estimates suggest that only a miniscule of the supply of Medicinal and Aromatic Plants (MAPs) to the pharmaceutical industry is originated from the cultivation, rest sourced directly from the natural populations (Fig. 17.1).

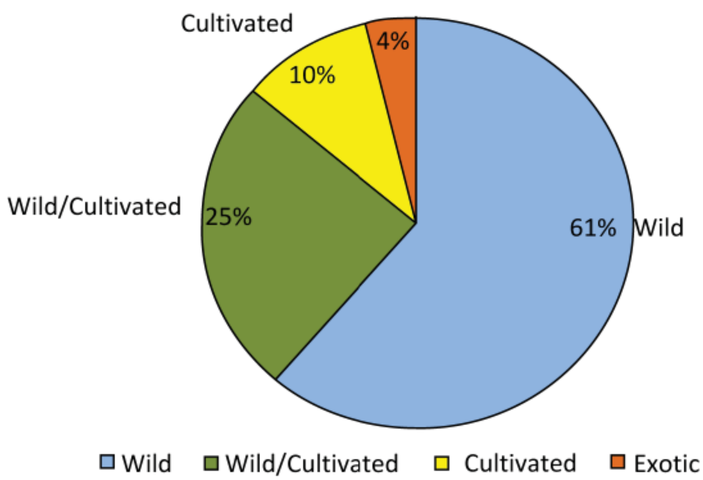

Fig. 17.1 Share of Wild collected and Cultivated origin of MAPs in trade

S. asoca, an evergreen tree species (family:Fabaceae), is one such species that immediately needs conservation attention. It is one of the 32 prioritised medicinal plant species by the Planning Commission, Government of India and National Medicinal Plant Board for the need of research and development (Haridasan et al. 2003).It is native to Indian subcontinent and is distributed in the Indo- Malaysian region and in Sri Lanka. The wild presence of this species has been recorded along moist zones of Western and

Eastern Ghats (Peninsular India), sub-Himalayan tracts (Uttar Pradesh to Arunachal Pradesh) and Eastern India, mainly up to 750 m altitude. Though widely distributed, the distribution of *S. asoca is* highly clumped (Kumar et al. 2006). From the Western Ghats it is restricted to only a few scattered patches in the low land humid evergreen forests along gently flowing perennial streams.

With more than half of the natural habitat from NWG being cleared (WWF, 2007), highly fragmented, scattered natural populations of medicinally important species (such as *S. asoca*, *N.nimmoniana, Symplocosracemosa*Roxb, *Dysoxylumbinectariferum*(Roxb.) Hook.f. ex Bedd., etc.) exist in remnant forest patches or informally protected forest landscapes such as 'Sacred Groves' (SG) (Mhaskar et al. 2011).

It has been observed that *S. asoca*has been extensively wild-harvested, sometimes even from forested areas.The population is declining due to harvest of a part (bark) that damages the plant. Habitat destruction, habitat encroachment, narrow niche of the species and other factors has led to decrease in population size. Considering the conservation need of this species, it has been listed under the threat category of 'Vulnerable' by IUCN, (2013) and 'Endangered' by CAMP, (2001). With this background it has become essential (i) to assess the current population and regeneration status of *S. asoca*from NWG of Maharashtra, and (ii) to identify and spatially map the existing populations of the species.Thus the present study was carried out to understand the population structure at various protection levels.

Trade Potential of the Species:

'*Ashok-chhal'* in Ayurveda, is the bark of *S. asoca*tree, constitutes a popular botanical raw drug used by India's herbal industry in the preparation of well-known Ayurvedic formulations.Every part of *S. asoca* has medicinal properties; more than 150 pharmaceutical formulations and traditional medicines are prepared from different parts of this plant. It yields many high value secondary metabolites which have wide range of clinical applications (Table 17.1). A number of leading pharmaceutical companies manufacture tonics, tablets, syrups made from *S. asoca* under different brand names like '*Ashokarishtha', 'Ashotone', 'M2 Tone', 'Ashonil', 'Mensta'* to name a few. It is speculated that natural populations are the primary source of dry bark for the manufacturers. According to FRLHT survey, the cost of *S. asoca* bark ranged around Rs.20-25/kg for the year 2005-2006 and it is estimated that about 2000 to 5000 tons of bark of *S. asoca* is required by the pharmacy industry annually in India suggesting a very high level of threat to the plant species (Ved and Goraya, 2007). Due to scarcity of authentic *S. asoca bark*, barks of *Polyalthialongifolia*Benth. & Hook. f., *Aphanamixispolystachya*(Wall.) R. Parker, *Caesalpiniapulcherrima*(L.) Sw., *Shorearobusta*Gaertn, *Mesuaferrea* L., *Browneaariza*Benth*, Bauhinia variegate* L., *Tremaorientalis*(L.)Blume and *Rhododendron arboreum* Sm. are used as adulterants (Pradhan et al. 2009).

Table 17.1 Chemical constituents and activities reported from Saraca asoca

Plant part Used	**Phyto-constituents**	**Activity**
Bark	Catechin, Epicatechin	Antibacterial activity against *Salmonella typhi, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus cereus, Klebsiellaaerogenes, Escherichia coli, Proteus vulgaris* and *Klebsiellapneumoniae* (Rajan et al. 2008), *Shigellasonnei, Salmonella enteritis* (Annapurna et al. 1999) Chloroform extract effective against early IV instar larvae of the vector mosquitoes viz., *Colletotrichumquinquefasciatus*(Verghese et al. 1992)Anti menorrhagia activity, in treatment of menstrual and uterine disorder (Middelkoop and Labadie, 1983, 1985; Bhandary et al.1995) Radical scavenging activity (Pandey et al. 2011) Anti-oxidant property (Panchawat and Sissodia, 2010)
Whole plant	Ketosterol	Androgenic in nature, Antibacterial activity against *Bacillus subtilis, Escherichia coli, Salmonella typhosa, Staphylococcus aureus (Pal* et al. *1985)* *Antifungal activity* against *Alternariacajani* (Dabur et al. 2007) Active in treatments against uterine disorders, piles, dysentery and even against diabetes (http://indianmedicine.nic.in, 2012)
Flowers		Antibacterial activity against *Salmonella viball-erup, Shigellaboydii, Escherichia coli, Vibrio cholerae, Shigellaflexneri*and *Shigelladyserteriae* (Jain and Sharma, 1967) Anti-cancer activity against Dalton's lymphoma ascites and Sarcoma-180 tumour cells (Verghese et al. 1992) Anti-menorrhagic activity (Middelkoop and Labadie, 1985)
Leaves		Antibacterial activity against *Escherichia coli* (Singh et al. 2009), *Bacilllussubtilis, Pseudomonas aeruginosa, Salmonella typhymurium* (Seetharam et al. 2003) Antifungal activity against *Alternaria alternate, Colletotrichumgloesporioides*and *Drechleraspecifera* (Seetharam et al. *2003*) Petroleum ether extract effective against early IV instar larvae of the vector mosquitoes viz., *Colletotrichumquinquefasciatus*(Verghese et al.1992) Anti-helmithic property of ethanol extract. (Nayak et al. 2011) Combination of *S. asoca* leaf extract with Pipernoylbutoxide and MGK 264 (ENT 8184) has a strong synergistic molluscicidal activity (Singh et al. 2010) Anti-pyretic activity (Varaprasad et al. 2012)
Roots		In treatment against paralysis, hemiplegia and visceral numbness, itching in eczema, psoriasis, dermatitis, and herpes- kushta / visarpa, Pruritis, scabies and Tineapedis (Nadakarni, 1957)

Materials and Methods

(a) Study Area

The northern ranges of the Western Ghats, referred as northern Western Ghats (NWG) (**15º 30'- 20º 30' N Latitude, 73º-74º E Longitude)**, lie in the states of Maharashtra, Gujarat and Goa. NWG make about one third of the total length of Western Ghats. Forests in this region are generally stunted, species poor and are fragmented as compared to the southern parts of Western Ghats. The study area covers Western Ghats part of Pune, Raigad, Kolhapur, Ratnagiri and Sindhudurgdistrict. The localities sampled were denoted as ST 1 to ST 8. This encompasses five SG, one Private Forest (PrF) and two Protected Areas (PA) including one Wildlife Sanctuary (WLS) and one Reserve Forest (RF).

(b) Sampling and Data Analysis

Transect of 5 m width with a length of 100 m waslaid at each sitetotalling 8 transects. Adult (GBH $\geq$15cm)and regenerating individuals of the specieswere recordedalong the transects. The observations regarding disturbance were made for each site such as canopy cover, presence of path, cut stump, lopping, soil removal and fire. The adult individuals were categorised into GBH classes of 15 cm interval and regenerating individuals were categorised based on height and GBH (Table 17.2) to assess the demographic profile. Kolmogorov-Smirnov (KS) test was performed for comparison of populations from study areas.

Table 17.2 Regeneration classes

Class 1	< 40 cm height
Class 2	40-100 cm height
Class 3	>100 cm height, <10 cm Girth at Breast Height
Class 4	>130 cm height, <15 cm Girth at Breast Height

(c) Preparation of Distribution Maps

The exact geo co-ordinates and elevations of all populations were recorded using a GPS receiver. Using this, spatially explicit distribution maps were prepared on a GIS platform (MapInfo 7.5). We used two different thematic maps for overlay analysis. The land-use map of India was digitized from Forest Survey of India Atlas (1973) and NDVI images from AVHRR satellite were downloaded from the internet. These images were from the year 2000 and the resolution was 250 m. These images were geo-referenced to geographic projection.

Major Findings

All the eight natural populations of *S. asoca* identified from NWG of Maharashtra occurred over a wide range of elevation ranging from 200 to 1250 m above mean sea level with slope varying from 0º to 40º. Floristically the habitats ranged from disturbed evergreen tomoist deciduous forests. (Table 17.3) gives details and other relevant ecological parameters of sampling sites. Among the eight localities sampled, a total of 258 adult and 449 regenerating individuals were encountered. The density of adult individuals in these populations varied from 15 to 57 individuals per 500 sq m per site. The populations were highly fragmented and showed signs of disturbances. The data generated had enabled us to come up with distribution map of the species (Fig. 17.2). Maps revealed the sparse distribution of *S. asoca*. Preferred habitats were found to be semi evergreen and moist deciduous forests. Commonly associated species consisted of both evergreen naturesuch as *Caryotaurens*L., *Mangiferaindica*L., *Syzygiumcumini*(L.) Skeelsand deciduous one such as *Terminaliatomentosa*(Roxb.) Wight &Arn.*Mallotusphilippensis*(Lam.) Müll.

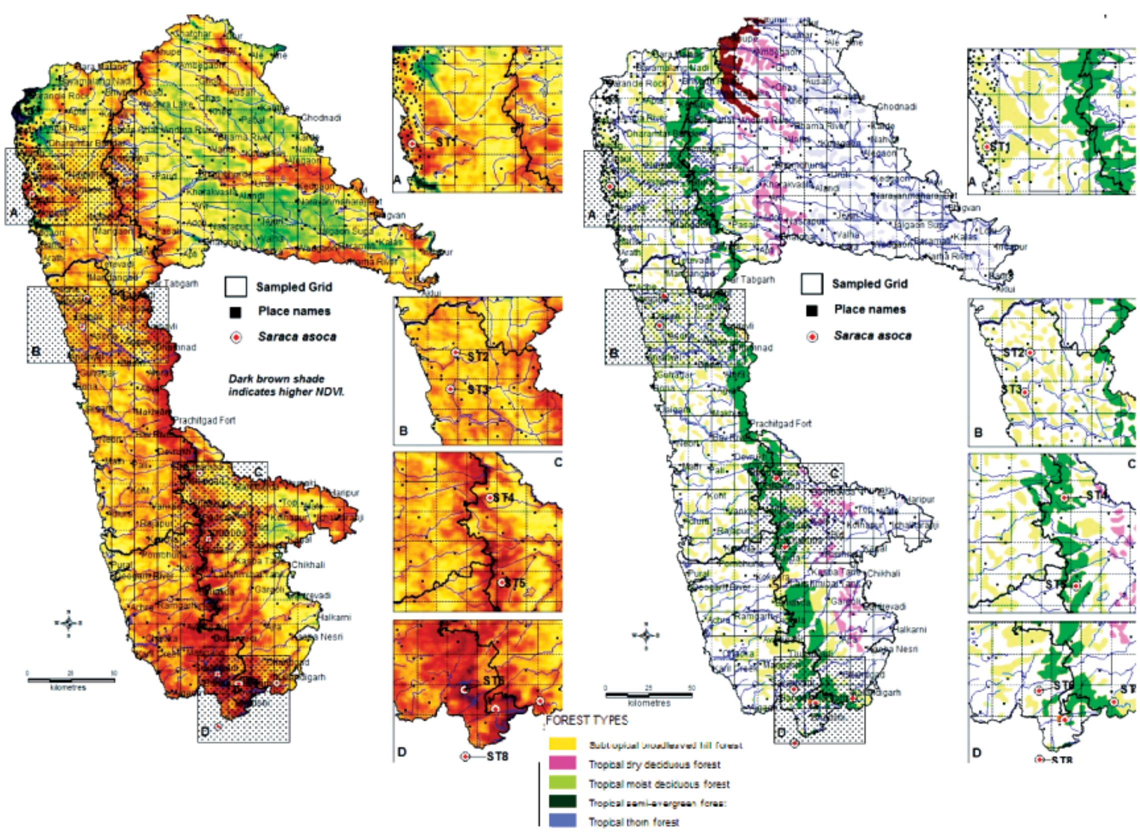

Fig. 17.2 Distribution of S. asoca overlaid on NDVI and Forest cover maps of NWG region

Table 17.3 Ecological parameters assessed for locations sampled

Code	Protection level	Latitude (Degree)	Longitude (Degree)	Altitude (m)	Canopy (%)	Slope (Degree)	Density (no. of individuals / 500 sq. m.)	Min GBH (cm)	Max GBH (cm)	Period of onset of flowering	Fauna	Associated Plant species	remarks
ST1	WLS	18.420	72.949	185	80-100	20-40	42	16	90	February end	Blue mormon Paradise fly catcher, Giant squirrel	*Dimocarpuslongan, Caryotaurens, Garciniatalbotii, Holigarnagrahamii, Mammeasuriga*	Cattle grazing, collection of seeds
ST2	SG	17.863	73.243	670	60-80	20-40	57	15	60	February end	Giant squirrel, Blue mormon	*Symplocosracemosa, Antiaristoxicaria, Dimocarpuslongan, Leeaindica*	Cattle grazing
ST3	SG	17.708	73.221	258	60-80	20-40	23	15	98	February end	Blue mormon, common crow	*Antiaristoxicaria, Syzygiumcumini, Caryotaurens, Mangiferaindica*	Cattle grazing
ST4	SG	16.931	73.848	1248	40-60	20-40	17	15	74	Late December	Blue mormon, Paradise fly catcher	*Dysoxylumbinecta-riferum, Meynalaxiflora, Nothapodytesnim-moniana, Terminaliatomentosa*	Tourism, predation of seeds by Bonnet macaques
ST5	SG	16.578	73.898	618	20-40	20-40	15	8	30	February end	Blue mormon, Paradise fly catcher	*Grewiamicrocos, Lagerstroemia parviflora, Terminaliatomentosa*	Tourism and fuelwood removal
ST6	PrF	15.853	73.947	200	20-40	20-40	28	12	67	February end	Blue mormon, Paradise fly catcher	*Terminaliabellirica, Terminaliatomentosa, Chukrasiatabularis, Sterculiaurens, Flacourtiamontana, Mangiferaindica, Syzygiumcumini*	Cattle grazing, fuelwood removal
ST7	RF	15.806	74.261	178	40-60	40-60	50	15	39.5	January end	Blue mormon, common cerulean, angled pierrot, common crow, grey count	*Caryotaurens, Hydnocarpuspentandra, Chionanthus mala-elengi, Brideliaretusa, Mangiferaindica*	Fuel wood removal
ST8	SG	15.575	73.950	290	60-80	0-20	33	15	149	February start	Blue mormon, crimson rose, common mormon, common crow	*Hydnocarpu spent an-dra, Macarangapeltata, Mallotusphilippensis, Nothopegiacastanaefolia, Stereospermumchelenoides*	Cattle grazing, mining, tourism, fuel wood removal and collection of seeds

Demographic profile (Figure 3) of *S. asoca* from (PA) (ST1 and ST7) showed reverse J-shaped curve with good representation of recruitment and large sized adults. It showed a healthy and mildly disturbed population structure. The population among the sampled SGs (ST2, ST3, ST4, ST5 and ST8) showed large variation. High proportion of medium aged trees was found in ST8 while, ST2, ST4 showed maximum number of individuals in lower GBH classes indicating a very high level of disturbance and illicit felling of the adult trees. Private forest (ST6) also showed similar demographic profile.

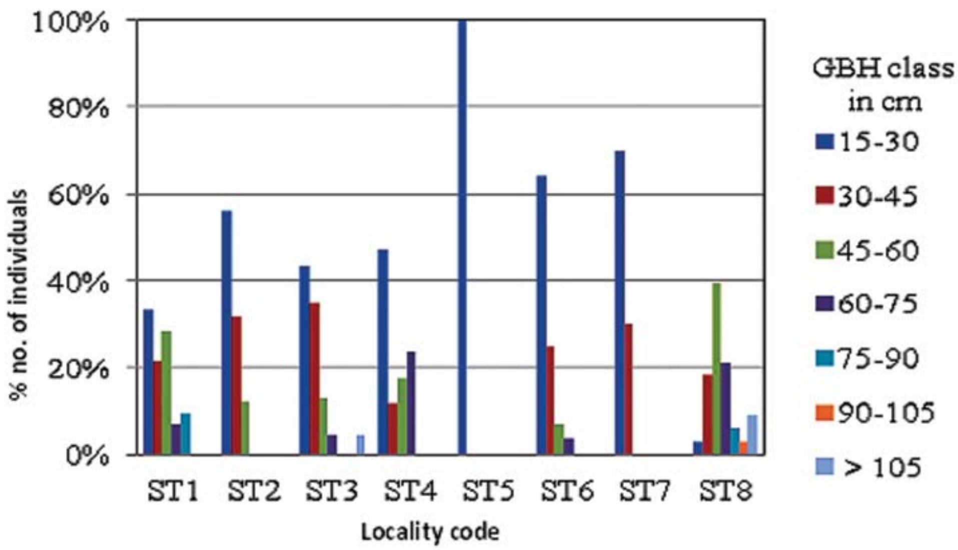

Fig. 17.3 Demographic profile of adult individuals

As per KS test results,size class distribution ofthe adult populations from the sacred groves differs both from formally protected sites and private forest. The statistically significant differences calculated were($D = 0.19$, $p = 0.024> 0.05$)and($D = 0.33$, $p = 0.008 < 0.05$) respectively (Fig. 17.4).But there was no statistical difference observed between size class distribution of adult populations from the protected areas and private forest($D = 0.1972$, $p = 0.337 > 0.05$) (Figure 5).

High proportions of individuals'were observed in lower regenerating classes in forest patches like ST7 (RF) and ST 3 (SG) (Fig. 17.6). Compared to other populations, highest per cent of regenerating individuals in Class 1 was seen in PA- ST1, while SGs (ST2, ST3, ST4, ST5 and ST8) showed highest per cent of regenerating individuals in recruitment classes 3 and 4. No recruiting individuals were observed in private forest (ST6) owing to their cutting for fuel wood.

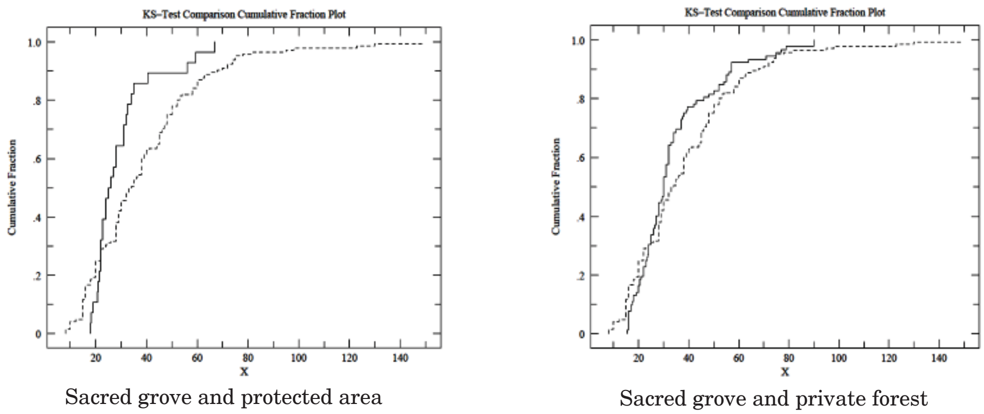

Fig. 17.4 KS test comparison cumulative fraction plot for adult individuals

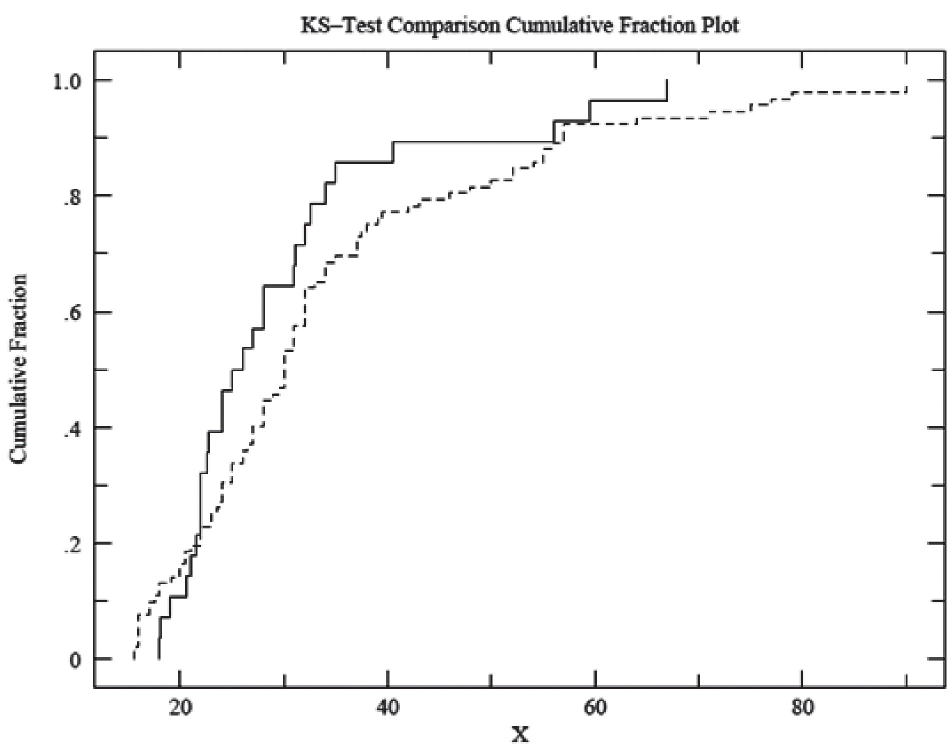

Fig. 17.5 KS test comparison cumulative fraction plot adult private forest vs. protected area

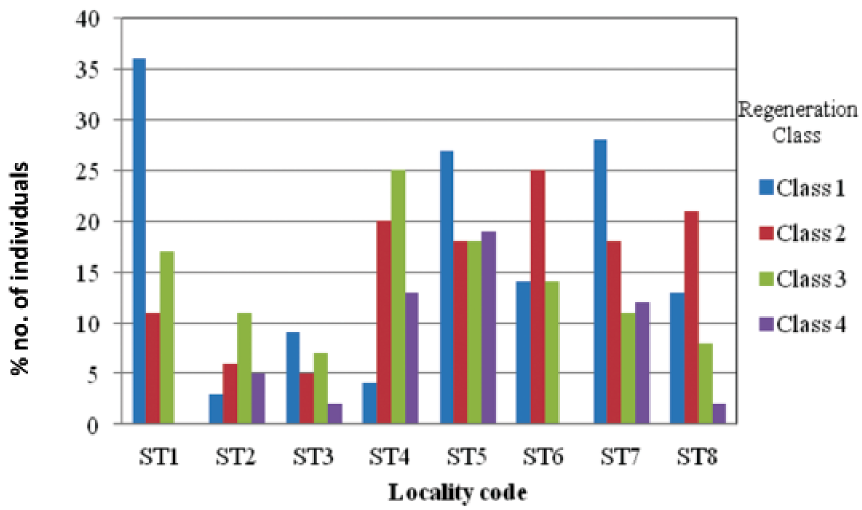

Fig. 17.6 Regeneration status

The population structural change is the function of regeneration pattern of individuals within the community (Cunningham, 2001). The lack of knowledge on distribution or population status may make the species vulnerable to extinction, especially when the population is small or has restricted distribution. The constraints to reproduction have resulted in poor natural regeneration, threatening the very survival of the species.

The distribution map showed that this is typically a species of low land evergreen forest patches, that too riparian one. This species strictly remains confined to edges of gentle flowing streams in its natural habitat.

The size class distribution had reverse J-shaped pattern with many individuals in low size classes and a few in high size classes, implying that their populations are expanding through active recruitment. KS test provided a more comprehensive measure of community distinctness and change in nature of size class distribution. Recruitment of viable seeds, germination, seedling establishment and their growth are indicators of the regeneration potential of a plant community. In tropical forests, many tree species are dependent on canopy openings for germination and seedling growth (Richards 1952, Hartshorn 1978). In this case, it was found that canopy openings favour regeneraton of *S. asoca* (Fig. 17.7).ST6 is a private forest in close proximity to human settlement and witnesses' high exploitation pressure. As a result, few stunted impoverished individualswere left behind after selective exploitation affecting natural regeneration. This is an indication of poor recruitment and the plant populations are likely to compress if intensive disturbance continued. Similar observations were recorded by Lyaruu*et al.* 2000 while working on floristic structural and seed bank diversity of a dry Afromontane forest of Tanzania.

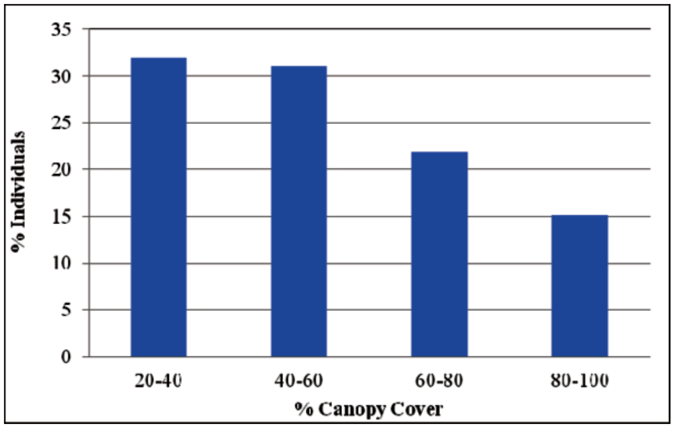

Fig. 17.7. Regeneration status at various canopy levels

Lack of individuals at lower size classes and mature reproductive individuals in ST4 and ST2; may be related to their regeneration failure in combination with over exploitation for poles, fuel wood and timber. In ST4, the population is not easily accessible due to steep slope. Bonnet Macaques were observed damaging the inflorescence and eating young leaves. They were major hindrance in development of seed pods because of the physical damage and predation of the unripe pods (Fig. 17.8). Besides, ST4 being a pilgrimage site, dumping of polythene bags, garbage had negative impact on the regeneration both in terms of seeds getting trapped in the polythene and attracting macaques. Site ST8 (a sacred grove) is easily accessible to humans. Because of construction of a road leading to bauxite mine had resulted in chopping of *S. asoca* individuals that existed along the periphery of the grove. A gentle flowing stream runs through ST7 and ST8.Regeneration through seeds was less in these sites as compared to the re-sprouting from rootstocks as seeds were dispersed because of the water. This ensured the survival of plants after being cut, a phenomenon especially evident at site ST8. The recruitment of the regenerated individuals was also seen to be affected.

Conclusions

Though presence of the species was observed throughout the study area, regenerating populations were less. A significant number of individuals are found on privately owned lands, where farming and fuel wood extraction is a primary land use activity. In such cases, the trees are lopped and regenerating saplings uprooted. However, under such conditions, small populations of the species still thrive in these areas. Though reducing harvest pressure on wild population and promoting viable commercial cultivation with the community and government participation is a good option, it offers a huge challenge. Effective conservation of *S. asoca* in NWG can be achieved by high levels of protection to natural population, creation of forest gene banks and more extensive, scientific studies of the species.

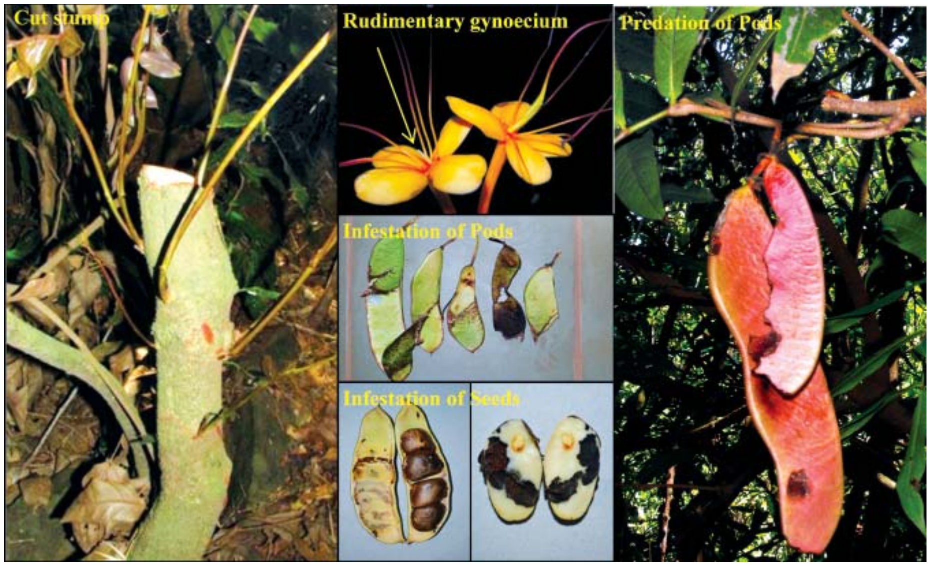

Fig. 17.8 Factors that delimit population build-up of the species.

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Impact of Degradation of Forest on the Livelihood of Inhabitants in Sariska Tiger Reserve, India

— Utpal Kumar De, Krishna Chauhan

ABSTRACT

Degradation of forest resources and biodiversity of Sariska tiger reserve has become an important issue due to its severe impact on the economy of century old forest dwellers. Due to extensive pressure from the villagers for grazing and other forest products for their survival, rising man animal conflict there has been an increase in the degradation of forest and its bio-diversity leading to decline in resource base. People living in this forest depends extensively on their pastoral activities and thus on the quality of the forest directly and indirectly. Also their economy is partly dependent on the growth of tourism which is based on the flora and fauna of the reserve. This paper tries to examine the degradation of forest in Sariska Tiger Reserve and its impact on the economy of the villagers inside the reserve. Analysis of primary data and other secondary information reveals that the percentage of earning of the villagers varies from 85 to 100 per cent depending upon the level of degradation and available alternative opportunities. Their economy and sustenance has been highly affected owing to the unsustainable extraction practice and thus degradation directly and indirectly. It thus calls for suitable population relocation with appropriate compensation in the form of opportunity creation and promotion of nature based tourism to take off further pressure on this forest. Steps are necessary to regenerate the carrying capacity through improvement of resource base by participatory management.

Keywords: Degradation of Forest, Economy of Forest Dwellers, Wildlife Tourism, Sariska Tiger Reserve

Introduction

Forests currently cover about 4 billion hectares all over the world (31 per cent of the earth's land surface) and contributes about 1.0 per cent of global GDP engaging around 0.4 per cent of the total labour force directly and indirectly (FAO, 2012). At least ten million people were employed in the management of forest and conservation and an estimated 1 billion people depend on forests for their subsistence directly or indirectly (Scherr et al., 2004). Besides providing food, timber and non-wood produces, forests also provide important services as preservation of biodiversity, protection of watershed by reducing surface run off of water, checking floods and soil erosion and safeguard against draught, atmosphere regulation as well as promotion of tourism (through its scenic beauty that generate income and employment), agriculture, overall ecosystem services and maintenance of environmental balance (Poffenberger et al. 1996; Olander et al., 2008). All these benefits drawn from the forests are not only very difficult to estimate but almost impossible. Thus, every attempt to estimate the contribution of forest would capture only a part of the total contribution.

About 350 million of the world's poorest people including 60 million indigenous people use forest intensively for their subsistence. Hundreds of millions of people rely on traditional medicines harvested form forests. In 60 developing countries, hunting and fishing on forested land supply more than 20 per cent of protein requirement to its population; and more than 2 billion people depend on fuelwood energy for cooking, heating and food preservation that is harvested from the forest around (FAO, 2012). Forest is thus an integral part of life of the forest dwellers and a key source of their livelihood. Large number of people living in forest depends on it for generations. They collect wood and non-wood forest products and use for self-consumption as well as for marketing. Commercially extracted timber from forest at a large scale for the production of various consumer goods like paper pulp, furniture, housing etc along with growing population and growth of trade in wood, illegal trade practice like poaching of wildlife etc. forest has been endangered (World Bank, 1987, 1988; Sharma, 2006; IUCN, 2012).

Dependence on Forest resources for fodder, fuel wood, timber and minor forest produce has been an accepted way of life for the rural people and accounts for nearly 74 per cent of India's population (Govt. of India, 2012). With critical demographic changes, the land to man ratio and per capita forest area has rapidly declined over time leading to relentless pressure of encroachment for cultivation, and unsustainable resource extraction, rendering the very resource base unproductive and in turn depletion of its biodiversity. Along with these incongruities and aberrations in land use, unsound development strategies have led to increasing threats to biodiversity by way of illegal encroachment of 0.07 Mn Hect of forest, cultivation of 4.37 Mn Hect and diversion of 0.52, 0.14 and 0.06 Mn Hect of forest for river valley projects, industries and townships, and for transmission lines and roads respectively with an additional 1.5 Mn Hect for miscellaneous purposes (TERI, 1999).

Though recorded forest area of Rajasthan is 32639 Sq Km (9.54 per cent of the state's geographical area), merely 72 Sq Km area is very dense forest, 4448 Sq Km is moderately dense and 11567 Sq Km is open forest and virtually no tree cover in the remaining areas (FSI, 2011, State of the Forest, 2012). Sariska Tiger Reserve (STR) represents only 0.027 per cent of the total geographical area of Rajasthan and 3.4 per cent of total forest area (32639 Sq Km) of the state.[1] Only 14 Sq Km of very dense forest has been ascertained in Sariska (Forest Survey of India Report, 2003). Total area of STR is however 866 Sq Km including 492 Sq Km of the notified Sariska Wildlife Sanctuary and 374 Sq Km of adjoining area of Alwar, Rajgarh and Sariska Forest Ranges (Fig. 18.1). The forest of STR falls within group V and VI of Champion and Seth classification of Tropical Dry Deciduous and Tropical Thorn forest (Champion and Seth, 1969). Total Reserve Forest area in the sanctuary is 39705 hect., while protected Forest Area is 9494.54 hect making a grand total of 49199.54 hec or 492 Sq Km.

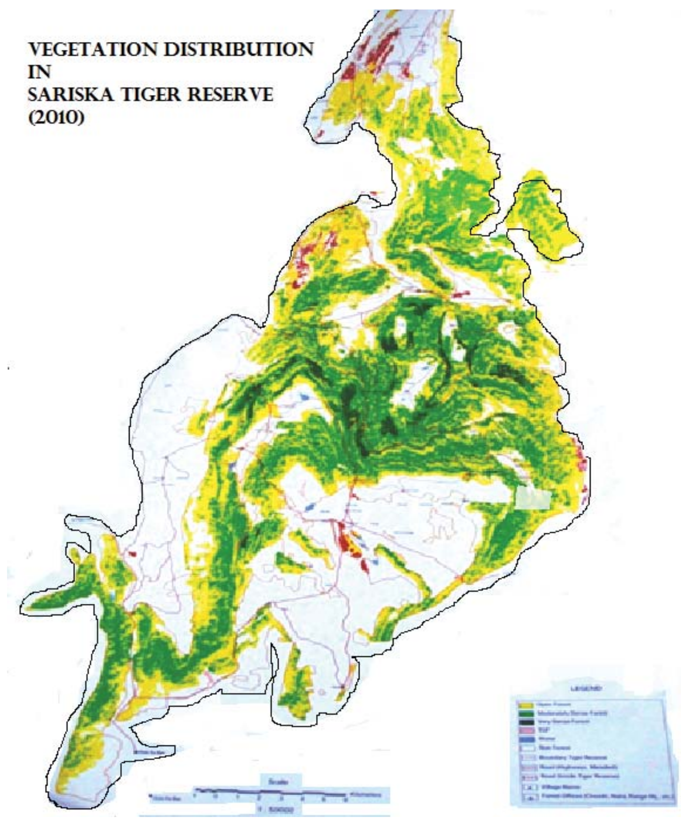

Fig. 18.1 Range Map of Sariska Tiger Reserve

Source: Forest Survey of India, 2010

1 This forest cover is estimated on the basis of the satellite data of Oct.-Dec. 2008.

Though area of the reserve kept same (Table 18.1), Sariska Tiger Reserve recorded a significant degradation over the years in terms of density of forest (State of Forest Report, 2004). Not only that, there has been a significant change in biodiversity in the park and that was the major attraction of large number of tourists (Rodgers, 1990; Ross and Srivastava, 1994; WII, 2009; Sankar et al., 2009). Forest cover of its outer surround also declined marginally.

Table 18.1 Change in Forest Cover in Sariska Tiger Reserve and its Outer Surround (Sq km)

	Geographical Area	Forest cover within Tiger Reserve			Change in Absolute Area		
		1997	2000	2002	1997-2000	2000-2002	1997-2002
Within Reserve	881	674	674	674	0	0	0
Outer Surround	2499	464	463	463	-1	0	-1

Source: State of Forest Report 2004.

Description of Study Area and Objective

After independence and formation of Rajasthan state in 1947, all forest areas were leased out to the private contractors for manufacturing of charcoal and firewood. Systematic felling was continued till 1967 even after the formation of sanctuary and they lacked in principles of forestry. Unrelenting extraction of other forest produce like fuel-wood, foliage, tubers, fruits, etc and grazing or pastoral activities have been continued and control mechanism remained inadequate.

Unplanned mining of marble, limestone and dolomite on the periphery of the reserve forest along with pumping of underground water and pollution also caused degradation of the Sariska Tiger Reserve and leading to broken periphery where water aquifers and other sources of water were substantially damaged. About 500 mines were functional in and around the STR during late 1970s, which were closed down in early 1980s with the initiative of local NGO, Tarun Bharat Sangh (TBS) that also started conservation work in the villages since 1985 (Govt. of Rajasthan, 2000).

Rodgers (1990), Shahabuddin *et al*. (2004), Govt. of India (2005), paid attention primarily to the degradation of Core-1 area where proposed national park has been carved out. But the other Core areas, adjacent to the buffer (core-2 and core-3), are also accessible to the villagers living in the surrounding buffer zone and under severe degradation. It has been observed that, not only the core zones but also the buffer, where the high anthropogenic interference in the periphery has been causing irreparable damage to the park. Cattle rearing are still a major economic activity in the STR and its vicinity, where grazing, lopping pressure combined with the villagers living in and around the reserve, and most of the inhabitants are living in a primitive condition.

Wildlife Institute of India (2005) through household survey in 11 villages of core-1 reported that the livelihood opportunity of majority of Gujjar Tribes pursuing cattle grazing has not improved, rather went down over the years and degraded forest leading to more intensive resource harvesting by those families in wider areas and caused degradation of resource availability and impoverishing themselves over time. Reduction in resource base for the livelihood of families living in and around the park and rising pressure on the reserve has also been described by the Tiger Task Force (2005), Shahabuddin, et al. (2006), Shahabuddin and Kumar (2007), Torri (2011).

Therefore, degradation of Sariska National Park has led to the increase in hardship of the dwellers that can be an appropriate revelation of the degradation as well as changing socio-economic conditions of those inhabitants. This paper tries to unearth the impact of degradation of Sariska Tiger Reserve (STR) and its biodiversity on the economy of the villagers inside the park.

A Brief Outline of the Economy of Forest Dwellers around STR:

The STR occupies an important place in the economy of the people living in and around it. The inhabitants (mostly Gujjar by caste)[2] draw their livelihood primarily from cattle rearing within the park. Also they extract the forest derivatives like timber, non timber forest products like fodder, fuel etc. for their survival (not for commercial purpose) since a long period of time. As per record, ancestors of the present population there settled during 1905 when the area was under the local ruler Maharaja J. Singh (Saini, 1983). In those early days, they were mainly hunters and nomads, but later on adopted pastoral activities. Villagers in the reserve rear a large number of cattle, produce milk, mawa (milk derivatives used for the preparation of various Indian sweets and dishes), butter, ghee (purified butter) etc. Along with that they also earn some amount from the sale of livestock.

Secondly, households outside the core-1 (buffer and its adjacent core-2, core-3) also used to earn a part of their income from the cropping activities though in small proportion that has been allowed under the provision of revenue village status. It has however been forfeited due to withdrawal of that provision in recent time and imposition of the forest act in the pretext of conflicting issues of degradation of forest and biodiversity.[3] Several issues of encroachment and poaching have come up in the past and many villagers have been suspected of killing animals in order to protect their crops as well. This often led to the damage of wildlife, which has compelled the authority to take such decision (Nagothu, 1998). A few people of core-2 and core-3 adjacent to the buffer areas on periphery (having almost identical characteristics of buffer) yet practice agriculture despite the harassment and illegal status accorded to such activity.

2 However, they have been trying to get the recognition of tribe and agitations have been observed.

3 This information has been collected by the author from the focussed group discussion in the area at the time of field survey.

Some family members of core-2 and core-3 also earn a little as daily wage labourer (apart from their income generated from forest) within the region or in many cases outside the region, working in the factories or industries located in Delhi, Jaipur, Gujrat, Punjab etc. Many families from the park also avail some gainful employment in MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) that provide 100 days guaranteed employment to the rural people for livelihood and other employment schemes available from time to time in the outer surround of the park. A very few villagers are however employed in the forest department and hotels within the STR, but in very low scale and earning a gainful employment as petty workers. Their numbers are very negligible due to the lack of skill and education required for the jobs. While some are working as a tourist guide in the park and earn fairly well because of their rich knowledge about the park.

Produced milk and mawa are sold in open market in the nearby villages or town, which is further supplied to various parts like Tehla, Thanagazi, Narayanpur, Akbarpur, Alwar city and also further to some big cities surrounding the Alwar region like Behror, Bharatpur, Bhiwadi, Jaipur, Gurgaon and Delhi. Rajasthan Dairy co-operative limited makes arrangement to regularly channelize milk from the villagers inside the park, that saves their time and energy and raise net earnings. Due to the high quality of milk products and relatively cheap, there is a high demand for those products. For its rich mawa (a popular milk product) production Alwar is known as the mawa capital of India.

However, over time due to the degradation of forest and pressure from the forest department in terms of restriction on harvesting forest resources; income of the families has been declining. They find it increasingly difficult to maintain livelihood owing to decline in the production of milk and sale of livestock (as opined by the villagers during the survey in 2010-11). Household study related to the socio-economic condition of the eleven villages in Core-1 by Shahabuddin and Kumar (2006) also stated the intensity of poverty and hardship of the inhabited villagers due to degradation of the vegetation caused by varying level of anthropogenic disturbances that over the years pushed the park dwellers towards impoverishment. Also report of Tiger Task Force (TTF, 2005) highlighted that degradation of forest has been associated with reckless poaching and further degradation of fauna in the reserve. The poachers are also supported sometimes by the villagers, who are affected by the loss of cattle or crops due to some wild species.

Materials and Method of Analysis

Nature and extent of degradation of forest and biodiversity of Sariska National Park is described in brief.[4] It is examined on the basis of primary data collected from the villagers by direct interview using a suitable interview schedule as well as through time to time organized focus group discussion. Over time quantitative and qualitative changes in forest cover or say level of degradation and its temporal effect on sustenance

4 Here many a time reserve and national park are used interchangeably.

of villagers is examined by the changes in difficulty and quantum of resource collection by the inhabitants.[5] Degradation leads to decline in availability of required materials and quality of grazing field in the nearby surrounding areas. Hence, the villagers have to travel longer distance and more manpower or labour time would be required for meeting their same needs as earlier. Overall, the effort used would be more.

Villagers within STR collect minor wood and largely non-wood forest products for self consumption. Grazing of cattle or harvested fodder is used to feed buffalos, cows, goats etc. Thus value of all the collected products is not observed directly. As the harvesting of forest resources is not practised on a commercial basis, it is very difficult to suitably estimate and compare the generation of income and employment across different core zones. Moreover, impact of over time changes in forest resource base on the economy of villagers is very difficult to examine as the villagers receives benefit from such resources directly and indirectly and the exact relation is very difficult to establish. Only the major impacts are captured here. The earning or revenue generated from the forest resources (like fuelwood, grass and tree fodder, timber poles and thatching grasses) are estimated first and then compared across the zones with varied level of degradation. A part of the products like milk, sales proceeds of cattle is generated from grazing or collected fodder, whose equivalent market value is however considered in the direct contribution of forest and hence is deducted from the sales proceeds of milk in order to avoid double counting. Only net earnings from milk are considered. As the major products (tree fodder, timber pole etc) collected from the forest are consumed at home and not marketed, its equivalent value at the going market rate in the outside areas, if available, are considered for estimation. Also, in case of some of the collected materials like thatched grass, fuelwood, fodder grass, which are also not sold in the surrounding market, the opportunity cost of daily labourer (at the going wage rate) is considered along with the per capita average daily collection to compute the imputed price of those items. Then, the proportional contribution of various components of income from forest is computed and compared across the zones.

Per capita monthly and annual income from all sources and average earning from the respective sources across the zones with different level of degradation are compared to find out the impact of degradation on their livelihood. Variation in tourist arrival over time is also examined to understand the degradation of forest and its biodiversity on the tourist inflow in the reserve. Thereafter, the impact of changing tourist arrivals on the employment in hotels and restaurants or rest houses is examined by looking at the temporal changes of those parameters. By this way the indirect impact of changes in forest biodiversity of STR (through tourism) on the economy of hospitality sector and the villagers if any is examined.

5 As the forest dwellers here are not commercial and they use it only for their survival the degradation would force them to use more manpower, more time for survival. It would lead to decline in children's enrolment or increase drop out (if they are used for the purpose). So, that information can be used as indirect information for the degradation across the areas.

Primary data is collected from a random sample drawn from 16 villages selected by simple random sampling without replacement from all the 28 villages (all belonging to different core zones within the park). The whole core area has been officially divided into three zones namely Core-1 (having 10 villages at present with 318 families), Core-2 (having 11 villages with 364 families) and Core-3 (with 6 villages 52 families) respectively making a total of 734 families in all the core areas. 9, 5 and 2 villages have been chosen from three core areas respectively by simple random sampling without replacement. A total of 294 families from the 16 STR villages (core I, II and III) are selected as final sample units, and household heads are chosen as the respondents. Here samples are distributed over core-1, core-2 and core-3 in order to have an idea of variation in degradation level in the prime forest area of core-1 and adjacent to buffer area of core-2 and core-3. Also we tried to understand the dependence of villagers on forest, nature of degradation across the zones, and reasons for it.

Moreover, primary data are collected from the 305 visiting tourists and secondary information on temporal variation in tourist is used in order to understand the impact of degradation of biodiversity on tourism and thereby on the villagers' economy.

Information is collected by direct interview on the socio-economic conditions, extraction of resources from the park as well as their involvement in cattle grazing and harvesting of forest resources (timber and non-timber) in the SNP.

Observation and Analysis:

The average involvement of family members, requirements of time and distance travelled for the purpose of grazing and collection of wood and non-wood forest products and their changes over time give an indirect indication of the changing dependence and livelihood opportunities. Table 18.2 reveals that in the earlier days like 1980-81 most of the forest dwellers used to get their required forest products in their close vicinity and respondents across the villages stated that it was available within 1 Km radius of their living places. However, over the years, with the growth of population and degradation of sources in the adjacent areas they have to travel more in order to collect such products. Though, scarcity in the neighbourhood has increased and also the requirement of growing population, the substitutes has not been adopted significantly by those poor people. Still now they are dependent on those forest products due to their unchanged livelihood pattern (food, cooking, housing, cattle rearing etc) and hence now they have to travel from 3 to 4 Km from their residences.

In the same way, from every family on an average 6 to 8 labour hours used to be spent per day for the purpose of collection of minor timber and non-timber forest products during 1980s. This information is gathered from the elder family members in case the main respondents could not supply the information. The daily labour time used for the purpose has increased to 30-32 hours across the zone during 2010-11, which is also an indication that more labourer from each family are now used for longer hours in this occupation. However, the rise in distance travelled and time used for the collection of forest products for their survival vary across the zones depending upon the extent of degradation of forest and pasture in the vicinity.

Table 18.2 Variation and Average Distance Travelled by an Average Household for Grazing and Fodder Collection in the Surveyed Villages of Various Core Zones

		Dist. Travelled (km)		Labour Hour/Day		Fuelwood (kg)/day	Grass/ Tree fodder (kg)/day	Timber Pole (per yr)	Thatching grass (per yr)	Change in Percentage	
Zone	**Village**	**1980-81**	**2010-11**	**1980-81**	**2010-11**	**2010-11**	**2010-11**	**Number**	**(Kg)**	**Distance Travelled**	**Labour Hour/ Day**
Core-1	Umri, Deori	1.00	3.00	7.00	29.86	89.05	73.10	48.33	53.33	200.00	326.53
	Kraska	1.00	2.91	7.00	22.57	87.71	75.29	43.86	49.00	191.43	222.45
	Rotkayala	1.00	3.00	6.00	36.05	106.32	93.16	61.58	64.74	200.00	500.88
	Sukola	1.00	3.67	6.00	44.00	124.44	111.11	74.33	85.00	266.67	633.33
	Kankwari	1.00	3.00	5.00	33.29	105.00	83.57	60.71	70.24	200.00	565.71
	Haripura	1.00	2.82	5.00	24.27	80.45	74.77	54.77	59.32	181.82	385.45
	Leelunda	1.00	4.00	7.00	31.60	53.25	45.75	40.00	45.00	300.00	351.43
	Dabli	1.00	3.96	6.00	34.87	92.61	74.13	49.78	53.91	295.65	481.16
	Raikamala	1.00	5.13	5.00	32.88	70.63	68.13	40.63	47.50	412.50	557.50
	Average	**1.00**	**3.50**	**6.00**	**32.15**	**89.94**	**77.67**	**52.67**	**58.67**	**249.79**	**435.90**
Core-2	Raika	1.00	3.80	8.00	24.00	79.00	65.00	40.00	44.00	280.00	200.00
	Panidhal	1.00	3.89	8.00	26.44	63.00	59.00	38.00	41.00	288.89	230.56
	Kali Khol	1.00	4.94	8.00	24.00	60.00	51.00	38.00	44.00	394.44	200.00
	Kalachara	1.00	4.67	8.00	22.86	63.00	47.00	36.00	41.00	366.67	185.71
	Bairawas	1.00	4.25	7.00	20.00	59	53.00	42.00	46.00	325.00	185.71
	Average	1.00	**4.31**	**8.00**	**23.46**	**67.46**	**58.44**	**38.59**	**42.72**	**331.00**	**193.25**
Core-3	Kanyawas	1.00	3.56	8.00	20.00	70.00	70.00	35.00	44.00	256.00	150.00
	Mandalwas	1.00	4.00	8.00	20.00	60.00	54.00	39.00	43.00	300.00	150.00
	Average	**1.00**	**3.78**	**8.00**	**20.00**	**65.00**	**61.88**	**37.08**	**43.36**	**278.00**	**150.00**
	Over All	**1.00**	**3.79**	**7.00**	**25.20**	**74.00**	**66.00**	**43.00**	**48.00**	**278.69**	**260.00**

Source: Calculated from Field Survey Data of STR during 2010-11

In core-1 distance travelled and man-hour required for collecting fodder and fuel wood has increased by 249.79 per cent and 435.90 per cent respectively during past three decades. The rise in distance covered is comparatively high considering the earlier vegetation cover in the core-1. The growth in labour hour required is even significantly higher than the other core areas and after so much of awareness even today the degradation has been continuing. The growth in distance travelled is however lower in core-1 as compared to the other zones. Distance travelled in core-2 and core-3 for the similar activities has increased during the same period by 321.11 per cent and 278 per cent respectively. Whereas, the labour hour used for the purpose has increased respectively by 303.98 and 327.81 per cent. Though because of relatively more vegetation in the core-1 the growth of distance travelled is comparatively lower than the other two zones the labour hour used increased at a rapid rate. The primary reason is that the people of core-1 are more dependent on the forest for their livelihood and there is less monitoring by the forest officials leading to longer use of time for extraction and grazing. Hence, more labour time is devoted to collect as much as possible and to feed their larger cattle groups in order to maintain its productivity. Whereas, the other zones are closer to the buffer zones where pressure of grazing over the years have been from both inside and outside the reserve and hence degradation has already been widened and people have to travel more. Despite that the growth in labour hour required is less because of the diversion of activities though not significantly. Due to availability of alternative job and income in the surrounding (in agriculture though on a small scale due to the restriction from the forest management) they devote less labour hours and compensate the fuel-wood and grazing by purchased fodders, as is clear from Table 18.3.

So the rising stress due to degradation of forest in STR is found to have direct bearing on the earning for survival. The stress is more in areas of more degradation as measured in terms of rising distance to be covered for the collection as well as grazing and rising requirement of labour for the same purpose. The rising engagement of total daily labour from a family and daily time of an average individual labour in core-1 despite comparatively less rise in distance would be in contradiction with the previously mentioned lower degradation of core-1 as compared to core-2 and core-3. Actually, the rising distance is in parity with the rising actual degradation that happens to be more in core-2 and core-3 (nearer to buffer zone and where the accessibility of outside villagers is also more). The more rise in timing[6] in core-1 is an indication of unchanged or rising dependence on forest by the people of core-1 than that of other areas, where people also earn a part of their livelihood from other occupations outside and proportionately more than the families of core-1 (shown later). So, they devote a part of their effort in outside activities which the core-1 families hardly do.

However, the rising time coupled with rising distance covered (as effort is positively related to the collection or grazing and productivity of cattle, while distance is inversely related to the collection or grazing) does not guarantee the rising or falling contribution of forest. The income generated from the forest directly or indirectly across the villages should be checked to find out the variation in impact of degradation on the economy (at least a major part) of villagers of different core zones.

Over-all average family income of those living in and around the park derived from various forest based items has declined due to the depletion of forest resources and restriction on grazing that resulted in decline of per capita cattle population in last few years and milk production per unit of cattle as well. As per the estimate on the basis of the response of sample households, a total of 750-1000 head loads (each measuring about 40-50 Kg each in weight, that makes about 23.4 thousand kg (Table 18.3) of fuelwood in total is extracted on an average day together by all the 734 families surveyed in 16 sample villages across the three core zones of the Tiger Reserve.[7] The quantity sometimes increased to 30.0 thousand Kg per day. Also, those people regularly collect grass fodder, thatching grasses etc. and in total daily collection of the non-timber forest products are estimated to be about 35.32-40.0 thousand kg.

6 It is assumed that the average family size remains more or less same, which is understood from the discussion with the respondents.

7 The value is estimated by multiplying the number of sample families with the average collection per day.

Table 18.3 Collection of Forest products, Distance Travelled and Labour-Hours Per Day in Surveyed Villages of Sariska Tiger Reserve during 2011

Zone	Village	Sample Families (No)	Sample Individuals (No)	Cattle (No)	Milk (Lit.) Per day	Family Members Involved (No)	Avg. Dist. covered (Km)	Total Lab. hrs per day	Avg. Lab. Hrs per Capita per day	Total Fuelwood (Kg/day)	Total Grass/ Tree fodder (Kg/day)	Total Timber Pole (No/yr)	Total Thatching Grass (kg/yr)
Core1	Umri, Deori	21	117	577	417	4	3.00	29.86	7.04	1870	1535	1015	1120
	Kraska	35	164	456	423	3	2.91	22.57	7.25	3070	1095	1535	1715
	Rotkayala	19	133	445	438	5	3.00	36.05	6.99	2020	1770	1170	1230
	Sukola	9	76	382	182	6	3.67	44.00	7.20	1120	828	669	765
	Kankwari	21	142	547	414	5	3.00	33.29	7.13	2205	1755	1275	1475
	Haripura	22	116	260	278	4	2.82	24.27	6.94	1770	746	1205	1305
	Leelunda	20	146	198	202	4	4.00	31.60	7.10	1065	915	800	900
	Dabli	23	164	1049	747	5	3.96	34.87	6.97	2130	1705	1145	1240
	Raikamala	8	52	342	211	5	5.13	32.88	6.74	565	545	325	380
	Sub-Total	**178**	**1110**	**4256**	**3311**	**5**	**3.50**	**32.15**	**7.04**	**15815**	**10894**	**9139**	**10130**
Core-2	Raika	15	123	333	304	6	3.80	24.00	4.19	1190	980	595	660
	Panidhal	9	53	236	146	4	3.89	26.44	6.10	570	530	345	365
	Kali Khol	18	149	811	334	6	4.94	24.00	4.04	1075	920	680	785
	Kalachara	21	131	365	339	4	4.67	22.86	6.00	1330	995	760	865
	Bairawas	16	113	457	253	5	4.25	20.00	4.38	950	850	670	735
	Sub-Total	**79**	**569**	**2202**	**1375**	**4**	**4.31**	**23.46**	**5.87**	**5115**	**4275**	**3050**	**3410**
Core-3	Kanyawas	25	171	568	525	4	3.56	20.00	5.00	1750	1740	885	1095
	Mandalwas	12	97	233	237	5	4.00	20.00	4.00	720	650	465	515
	Sub-Total	**37**	**268**	**801**	**762**	**4**	**3.78**	**20.00**	**4.50**	**2470**	**2390**	**1350**	**1610**
	Grand Total	**294**	**1947**	**7259**	**5447**	**4**	**3.79**	**25.20**	**5.29**	**23400**	**17559**	**13539**	**15150**

Source: Field Survey 2010-11.

Per capita per day fodder (grass and leaves) collection by the sample families in core zone-1 is estimated to be 9.81 kg. For the households in core-2 and core-3, daily per capita collection of the same is however estimated to be about 7.51 kg and 8.91 Kg. respectively (Table 18.6), which is relatively lower than that of core-1 villages. At the same time per capita per day timber pole collection are about 8 units in core-1, whereas it is almost half in core-2 and core-3 with 5 poles per person on an average.

The thatching grass collection in core-1 is also the highest among all the cores with 9 kg per capita, followed by 6 kg each in core-2 and core-3 (Table 18.7). These are in parity with the argument of perceived more degradation of forest in the outer surrounding and the adjacent core-2 and core-3 as compared to core-1. Not only that, degradation at local level is also not uniform across the villages and thus though the family members of core-1 travel less in comparison to the members of core-2 and core-3, there is wide variation in that across the villages within core-1 and that is true for other core areas as well.

Bivariate correlations (Table 18.4) reveal significant inverse relationship between the distances travelled by the families across villages of core areas and collection of fuelwood, fodder, timber and thatching grass etc per unit of labour time used. It indicates the lower productivity of labour of more degraded areas as measured in terms of changing distance travelled over time for the collection of forest products. However, a positive relation is observed among the collection of fodder, fuelwood, timber and thatching grass per unit of labour, which is an indication of coexistence of these materials (means where one is available in good amount others are also available and vice versa). Again, milk productivity of cattle is more in the villages where per unit of labour collection of fodder is also more. Availability per cattle has significantly negative correlation with per capita holding of cattle. Also, milk productivity of cattle has significantly positive association with the availability of fodder per cattle.

Table 18.4 Pearson Correlations

	Cattle Per Capita	**Milk per Cattle**	**FW per Lab hr**	**Fodd. Per Lab hr**	**Tim Per Lab hr**	**Th-Grass Per Lab hr**	**Dist**	**Per Cap Lab hr**
Milk per Cattle	-.801*	1						
FW per Lab hr	-.307	.407	1					
Fodder per Lab hr	-.149	.283	.659*	1				
Timber per Lab hr	-.397	.448***	.967*	.603**	1			
Th Grass Per Lab hr	-.391	.434***	.972*	.651*	.995*	1		
Dist.	**.384**	**-.458*** **	**-.578** **	**-.356**	**-.597** **	**-.570** **	**1**	
Per Cap Lab hr	.426	-.297	-.351	-.334	-.390	-.409	-.130	1
Fodder per Cattle	-.761*	.751*	.108	.208	.157	.154	-.493**	.091

*, ** and *** indicate that Correlation is significant at 1, 5 and 10 per cent level of significance by 2-tailed test.

$$\text{Milk Productivity} = 444.65^{*} - 40.47^{*}\ \text{Cattle per Capita} \ldots (1)$$
$$(33.346)\quad (8.086),$$
$$F = 25.053^{*},\ \bar{R}^2 = 0.62$$

$$\text{Milk Productivity} = 472^{*} - 48.41^{***}\ \text{Distance Covered} \ldots (2)$$
$$(96.6)\quad (25.07),$$
$$F = 3.73^{*},\ \bar{R}^2 = 0.25$$

$$\text{Milk Productivity} = 119.19^{*} + 64.731^{*}\ \text{Fodder per Cattle} \ldots (3)$$
$$(41.946)\quad (15.222),$$
$$F = 18.085^{*},\ \bar{R}^2 = 0.532$$

Notes: (1) Figures in the parentheses represent standard error of the corresponding coefficients.
(2) Here *, ** and *** indicate that the coefficient is significant at 1, 5 and 10 per cent level of significance by two tailed test.

The simple regressions of milk productivity of cattle across the villages in the core areas on the per capita holding of cattle, distance covered for the collection of forest products and collection of fodder per cattle are presented below. Equation-1 shows significant negative impact of per capita rearing of cattle on its productivity. It indicates that with more cattle holding and identical effort availability of fodder per cattle declines and leading to fall in output of milk. Equation-2 also indicates inverse impact of rising distance for collection of fodder. With same manpower and available total time, more distance travelled leads to fall in availability of fodder or time for grazing that caused decline in productivity. Equation-3 however indicates that more availability of fodder per cattle significantly increase milk productivity.

Variation in Value of Materials Collected from the Forest of STR and Share in Total Earning of the Inhabited Villagers across Different Core Areas:

Though collected fuelwood and fodder is generally not sold by the villagers themselves, it possesses a very high value when collected in such large quantity. The Final Report of Ecological Studies in Sariska Tiger Reserve, Rajasthan, 2009 recorded the value of quantity of fuelwood exploited annually worth Rs 8084750 for the entire Tiger Reserve and Rs 985500/- for the villages outside the Reserve, considering a minimum price of Rs 20 per head load of fuelwood collection at that time. Similarly, for annual fodder exploitation the estimated value is Rs 5105944/- and Rs 186556/- for the villages of entire Tiger Reserve and villages located outside its periphery respectively (WII, 2009). At present the value of each kg of fuelwood and fodder is estimated on the basis of the opportunity cost of labour i.e., by using the daily wage of agricultural labour and quantity of collection by an average person, which comes to about Rs 4 per kg. Also, income from cattle i.e., milk and sell of cattle/ livestock is considered to be the indirect contribution of forest. Then all these are used to estimate the total earning from their collection of forest resources and cattle raising and adding with the income from other sources if any (agriculture, wage labour etc), total monthly and then annual income is estimated. Thereafter, proportion of income contributed by forest directly or indirectly is computed in order to examine the variation across the villages in zones with different levels of degradation.

Table 18.7 indicates that per capita annual value of resources collected from forest in core-1 in the form of fuelwood is Rs. 20517. Whereas in case of core-2 and core-3 it is Rs. 12945 and Rs. 13272 respectively, which are much lower than that of core-1. Also, villagers of core-1 generate the highest per capita from grass and tree fodder collection (Rs. 17763 per annum) and it is followed by core-3 and core-2 with about Rs. 13020 and Rs. 10969 per capita earned from such resources. Annual per capita income from timber and thatching grass in core-1 is Rs. 988 and Rs. 37 respectively, which is also comparatively higher as compared to the other core areas. These values in core-2 are Rs. 643 and Rs. 24 and in core-3 are Rs. 604 and Rs. 24 respectively.

Collection of thatching grass per family may vary depending upon the size of house or hut, which is again dependent upon the family size (as the livelihood pattern is same for all those villagers and as the family size is more or less identical across the villages) and thus worth of per capita collection of such material should have been same whatever be the labour and time required across the zones. Here the differences in requirement may however vary due to the size of the cattle.

However, in core-1, per capita cattle holding is not more than the other areas (as shown earlier) and thus maintenance of them does not require more shed or more of such materials. Here one point may be noted is that the people in core-2 and core-3 also collect such shedding materials (like plastic sheets) from the nearby market and thus the per capita collection of such material and its worth is found to be much lower than that of core-1. Per capita annual income generated from milk and livestock sale in core-1 is about Rs. 3712 and Rs. 3209 respectively (Table 18.7). Also average per capita cattle reared in core-1 is 3.83, which is more or less same as that of core-2 (3.86). But the production of milk and earning from it is relatively more in core-1 due to relatively higher availability of grasses and tree fodder for cattle despite continued degradation in core-1 as well. However the income from agriculture and other off-farm activities is not accrued to the people of core-1.

Since core-1 is in the heart of the reserve and every possible attempt has been made to minimise the pressure to protect the habitat from degradation, agriculture has been banned in the area. In core-3 however, per capita earning from milk and sale of livestock is Rs. 7438 and Rs. 2867 respectively, which are even higher than that of core-2 with figures registered at Rs 6430 and Rs 2888 respectively. Annual per capita earning from off-farm activities is about Rs 1295 and Rs. 943 in core-2 and core-3 respectively. It thus, reveals that forest resources extracted in STR has been contributing to total income more in core-1 directly and indirectly than in core-2 and core-3. It is due to the relatively less degradation in core-1 than the other areas. It also shows a relatively higher dependency of the families living in core-1 with no other alternative opportunities as in core-2 and core-3 (Tables 18.6 and 18.7).

Table 18.5 Aggregate Annual Earning of the Respective Villages and Percentage Share of Various Sources in STR

		Annual Income from various Sources by all the Families Together (Rs)						Share of different Sources (%.)					
		Direct Forest	Indirectly from Forest		Non-Forest		Total Income	Direct Forest	Indirect from Forest		Indirect	Non-Forest	
Zone	Village		Milk net of Fodder	L/Stock	Agri.	Off-Farm			Milk net of Fodder	Live-stock	Total	Agri.	Off- Farm
Core1	Umri, Deori	5029480	759500	580667	Nil	Nil	6369647	78.96	11.92	9.12	21.04	0.00	0.00
	Kraska	8406260	1448700	345000	Nil	Nil	10199960	82.41	14.20	3.38	17.59	0.00	0.00
	Rotkayala	5602920	565800	306667	Nil	Nil	6475387	86.53	8.74	4.74	13.47	0.00	0.00
	Sukola	3136140	97920	231667	Nil	Nil	3465727	90.49	2.83	6.68	9.51	0.00	0.00
	Kankwari	5861300	418500	463333	Nil	Nil	6743133	86.92	6.21	6.87	13.08	0.00	0.00
	Haripura	5067420	914240	175000	Nil	Nil	6156660	82.31	14.85	2.84	17.69	0.00	0.00
	Leelunda	2950800	116700	251667	Nil	Nil	3319167	88.90	3.52	7.58	11.10	0.00	0.00
	Dabli	5664760	2890900	965000	Nil	Nil	9520660	59.50	30.36	10.14	40.50	0.00	0.00
	Raikamala	1638920	719900	243333	Nil	Nil	2602153	62.98	27.67	9.35	37.02	0.00	0.00
	Average	**43358000**	**7932160**	**3562333**	**Nil**	**Nil**	**54852493**	**79.04**	**14.46**	**6.49**	**20.96**	**0.00**	**0.00**
Core-2	Raika	3198840	756200	355000	39000	223333	4572373	69.96	16.54	7.76	24.30	0.85	4.88
	Panidhal	1626860	273800	250000	24000	0	2174660	74.81	12.59	11.50	24.09	1.10	0.00
	Kali Khol	2957540	1063400	450000	0	0	4470940	66.15	23.78	10.06	33.85	0.00	0.00
	Kalachara	3442660	984500	168333	438500	12000	5045993	68.23	19.51	3.34	22.85	8.69	0.24
	Bairawas	2675340	580600	420000	116500	501667	4294107	62.30	13.52	9.78	23.30	2.71	11.68
	Average	**13901240**	**3658500**	**1643333**	**618000**	**737000**	**20558073**	**67.62**	**17.80**	**7.99**	**25.79**	**3.01**	**3.58**
Core-3	Kanyawas	5136180	1239600	518333	450000	6000	7350113	69.88	16.87	7.05	23.92	6.12	0.08
	Mandalwas	2030660	753800	250000	575000	246667	3856127	52.66	19.55	6.48	26.03	14.91	6.40
	Average	**7166840**	**1993400**	**768333**	**1025000**	**252667**	**11206240**	**63.95**	**17.79**	**6.86**	**24.64**	**9.15**	**2.25**
	Grand Total	**64426080**	**13584060**	**5974000**	**1643000**	**989667**	**86616806**	**74.38**	**15.68**	**6.90**	**22.58**	**1.90**	**1.14**

Source: Field Survey 2010-11.

Note: Here, the fodder is the input in milk production and thus a part of earning from milk includes value of fodder that the family would have to spend for buying from the market, if it was not collected from the forest. Again the there is opportunity cost of family labour who could earn from other activities as a labourer and thus its contribution has to be included. As it is directly collected from the forest, it forms a part of the income from forest directly. Despite a small investment in buying cattle and tools for the collection of materials it does not make much difference in the net earnings. Similarly, a part of the fuelwood collected from the forest is used for boiling milk and mawa production. But it is included in the contribution of forest as a direct source.

On an average, milk production per cattle per day in core-1 is found to be 0.8 litre, while core-2 ranks last with 0.6 litre and in core-3 production of milk per cattle is the highest with about 1.0 litre per day per cattle (as there supplementary fodder from outside is also provided to the cattle) (Table 18.6). However, despite low productivity of cattle and its low proportional contribution; share of income from extracted forest products, milk as well as sale of cattle together is the highest (100 per cent) in core-1, (Table 18.8). Here, families extract more resources to increase the total milk production in the absence of agriculture and other opportunities of income and thereby expediting the process of degradation though the area is still in a comparatively better-off position in terms of quality of forest.

Table 18.6 Per Capita Milk Production, Forest Products Collected, Distance Travelled and Labour-Hours Per Day in STR

Zone	Popul.	Milk Production Per Unit of Cattle (Litres)	Avg, Family Member Involved	Distance Covered (Km)	Labour-Hours (Per day)	Fuelwood (Kg/day)	Grass/T fodder (Kg/day)	Timber/ Pole (Per yr)	Thatching Grass (Kg. Per yr)
Core-1	1110	0.8	5.0	5.0	32	14	9.81	8	9
Core-2	569	0.6	4.0	4.3	23	9	7.51	5	6
Core-3	268	1.0	4.0	3.8	20	9	8.91	5	6

Source: Field Survey 2010-11.

Table 18.7 Per Capita Annual Value of Resource Collected and Income from all Sources in STR

		Annual Value of Resource Collected (Rs)					Annual Income from all Sources (Rs)					
1	2	3	4	5	6	7	8	9	10	11	12	13
Zone	Popu-lation	Avg, Fam. Member Involved	Fuel-wood	Grass/ Tree Fodder	Timber/ Pole	Thatching Grass	Direct Forest Collection (4+5+6+7)	Milk Net	Live-stock	Agri.	Off-Farm	Dir. & Ind. from Forest (8+9+10)
Core-1	1110	5	20517	17763	988	37	39305	3712	3209	0	0	46226
Core-2	569	4	12945	10969	643	24	24581	6430	2888	1086	1295	33899
Core-3	268	4	13272	13020	604	24	26920	7438	2867	3825	943	37225

Source: Field Survey 2010-11.

Table 18.8 Average Share of Income of the Village Households from Different Sources in STR (in %)

Zone	Forest	Milk	L/stock	Agri.	Off-Farm	Total
Core-1	84.95	8.07	6.98	0.00	0.00	100.00
Core-2	67.62	17.80	7.99	3.01	3.58	100.00
Core-3	63.95	17.79	6.86	9.15	2.25	100.00
Over All	77.80	11.80	7.21	1.98	1.20	100.00

Source: Field Survey 2010-11.

In sample villages of core-2, combined earning from forest and milk is about 85.42 per cent of the total family earning and they also generate a small portion of their annual income from agriculture (3.01 per cent) and from off-forest activities (3.58 per cent). Average contribution of agriculture to the earning of sample villagers in core-3 is 9.15 per cent and that of off-forest sources is merely 2.25 per cent. In Core-3, forest and milk production contribute about 81.74 per cent of the family earning. So, directly or indirectly forest in STR contributes significantly to the income and livelihood opportunities across the villages of various core areas though some agriculture and other than forest sources contribute in meagre proportion in the areas adjacent to buffer. In actual buffer areas those proportions could be more due to more degradation of forest resources and rising difficulty in collecting such materials, but some alternative opportunities are available outside those villages and nearby towns. But due to paucity of information (as survey could not be conducted due to some prohibitions there) it was not possible to check with facts and figures here.

Table 18.9 reveals that collection of various forest resources by an average family in core-1 is significantly higher than that of core-2 and core-3. On an average, a family in core-1 collects fuel-wood 42.36 and 33.32 per cent higher than that of a family of core-2 and core-3 respectively. In other cases like grass, tree fodder, timber or thatching grass also core-1 families collect significantly more than those of core-2 and core-3.

Table 18.9 Comparative Difference of Core-1 from Core-2 and Core-3 in terms of Collection of Some Items by an Average Family (%)

	Fuelwood (Kg Per Day)	**Grass/Tree fodder (Kg Per Day)**	**Timber Pole (No. Per Yr)**	**Thatching grass (kg Per Yr)**
Compared to Core-2	42.36	38.52	38.42	35.00
Compared to Core-3	33.32	32.91	36.49	37.34

Source: Computed by author from primary data.

Impact of Degradation of Forest and Biodiversity on Tourism in STR:

Tourism activity in the form of visitors to the park and pilgrimage are regular feature of the Sariska National Park (core-1) due to its rich flora and fauna and unique sacred heritage of Pandupole Hanuman temple (Lord Hanuman is a Hindu God whose reference is also available in the great Epic of Mahabharata)[8]. However, despite rising inflow of tourists in Rajasthan as a whole over the years, tourist inflow in Sariska is reported to have been decreasing (Table 18.10) and profit generated from hospitality businesses has also been declining due to falling tourists' inflow and longer lean period, which is attributed to the deteriorating condition of both flora and fauna. Tourist arrival in Sariska as percentage of

8 Pandavas during their Gupta Baas or concealed exile (exile in unknown place), met lord Hanuman on their journey to the present day Delhi (Hastinapur) in core-1 at Pandupole, which is about 22 Km. from the reception centre of the Sariska Tiger Reserve.

visitors to the state of Rajasthan has declined drastically from 1.05 in 1991 to 0.13 in 2008 (Table 18.10). In absolute sense, the percentage growth rate in the tourist arrival during 1991 to 2008 was -23.58 per cent, where as the growth rate for the state as a whole during the same period was 522.24 per cent. This decline in attraction of tourists can be associated with the degradation of biodiversity in the park over time, especially of tiger as shown in Table 18.11. Also, opinion given by the 94 per cent of the repeated visitors in the park during last 5 to 10 years confirms severe degradation of the forest and deteriorating condition of the park (Table 18.12) and only 6 per cent of them responded to minor degradation; however no one asserted the improvement of the park.

Table 18.10 Percentage Growth in Tourist Arrival in Sariska Tiger Reserve during 1991-92 to 2008-09

Year	**1991-2 to 96-97**	**1996-97 to 2001-02**	**2001-02 to 2006-07**	**2006-07 to 2008-09**	**1991-92 to 2008-09**
Sariska	44.47	-19.54	-47.86	26.08	-23.58
Rajasthan	31.12	33.05	195.30	20.78	522.24

Source: Field Survey 2011-2012.

Table 18.11 Changes in Wild Animal Population during 1987 to 2009 in STR

Sl. No	**Species/Zoological Name**	**No**	**No**	**No**	**No**	**Change in Percentage**				
		1972	**1988**	**1999**	**2009**	**1972-1988**	**1988-1999**	**1999-2009**	**1988-2009**	**1972-2009**
1	Tiger/Panthera Tigris	14	45	27	3	221.4	-40.0	-88.9	-93.3	-78.6
2	Leopard/Panthera Pardus	35	47	55	47	34.3	17.0	-14.5	0.0	34.3
3	Jungle Cat/Fellis Cnaus	NA	749	125	168	NA	-83.3	34.4	-77.6	NA
4	Caracal/Fellis Caracal	NA	NA	7	NA	NA	NA	NA	NA	NA
5	Hyaena/Hyaena Hyaena	NA	284	115	296	NA	-59.5	157.4	4.2	NA
6	Jackal/ Canis Aureus	NA	2264	363	1521	NA	-84.0	319.0	-32.8	NA
7	Sambhar/ Cervus Unicolar	800	12336	6150	7196	1442.0	-50.1	17.0	-41.7	799.5
8	Chital/ Axis Axis	540	7979	3600	4021	1377.6	-54.9	11.7	-49.6	644.6
9	Neelgai/ Boselaphus Tragocamelus	300	11022	5200	6018	3574.0	-52.8	15.7	-45.4	1906.0
10	Chowsinga/ Tetraceros Quadricomis	30	489	13	NA	1530.0	-97.3	NA	NA	NA
11	Chinkara/ Gazella Gazella	NA	12	NA	NA	NA	NA	NA	NA	NA
12	Wild Boar/ Sus Scrofa	NA	4895	3450	5033	NA	-29.5	45.9	2.8	NA
13	Rhesus Monkey/ Mecaca Mulatta	NA	6803	E	P	P	P	P	P	P
14	Common Langor/ Presbyts Entellus	NA	12797	VC	8136	NA	NA	NA	-36.4	NA
15	Indian Porcupine/ Hystrix Indica	NA	653	368	512	NA	-43.6	39.1	-21.6	NA
16	Civet Cat	NA	NA	E	165	NA	NA	NA	NA	NA

Source: Management Plan 1978-79 to 2004-14 and Relocation document 2008, Sariska Tiger Reserve, Govt. of Rajasthan.

Note: VC = Very common, E= Present, P = Plenty, NA= Not Available.

Table 18.12 Previous Visits and their Opinion on STR during 2010-11

Time of Previous Visit	Severely	Minor	No Change	Improved	Total
10-15 yrs	0 (0)	2 (6)	0 (0)	0 (0)	2 (6)
5-10 yrs	31 (94)	0 (0)	0 (0)	0 (0)	31 (94)
0-5y rs	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	31 (94)	2 (6)	0 (0)	0 (0)	33 (100)

Source: Field Survey 2010-2011.

Note: Figure in Parentheses represents percentage to total.

Activities like tourist guide and hospitality workers in tourism sector have very low direct significance on the total income and employment generation of the villagers within the park. It is mainly due to low skill and education of the people that prevent them from entering in such activities. Numbers of such people from the sample is found to be negligible. Only a few nature guides, drivers and petty staffs in the hotels come from the families living in the reserve. Of course, some people from the adjoining areas around the park would be benefitted from such activities as some of them are involved in tourism and hospitality sector prevalent outside the park. Only three hotels and a few guest houses are there within the park. The only possibility of direct income for them is the sale of milk and milk products to the nearby road-side restaurants and Dhabas (road side eatery with modest arrangements) and hotels. But their share in the total demand for such products is very insignificant due to which villagers mostly supply their items to the nearby markets in town. So if there is any impact on the employment and income of the owners of hotel or restaurant, their employees and the related people who supply their products in these hotels and restaurants would be reflected from the changes in tourist arrival over time and that may be linked with the changing forest bio-diversity.

Table 18.13 reveals an overall negative growth of staffs and very less increase in staff salary of a prominent hotel (Tiger Heaven) where majority of nature loving tourist in Sariska stay. Whatever rise in salary is noticed from 2000 to 2010 was actually negative if the rise in price level during the period is considered i.e., discounted income of 2010 is compared. There is a comparable fall in tourist visited the same hotel in a year, which is clear from Table 18.14. Though during 2000 tourists visited the hotel was 151 and increased to 345 during 2003, it then declined continuously to 131 in 2008. Thus though tourism does not contribute much directly to the economy of insiders, it has also been adversely affected due to recession in tourism activities during last few years on account of degradation of forest and biodiversity

Table 18.13 Number of Staffs and their Average Monthly Salary in Tiger Heaven Hotel during 2000 to 2010

S. No.	Designation	Staff		Salary		Percentage Change	
		2000	**2009**	**2000**	**2009**	**Staff**	**Salary**
1	Manager	1	1	5000	6000	0.00	20.00
2	Chefs	1	1	5000	6000	0.00	20.00
3	Asst. Chefs	1	1	3500	4500	0.00	28.57
4	Service Boys	2	1	3000	4000	-50.00	33.33
5	Guard	1	1	2500	3500	0.00	40.00
6	Gardener	2	1	3000	4000	-50.00	33.33
7	Cleaner	1	1	3000	4000	0.00	33.33
	Total	9	7	25000	32000	-22.22	28.00

Source: Field Survey 2010-11

Table 18.14 Tourist Arrival in Tiger Heaven Hotel in STR during 2000-08

	Number of Tourists					Percentage Changes			
	2000	2003	2005	2007	2008	2000-03	2003-05	2005-07	2007-08
Indian	101	205	170	112	106	103	-17.1	-34.1	-5.36
Foreign	50	140	80	50	25	180	-42.9	-37.5	-50
Total	151	345	250	162	131	128	-27.5	-35.2	-19.1

Source: Field Survey 2010-11

Conclusion

This paper provided an analysis of how degradation of forest and its biodiversity affects the economy of the villagers living within the Sariska national park. Direct and indirect employment and earning of the families living in various core areas have been computed and compared to understand its relation with the variation in degradation. Despite absence of time series data, it could clearly show how the primary cattle rearing activity and earning from forest resource collection is seriously affected due to the process of degradation.

Moreover, the focus group discussion (as reported during field survey) reveals that today villagers experience longer dry and resource scarce months due to the degradation of forest and habitat. During the rainy season as villagers call it Chowmasa (July-September, Monsoon season when sufficient rain occurs and thus more fodder is available), members who are engaged outside, come back to their respective village to participate in their family (cattle rearing) activities. Due to availability of sufficient fodder in the park during this period pastoral activity, milk processing etc increase.

Along with that the tourism is also found to be affected due to the degradation, though it does not contribute much to the earning of villagers inside the park. But, it affects the tourism and hospitality sector and its related people.

Overall, it can be argued that heavy dependence on forest beyond its carrying capacity that led to the degradation of STR and its bio-diversity, in turn affected villagers' economy and that further intensified the extraction activities over extended areas and leading to further degradation. Therefore in order to shift the focus from high dependence on forest and forest derivatives, it is necessary to generate the off-forest based activities along with successful relocation of villagers from core areas as has been undertaken to take the pressure off the forest.

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A Vision of Forest Resource Management Through Lense of Community Strength in an Ethnic Belt of Southern Rajasthan

— Dr. Lalit Choudhary, Dr. Seema Bharadwaj

ABSTRACT

Tropical forests are home for two thirds of all plant species of the world, and play a vital role in maintaining global biodiversity and ecosystem functioning therefore the main objective for all forest actors should be integrated in order to safeguard the values that forest resources intended to achieve. Community based forest resource management (CBFRM) still stands as a logical instrument and a tool for management of community forest activities. CBFRM system frequently includes religious beliefs, traditional knowledge and ethics full with forest management. In this paper we present the results of an analysis of the role of JFM, ethno practices, sacredness, religion and traditions in CBFRM. India has been at the forefront of devolving natural resource management to the local community, particularly in the forestry sector. The findings of the study in the context of CBFRM are achieving their primary objectives of afforestation, regeneration, eco-development of degraded forests and increase in the availability of fodder grasses and biodiversity conservation in the form of basic pillars of CBFRM in this area.

Keywords: CBFRM, JFM, PRA, Traditional knowledge, Sacredness

Introduction

Country's social, cultural, and ecological multiplicity requires specific tailored local forest management in meeting the local needs yet conserving the forest wealth in perpetuity. Joint forest management system was a helpful tool for devolving everyday forest use and management rights to the community with the help of community with some conflicts. Management and conservation of forest resources are big current challenges of this age of globalization, privatization and industrialization. Combination of participatory management approach and forest policy is a pertinent strategy to face this challenge. Religious governance can positively affect natural resource conditions. Such religious systems should be accounted for as new policy interventions are implemented (Hartberg, Y., 2014). An understanding of the ways in which forest resources are perceived by the forest dwellers on the one hand and by the forest managers on the other is critical for designing strategies for sustainable forestry in the Asian context. There is an increasing realization that today there is need to move beyond formal knowledge based on silvicultural issues, and find appropriate linkages with traditional forest knowledge generated over generations by forest inhabitants through an experiential process of trial and error. Strengthening linkages between knowledge systems using community participatory management an approach is now seen as critical for sustainable forestry (Ramakrishnan, P.S. 2007).

Community forests called Orans and Gauchars in the western arid part of India constitute a significant proportion of the total geographical area of the region. Given the economic importance of these areas from time immemorial, the local people took special care to protect and sustainably utilize these common property resources (Chaudhry, P. et al. 2011). Through their traditional wisdom and experience, people have developed strategies to face and manage these vagaries of nature. However, increasing pressure from livestock and human population along with socio-economic development in the region has caused severe land degradation and desertification (Narayan et al., 2003). Orans are unique examples of gene pool conservation based on the socio-cultural value system of Rajasthan. However, traditional biodiversity conservation methods have not appealed much to scientists, foresters, academicians and policy makers; therefore, there is an urgent need to systematically survey, demarcate and conduct research in all of the existing Orans in Rajasthan (Singh and Bahl, 2006). Climate change poses a great threat to the fragile desert ecosystem. It includes changes in rainfall, temperature and atmospheric carbon dioxide concentrations. Knowledge of climate variability can assist in adapting to climate change (White, 2000). The important issue is the capacity of the local inhabitants to adapt the management of rangeland ecosystems to changing circumstances, without incurring adverse environmental consequences (Chaudhry, P. et al. 2011). An ethnoforestry element is an example of traditional biophilia of ancient human cultures which express a tendency to love and respect of nature and mother earth. The conservation of biodiversity through local realities of people of traditional societies in the Banswara dates back to millennia (Bharadwaj, Choudhary and Bhatt 2012). The customary practices of home garden of tribal communities are not only to provide daily food needs but also well and good sustainable use and conservation of biodiversity and gene pool (Kala, C.P. 2010). Forest community-based monitoring movements for biodiversity conservation are today assuming increasingly important roles in environmental governance in the world's forests. These forest community stewards promote local resource access and management (Taylor, P.L., 2012). Incentives are key to attracting and maintaining participation in community based natural resource management (CBNRM) initiatives. In southern African CBNRM initiatives, many incentives are offered, particularly jobs and community income from hunting and photographic tourism activities. There is a need to assess jointly resident's knowledge and perceptions of these incentives and their actual delivery to determine whether they are likely to be effective in sustaining participation in CBNRM activities over the long run (Suich, H., 2013).

The paper retrace to foster interdisciplinary research that is required to fully understand a component of community based forest resource management that is common, widespread, and that serves both community and forest resources.

Conceptual Framework

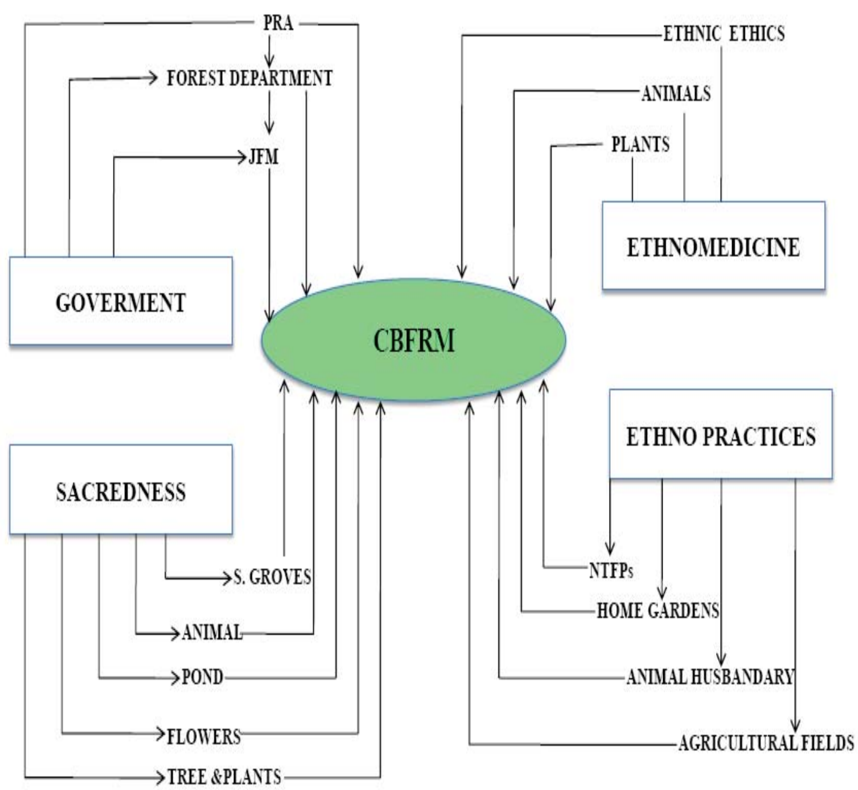

Fig. 19.1 Conceptual Framework of Community based resource management (CBFRM) in ethnic belt of Southern Rajasthan.

Methodology

Study Site: Banswara and Pratapgarh districts are come in tribal belt of southern most part of Rajasthan. Communities of this remote area have traditionally derived their subsistence from forest in the form of livelihood goods, such as food, fuel wood, fodder, fiber and timber for construction. Present work is centralized at Bagidora and Pipalkhunt forest ranges of Banswara forest division. Target villages of present study were Sobania, Jathalia, Narukheda, Borapada and Bagidura. The present study is a kind of social science research and it basically qualitative which requires primary data with the gathering of data from field survey, direct observation and interviews based on the role of indigenous knowledge and how it is applied in the community forest management and secondary information from related research and documents.

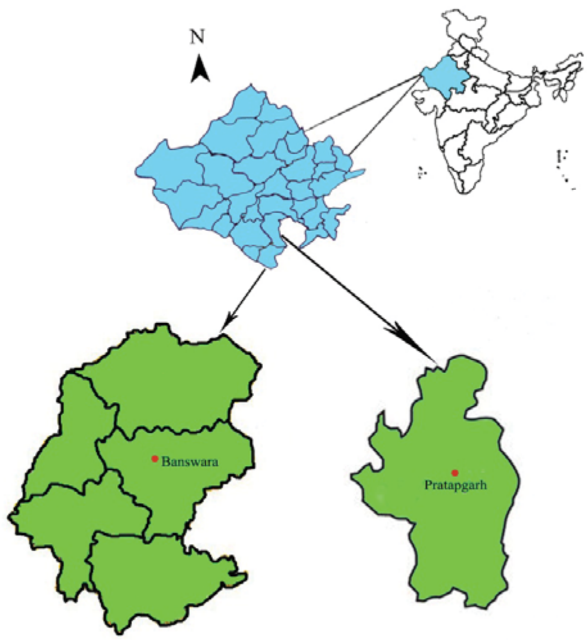

Fig. 19.2 Location of study area

Findings

Following findings of this study are in favour of CBFRM in this ethnic belt of southern Rajasthan:

Conservation of forest resources: Biodiversity in habitat corridors on the hills of Pipalkhunt and Bagidora forest ranges indicates oracularity of CBFRM. This is due to the results of promising practices of conservation strategies of regional sustainable development, afforestation, regeneration, eco-development of degraded forests, increase in the availability of fodder and grasses. Rehabilitation, reclamation, soil and moisture conservation, ecological restoration, environmental conservation through peoples partaking are some other conformity impacts with the objectives of CBFRM. VFPMCs, sacred groves and sacred ponds have been successful in achievement of management of forest resources and sustainability. This paper also focuses on the role of home gardens in management of forest resources. We found that home gardens are good sites for protection of genepool of trees, plants, flowers, fruits, vegetables and herbs and that fauna which is related with these floras.

Community efforts for Forest resource management: Forests have a strategic role in management of environment and better sustainable management of common property resources, for this participation of ethnic community is very important. JFM was spread fastly in this area because of its mutual aid attitude between forest department and community. Once the people of the area were very much associated with depletion of forest resources but now they are protecting the forest resources and finding out way to preserve the forests through JFM. Participatory Rural Appraisal [PRA] and Micro planning exercises also identified other developmental (non-forestry) priorities which are also related with forest resource management and basic needs of local community. 68 VFPMCs constituted in the last nine years which are actively engaged in development, protection and management of 14823 ha forest land. Because of this participatory protection VFPMCs were able to produce 4,217 Qts. of fodder grasses worth Rs 8.43 lacs from these production 3995 families were benefited. 82 SHGs were formed during last nine years of working periods. Out of these, 38 SHGs are of feminine group with 305 women members. In these groups 711 members were from Schedule tribe.

Soil and moisture conservation: The mission mode approach of this work is to accomplish the goals of saving every drop of rain, providing adequate water for agriculture and conservation of life support system. The treatment measures for soil and moisture conservation and afforestation were planned in a synchronized manner. RCC check dam, Earthenbund and Loose stone masonry check dam, Ponds, Gabion bund, Percolation tanks, Contour trenches, Contour dykes, V-ditches and Anicuts were main treatment measures to achieve the goal. These structures were extensively constructed in and around forest areas.

Afforestation: Existing forests of Bagidora and Pipalkhunt range were established and managed in afforestation work of the period 2003 - 2009 in Pipalkhunt and 1996 – 1998, 2009- 2011 in Bagidora. Sustainability of plantation works was an important issue of special interest and concern. The animal biodiversity of the mixed forest community also increased progressively due to ecosystem development. 750 ha area has been planted with 2.44 lacs plants during the year 2003 – 2007 in Pipalkhunt range and the total area of plantation in Bagidora range during 1996 to 1998 and 2009 to 2011 was 1130 ha with 7.06 lacs plants.

Conclusion

VFPMCs and sacred groves have been successful in protection of their forests from threat of illicit grazing, and forest fires. As a result, these forests are regenerating with vigor therefore the community through implementation of JFM has played catalytic role in development of ethnic villages with increased production through improved irrigation, soil and moisture conservation, value addition in collection and processing of NTFPs and enhanced biomass production. Afforestation areas of present work offer an excellent platform for enhancement of socioeconomic status, management for forest resources and conservation of biodiversity. Above concluding findings also through light on environmental impact assessment of study area.

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Application of bioinformatics in management, analysis and conservation of biodiversity data

— A.K. Roy, A. Dixit, R. Ranjan

ABSTRACT

Biodiversity is variation between and among organisms at organism, ecological and molecular level. In this study, an attempt has been made to review the role of bioinformatics in managing, organising, analysing biodiversity data and make it public accessible.

Keywords: Biodiversity informatics, DNA Barcoding, Conservation.

Introduction

Biodiversity is a fascinating multifaceted subject, worthy of deep exploration, investigation and analysis. This subject has been intensely studied by many eminent biologists during the last century and masterly presentations have appeared in the literature. However, there are still unseen faces and parameters hidden inside this vast subject, which are yet to be analyzed and exposed. The term Biodiversity was introduced recently as a new concept to portray the multiplicity of all biota including animals and plants together interacting in an ecosystem. It can be plant diversity, animal diversity, family diversity, species diversity, population diversity, ecological diversity or genetic diversity, all intergrading into one another. In 1982 an explicit definition was first given in a paper by Bruce A. Wilcox commissioned by the International Union for the Conservation of Nature and Natural Resources (IUCN). Subsequently, in 1992 **United Nations Earth Summit in Rio de Janeiro defined "**biological diversity" as "the variability among living organisms from all ecological complexes". In simple way it may be defined as the sum total of species richness, i.e. the number of species of plants, animals, fungi, bacteria, viruses and other micro-organisms occurring in a habitat. Thus, biological diversity/biodiversity could be identified at four levels i.e. Species diversity, Ecosystem diversity, Molecular Diversity and Genetic diversity.

World economy and needs of human being directly depend on biological resources. The biological diversity increases the survival chance of an organism and ensures the continuance of life on earth. It provides fundamental requirement for adaptation, better survivability and evolution of an organism. A significant proportion of drugs are derived, directly or indirectly, from biological sources as at least 50% of the pharmaceutical compounds on the US market are derived from plants, animals, and micro-organisms, while about 80% of the world population depends on medicines from nature (used in either modern or traditional medical practice) for primary healthcare (Chivian *et al.*, 2008).

Bioinformatics is an interdisciplinary field evolved to organize and analyse the biological data through computational tools, technique and database. Recently due to rapid development in techniques and research technology, tremendous data has been generated in the field of biological sciences which also plays important role in understanding biodiversity. Bioinformatics combined with biodiversity to form the Biodiversity informatics, is applied to study biodiversity research by managing and analysing biodiversity data including its conservation around the world.

Application of bioinformatics in biodiversity knowledge discovery

1. Digitization

Without bioinformatics, biodiversity data means basic information about occurrence and variation in species. Such information may be in the form of retained specimens that assembled in the natural history collections of museums and herbaria. Bioinformatics convert this relevant primary biodiversity information to more sophisticated information. Bioinformatics involved in large scale digitization of data related to biodiversity, so that more information regarding diversity available to public access and advanced research and analysis on this topic possible. Many databases regarding biodiversity were generated.

Some of the global biodiversity databases

Species 2000 - It is a "Federation" of database organizations working closely with users, taxonomist and sponsoring agencies. Ambitious undertaking with the aim of "enumerating all known species of plants, animals, fungi and microbes on Earth," in a comprehensive resource that ties together a variety of smaller online taxonomic indexes. Users will be able to access the data through one of two search engines: An "annual checklist" that's reviewed and updated every 12 months, and a "dynamic checklist" that provides more current information. *[http://www.sp2000.org/]*

Species Analyst - Provides access to a variety of natural history databases through a Web interface. Data (principally museum collection information such as date specimen was collected, latitude and longitude of collection site, and the collector's name) can be downloaded in a variety of formats. Site will also generate a global distribution map of the collection sites for a given query, and can link users to online tools for further analysis and modelling of the data at the San Diego Supercomputer Center. [*http://speciesanalyst.net/*]

Global Biodiversity Information Facility - It is responsible for digitisation and global dissemination of primary biodiversity data, so that people from all countries can benefit from this information. This establishes a standard method for exchange about specimens for researcher. GBIF, a long-term project of the international Organisation for Economic Cooperation and Development, is building "an interoperable network of biodiversity databases and information technology tools," the structure of which is summarized in the project's business plan. *[http://www.gbif.org]*

Tree of life (ToL) - It contains more than 3000 world wide web pages, provide information about the diversity of organism on earth, their evolutionary history (phylogeny) and characteristics. Each page contains information about particular group of organisms. ToL pages are linked to one another hierarchically, in the form of evolutionary tree of life. Starting from the root of all life on earth and moving out along diverging branches to individual species, the structure of the ToL project thus, illustrates the genetic connection between all living things.

[http://www.tolweb.org/tree/phylogeny.html]

Deep Green - Comprehensive databases presenting phylogenetic and biodiversity data from published papers in interactive phylogenetic-tree form[*http://ucjeps.berkeley.edu/bryolab/GPphylo/].*

CONABIO - Mexican-government site with primary aim of establishing a continuously updatable national biodiversity information system. *[http://www.conabio.gob.mx/]*

Belize Biodiversity Information System - Site providing nomenclature, taxonomic, distribution, and life history data for a variety of bird, mammalian, reptilian, amphibian, and fish species in Belize. [*http://gcmd.nasa.gov/index.html*]

Nature Serve - An "online encyclopaedia of life" sponsored by the Association for Biodiversity Information which provides data on nomenclature, conservation, geographic distribution, and life history of more than 50,000 U.S. and Canadian plant and animal species and ecological communities. Users can search by common or scientific species name, species association, and other criteria. [*http://www.natureserve.org/]*

Biological Collection Information Service in Europe (BioCISE) - Project to identify and publish a Web-based catalogue of European biological collections and collection information systems. [*http://www.bgbm.fu-berlin.de/BioCise/]*

Barcode of Life Data Systems (BOLD) - The Barcode of Life Data Systems (BOLD) is an informatics work bench aiding the acquisition, storage, analysis, and publication of DNA barcode records. By assembling molecular, morphological, and distributional data, it bridges a traditional bioinformatics chasm. BOLD is freely available to any researcher with interests in DNA barcoding. **[***http://www.boldsystems.org***]**

2. DNA Barcoding & Biodiversity

DNA Barcode plays important role in biodiversity analysis. DNA barcode is standardized species specific 650 bp fragment of cytochrome c oxidase I (COI) gene of mitochondria. DNA barcodes used as a global standard for species identification and biodiversity studies. DNA sequence can be used to identify different species specially in mammals, birds, arthropods, fishes and many other animal groups in the same way a supermarket scanner uses the familiar black stripes of the UPC barcode to identify our purchases. When the barcode sequence has been obtained, it is placed in the Barcode of Life Data Systems (BOLD) database as reference library of DNA barcodes that can be used to assign identities to unknown specimens. Four articles focus on DNA barcoding analytical approach in biodiversity; i) the first of these articles, from Bertolazzi *et al.,*(2009) presents a machine learning approach for classifying species according to DNA Barcode derived information. Chu *et al*. (2009) have described a 'composition vector' approach for making use of large data sets of DNA Barcodes for classification. In light of molecular sequence alignment as an often rate limiting step in many classification approaches, Kuksa and Pavlovic(2009) have presented an alignment-free approach for DNA Barcode data. In light of the range of approaches associated with DNA Barcode based classification, Austerlitz *et al*. (2009) have also presented an overview of common phylogenetic and statistical methods most commonly considered. DNA barcodes generated by laboratories that have an expertise in DNA sequencing, to facilitate efficient use of barcode information in biodiversity studies, bioinformatics developed web based tool available at *iBarcode.org*. This tool is developed for visualization and analysis of DNA barcode data at sequence, genetic distance and phylogenetic tree levels (Gregory AC Singer *et al*, 2009). In DNA barcoding generally 650 bp sequence used for analysis, but with the help of bioinformatics sequence analysis it was observed that 90% identification success is obtained with 100 bp regions of COI gene and 95% success with 250 bp Barcodes. In another words, in 90% of the species tested a DNA barcode of only 100 bp contains nucleotide substitution(s) specific to members of a particular species. These are mini-barcodes to identify unknown specimens (Isabelle Meusnier *et al*, 2008).

3. Tools and software for Biodiversity data integrating

Alice Software- Software used for creation, management and publication of biodiversity data. [*http://www.alicesoftware.com*]

Spice for species 2000 - It creates and maintained autonomous Global Species Database (GSDs). It investigates authority and wide taxonomy coverage through accurate mapping quality GSDs from many organisations.

[*http://www.systematics.reading.ac.uk/spice*]

Biodiversity Pro Software - It has following feature:

Alpha calculation- Abundance Plot-Dominance, Rank, Abundance Model-Log-series, Broken Stick, Rarefaction, Diversity Indices-Shannon, Alpha Caswell, Berger-Parker, Simpson, Hill, Margalef, McIntosh.

Beta calculation- SHE analysis, Species Richness, Species Distribution.

Multivariate Calculation - Principal Component, Correspondence Analysis, Cluster Analysis Non-Metric MDS

Comparisons - Descriptive Statistics, Kulczynski, Mann-whitney, Rank Correlation, Correlation, Variance-Correlation, ANOSIM.

Tools- Send Data, Transform Data, Standardise Data, Add-Ins Options

PHYLIP (the Phylogeny Inference Package) - It is package of programmes for phylogenetic analysis. It uses parsimony, distance matrix and likelihood method with bootstrapping and consensus trees.

[http*://evolution.genetics.wahington.edu/phylip.html*]

World Map - Used for exploring geographical patterns in diversity, rarity and conservation priorities from large biological datasets.

[*http://www.nhm.ac.uk/science/projects/worldmap/*]

LOCKSS (Lots of Copies Keep Stuff Safe) - It is an international community program, based at Stanford University Libraries, that uses open source software and P2P networking technology to map a large, decentralized and replicated digital repository. LOCKSS box collects content from the target sites using a web crawler similar to the ones that search engines use to discover content. It then watches those sites for changes, allows the content to be cached on the box so as to facilitate a web proxy or cache of the content in case the target system is ever down and has a web-based administration panel to control what is being audited, how often and who has access to the material (Anthony Goddard et al, 2011).

4. Phylogenetic Diversity

It states how much evolutionary history is represented by a group of species or how variation in taxa of one locality increases the variation in another locality (Daniel *et* *al.,* 2006). To analyse the phylogenetic diversity data, Phylogenetic Diversity Analyzer software developed. It provides a wide range of biodiversity analysis using Phylogenetic Diversity (PD), Split Diversity (SD) and related measures based on both phylogenetic trees and networks. This provides conservation biologists with an objective decision-making process.

5. Databases developed for Biodiversity Conservation

Databases increase knowledge of Earth's taxonomic diversity and provide public access to vast resources available in the world's scientific collections, and these are goals of the Global Biodiversity Information Facility (GBIF). Involvement of historical biodiversity data to biodiversity conservation database increase it's important as historical data reflecting long-lost landscapes that play important role in biodiversity in past and its role in future biodiversity. In response to this need, the Species Survival Commission (SSC) of the IUCN-World Conservation Union recently announced the development of its Species Information Service (SIS), which will link the SSC's network of more than 7000 species specialists in a distributed data management system, integrating modern principles of data custodianship. The most powerful feature of SIS is that its data will be continuously updated and managed by species experts. This mechanism will link policymakers with scientists who have first-hand knowledge of the current status of Biodiversity (anonymous, 2004).

An attempt has been made to develop database of pathogenic fungi causing the diseases of medicinal plants of Bihar & Jharkhand state by following the bioinformatics tools known as mediPDB in which descriptions of 185 medicinal plants available with respect to their uses, name of pathogenic fungi and disease symptoms providing useful information in biodiversity conservation.The known medicinal plants alongwith their uses and diseases caused by fungi stored in database are taken from the Report on "Diseases of Medicinal plants" authored by Roy & Pandey(2012).

The interface of mediPDB

Various query interfaces and graphical visualization pages were implemented to facilitate access to data and further analysis to support research on medicinal plants. The mediPdb provides three modes for browsing the plants information—the botanical name of plant browser, common name of plants browser and fungi name browser. As presented in Fig. 20.1, the plant view shows the Botanical names of particular plant, their common name, distribution, uses of those medicinal plants, diseases symptoms of the plants developed by fungal pathogen, place and date of collection of samples.

Fig. 20.1 Interface of Plant information in mediPdb

Conclusion

Application of bioinformatics in biodiversity is to collect information regarding diversification of plants, animals and microbes and provide public access by creating biodiversity databases, software and tools for their analysis so that useful information can be derived.

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Natural Resource Management for a Greater Future

— *S. Ganeshan, K. Lavanya Devi*

ABSTRACT

Soil, water and vegetation are three basic natural resources. The survival of creation depends upon them and nature has provided them as assets to human beings. In a wider context, land, water, biodiversity, genetic resources, biomass resources, livestock, fisheries, wild flora and fauna are considered as natural resources.

Natural Resources Management (NRM) refers to the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, wild flora and fauna. Together, these resources provide the ecosystem services that underpin human life. Natural resource management specifically focuses on a scientific and technical understanding of resources and ecology beside the life-supporting capacity of these resources (1).

Key Words: Soil, water, vegetation, biodiversity, genetic resources, biomass resource, livestock

Introduction

Natural resources form the very basic foundation of human survival, progress and prosperity. They are degrading fast and the unprecedented pace of their erosion is one of the root causes of the agrarian crisis that the country is facing. The demographic and socio-economic pressures notwithstanding, the unmindful agricultural intensification, over use of marginal lands, imbalanced use of fertilizers, organic matter depletion and deteriorating soil health, extensive diversion of prime agricultural lands to non-agricultural uses, misuse and inefficient use of irrigation water, depleting aquifers, salanisation of fertile lands and water logging, deforestation, biodiversity loss and genetic erosion, and climate change are the main underlying causes.

Concern for Natural Resources Management:

Natural resources have always been the material basis of societies and their economic systems. However, in human history, the per capita level of resource consumption changed dramatically. Today, inhabitants of industrialized countries use 4 to 8 times more resources than people living in agricultural societies and 15 to 30 times more resources than people in hunter-gatherer societies. Achieving a sustainable level of resource use globally does not mean that we should go back to the Stone Age. However, we need to find new models of resource use, which ensure a high quality of life for all people on our planet.

Early social systems such as hunter-gatherers as well as early agrarian societies were mainly dependent upon the use of renewable natural resources such as wood and the sun. A hunter-gatherer society had a per capita consumption of natural resources of about one metric ton per year. This equals around 3 kg per day. Over‑exploitation of natural resources by growing population resulted in severe problems. Destruction of vegetation has resulted in land degradation, denudation, soil erosion, landslides, floods, drought and unbalanced ecosystems. A balanced ecosystem is an urgent need (2).

The Unequal Consumption of Natural Resources

A major part of natural resources are today consumed in the technologically advanced or 'developed' world, usual termed 'the North'. The 'developing nations' of 'the South', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases. Energy from fossil fuels is consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste of enormous quantities of food and other products, such as packaging material used in the food industry. The USA for example with just 4% of Natural Resources its population consumes about 25% of the world's resources. Producing animal food for human consumption requires more land than growing crops. Thus countries that are highly dependent on non-vegetarian diets need much larger areas for pastureland than those where the people are mainly vegetarian.

Trade in Natural Resources

The Structure of World Trade

Current patterns of trade are largely determined by the availability of resources in different world regions and the economic position of countries in the world system (3).

Industrialized countries in Europe and North America and Asia, largely export manufactured products which are value added. Many developing countries, on the other hand, continue to rely strongly on the export of raw materials such as agricultural products, minerals and fossil fuels. Exporting manufactured products usually generates higher profits compared to export of raw commodities. Furthermore, environmental pressures related to extraction and processing of resources are high. However, some resource exporting countries do gain significant income from their exports, for example prices of many resources increased sharply between 2003 and 2008.

In recent years, more and more countries have become net-importers of natural resources and products and thus consume more than could be possible based on domestic resources only. These countries run an "ecological trade deficit". It may not be regarded as problematic that countries with poor natural endowments have net resource imports. However, the inequalities in resource use facilitated by the current patterns of world trade raise concern as they may jeopardise sustainable and equitable development in all world regions. In order to ensure material welfare for all people, trade could help redistribute resources from countries with a high extraction to countries with lower extraction. Currently, however, the opposite is in general the case. Developing and emerging economies are net exporters of natural resources. Currently, international trade does not balance, but instead reinforces inequalities in per capita resource use.

Consumption of Resources

In Europe, around 36 kg of resources are extracted per person per day, excluding the unused resource extraction, whereas 43 kg are consumed per person per day. Europeans therefore need resources imported from other world regions to maintain their level of consumption. Consumption is even higher in other world regions. An average North American consumes around 90 kg per day; inhabitants in Oceania about 100 kg per day. On an average, in comparison to Europe, people in these continents have larger houses, eat more meat and drive bigger cars. These differences in lifestyle increase resource consumption. Far fewer resources are consumed in other world regions. In Asia, resource consumption is about equal to resource extraction at around 14 kg per person per day. The average resource consumption of an African is only 10 kg per day (compared to the extraction of 15 kg per day).

Ecological Rucksacks of Products

The ecological rucksack comprises all resources used to produce the product, to transport it between factories and from factory to consumer. The rucksack of a product also includes the material and energy used by the shop selling it (its construction, maintenance, heating and cooling, etc.), the energy and materials needed to use the product (electricity or fuel, for example) and finally everything that is required for safe dismantling and/or disposal (4).

But the "resource curse" effects not just host country governments and their populations; it also affects the operations of major international corporations, their home governments, and those in consuming nations.

High Prices and Peak Extraction of Non-Renewable Resources

The rapidly increasing demand for resources has already caused an unprecedented boost in resource prices, particularly since 2003. Although the economic crisis of 2008 led to a downturn in resource prices, it is generally expected that the age of cheap resources is over. Countries with large raw material deposits (or those companies who own these deposits) will profit from this situation, and will be able to export resources at higher prices, while countries or regions with relative resource scarcity will be negatively affected. These countries will face increasing competition for resources in the future, and they will have to pay high, and probably increasing, prices. Additionally, for various commodities, the peak of extraction as already been reached or is about to be reached. This means that future extraction of these materials will decrease and their availability will be restricted. In the case of oil, about half of the world's reserves have been used already and peak-oil is expected between 2015 and 2030 (5).

Overuse of Capacities of Global Ecosystems

The limited capacity of the global ecosystems to provide us with biotic resources, such as cereals, fish and timber, and to absorb the waste and emissions we generate through our resource use. This capacity is called "bio-capacity". Calculations using "Ecological Footprint" illustrate that the world is already using around 30% more bio-capacity than the global ecosystems can provide in a sustainable manner (6).

The Ecological Footprint warns us that with our current level of resource consumption, we are already overusing the biological capacities of the global ecosystems. In other words: we are liquidating the "natural capital" of the planet, instead of living on the sustainable interest from this capital. This depletion of natural capital can be observed in several ways: many fish stocks are depleted, world forests are shrinking, fertile land is being lost due to erosion and carbon emissions are causing changes to climate with potentially disastrous impacts on our economies and societies.

Natural Resource Management (Nrm) for Future

Equitable use of Resources for Sustainable Lifestyles

Reduction of the unsustainable and unequal use of resources and control of our population growth are essential for the survival of our nation and indeed of human kind everywhere. Our environment provides us with a variety of goods and services necessary for our day-to-day lives, but the soil, water, climate and solar energy which form the 'abiotic' support that we derive from nature, are in themselves not distributed evenly throughout the world or within countries. A new economic order at global and national levels must be based on the ability to distribute benefits of natural resources by sharing them more equally among the countries as well as among communities within countries such as our own. It is at the local level where people subsist by the sale of locally collected resources, that the disparity is greatest. 'Development' has not reached them and they are often unjustly accused of 'exploiting' natural resources. They must be adequately compensated for the removal of the sources to distant regions and thus develop a greater stake in protecting natural resources.

There are several principles that each one of us can adopt to bring about sustainable lifestyles. This primarily comes from caring for our Mother Earth in all respects. A love and respect for Nature is the greatest sentiment that helps bring about a feeling for looking at how we use natural resources in a new and innovative ways. Think of the beauty of a wilderness, a natural forest in all its magnificence, the expanse of a green grassland, the clean water of a lake that supports so much life, the crystal clear water of a hill stream, or the magnificent power of the oceans, and we cannot help but support the conservation of nature's wealth. If we respect this we cannot commit acts that will deplete our life supporting systems.

Participation and Community Organization

NRM is more sustainable when beneficiaries engage in managing resources and maintaining structures. Strong local institutions are a prerequisite for equitable NRM, and in many cases the most successful interventions involve community organizations such as water users' associations. In building on existing formal or informal community groups, it is crucial to ensure that the poorest and most vulnerable, particularly women, are included and have an opportunity to participate n community decision-making processes.

Focused and Flexible Technologies

Conservation technologies do not always lead to quick increases in yield and cash returns. This is a disincentive for the poor to adopt and maintain them. Where technologies do exist, adoption is constrained by low short-term returns, lack of labour, food-security needs, poor marketing opportunities and poor communication and extension services. The success of technology packages depends on detailed knowledge of local, integrated farming systems and livelihood strategies of local populations.

Traditional Knowledge

Indigenous knowledge is directly tied to the sustainable use and maintenance of a healthy and vibrant ecosystem. Many successful examples of regenerating ecosystems and supporting local livelihoods are found in areas where users themselves have established a management structure, or management is based upon an indigenous system. Further efforts are needed to document traditional, sustainable farming systems and best practices besides designing projects that blend traditional and new technologies.

Gender Issues

Rural women have specific knowledge of local resources and processes. They also have gender-specific NRM responsibilities and are experienced natural resource managers. NRM activities need to consider this knowledge and experience and build upon it. The development of sustainable livelihood systems depends on improving women's access to productive natural resources, including land, forest and water resources, and their participation in decision-making processes. Enhancement of women's roles, including participation in public and community affairs, is critical to NRM.

Land Issues and Common-Property Resources

Land rights are of utmost importance in relation to NRM. Secure land rights are an incentive for farmers to invest and engage in sustainable land- and water-management practices. Common-property resources are also crucial to the livelihoods of many poor people, supplying them with fuelwood and fodder. In many countries, however, the poor continue to be systematically excluded from these resources.

Holistic Approach to NRM

International Fund for Agricultural Development (IFAD) carries out the vast majority of its interventions at the micro level. NRM issues are, however, affected by economic, social and political situations at macro levels as well. The main beneficiaries of projects are usually smallholder farmers, but in some regions within a given ecosystem, more land is under the management of large-scale owners and commercial farms.

The ecological fate of the entire ecosystem thus depends mostly on the decisions of the large landowners and commercial enterprises, regardless of the support provided to small farmers for sustainable NRM. A comprehensive approach to improving land management requires consideration of environmental decision-making at the regional, national and international level as well as at the local level. It is expected that this will lead to a more integral vision during project design as well as pay more attention to conflict resolution with large-scale farmers.

Environmental Assessment

Greater use of strategic environmental assessment is needed at the country and regional level, and more attention must be given to building in-country and regional capacity to carry it out. Impact assessments must be used more effectively to grapple with complex NRM issues, enabling increased stakeholder involvement in their preparation and acting on recommendations.

Measuring Progress and Impact

Reliable indicators are needed in order to measure the state of natural resources in a given area and evaluate the environmental effect and impact of development projects. Emphasis on developing indicators that is project-specific, which create a participatory monitoring process will be the need of hour.

Integration

NRM approaches must shift from inputs and processes to achieving tangible benefits. A five-prong strategy has to be adopted comprising policy-level activities, operational activities, capacity-building, partnerships and knowledge management. In addition, a more proactive role must be pursued towards building synergies with crosscutting issues such as gender, participation, civil-society organizations and institutional strengthening.

Conclusion

Global extraction and consumption of natural resources will continue to increase dramatically, unless measures are implemented to reduce the overall amounts of resource use. This growth will mainly be driven by increasing consumption in the emerging and developing countries. These countries legitimately aspire to obtain a life-style similar to that enjoyed in richer parts of the world. Many non- renewable raw materials have already reached a peak of extraction, or are about to reach a peak in the near future. Growing global demand for resources from this planet will therefore increase competition and possible conflicts over access to scarce resources.

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Application of Eco-Technology for Sustaining Soil Fertility and Crop Productivity in Slash and Burn Agriculture in Mizoram, Northeast India

— S. K. Tripathi, F. Lalnunmawia

ABSTRACT

Slash and burn agriculture practice, a traditional system of cultivation, is being carried out in northeast India through centuries and is the basis of subsistence for the rural population. The ancient shifting cultivation based agriculture with sufficiently prolonged fallow period (i.e. about 20-30 years) that allowed the land to return to the natural condition by accumulating optimum level of soil organic matter was often remarkably productive and ecologically balanced. As a result of increasing demand for agriculture because of expanding population, there is a recent strong trend towards shorter fallow periods (ca. <5 years) which does not allow the soil to restore fertility to support new crops. This has led to widespread concern about forest degradation, declines in soil fertility, crop yields, food security, and ecological balance of this region.

The main aim of this paper is to improve the efficiency of shifting cultivation practice of Mizoram by using the ecological principles of soil fertility management in natural ecosystems which is based on five basic principles: soil organic matter, soil water, soil fauna, nutrient synchrony, and integration of biological processes. On the basis of these principles, viable options to shifting cultivation includes: inter-row cropping between contour hedgerows of nitrogen-fixing shrubs, slope terracing, agroforestry with anti-erosional plants. Further trials like top soil and litter amendments from adjoining forest, microbial inoculation and enhanced fallow recovery rates are being made to understand the effects of these treatments on soil fertility and crop productivity. Hedgerows of *Tephorosia candida* along with various treatments have been found to greatly improve the soil fertility (e.g. microbial biomass C,N,P and soil enzyme activities) and crop productivity. Study is on the way and data is being recorded periodically.

Keywords: Crop productivity, soil enzyme, soil fauna, nutrient, biological process.

Introduction

Expanding human population and increasing activities towards exploiting natural resources from the ecosystems more than their carrying capacity has put tremendous pressure on land and water resources over the world. The situation in densely populated tropical regions due to rapid population growth coupled with economic expansion is more dramatic and putting claims on land. Thus, there is challenge for the land use analysis to explore and evaluate land use options for sustainable development. The problem of food availability due to increasing population from a finite land resource was addressed in the 1960s/70s by the 'green revolution' which was based on expanded use of commercial fertilizer and pesticides as well as novel crop strains developed using genetics and biotechnology (Mooney *et al.*, 2005). Production of ammonium fertilizer was relied on industrial technology using fossil fuel energy reserves and major advances in the biological sciences achieved the goal, but of course the solution is not ecologically sustainable (Tripathi 2009). Commercial fertiliser applications to tropical soils under intensive agriculture often reduce overall soil fertility because of the eventual depletion of other plant nutrients as well as effects of depleted soil organic matter content, and lead to eutrophication of rivers and lakes because of inefficient nutrient uptake and retention by plants and the soil. Environmental nutrient loading has also been reported to affect the structure and functioning of natural and derived ecosystems in Indian dry tropical ecosystems (Singh and Tripathi, 2000; Tripathi *et al.*, 2008).

Slash and burn agriculture, shifting cultivation, commonly known as Jhooming in northeastern of India. This is a common agricultural practice that sustain majority of rural populations in this region. During this practice, village communities slash the vegetation on selected sites during winter, wait for it to dry, and then burn it *in situ* before planting a variety of annual crops to coincide with the return of the rains (Toky and Ramakrishnan, 1981 a & b). These sites are then abandoned for few years (~5-30 years) to recover the vegetation and soil fertility through natural regeneration and villagers move to other sites for cultivation during this period. This agriculture practice was an economically and ecologically well-organized in earlier time because of low population densities and prolonged fallow periods (20-30 years) that allows the sites to recover their fertility (Ramakrishnan, 1992, Bruun *et al.*, 2009). However, in recent years due to increasing population pressure, fallow periods have been shortened from 2-3 decades to <5 years, that has led to declining soil fertility and crop yields. This current trend toward reduced fallow periods in lands under shifting cultivation makes this practice unsustainable, and results in reduced crop yields as well as increased environmental degradation due to soil erosional losses, watershed siltation, and atmospheric pollution (Grogan et el. 2012).

Northeast India is characterized by favourable climatic conditions for plant growth and thus makes the part of Indo-Burma biodiversity hotspots. Prevailing shifting cultivation in the region causes significant loss to the health of forest and environment. Mizoram is one of the sister state of the northeast states which characterized by steep slopes where shifting agriculture is practiced (Fig. 22.1 and 22.2). Of the total planimetric land area (~2,10,8700 ha, Anonymous, 2009b) of the state, only 24% has gentle slopes (10-33°) and remaining 76% has slopes >33° (Anonymous, 2009b) where shifting cultivation is being carried out by about half of all households in Mizoram. Estimated burned area each year range from 40,000-110,000 ha. Burning of this much area is responsible for shifting of large pools of carbon from soil and vegetation to the atmosphere. Biomass burning has led to increase the emissions of green house gases (like CO_2, CO, CH_4, N_2O, NO) in the atmosphere and thereby contributing to N loadings in the primary and secondary forests of the region. The state of Mizoram has the highest forest cover (~89% of the total land area) and burnt area (736 km^2) for shifting cultivation leading to largest emissions of green house gases (Chand and Badarinath, 2007). Further, accelerating the problems of declining soil fertility, lowering crop productivity, and increased soil erosional losses on steeply sloped lands due to shortened shifting cultivation fallow periods (Grogan et al. 2012). Most studies of shifting cultivation across the tropics have focused on fairly flat or gently sloping lands. Even the shifting cultivation in Meghalaya is carried out in gentle sloping and cooler climate (Ramakrishna 1992). Therefore, the conclusions and management options recommended for shifting cultivation practices or alternative forms of agriculture for those regions need careful consideration in the specific context of steeply sloped landscapes of Mizoram (Grogan et al 2012). This paper highlighted the major problems of shifting cultivation on steep sloped regions of Mizoram and suggested viable option to sustain soil fertility and crop productivity in the region.

Fig. 22.1 Extensive slashed areas in a typical Mizoram landscape in February.

Fig. 22.2 Extensively burned areas in a typical Mizoram landscape in March.

Available Ecological Studies on Shifting Cultivation

Available ecological studies on shifting cultivation in northeastern India using a wide range of sites of differing climate and agricultural land use has been summarized (Ramakrishnan 1992). Ecological studies at low elevation Burnihat site in Meghalaya by Toky and Ramakrishnan (1981a) with gentle sloping (20-40°) that resembles typical climatic conditions in Mizoram has been briefly explained. The authors reported results of economic yields and soil biogeochemistry by comparing replicated fields of similar slopes with three fallow periods (e.g. 5, 10 and 30 years). Mean annual total economic yields were more than twice in the 10 and 30 years compared to the 5 years fallow lands (Toky and Ramakrishnan 1981a). Whereas, mean annual surface run-off losses of soluble nutrients as sediment in the shortest fallow fields were ~40% higher in the shortest fallow lands compared to prolonged fallow lands (Toky and Ramakrishnan 1981b). This indicates that the loss of soil nutrients in the short fallow lands could be one of the major reasons for the decrease crop productivity (Grogan et al. 2012).

Further, soil nutrient investigations in these sites indicated about one-fourth reduction in soil organic carbon and nitrogen concentrations (top 7 cm depth) in 5 years fallow compared others (10 and 30 years) without affecting the pools sizes (g m^{-2}) possibly because of higher bulk density in the 5 year fallow site (Ramakrishnan and Toky 1981). Concentrations of available phosphorus and potassium were also 2-3 times lower in the 5 years fallow lands compared to others. The authors further reported that fire reduced surface soil carbon concentrations by ~15% in the 10 and 30 year fallow lands, but not in the shortest fallow period site. This was attributed due to less intense fire as a result of lower biomass, litter and humus levels. The surface soil carbon pool is directly proportional to organic matter content in the soil and thus, considered important for maintaining the fertility of soil by affecting water holding capacity and nutrient stocks for microbial processing that build up pool of plant-available nutrient pool (Chapin et al. 2002). Therefore any changes in the size of the surface soil carbon due to fire, and any impacts of differing fallow period are particularly important.

Grogan et al (2012) have summarizes that these studies support the conclusions that (a) a minimum 10 years fallow period should be maintained to allow sufficient site recovery for economically viable and ecologically sustainable shifting cultivation; (b) soil fertility (at least availability of phosphorus and base cations) is reduced when fallow periods are shortened to 5 years because of increased sediment run-off rather than soluble nutrient losses; (c) soil carbon pool size (i.e., organic matter content) is depleted when fallow periods are shortened to 5 years, thereby contributing to reduced supply of plant-available nutrients. Second and third year cropping during shifting cultivation would be a promising option to reduce the area required for burning each year, however, it would require more labor inputs to manage soil fertility and weed so the farmers do not prefer to continue cropping for second year or more. Studies would be needed to work on weed biology and weed-crop interaction to find solutions to this problem. To overcome with problem of depletion critical nutrients like N and P, introduction of N fixing plants (like *Tephrosia candida* and *Flamengia macrophylla*) and improving mycorrhizal associations along with selection of suitable plant species that can grow well at nutrient deficient sites. Also, application of manure, crop and weed residues as organic mulch may be tried (Fig. 22.3).

Several reviews on this topic have concluded that the science underlying our understanding of shifting cultivation and the impacts of shortening fallow periods needs further strengthening (Ramakrishnan, 1992; Craswell *et al.*, 1997; Sun *et al.*, 2008; Bruun *et al.*, 2009; Grogan *et al*. 2012). According to Tawnenga *et al.* (1996) cultivation on burned sites could be extended by effective cropping in the second year after burning in two sites under differing fallow periods in Mizoram. They reported that ecosystem productivity (total dry matter production in crops and weeds) in the 6 year fallow site during the two successive years after burning was ~45% and 22% lower, respectively, than in the 20 year fallow site. In other paper, Tawnenga *et al.*, (1997b) found that soil organic carbon, total nitrogen, extractable phosphorus and exchangable cation pools were all depleted in the shorter fallow site, whereas, soluble nutrients progressively declined during each of the successive cropping phases at both sites. Commercial fertiliser and/or farmyard manure additions have been found to increase second year productivity in the shorter and longer fallow period sites by ~50% and ~33% respectively. A detailed analysis of the economic efficiency of the various treatments at the two sites indicated that labour costs dominate and that the additional monetary input associated with fertiliser and farmyard manure acquisition and application increased total costs by 11% and 22% in the short and long fallow sites, respectively (Tawnenga *et al.*, 1997a). Patterns for economic yields (rice grain production) were similar to ecosystem productivity although the magnitudes of the effects were sometimes much smaller.

Soil Fertility Management Options for Shifting Cultivation on Steep Slopes of Mizoram

Most of the available studies are carried out on gentle slopes in different states of northeast India. Significant amount of information soil fertility studies are available in Meghalaya (Ramakrishnan 1992). Mizoram is characterized by steep slopes where soil erosional losses are likely to be larger that requires, distinctive solutions (Grogan et al 2012). This paper focuses on the particular features of steeply sloped regions of Mizoram northeast India. As per ecological and environmental understanding of the problem, Grogan et al (2012) have identified several options for improving shifting cultivation in Mizoram (Table 22.1). Most promising options for improving shifting cultivation in this region includes nutrient and water supplementation, optimising crop choice, extending the site use period, reducing the minimum required fallow period, and controlling burns and their environmental impacts (Table 22.1).

Various options have been suggested to replace shifting cultivation with continuous cropping include inter-row cropping between contour hedgerows of nitrogen-fixing shrubs, slope terracing (Fig. 22.3), anti-erosional plants, and bamboo forest farms (Grogan et al 2012). According to Tripathi *et al.*, 1999, bamboos developed widespread adventitious roots dry tropical region in India to outcompete with herbs for soil nutrients and water (Tripathi and Singh, 1994). Therefore, these options need to be scientifically tested through quality research before they can be evaluated and recommended as part of land use planning initiatives (Table 22.1 and 22.2). However, care should be taken that the research should focus on providing realistic, feasible, economically viable improvments or alternatives to shifting cultivation. Solutions will only be successful if they incorporate and integrate the economic, ecological and social components of this issue (Ramakrishnan, 1992). Furthermore, the research output or technology must be acceptable and accessible to farmers (Craswell *et al.*, 1997; Anonymous, 2009a). Successful implementation will require field demonstration plots across the region and an active extension education programme that addresses the associated landholder and social constraints (Cairns and Garrity, 1999).

Fig. 22.3 Construction of terrace on slopes containing banana plants (at left) and organic manure application to a terrace (at right) in central Mizoram.

Table 1. Potential research options for improving shifting cultivation practices in Mizoram.

S.l. No.	Potential options	Scientific research required
1.	Nutrient and water Supplement	i). To know the relative importance of nutrients (N, P, K) in determining crop growth and economic yields in this region. ii) To know the relative importance of water and nutrient availability in limiting crop production and economic yield in this region. iii). To identify important site factors such as slope, aspect, soil-type, and climate that influence the crop growth. iv). To know the optimum amount of organic matter mulch inputs required to enhance crop growth and the source of these inputs e.g. composted weeds and crop residues (green manure) from within a site or from adjacent land. v). To know the potential to apply commercial fertilizer to enhance crop economic yields by finding out the way of application to minimize the nutrient loss downslope.
2.	Crop choice and extend the site use period	i). To know the optimum mix of crop species and fallow period length to maximise subsistence and economic yields of shifting cultivation sites. ii). To know the influence of local site factors (e.g. slope, aspect, soil-type, and climate) and the nearby markets for choice. iii). To develop wild plants as appropriate crops for the region. iv). To find out suitable perennial crops appropriate to sustain economic yields over successive year. v). To know the detailed biology of weeds to come up with the techniques to suppress weeds in the 2nd and 3rd years after burning. vi). Ecologically effective and economically feasible slope management options to reduce soil losses.
3.	Enhancing fallow recovery rate	i). To know the role of nitrogen-fixing and other species that could be planted on cropped sites to enhance vegetation succession. ii). To know ground-cover species appropriate for planting after cropping to protect the soils against subsequent erosional losses. iii). To know effect of fertilizer addition to speeding up vegetation regeneration, and its economical feasibility, and to find out limiting nutrients.
4.	Improvement of Fire management and its environmental impacts	i). To know the potential for improving fire management, and its possibility; for example, a) the proportion of land burned each year but not cultivated and b) to control the areal extents of burns using fire-breaks being used widely and effectively. ii). To know the potential of bamboo varieties and other fast-growing native trees to be effectively utilized as wind-breaks to minimize wind- and water-borne soil, ash and soluble nutrient losses. iii) To know the effect of mulching with organic matter residues after the burns on cultivation.

Source: Grogan et al. 2012

Table 22.2 Viable options and research priorities for shifting cultivation using continuous cropping practices on steeply sloped lands (Grogan et al 2012).

Sl. No	Potential options	Viable scientific options	Research priorities
1.	Nitrogen-fixing shrub hedgerows (Sloping Agricultural Land Technology, SALT)	i. Maintenance of soil fertility over the long term through SALT practice using nitrogen-fixing shrub species depending on slopes, soil-types and climatic conditions that vary across the state. ii. Management of weeds in shifting cultivation sites by retaining certain amount of weed composition that can prove beneficial to crop through crop-non crop interaction. In general definition 'weeds' are supposed to be detrimental to the crop but about 20% of 'weeds' have been reported to be deliberately left undisturbed because they are providing protective cover for the soil (Ramakrishnan 1992) and improving plant productivity.	i. Temporal patterns of availability of all potential growth limiting nutrients and whole farm nutrient budgets over at least a decade. ii. Period of crop productivity maintenance in continuous cultivation sites need to be worked out by assessing patterns of individual and overall crop productivity and yields. iii. Economically viability of this practice with financial and labour investment analyses over a long period. iv. Suitability of native and exotic nitrogen-fixing shrub species on different slopes, soil-types and climatic conditions. Such trials, if successful, would also be a critically important resource in disseminating this technology to local farmers (Grogan et al. 2012). v. Potential of *Alnus nepalensis*, *Albizzia* spp., *Casuarina* spp., *Leucaena* spp., *Derris robusta* and other nitrogen-fixing shrub (*Flamengi a macrophylla* and *Tephrosia candida*) and tree species (like *Delbergia* and *Azadirachta*) should be assessed as they grow well in this region. vi. Reproductive phenology of common noxious weeds occurring during the continuous cultivation and their managed. vii. Crop and non-crop interaction for their growth performances. A general farmers based hypothesis that *Tephrosia candida* seedlings have weed suppressing activity (see SALT case study below) can be tested, and to know if this is due to their natural abundance that results in extensive soil surface cover or because of allelopathic interactions (Grogan et al. 2012).
2.	Slope terracing	i. Use of suitable plants as per slope angles and terrace height. ii. Use of appropriate terrace crop for the region.	Economic and ecological feasibility of terrace slope angle and height. Economic feasibility and longevity of terrace walls using contour fences of bamboo or tree stem poles. Suitability of crops (for example, yam, corn, sweet potato, ginger, turmeric) for optimizing production on terraces. Suitability of wild plant to grow on terraces.

A Case Study of Sloping Agriculture Land Technology (SALT).

The sloping agriculture land technology (SALT) nitrogen-fixing hedgerow inter-row cropping approach seems promising as an alternative cultivation practice that would allow continuous cropping on steep slopes, but even that requires significant manure inputs as supplied in the case study mentioned below.

A SALT (Tacio, 1993) trial farm was established on lands (~5 ha) that had previously been under shifting cultivation ~20 km north of Lunglei in 2003. The farmer landowner (Mr. Mawia) has been cultivating the gentler slopes of these lands every year since then, and slowly expanding the area under continuous cultivation into the steeper sloped areas (Fig. 22.4). This gradual expansion over successive years seems to have been a key feature in allowing him to develop, adapt and optimise the SALT approach to the particular soil and local environmental conditions on his farm. His agricultural extension education activities have since resulted in SALT practices being adopted by many farmers in southern Mizoram in particular (Mawia, pers. comm.). Some of these farms sites will be selected to investigate the soil organic matter dynamics and nutrient synchronization with that of the crop nutrient demand for the better management of this practice in this region.

Fig. 22.4 *Flemingia macrophylla* hedgerows along with decomposing branch (at left), extensive litter and crop residues (in middle) and diverse crops (at the right) in the SALT trial farm, Lunglei, Mizoram.

In conclusion, although there are very important ecological and economic considerations, the intelligent and careful use of commercial fertilizer in combination with organic matter additions is likely to be an important component of most of the options highlighted above, and therefore a central part of the solution to the problem of shortening fallow periods in shifting cultivation on steep slopes. But the doses of chemical fertilizers and organic manures that will optimize the crop growth in combination with N-fixer hedgerows plants need to be tested for various eco-regions and cropping patterns so that the runoff losses of nutrient can be minimized.

Department of Forestry, Mizoram University has initiated some trails of hedgerows of *Tephrosia candida* on slopping lands at different places in Aizawl district of Mizoram to work out all the problems raised above and demonstrates high quality scientific inputs to farmers by demonstrating projects. Scientific data collection and demonstration of various beneficial field trials are on the way in farmer field (Fig. 22.5). Various trails are being made with three fallow lands (i.e. 2 years, 5 years and 10 years), burned and un burned along with various treatments like litter input, top soil inoculation, microbial inoculation. Soil chemical and microbiological properties are being recorded along with crop productivity and grain yield in different treatments in comparison to a control plot.

Fig. 22.5 Planting of *Tephrosia hedgerows* in 10 years old burn fallow land (at the left), growth after few months (at middle) at 10 years old fallow and growth and 5 years old fallow land.

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23

Natural Resource Management through Watershed Development Programme Reflections from Andhra Pradesh

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ABSTRACT

This paper attempts to assess the impact of the Watershed Development Programme (WSDP) from two different schemes (Integrated Watershed Development Projects (IWDP) and Drought Prone Area Programme (DPAP) in drought-prone region of Andhra Pradesh (AP). The main objective is to examine the performance of the WSDP in terms of conservation of resources, improvement in production and increase in incomes. The analysis is based on the data collected from 21 watersheds spread over 4 Mandals of Kurnool district of AP.

The analysis indicates that the WSDP has created a positive impact in the watershed villages in terms of soil and moisture conservation (SMC) and a rise in the water table level by 20 to 23 per cent leading to increase in irrigated area and an increase in crop production. The overall impact of watershed is positive on irrigation, environment and livelihoods as it stabilizes production in spite of droughts. It has also been successful in promoting horticulture and animal husbandry activities. These achievements have resulted in reducing seasonal migration by about 75 per cent in IWDP areas and about 47 per cent in DPAP areas. It has also been successful in bringing about fairly good awareness among people regarding the need for WSD activities for promotion of agriculture in fragile ecological zones. Moreover, when compare to all the rural wage employment programmes implemented so far (except MGNREGA), it not only equalizes wages between men and women in watershed areas but also helps in improving the wage rates in the watershed areas. The provision of equal wages for both male and female under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is to a large extent instrumental in reducing the wage disparity. Though in the earlier rural wage employment programmes, provision of equal wages for both male and female was also there, they were not effective.

Keywords: WSD, MGNREGA, DPAP, IWDP, SMC

Introduction

India was perhaps the first developing country to formally recognize the danger of soil erosion and land degradation *vis-a-vis* food security and prosperity of the nation. Watershed Development Programmes (WSDPs) have emerged to deal with the complex challenges of natural resource management (NRM) adopting watershed as an appropriate unit of implementation. India which is considered as the largest implementer of the WSDP in the world is spending about Rs. 2300 crores (US $ 600 million) annually through different projects supported by the Government (GO), Non-Governmental Organisations (NGOs) and bilateral funds (MoRD, 2006). The Drought Prone Area Programme (DPAP) and the Desert Development Programme (DDP) adopted the watershed approach since 1987. The Integrated Watershed Development Projects (IWDP) taken up by the National Wasteland Development Board (NWDB) in 1989 also aimed at developing wastelands on a watershed basis.

The technical committee constituted by the Ministry of Rural Development (MoRD) under the Chairmanship of Prof. C.H. Hanumantha Rao studied the implementation and impact of DPAP, DDP and also IWDP programmes and recommended a common set of guidelines in 1994 so as to improve the performance of the WSDPs in India. The guidelines were further revised and reissued in 2001. Subsequently, to involve *Panchayati Raj* Institutions (PRIs) more meaningfully in the implementation of WSD activities, the '*Haryali* Guidelines' were introduced in the year 2003. At present, the Common Guidelines for WSD, 2008 is effective and all the new watersheds are being implemented under these guidelines from 2010 onwards.

A review of the performance of watershed projects during the last several years reveals their potential for drought-proofing, agricultural growth, environment protection and employment generation (for seminal review refer Chopra *et. al.,* 1990; Deshpande and Thimmaiah, 1999; Rao, 2000; Kerr *et. al.,* 2000; and Reddy, 2000). The evidence from the micro-studies conducted in different parts of the country shows improvement in crop production and productivity, moisture retention capacity of the soil, recharging of groundwater, decline of area under wasteland, employment and income generation in areas under WSDP. The economics of watershed technology, though explicitly supports WSDP; the magnitude of its impact varies across regions and locations, as the success rate in some of the states is as low as 15-20 per cent (Reddy *et. al.,* 2010).

Andhra Pradesh and Its Experience with WSDP

WSD assumes particular relevance in a state like Andhra Pradesh (AP) as more than 50 per cent of its cropped area is rain-fed. Most of this area is characterised not only by low and erratic rainfall and water stress, but also by soil erosion, environmental degradation, and recurring drought. It has resulted in large tracts of fallow land, insecure livelihoods, distress migrations of both landed and landless (LL) farmers, and thus, ultimately increasing poverty. It is firmly believed that development of degraded lands is an important input required for eradication of poverty. Therefore, it is anticipated that the WSD approach would support the widespread rain-fed agriculture in AP.

In the recent years, state of AP is in the forefront of watershed implementation. The programmes of dry-land development in AP have undergone a major change since 1995-96 with the introduction of watershed guidelines, based on the recommendations of Prof. C.H.Hanumantha Rao's Committee Report. The main principle adopted in the guidelines lays special emphasis on the active mobilisation and participation of the stakeholders in the programme including planning, implementation and subsequent management. Over the late 1990's the approach has been continuously modified in the light of experience. The state has initiated about 10000 watersheds under the Common guidelines since 1995 and WSDPs (DPAP, DDP, IWDP, and IWMP), Comprehensive Land Development Programmes (Indira prabha under RIDF IX, X, XIII and XV) and Wage Employment Programmes (MGNREGS-AP) are being implemented in the state (Table 23.1).

Table 23.1 Progress of Watersheds (No.)

Scheme	Sanctioned	Completed	Ongoing
DPAP	4,242	2,966	1,276
DDP	1,054	552	502
IWDP	1,499	738	761
IWMP	552	-	552
Others (EAS, APRLP, APHM)	2,506	2,506	-
Total	**9,853**	**6,762**	**3,091**

Source: GoAP, Rural Development Department.

IWMP – Integrated Watershed Management Programme; EAS – Employment Assurance Scheme; APRLP - Andhra Pradesh Rural Livelihoods Programme; APHM – Andhra Pradesh Hazard Mitigation. The study is based on the experience of IWDP and DPAP watersheds which were till recently the main WSDPs of the state. In 2008, Government of India (GoI) issued new common guidelines for Watershed Development Projects bringing all schemes under one umbrella and provided for cluster approach wherein, contiguous areas up to 5,000 ha. are to be taken up for treatment. Following is a brief description of the experience of AP with these programmes.

Drought Prone Area Programme/Desert Development Programme

It is a centrally sponsored scheme funded by the Central and State on 50:50 basis up to IVth batch i.e., 1998- 99 and on 75:25 cost sharing basis from 1999-2000 onwards. It is aimed at developing drought prone areas for drought proofing by taking up soil and moisture conservation (SMC), water harvesting structures, afforestation and horticulture programmes on a comprehensive micro-watershed basis. DPAP scheme is being implemented in 94 DPAP Blocks of the 11 districts and Desert Development Programme (DDP) is being implemented in 16 Blocks of Ananthapur district since 1995-96. Details of the achievements are shown in Table 23.2.

Table 23.2 Achievements under DPAP/ DDP

Items	**2011-12**	**2012-13 (up to Sep'2012)**
No. of Watersheds		
DPAP	4242	4242
DDP	1054	1054
Expenditure (Rs.crore)		
DPAP	54.04	13.28
DDP	20.09	2.83

Source: GoAP (2013), Socio Economic Survey 2012-13, Planning Department.

Integrated Wasteland Development Programme

Rapid depletion of green cover and vast stretches of marginal lands lying fallow, are causing enormous ecological imbalance and decreasing productivity because of soil erosion and marginalization of lands. Massive integrated wasteland development project was under taken during 1992 with 100 per cent central assistance to arrest this. The state dry land development programme underwent a major change from 1995-96 with the introduction of new watershed guidelines. IWDP is implemented in non-DPAP blocks of DPAP districts and in all non-DPAP Districts. New guidelines called *Hariyali* are being implemented in watersheds since 2003-04. The area is treated with SMC works, water harvesting structures, afforestation from ridge to valley concept. The achievements details of these watersheds are shown in Table 23.3.

Table 23.3 Watersheds under IWDP

Details	**2011-12**	**2012-13 (up to September 2012)**
No. of Watersheds	1499	1499
Expenditure (Rs. Cr)	10.43	3.03

Source: GoAP (2013), Socio Economic Survey 2012-13, Planning Department.

The present Paper has been divided into three major sections. *Section I* presents *Introduction* that provides objectives, methodology, description of the study area, Profile of Programme Mandals and basic features of the sample watersheds. *Section II* explores the *Impact of WSDP in Sample IWDP and DPAP implemented watersheds* and the last section (*Section III*) presents *Conclusions and Observations*.

Objectives

Though a number of studies have been conducted over the past decades, examining the impact of various watershed projects in the country, the empirical evidence relating to the impact of these projects is quite mixed and hence does not provide any comprehensive view. While the achievement of WSD as a technology for soil and water conservation is well accepted, the human dimension including the experience of farmers and end users in large scale adoption of several technologies are poorly addressed. The complexities and diversity associated with human dimension is proving to be the main obstacle for the extensive success of the programme.Against this background, the present study aimed at examining the functioning of the WSDP under the common guidelines, which lays emphasis on the human dimension/people's participation. For this purpose, impact of WSDP was examined with respect to resource conservation, improvement in production and increase in incomes. The study also takes into account people's perception about the programme while assessing the impact.

Methodology

To evaluate the impact of the WSDP under the common guidelines, six IWDP implemented watersheds from Devanakonda Mandal of Kurnool district and 15 DPAP implemented watersheds from Peapully, Betamcherla and Banaganapalli Mandals were selected from Kurnool district of AP. The watersheds were selected in such a manner so as to include both GO and NGO implemented watersheds for making a comparison between them. However, only in case of DPAP watersheds both types of implementing agencies were found. All these sample watersheds are located in the scare rainfall agro-climatic zone of Rayalaseema region of AP.

The methodological approach adopted in the field involves a survey-based data collection exercise comprising close-ended questionnaires. Two independent sets of questionnaires (Schedule I: Community Level Survey and Schedule II: Household/ Beneficiary Level Survey) were used to collect the data, which were developed by at the Ministry of Rural Development (MoRD) level. In order to understand the impact of the programme, two different questionnaires were prepared - at community level and HH level to capture the changes due to the advent of WSDP.

About 25 sample households (HHs) were selected from each watershed by using probability proportionate sampling method. Land holding status was considered for this purpose. These sample HHs are divided into two categories: Small and Marginal Farmers (SMF) and Large and Medium Farmers (LMF). Thus a total of 525 HHs were covered across 21 watersheds covering 21 communities/villages of 11 Gram Panchayats in the sample District. Approximately 65 per cent of the sample HHs belong to the SMF category and 35 percent to the LMF category. Field visits for data collection were carried out during July to August 2009.

Description of the Study Area

Kurnool District is situated between $14^o - 50^l$ and $16^o - 18^l$ Northern latitude and $77^o - 24^l$ and $79^o - 40^l$ Eastern longitude at an altitude of 1000 m above the mean sea level It is the 10th largest district (in terms of population) in AP with 35,29,494 people and a density of 168 / Sq. Km accounting for 4.63 per cent of the total Population of the State as per 2001 Population Census and in area it occupies the 3rd place with 17658 Sq. Km. which account for 6.43 per cent of the total area of the State. The District has shown a population growth of 19.1 per cent over the period 1991-2001. The population of SC/ST is 19.78 per cent of the total population. The percentage of literacy in males and females is 43.3 and 21.1 per cent respectively. In the District the total number of operational holdings are 512128, for all social groups inclusive of institutional, joint and individual holdings with 1060257 ha of area operated. About 65,118 Scheduled Castes (SC) holdings operate over 84,819 ha while 9534 holdings by Scheduled Tribes (ST) members operate over 15919 ha.

I. 7. Profile of Programme Mandals

WSD activities were carried out during the period 1995 under IWDP in Devarakonda Mandal covering 15 watersheds and under DPAP in Peapully, Banaganapalle and Bethamcherla Mandals covering 105 watersheds. The general characteristics of the sample Mandals are presented in Tables 23.4 and 23.5.

Table 23.4 Socio-Economic Details of the Sample Mandals with IWDP and DPAP Programmes

Programme	Mandal	Area (Sq Kms)	No HHs	Population (2001 Census)	Density (Sq.Km)	SC/ST (%)	Total Literacy	Main Workers(%)
IWDP	Devanakonda	481.69	11207	61923	129	18.36	40.65	50.52
DPAP	Peapully	378.46	13461	67080	177	16.06	48.70	48.13
DPAP	Bethamcherla	429.65	16505	77579	181	21.14	54.78	42.70
DPAP	Banaganapalli	390.45	19061	89030	228	20.16	53.79	39.34
District Total		**17600.34**	**699191**	**3529494**	**200**	**19.78**	**53.22**	**42.52**

Source: Chief Planning Officer (2010), Hand Book of Statistics, Kurnool District -2009, Kurnool

The population density is more in Banaganapalli when compared to other Mandals. The SC / ST population varied from 16 to 21 per cent. The literacy level varied from 40 to 53 per cent. The percentage of main workers is about 39.34 per cent while it is the highest in Devanakonda about 50 per cent. The agricultural labours as well as cultivators are high in Devarakonda and Peapully Mandals. The proportion of HHs depending on other industries more in (20 per cent) Bethamcherla and Banaganapalli Mandals are due to stone mining and slab industry (Table 23.4).

Around 68 per cent of the land is cultivated in Peapully whereas only 45.59 per cent is cultivated in Banaganapalli Mandal. About 25 to 30 per cent of the land is either under forest or barren. The SMF constitute more than 50 per cent and the Medium Farmers (Med.F) are 30 to 40 per cent in numbers leaving Large Farmers (LF) to around 10 per cent. The net area irrigated varies from 8.92 at Peapully to 16.73 per cent in Betamcherla. Thus the selection of Devanakonda for IWDP and other Mandals for executing DPAP programmes is highly justified (Table 23.5).

Table 23.5 Land use Statistics of Sample IWDP and DPAP Mandals

Mandal	Total cropped area (%)	Land Utilization (% to total Geographical Area)					Area under farm size (%)				Irrigated area (%)	
		Forest	Barren and Un cultivable land	Land put to non-agricultural use	Permanent pasture and other grazing lands	Miscellaneous tree crops	MF	SF	Med. F	LF	area irrigated	net area irrigated
Devanakonda	68.03	6.28	19.45	6.34	0	0	14	47	34	5	12.15	8.92
Peapully	62.02	5.37	12.81	8.75	0.3	0.05	8	34	45	13	11.19	9.72
Bethamcherla	59.42	8.07	22	7.19	0.34	0	15	44	30	11	22.76	16.73
Banaganapalli	45.59	16.31	7.57	6.07	0.0	0	19	37	37	8	15.70	13.74
District Total	**58.6**	**19.29**	**7.21**	**7.8**	**0.2**	**0.1**	**17**	**30**	**40**	**13**	**24.53**	**20.02**

Source: Chief Planning Officer (2010), Hand Book of Statistics, Kurnool District -2009, Kurnool

Basic Features of the Watersheds

Of the six watersheds under IWDP, three of them have an area around 400 ha in each case and the remaining three had watershed area ranging from 685 ha to 816 ha. Of the 16 watersheds under DPAP, ten of them had an area around 500 ha, two of them around 400 ha and the remaining three watersheds have an extent more than 700 ha in each case. Across watersheds the average area of the watershed is 586 ha under IWDP and it is 488 ha. under DPAP watersheds (Annexure: 1). The proportion of non-arable land is more in DPAP than IWDP implemented watersheds. While the extent of non-arable land is 22 per cent in case of DPAP watersheds, the same is 12 per cent for IWDP watersheds (*Annex*: 3).

Funds have been sanctioned and released Rs 4000 per hectare with respect to IWDP watershed and Rs 3000 per hectare for DPAP watersheds. The physical and financial achievements under different programmes are presented in *Annex*: 2. It is evident from the data presented that 25 per cent share of the State Government is not used for the programme under DPAP.

Impact of WSDP in Sample IWDP and DPAP Watersheds

Land use Changes

Watershed development is expected to bring changes in land use pattern by undertaking watershed activities in waste lands. The data in this regard reveals that 6 per cent of the non-arable lands were treated under IWDP watersheds, whereas 11 per cent non-arable lands were treated in case of DPAP watersheds (*Annex*: 3). As the IWDP is a specific programme for developing wastelands, all the wastelands should have been developed. It is obvious that neither the Project Implementing Agency (PIA) nor the monitoring agency has paid any attention to this aspect. Similarly GO as PIA in DPAP watersheds developed 50 per cent of the existing wastelands where as development of wastelands are only 36 per cent in case of NGOs implemented watersheds. This has occurred in spite of the fact that the overall fund utilization is more than the allocation either for the works or overall developments indicating improper prioritization of activities.

Impact on Groundwater

Improvement in groundwater is one of the most important expected benefits from soil and water conservation activities undertaken through WSDP. The average depth of water table in IWDP watersheds was 68.1 meters during pre-project period which was observed to be improved to 45 meters. Thus, there is 33.5 per cent improvement in depth of water table in the sample watersheds. On the other hand, the impact was not that prominent in DPAP watersheds as the depth of water table is reduced from 52.2 to 42.30 meters, the improvement being 22 per cent. Within the DPAP watersheds the improvement in depth of water table was 23 per cent in GO implemented watersheds as against 19 per cent in case of NGO watersheds. Similar trend is also reflected from the sample HHs with 41 per cent increase in irrigated area in the IWDP as against 32 per cent in case of DPAP watersheds. On the contrary when NGO implemented watersheds in DPAP watersheds were considered, the percentage increase in irrigated area was found to be 43 per cent. This could be due to the fact that in GO implemented watersheds the extent of money spent was only up to 60 per cent (in five of them).This indicates that conservation measures are not carried out on extensive scale when compared to others, which might have been responsible for the low increase.

As for as IWDP implemented watersheds were concerned, the impacts were much more conspicuous wherein an average five wells were rejuvenated. During the project period, five open and seven deep borewells were constructed leading to an additional irrigated area of 9 ha under open wells and 14 ha under borewells. The results suggest improvement in the phreatic water table due to watershed intervention. In case of DPAP watersheds rejuvenation was not observed in five watersheds and in the remaining watersheds open wells were observed to be rejuvenated. Across watersheds four wells were found to be rejuvenated, 22 additional borewells were constructed, which have helped to increase the area irrigated by 9 ha under open wells and 48 ha under bore wells. In case of GO implemented watersheds the rejuvenation was to the extent of 3 wells per watershed, adding 19 bore wells which have led to an increase in the irrigated area by 3 ha under open wells and 38 ha under bore wells. On the other hand, under NGO implemented watersheds the wells rejuvenated were 7, and 30 borewells were added, resulting an increase in the irrigated area by 24 and 41 ha. under open and borewells respectively. Better performance of the NGO implemented watersheds can be attributed to the execution of all the physical works related to water

Afforestation

Improving the vegetative cover through afforestation was one of the major activities undertaken in both the programmes. Afforestation was carried out by planting seedlings. On an average under IWDP, plantation was carried out in 12 ha of land covering 1552 plants with a density of 129 plants per ha. On the other hand, in case of DPAP watersheds, 18 ha were afforested using 2653 seedlings at a density of 147 plants per ha. While, watersheds implemented under DPAP are ahead of IWDP implemented watersheds with regard to number of plantations, IWDP watersheds show better performance in terms of coverage of area and survival rate. The percentage of survival rate was 81 for IWDP implemented watersheds, whereas it was only 35 per cent in case of DPAP watersheds. This was expected considering the hostile environment of DPAP areas as compared to that of IWDP areas (*Annex*: 5).

Attempt has been made to convert waste lands into productive lands through horticultural plantations in marginal lands in both the projects. About 31 ha of area on an average were covered in IWDP watersheds using 4005 plants with 85 per cent survival rate (*Annex*: 5). Similarly across watersheds *silvi* pasture programme (SPP) [1] was implemented over 65 ha area under IWDP. In contrast to IWDP only 8 ha areas on an average were developed using 616 seedlings with a low density of 77 plants per ha under DPAP. The survival rate of these plants is only 42 per cent in DPAP watersheds as against 85 per cent under IWDP watersheds. As far as afforestation programme is concerned, the performance of the GO implemented watersheds were observed to be better than their NGO counterparts in terms of coverage, density and survival rate Moreover, the condition of horticultural plantation is very poor due to absence of post-planting care in NGO watersheds when compared GO watersheds. On an average 45 per

1 WSDP concentrated on promoting technologies that conserve soil and moisture on wastelands under government/community/private to establish silvi-pasture/pasture development systems so as to enhance bio-mass production.

cent of the sample HHs have developed their wastelands in IWDP watersheds whereas it was 30 to 32 per cent under DPAP watersheds (*Annex*: 5).

Dairy Development

Soil and water conservation activities carried out under WSDP are assumed to improve the quality of CPRs and thus, the availability of fodder which in turn expected to support more number of livestock compared to the pre-watershed period. The impact of WSDP on livestock economy is assessed and compared in terms of number of HHs purchased new species of livestock and milk yield. Many HHs in the study areas keep livestock to supplement their HH income. In case of IWDP watersheds, 80 to 100 per cent of the HHs have purchased livestock to increase their household incomes, whereas number of HHs purchased livestock ranged from 35 to 90 per cent for the DPAP watersheds. On an average, 58 per cent of the HHs have purchased livestock consequent to the intervention in DPAP watersheds. As far as GO and NGO implemented watersheds are concerned, 63 per cent of HHs in NGO watersheds have purchased livestock as against 57 per cent of the household in GO implemented watersheds (*Annex*: 6).

As a result of increasing number of livestock, especially of milch animals, some of the families have got direct benefit in terms of increased household incomes through milk sale on continuous basis. Thus, on an average, 9 per cent families have produced an extra milk of 92 liters per day in IWDP watersheds and 11 per cent families have produced an extra of 94 liters of milk per day in DPAP watersheds.

Crop Yields

Activities related to soil and moisture conservations (SMC) are expected to augment agricultural development through improvement in crop yields. Thus, improvement in crop yield determines the viability of agriculture. When the changes in yield rates are considered, performances of the IWDP watersheds were found to be better than DPAP watersheds in case of irrigated paddy (56 per cent in IWDP watersheds against 20 per cent in DPAP watersheds). When it comes to farm size the increase was 38 per cent for SMF categories of HHs whereas it was 56 per cent for LMF HHs. This could be mainly due to the fact that paddy requires more inputs (especially fertilizers and pesticides), which SMF may not be able to afford. On the contrary, in case of rain-fed crops like Jower, SMF HHs have experienced more increase (20 per cent in Kharif and 50 per cent in Rabi), than LMF HHs (43 per cent in Rabi) in IWDP watersheds. However, this was not the case in DPAP watersheds, where LMF HHs generally experienced more increases when compared to SMF HHs (*Annex*: 7). Similar is the case with other crops where intensive cultivation is practiced.

Employment Generation, Wage Rate and Migration

As a result of soil and water conservation activities undertaken through WSDP, agriculture is expected to flourish which in turn generate more days of employment.

Across watersheds the increase in number of man-days for men and women in IWDP programme were 63 and 53 respectively and the same was 77 and 70 for DPAP watersheds. There was not much variation in this regard between GO and NGO implemented watersheds under DPAP. When compare to all the rural wage employment programmes that were implemented so far (except MGNREGA), WSDP not only equalizes wages between men and women in watershed areas but also helps in improving the wage rates in the watershed areas. The provision of equal wages for both male and female under MGNREGA is to a large extent instrumental in reducing the wage disparity. Though in the earlier rural wage employment programmes, provision of equal wages for both male and female was also there, they were not effective. WSDP is the starting/beginning point in this direction implemented by MGNREGA. The wage rates in GO watersheds are 25 to 50 per cent higher than NGO watersheds under DPAP programme (*Annex* -8). Because of improved wage rates and more employment opportunities, the seasonal migration has also reduced by about 75 per cent in IWDP areas and about 47 per cent in DPAP areas.

Additional Income

All the positive impacts of WSD discussed so far are expected to culminate in to improved standard of living at the household level. Standard of living is linked to disposable income at the household level i.e., gross income minus costs and social payments. In general the increases in income amongst HHs of IWDP watersheds were more than the HHs of DPAP watersheds. The average increase in household income is 39 per cent for HHs of IWDP watersheds whereas it is only 21 per cent for the HHs of DPAP watersheds. SMF HHs have realized on an average Rs 4583 per annum in DPAP watersheds. SMF and LL HHs in GO managed watersheds in DPAP areas have experienced more rise in their income compared to their NGO counterparts. This could be due to higher wages paid and higher yields associated with increased irrigation facilities, etc., (*Annex*: 8).

People's Perceptions on the Programme:

All the HHs irrespective of the programme felt that soil and water conservation activities undertaken through WSDP has a positive impact on natural resources in general and agriculture in particular. Apart from the bio-physical impacts, all stakeholders also acknowledge the role of WSDP in reducing gender discrimination with respect to wage earnings in their watershed areas. To augment the performance of the WSDP further, the community suggests to use the Watershed Development Fund (WDF) to treat the untreated areas as well as to carry out the maintenance activities for the created assets under the programme. They prefer to undertake these activities through a committee. The present generation WSDPs are now trying to link conservation activities with livelihoods of the people. This study also tries to capture the awareness level of the people in this regard. While HHs in DPAP watersheds have no awareness about the livelihood component, a good number of HHs in IWDP watersheds appear to be familiar with these themes and they also demand more and more support (*Annex*: 9).

Conclusions

The soil and water conservation activities undertaken through WSDP have created a positive impact in the watershed villages in terms of improvement in quality of land and a rise in the water table level by 20 to 23 per cent leading to increase in irrigated area and thereby an increase in crop production. It has also been successful in promoting horticulture and animal husbandry activities. These achievements have resulted in reducing seasonal migration by about 75 per cent in IWDP areas and about 47 per cent in DPAP areas. Distribution of benefits appears to be evenly spread in the case of most indicators, except yield rates. It has also been successful in bringing about fairly good awareness among people regarding the need for WSD activities for promotion of agriculture in fragile ecological zones. Nevertheless, the programme appears to be weak with regard to community organization for maintaining the assets created as well as continuing the programme through User Groups (UGs) and people's involvement. Grounding of different physical activities seems to be underway before proper groundwork in the watershed villages, in terms of creating homogeneity among the community towards holistic approach for developing the area. Further, development of wastelands is not up to the desired level. In such holistic environments, it is better to organize social fencing, allow natural vegetation to regenerate and plant seedlings of local choice by filling the gaps.

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Annexure

***Annex* 1.** Details of Sample Watersheds

Scheme/Name of the Watershed	Name of the GP	Mandal	Name of the PIA (GO/NGO)	Starting Year	Closing Year	Total population	Per cent of Population			Area of Watershed (ha)	Area Waste Land (%)	Area under Irrigation (%)	Occupational Status		
							SC	ST	Others				Agrl	Agrl. Labor	Artisans
IWDP	Peddapodilla	Peapully	NGO	1996	1999	2159	25	0	75	448	30	7	70	30	0
Chinnapodilla															
Peddapodilla	Peddapodilla	do	NGO	1996	1999	1436	30	0	70	404	27	8	80	20	0
Goganivanka	Peapully	do	NGO	1996	1999	13957	9	2	89	453	15	9	60	40	0
Kalachetla	Kalachetla	do	NGO	1996	1999	1000	33	0	67	685	20	15	60	30	10
Yerraguntapalle	Kalachetla	do	NGO	1996	1999	917	33	0	67	708	20	15	50	45	5
S.Rangapuram	S.HO Rangapuram	do	NGO	1996	1999	407	3	32	75	816	40	3	65	25	10
IWDP Average							**22**	**6**			**25**	**10**	**64**	**32**	**4**
DPAP															
Bathuluripadu	Bathuluripadu	Banaganapalle	GO	1999	2003	525	0	15	85	500	12	35	65	20	0
Fathenagar	Katikavani Kunta	do	GO	1999	2003	300	25	0	75	600	68	1	60	35	0
Katikavani Kunta	Katikavani Kunta	do	GO	1999	2003	439	31	2	67	500	70	1	60	40	0
Meerapuram	Meerapuram	do	GO	1999	2003	1835	9	0	91	717	25	1	65	10	15
Yagantipalli	Yagantipalli	do	GO	1999	2003	1761	25	0	75	550	22	10	60	40	0
Bukkapuram	Kothapalle	do	GO	1999	2003	575	25	0	75	398	30	5	50	45	0
Kothapalli	Kothapalli	do	GO	1999	2003	2070	15	1	84	545	34	5	60	35	5
Paramma Kunta	Kothapalle	do	GO	1999	2003	2070	15	0	85	360	34	5	50	40	0
Somapuram Kunta	Kothapalle	do	GO	1999	2003	2070	15	1	84	506	34	5	60	30	10
Gudumariyellamma	Rangapuram	do	GO	1999	2003	7103	23	2	75	469	31	5	65	30	5
M.T.Kunta	Rangapuram	do	GO	1999	2003	7103	23	2	75	679	31	5	65	30	0
GO Average							**19**	**2**			**36**	**7**	**60**	**32**	**3**
B.Centre	Palakurthy	Devanakonda	NGO	1999	2003	550	25	0	75	496	15	9	55	40	0
Gummaralla	Palakurthy	do	NGO	1999	2003	864	15	2	83	498	17	8	70	30	0
Guttakindavanka	Palakurthy	do	NGO	1999	2003	400	25	0	75	501	18	8	55	45	0
Palakurthy	Palakurthy	do	NGO	1999	2003	750	20	2	78	496	18	8	55	45	0
NGO Average							**21**	**1**			**17**	**8**	**59**	**40**	**0**
DPAP Average							**19**	**2**			**31**		**60**	**34**	**2**

Source: Field Survey & Watershed Records

***Annex* 2.** Physical and Financial Progress Achieved (Amount in Rs.Lakhs)

Scheme	Type of PIA	Watershed Area (ha)	Amount Sanctioned	Total Amount Spent on works	Amount spent on Works (%)	Trainings cost	Amount spent on Trainings (%)	Administrative Cost	Administrative Cost (%)	Total WS Expenditure	Fund utilization (%)	Corpus fund* (%)
IWDP	All GOs	586	25	19	77	6	25	2	8	27	110	1
DPAP	GO	529	16	10	66	2	12	1	8	13	86	5
	NGO	498	15	14	90	3	18	1	5	17	113	1
	Overall	521	16	11	72	2	14	1	7	14	93	4

*includes contribution, unspent money and interest accrued in the Bank. Source: Field Survey

***Annex* 3.** Details of Land-use in Watersheds

Scheme/PIA/ Name of the Watershed	Watershed Area (Ha)	Area allocated (%)		Area Treated (%)		
		Arable	Non-arable	Area Treated	Arable	Non-arable
IWDP I Batch Chinnapodilla	448	92	8	81	76	5
Peddapodilla	404	89	11	70	64	5
Goganivanka	453	89	11	71	66	5
Kalachetla	685	88	12	77	70	7
Yerraguntapalle	708	84	16	76	67	10
S.Rangapuram	816	88	12	67	61	6
IWDP Average	**586**	**88**	**12**	**74**	**67**	**6**
DPAP						
Bathuluripadu-GO	500	84	16	80	72	8
Fathenagar-GO	600	76	24	77	67	10
Katikavani Kunta-GO	500	80	20	80	71	9
Meerapuram-GO	717	67	33	42	31	11
Yagantipalli-GO	550	73	27	91	82	9
Bukkapuram-GO	398	81	19	85	72	14
Kothapalli-GO	545	77	23	75	55	20
Paramma Kunta-GO	360	75	25	83	64	19
Somapuram Kunta-GO	506	85	15	86	76	10
Gudumariyellamma-GO	469	68	32	72	64	8
M.T.Kunta-GO	679	85	15	75	68	7
GO Average	**529**	**77**	**23**	**77**	**66**	**11**
B.Centre-NGO	496	70	30	80	75	5

Gummaralla-NGO	498	76	24	80	75	5
Guttakindavanka-NGO	501	85	15	80	74	6
Palakurthy-NGO	496	80	20	79	60	19
NGO Average	**497**	**77**	**23**	**80**	**71**	**9**
DPAP Average	**521**	**77**	**22**	**78**	**67**	**11**

Source: Field Survey

***Annex* 4.** Impact on Groundwater recharge

Scheme	**Type of PIA**	**Depth to water table (mets)**		**No. of abandoned wells rejuvenated**	**No. of Additional wells**		**Additional area Brought under cultivation (in Ha)**		**Irrigation changes in Sample HHs**		
		Pre WS	**Post WS**		**open wells**	**Bore wells**	**wells**	**bore wells**	**Area irrigated pre watershed (in Ha)**	**Area irrigated post watershed (in Ha)**	**% increase**
IWDP	All GOs	68.1	45.0	5	5	7	9	14	2.2	3.1	40.9
DPAP	GO	47.1	38.1	3	0	19	3	38	1.8	4.8	166.7
	NGO	63.3	51.6	7	0	30	24	41		3.3	
	Overall	52.2	42.3	4	0	22	9	48		4.3	

Source: Field Survey

***Annex* 5.** Area Developed under Afforestation, Horticulture and Silvi -pasture

Scheme	**Type of PIA**	**Afforestation**			**Horticulture**				**Area sown with silvipasture/pasture development (Ha.)**	**HHs Fallow land brought under cultivation post project period (%)**
		Area covered (ha)	**No. of seedlings planted**	**Survival Rate (%)**	**Plants supplied (No)**	**Survival (%)**	**Area covered (ha)**	**condition of the plantation***		
IWDP	All GOs	12	1552	81	4005	85	31	1	65	45
DPAP	GO	16	1981	43	613	50	6	2	0	30
	NGO	24	4500	14	625	19	14	3	0	36
	Overall	18	2653	35	616	42	8	2	0	32

* 1.Yield well; 2.yielded moderately; 3.Less yield

Source: Field Survey

***Annex* 6.** Impact of Watershed Development Programme on Production of Milk

Scheme	**Type of PIA**	**HHs purchased livestock/animals in post-project period (%)**	**Increase in quantity of milk produced (liters/day)**	**No. of families benefitted with Dairy**
IWDP	All GOs	92	92	**13**
DPAP	GO	57	107	48
	NGO	63	45	12
	Overall	58	94	**40**

Source: Field Survey

***Annex* 7.** Impact of WSDP on Crop Yields (% change over pre-WS)

Scheme	**Farm Size**	**Paddy**		**Jower**		**Redgram**		**Groundnut**		**Vegetable**	
		Kharif	**Rabi**	**Kharif**	**Rabi**	**Kharif**	**Rabi**	**Kharif**	**Rabi**	**Rabi**	**Summer**
IWDP	SMF	38		20	50	41	13	57		26	
	LMF	56			43	35	18	78	32	23	14
DPAP	SMF	17	3		35	25		11	6	17	25
	LMF	20	5	27	50	35	45	17	23	22	35
All Schemes	**SMF**	**18**	**17**	**44**	**57**	**20**	**13**	**33**	**22**	**5**	**20**
	LMF	**27**	**15**	**25**	**88**	**30**	**18**	**59**	**50**	**25**	**38**

Source: Field Survey

***Annex* 8.** Impact of WSDP on Employment Generation

Scheme Scheme	**Type of PIA**	**Increase Employment (Man-days)**	**Wages/day for WS works (Rs)**		**Wages/day for agricultural works (Rs)**		**Reduction of Seasonal Migration (%)**	**LL**	**Additional Income (Rs)**		
			Men	**Women**	**Men**	**Women**			**SC/ ST**	**SMF**	**Others**
IWDP	All GOs	53	40	40	28	20	75	2917	2917	4583	8750
DPAP	GO	69	49	49	34	27	36	2409	2409	3909	7545
	NGO	71	40	40	25	17	76	2000	2000	3250	7000
	Overall	**70**	**47**	**47**	**32**	**25**	**47**	**2300**	**2300**	**3733**	**7400**

Source: Field Survey

***Annex* 9.** People's Perception about WSDP

Scheme Scheme	Type of PIA	HHs Comments and Suggestions about WSDP (%)					Livelihood Support Systems (LSS)	
		1. WSDP got the Positive impact on Agrl.	2. Due to WSDP labours got remunerative wage labour and reduced the Wage difference between men and women	3. Need to immediate releasing of WDF for dysfunctional structures	4. WSDP Works to be extended in untreated area	5. Need to apply Cement Concrete to the damaged and dysfunctional RWHS structures	% HHs on LSS involved-(vermi compost)	% HHs on LSS involved (bee keeping)
IWDP	All GOs	100	100	91	98	28	9	13
DPAP	GO	99	98	80	95	28	0	0
	NGO	95	100	74	90	64	0	0
	Overall	98	99	79	94	37	0	0

Source: Field Survey

RWHS: Rainwater Harvesting Structures

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Natural Resource Management through Watershed Development Programme Reflections

— *Tapas Ranjan Chakraborty*

ABSTRACT

Bangladesh is a plain land delta. Around 60% of the country is wetland. Haor is a special type of wetland found in the north-east of the country. Haor(s) with their unique hydro-ecological characteristics are large bowl shaped floodplain covering about 1.97 million hectors of areas and accommodating about 19.37 million people. There are 373 large wetlands which is around 44% of the total area of the Haor basin. The region receives water from catchments slopes of the Shillong Plateau across the borders in India to the north and the Tripura Hills in India to the south. Flash flood is the main disaster in the Haor area which engulfs the primary production sectors agriculture and fisheries and thus threatens the lives and livelihoods of the people. In recent years changes in weather event are reported; recent year first flash flood of a season is much earlier comparing with its regular timing, cold spell causing no grain in rice in different fields, rainfall is erratic now a days.

Keywords: wetland, hydro-ecological, floodplain, Tripura Hills, Flash flood, engulfs

Introduction

Adaptation to climate change in Haor basin is both planed and autonomous. In Bangladesh because of the livelihood state most of adaption practices Natural Resource Management in character. Adaptation practice has direct impact in biodiversity conservation. The current paper aims to note the climate change impact and community based adaptation practices in Hakaluki Haor areas. The study was conducted in Kulura subdistrict, under Moulvi Bazar district from July 2011 to June 2012.

Method

The threat to the Haor biodiversity was assessed based on impact assessment on biodiversity on the basis of DPSIR frame work (UNEP 2007). The DPSIR (D-Driver, P-Pressure, S-State, I-Impact and R-Response) framework focuses on what has gone wrong with the environment and how to fix it.

- **DRIVER (D)** is the underlying cause that drives actions that have an impact on the environment
- **PRESSURE *(P)*** is the impact on the environment and natural resources caused by human activities. A pressure can be direct or indirect.
- **STATE (*S*)** is the environmental condition related to quality and the impact on the environment and natural resources.
- **IMPACT (*I*)** is the effect of environmental change. It also implies conditions and directions of the response of the environment.
- **RESPONSE (*R*)** is what authorities and individuals are doing to improve environmental conditions, whether these actions are effective and what more can be done.

The climate change vulnerability and the adaptation practices were identified in community consultations (SDRC 2007). The consultation contained Focus Group Discussion, Hazards and Resource Mapping, Key Informant Interviews etc.

The survey of the biodiversity was limited to wildlife only. The amphibian and birds were identified by direct observation, and the reptile and mammal were recorded by indirect observation and authentic sight record by the community within one month. Record of fish was made by catch assessment.

Study Area

Hakaluki Haor is a bowl shaped depressed water body comprises a number of 276 beels, 7 rivers and 31 canals which generally retains water throughout the year; it is one of the important mother fisheries in Bangladesh. The land area is 24,939 hectares, it shelter globally significant wetland biodiversity and provides livelihood to around 250 thousand people living surrounding haor. It lies between latitude 24º35’ N to 24º45’ N and longitude 92º00’ E to 92º08 ‘ E. Government declared Hakaluki Haor as Ecologically Critical Area (ECA) due to its critical ecological condition happened over the last two decades through some man-made and natural causes. There are about 1191 species of flora and fauna found in this Haor area; 107 fish species of which 32 are threatened, 526 plant species of which 89 are threatened and 558 wildlife species of which 100 are threatened. Among the wildlife biodiversity 12 species of amphibians, 70 species of reptiles, 417 species of birds and 59 species of mammals recorded from different surveys.

Findings

Perception of Climate Change and Variability

Community views of climate change and variability are as follows:

- It is getting warmer each year
- Flash flood due to sudden rush of rainwater from upstream hills have increased
- Excess rainfall in few days
- Floods, and particularly flash floods have increased and is common every year
- Northwester (Kal Boishaki) – has increased in number and hits more areas than before
- Strong waves during May to July
- During winter, all the water bodies dry up faster
- Winters are less cooler and short of duration.
- Excess fog/mist
- Localized drought conditions
- Hailstorms

Impact of Major Climate Challenges

	Challenge	Primary Effects, consequences
1	Flash Flood	The water rushes from the surrounding hills during the months of April, damaging standing crops of paddy
2	Flood	During the months of June-July every year, almost a quarter of the homes in eastern villages are severely damaged whereas the remaining three quarters of homes are also partially damaged. A large number of settlers who are poor are displaced, temporarily or permanently. With many households losing even their stocked food grain, or forced to sell them, local food availability and crisis happens. Floods damage all the roads and connecting links and bridges/culverts. In terms of health, during flood over 40% of the tube well (hand pumps) are submerged, resulting in drinking water insecurity and scarcity for over three quarter of the population. Diarrhoea, high fever, cold, pneumonia, skin disease outbreaks. Floods often result in inundation of school and college facilities. At least one fifth of the households consider themselves in a crisis where they fail to continue sending their children. During flash flood and flood, women have extreme difficulty in bathing, relieving themselves as well as in carrying out daily chores like cooking. Women in advanced stages of their pregnancy also face extreme difficulty in accessing essential care/service.
3	Tornado	Areas hit by tornados lose as much as three quarters of their crops. A quarter of homes are totally destroyed while the remaining areas damaged. Almost half of the plants and trees are also destroyed.
4	Wave	During June-July, these waves cause destruction and damage to homes, settlements, road connections and latrines. Wave destroy almost a fourth of homes in some small villages while the remaining also suffer damages. Roads are damages creating difficulty in mobility. Almost a quarter of the open latrines are washed away.
5	Hail	Where they take place also damage all the crops of about half the farmers;
6	Drought	At the end of March, the land dries up quickly causing damage to about a quarter of crops for all farmers; As the ground water level falls further, a large number of families face drinking water shortage, and also attacked by related diseases.

7	Northwester (Kal Boishaki)	Sudden storms in April damage 20-40% of standing crops of all farming household. And at least a tenth of homes are damaged or destroyed, with plants and trees, and losses in livestock and poultry also take place.
8	Less Rainfall	During March-April, due to fall in ground water level topped by lack of rainfall, households face both drinking as well as irrigation water crisis.
9	Lightning	Every year a number of people die due to lightning
10	Dense Fog	At the end of winter and beginning of spring, this also damage bloom of mango flowers.

Impact of Major Climate Challenge and Possible Options/Practices for Confronting Challenge

Rank	Climate Challenge	Underlying cause	Possible & Practiced Options
1	Crop loss/ damage from flash flood and moon floods	Geographical location; Sudden rush of water; Without warning; No preparedness; Clearing of trees in upstream foothills; Silting of river beds; No means to drain water quickly; All land are single cropped land;	Ensure flash flood early warning reaches farmers and households; Plant Hijol *Brringtonia racemosa*, Koroch *Miletia pinnata* and other local tree species for protection; Re-excavation of river and canals; Bilateral talks and agreement between India and Bangladesh to ensure real time early warning;
2	Damage of home and settlements from flood	Low lying area; wave action; Flash flood and torrential rain; No early warning available; Foundation of home erodes; No protection dyke/embankment; Silting of river; Roads are low; Lack of adequate tree/plants; Lack of any public policy and process;	Establish early warning systems; Construct embankment around village for protection; Reexcavate river; Reinforce homestead and home plinth with stones and grass; Develop and implement policy and actions to address the challenge;
3	Damage of roads from flood and wave action	Large and high waves of *Afal* damage roads; No trees along the road; No road protection support (boulder, etc); Low and poorly made roads with few culverts; Corruption at different levels in implementing plans and programmes;	Plant trees along the road side; Plant grass along road slope; Build RCC protection block along road side; Road width has to be broadened and sluice gate constructed in the middle; Raise the level of the village settlement area; Take action to address corruption;
4	Health risks, safety and diseases from flood	Scarcity of drinking water; After recession of flood water, drinking water sources may remain contaminated; Financial pressure; Scarcity of necessary drugs in market; Hospitals/Health Care Centers cannot provide care or drugs; Government support do not reach in time, if reaches at all;	Ensure access to drinking water; ensure safe latrine & sanitation; increase awareness on risks; install deep tube well; availability of drugs; ensure proper management at local government level; ensure medical staff provide necessary service and care to people; establish more health service delivery centers; health service at village level;
5	North western (Kal Boishaki)	Happens without warning; Damages crops at early stage	Plant trees around village;
6	Livestock in risk due to flood	Fodder crisis as fodder not stored; Drinking water crisis;	Erect a platform to keep livestock safe; Store fodder/feed; Ensure health/vaccination services
7	Women specific risks	Lack of awareness; Drinking water scarcity; Sanitation & latrine problem; Difficulty in mobility and communication; Inadequate health centers	Organize volunteers to assist women; Arrange safe refuge, drinking water, drugs, safe sanitary practice;

Inter-Relationships among Non-Climatic Drivers, Pressures, State, Impacts and Policy Responses Related to Biodiversity in Haor Basin:

Drivers	Pressures	State	Impact		Policy Response	
			Natural System	Human, Social and Economic	Capacity Available	Lacking
Population boom	Over Exploitation of Ecosystems Goods and Services	Degradation of ecosystems	Degradation of Ecosystems; Biodiversity Loss	Livelihoods, Impaired food security, Loss of health and nutritional services, Increased flood and fresh flood	Increased level mass awareness on birth control and literacy; Alternative Income generation	No migration control policy
Poverty	Increase of dependency on natural resources, Over exploitation, Encroach-ment of swamp forest, wetland	Decrease of aquatic and terrestrial biodiversity	Loss of Habitat, Species diversity, Ecosystem integrity	Loss of livelihoods	Increased literacy, Alternative income generation, Safety net coverage, poverty reduction strategies of government	Alternative livelihoods diversity, Access of women market
Intensive Agriculture Practices	Increase the use of chemical fertilizer & insecticide, underground irrigation	Receding Water table, biomagnifi-cations	Loss of crop diversity, Water pollution, flora and faunal diversity reduced	Increased production, Nutritional imbalance	Govt agriculture extension and institution, Local knowledge and indigenous technologies, Use of organic fertilizer, Agriculture Policy	Agricultural practices harmonized with various types of crops and crop rotation, No land zoning
Invasive Alien Species	Threatening local species	Population and Habitat degradation	Degradation and imbalance of local species, Wildlife habitat impaired	sources of livelihood are impair	Quarantine rules	Absence of Legal Framework
Dam/ embank-ment/ Rural Infrastruc-ture	Water logging, Drainage congestion, Migration of biodiversity	Habitat loss, Decrease biodiversity	Deteriorate water quality, Loss of habitat, Changing fish migration route	Accessibility increased, Agro-land Increased, Open water fisheries resources shrinkage and Livelihood loss	Fisheries and wetland land policies	Environmental Impact Assessment not undertaken duly, Database on ecosystems not available

Climatic Presses in Haor habitats and the drives

Key Habitat	Goods and Services Provided by the Ecosystem to Community	Climatic Presser	Drivers
Beel (Perennial water body)	83% of people are involved in activities related to fishieris; Winter habitat for the mother stock of fish; Bank of beels are used for the production of paddy; Bank of beels serve as livestock grazing land; Winter habitat for migratory waterfowl	Reduction in spawning of fish	Late arrival of monsoon
		Siltation of beels	Upstream erosion and deposition with river flow
Agricultural Land	36.80% people involved in agricultural activities; Paddy is the main agricultural products; Vegetable cultivation increased	Damage of field crop before harvesting	Excessive rainfall in upstream resulting flash flood
River	Way of transportation; Natural source of fish; Sources of water in beels	Siltation of rivers	Excessive rainfall and deforestation resulting erosion in upstream
Swamp forest	Foul wood; Wave protection	Localized drought condition	No rain in early summer

Adaptation Practices

Following are the common adaptation practices, both autonomous and planned recorded in Hakaluki Haor:

Submergible dyke to protect crops from flash flood: Dyke makes water delay enter into the Haor which can ensure crop cultivation and harvesting and also has use as road in winter season. During monsoon the dykes go under water.

Flash flood proof rural market and common place: Rural market, community clinic etc. built on high plinth.

Crop diversification: Haor was mono cropper; in winter community recently cultivating around 11 winter crops mostly vegetable like wheat, maize, onion, garlic, potato, pigeon-pea, bean, etc.

Early maturing rice variety: Country cultivating early rice verity, like BRRI 28, BRRI 45; those rice have comparatively shorter days to have the production, its 140 days.

Hydroponics: Floating base made of rotten water hyacinth uses as seed bed for climber vegetable in Haor basin, now a days also used as paddy seed bad and to cultivate vegetables mostly leafy vegetables. Such a cultivation practice ensures the farming during the flood and early recovery.

Village mound protection: It's a local technology to protest wave action causing landslide. Bamboo made protection fence containing Chailla grass *Hemarthria protensa* helps to mitigate the wave action intensity.

Swamp forest: Hijol *Brringtonia racemosa*, Koroch *Miletia pinnata* are the common swamp trees. Swamp forest mitigates the wave action intensity.

Duck farming: Duck farming at commercial and or household level ensure income generation. In haor as the food for duck mainly snail is available and the road communication network has increased duck farming getting popularity.

Canal re-excavation: Dredging or removal of mad will reduce siltation that helps on flood control and navigation also.

Mana: Mana is a designated area of water body where regular fishing is not occurred; Braches of tree are also kept.

Reed protection: Reed grows naturally in Haor basin. The reeds were harvested by the community for different uses. Currently from the experience the local community believe reed land helps fisheries protection and protect reed patches.

Conservation Co-benefit

Adaptation practice	Benefit to biodiversity	Species reported	Species Reported from Hakaluki Haor
Submergible dyke	Habitat, Roasting Tree	Rodents, Jackal, Mongoose	59 Species of mammals
Flash flood proof rural market and common place	Key stone species protected	23 spp of Birds, 4 reptiles, 5 mammal	
Crop diversification	Food (insect and rat) availability for birds significant	42 vascular plants	526 plant species of which 89 are threatened
Early maturing rice variety			
Hydroponics	Nest of Tailor Birds	12 spp birds, Stripped skink	
Village mound protection	Homestead biodiversity	Village grove forests	
Swamp forest	Habitat, Breeding ground	12 spp birds, 9 spp mammals, 7 spp reptile and 3 spp amphibian	558 wildlife species of which 100 are threatened
Duck farming in Haor			
Canal re-excavation	Aquatic Habitat		
Mana	Breeding ground for fish	53 fish species, 31 species with eggs.	107 fish species of which 32 are threatened
Protection of Reed	Habitat of Moorhen	Common Moorhen, Purple Swamphen	

Mana: Practice of Mana is traditional, but to ensure more harvest and more production the practice of Mana has increased significantly. It was reported that though number of mana has increased in double but average size has reduced by two third. Fifty three species of fish were recorded from a mana near Vukshimul village where 31 species were found carrying eggs.

Swamp forest: Hakaluki has both naturally grown swamp forests and planed swamp forests. The main species of the Swamp forest are Karoch *Milletia pinnata* and Hijol *Barringtonia racemosa*. No significant vegetation diversity was reported between the natural growth and planted vegetation. Twenty six species of Birds, 9 species of mammals including fishing cat and jangle cat, 4 species of snakes, 2 skink (common skink, bronze grass), Spotted Flapshell Turtle and 3 species amphibians were reported. Cormorant and Pond Heron use the swamp forests as their breeding colony.

Crop diversification: Crop diversification extended the habitat for wildlife during winter. The insect production has increased that allows more insect food to the birds. According to the community the population of Jackel *Canis aures* that was reduced drastically because of the flood of 1988 has increased now; the winter vegetation also helping them with food and habitat.

Conclusion

Adaptation is a must to cope with climate change. The livelihood of the Haor basin is mostly dependent on natural resources, and the adaptation practices are mostly natural resources management. Haor basin is the second most vulnerable ecosystem of Bangladesh. Government of Bangladesh has taken number of initiatives to cope with climate change. Sumon (2010) reported that the rainfall pattern in upstream of Haor has changes and resulting change in timing in flash flood. Ullah *et al* (2013) recorded 162 vascular plant species of genre 116 genera from Hakaluki Haor. Biodiversity National Assessment and Programme of Action 2020 reported that construction of embankment created obstacle to fish movement and migration. Very little research has so far been undertaken to fully appreciate implications of climate change on ecosystems and biodiversity (Ahmed 2006). However, it is suggested that ecosystems and biodiversity may be at greatest risk of all sectors sensitive to climate change (WB, 2000). Since the management of ecosystems is still relatively weak in its institutional realization and the institutions that are involved lack the capacity, adaptation to climate change for ecosystems and biodiversity warrant special institutional arrangements. Except some works on floating garden a few research has been conducted to accesses the significant and values of adaptation practices. IUCN conducted series of study on the biodiversity of Tanguar Haor, the study noted that sustainable forest (swamp forest and reed beds) management will help local people to continue collecting their variety of products and services and also assist in fish breeding (Alam *et al* 2012). In the community consultations it was reported that community though the experience has identified the ecological value of the reed beds. Hossian and Chakraborty (2011) noted that the rice paddy cultivation benefited the birds specifically the waders birds. Bangladesh Climate Change Strategy and Action Plan has identified number of activities and also a good number of adaptation initiatives has been implemented by Government and non-government organization. Natural resource based adaptation are mostly ecosystem specific. Biodiversity conservation is essential because it not only plays a key role in the global carbon cycle and in adapting to climate change; it also provides a wide range of ecosystem services that are essential for human wellbeing (Turnbull *et al* 2013).

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Non-Destructive Harvest of Non Timber Forest Products: Potential Approach for Resource Conservation and Livelihood Augmentation

— *A.K.Pandey*

ABSTRACT

The paper deals with the non-destructive harvesting practices of some important commercial Non Timber Forest Products (NTFPs) as a major conservation strategy and potential approach for resource conservation and livelihood augmentation. In recent years, NTFPs have attracted considerable interest as a component of sustainable development initiatives in respect of their ability to support and improve rural livelihoods vis-à-vis resource conservation. However, there is lack of systematic understanding in the contribution and impact of harvesting practices on NTFP resources and rural communities. Consequently, studies were conducted in central India to develop non-destructive harvesting practices of some bark yielding NTFPs i.e. Arjun (*Terminalia arjuna*), Ashok (*Saraca asoka*), Kachnar (*Bauhinia variegata*), Kutaj (*Hollarrhena antidysentrica*), Maida (*Litsea glutinosa*) and Sheonak (*Oroxylum indicum*). The study recommends that ¼ of mature bark of total girth should be either extracted by making blaze in middle aged trees having GBH more than 60 cm or by removing longitudinal strips (alternate/opposite) in younger aged trees (GBH less than 30 cm). Only outer and middle bark should be extracted leaving inner bark for regeneration so that the sustainable bark harvesting can be done after every two to three years by removing opposite quarters of trunk bark. By analyzing the harvested bark samples for their active ingredients it was found that harvesting time and age of the tree is directly related to the quality. Involvement of local people and adaptive management practices had enhanced the ecological knowledge base of harvesting communities that narrowed the disparities between livelihood gains and the ecological cost, ultimately leading to a greater livelihood security to the poor communities.

Key words: Non-destructive harvesting, conservation strategy, livelihood augmentation.

Introduction

In India, Non Timber Forest Products form the backbone of forestry sector as they provide 50% of forest revenues and 70% of forest export incomes (Shiva, 1994). The direct contribution of NTFPs is estimated to be about $ 27 billion compared to $ 17 billion from timber forest products (ITTO, 2007). The forests of central India are depository of several valuable NTFPs including medicinal plants. Collection and sale of non-timber forest produce (NTFPs), including medicinal plants, from its vast forest resources has a significant bearing on the socio-economic fabric of Madhya Pradesh and Chhattisgarh as it forms an important source of livelihood for the tribal population of the state (Pandey and Shukla, 2006). An annual consolidated trade worth Rs. 525 crores in respect of the 'nationalized' and the 'non-nationalized' Minor Forest Produce has been reported from the state of Chhattisgarh for the year 2006-07 (CGMFP Federation Survey Report, 2006). The present harvesting practices are destructive and unsustainable leading to decrease in population of NTFP species.

NTFP resources are used throughout the world by subsistence communities for daily needs, as well as to generate income. It has been argued that the income generation potential of many NTFPs can be sources for income to rural communities and thereby be an incentive for resource conservation. An alternative perspective is that commercialization of NTFPs frequently leads to over utilization, resulting in a decline of resource and income of the communities dependent on them (Peters, 1999). At present, 90% collection of medicinal plants is from the wild, generating about four million mandays employment (both part and full time) and since 70% of plants collection involves destructive harvesting many plants are endangered, vulnerable or threatened. Due to this spurt medicinal plants are being overexploited and many of them are pushed to the brink of extinction. Similarly, the medicinal plants are collected without paying attention to the stage of maturity.

Tree bark is a commonly used traditional medicine in the world (Cunningham, 1993). The growing demand for medicinal bark, commercialization and destructive harvest techniques pose a major threat to high demand forest species. The increasing demand has lead to uncontrolled and destructive harvesting of trees (Cunningham, 1993; Mander, 1998; Grace, 2002; Grace et al., 2002) which is a matter of great concern. The management and extraction of NTFPs is enormously important as it has direct consequences to the environment and communities in terms of economic benefits. The harvesting of NTFPs should concur to the sustainability principle of forest management.

The basic idea behind sustainable harvesting is that a biological resource should be harvested within limits of its capacity for self renewal. More than that, the manner of its harvest should not degrade the environment in any way (Hamilton, 2005). In present harvesting practices, generally the collectors harvest medicinal plants without considering the sustainability issues. Good collection practices are necessary for the long term survival of wild populations and their habitats. Medicinal plant materials need to be collected in a proper season to ensure the best possible quality of both the starting material as well as the finished product.

Arjuna (*Terminalia arjuna*), Maida (*Litsea glutinosa*), Kutaj (*Hollarrhena antidysentrica*), Kachnar (*Bauhinia variegata*), Sheonak (*Oroxylum indicum*) and Ashok (*Saraca asoka*) are some of the important medicinal trees of central India. The demand of all the above species is between 1000-2000 MT annually in India (Ved and Goraya, 2007). Due to illegal logging and unsustainable harvesting, the availability of these important medicinal trees is threatened. Keeping in view the demand and status of above medicinal trees, a study was conducted for sustainable harvesting of *T. arjuna*, *S. asoka*, *B. variegata*, *H. antidysentrica*, *L. glutinosa* and *O. indicum* bark in different forest areas of central India.

About the Species

Arjuna (*Terminalia arjuna*)

Terminalia arjuna Roxb. (Arjuna) belongs to family Combretaceae, is a large tree with fissured bark and numerous dropping branches. The tree is common throughout the greater part of Indian peninsula along rivers, streams, ravines and dry water courses. Arjuna is a water loving species and typical of dry deciduous forests of central India. The tree prefers humid, fertile loam and red lateritic soils. It grows in low land to hilly areas and can tolerate half submergence for a few weeks. It is also planted for shade and decoration in avenues or parks (Anonymous, 1992).

Its bark has been used in traditional Ayurvedic preparation for generations, primarily as a cardiac tonic. It is beneficial in the treatment of coronary artery disease, heart failure and hypercholesterolemia. It is also having antibacterial, antioxidant, antimutagenic febrifuge and anti-dysenteric activities. It is also effective in biliousness, sores, hepatic, congenital, venereal and viral diseases (The Wealth of India, 1997).The wood is used in agricultural implements, water troughs and certain types of tool handles. Another economic importance is that the leaves are fed to tasar silkworms. Demand of *T. arjuna* bark, both in India and abroad has been growing rapidly for over a decade. The shift from subsistence use to commercial trade of medicinal plants has led to an increase in intensity and frequency of medicinal plants harvested from wild habitats.

About 95 percent of the Arjuna bark requirement is met from the wild, which is collected in a pattern that is not concomitant with sustainable harvesting practices. Harvesting commercial quantity of bark has affected Arjuna population. It is estimated that the annual demand of Arjuna bark is between 2000 to 5000 tonnes. However, the total consumption of Arjuna bark by India's herbal industry was more than 2000 MT during 2005-2006.

Maida (*Litsea Glutinosa*)

Litsea glutinosa C.B. Robinson (commonly known as Maida) belongs to family Lauraceae. It is an evergreen tree with somewhat corky and lenticellate bark. It is found in mixed primary and secondary forests upto the altitude of 1300 m. It is native to India and distributed through Indo-China towards Malaysian area where it occurs in all parts. Earlier the species was abundantly available in the forests of Madhya Pradesh and Chhattisgarh. However, mass scale collection of the bark of this plant for agarbatti industry from natural habitats has lead to the depletion of this important plant. This has threatened the survival of this species from the natural sources. Therefore, it is necessary to develop non-destructive harvesting practice of this important tree species. The root, bark, leaves, fruits and seeds of Maida are used as medicine.

According to Ayurveda, roots are cooling, aphrodisiac, galactagogue and useful in treatment of biliousness, burning sensation, bronchitis, fever, leprosy etc. According to Unani system of medicine, root is astringent, tonic, expectorant, aphrodisiac and useful in treatment of inflammations, overheated brains, thirst, throat troubles, spleen diseases, paralysis etc. The bark is powdered and paste is applied on boil. Local people believe that it is excellent remedy for boil (Baltod) (The Wealth of India, 1997). The bark of *L. glutinosa* plays a key role in the survival of the agarbatti (incense stick) industry in India. Powdered bark of *L. glutinosa* and *Machilus macrantha* is known as JIGAT in trade, functions as an adhesive or binder in agarbatti manufacturing. It has great demand in market (Kirtikar and Basu, 1981).

Kutaj (*Holarrhena Antidysenterica*)

Holarrhena antidysenterica **Wall. Ex A. DC** (commonly known as Kutaj) belonging to family Apocyanaceae, is a small tree or shrub. It is found in Asia, Africa, Madagascar, India, and Philippines. This tree grows throughout India up to an altitude of 4,000 ft. and often gregariously found in deciduous forests, open waste lands and is especially abundant in the sub-Himalaya tract. *H. antidysenterica* is up to 13 m in height, with milky latex, its bark peels off in flakes and is grey to pale brown in color. The leaves are shiny on the upper surface, dull and hairy on the lower, opposite, subsessile and elliptic. The flowers are white, in terminal corymbose cymes; the fruits are cylindrical, dark grey with white specks and occur in pairs; the seeds are light brown and 0.5 X 1.5 cm in size (Anonymous, 1982). Around 30 alkaloids have been isolated from the plant, mostly from the bark. These include conessine, kurchine, kurchicine, holarrhimine, conarrhimine, conaine, conessimine, iso-conessimine, conimine, holacetin and conkurchin.

Leaves, barks and fruits of Kutaj are useful in various diseases. However, bark is the most useful part and used as an astringent, anthelmintic, antidontalgic, stomachic, febrifuge, antidropsical, diuretic, in piles, colic, dyspepsia, chest infections and as a remedy for skin and spleen diseases. A hot decoction of the drug is used as a gargle in toothache. It is a well-known drug for amoebic dysentery and other gastric disorders.

Till now the bark is being harvested by cutting down the entire tree and chopping the main stem and branches and removing the entire bark from the existing tree. The bark exploitation has caused serious damage to wild populations, including trees inside the forests.

Sheonak (*Oroxylum Indicum*)

Oroxylum indicum (L.) Benth. ex Kurz (Hindi: Sheonak) belongs to family Bignoniaceae. The plant grows all over India in deciduous forests and in moist areas. In India it is distributed in Eastern and Western Ghats and North-East regions. The existence of Sheonak in natural population is highly threatened and it has been categorized as vulnerable medicinal plant species. It is a medium sized deciduous tree growing 8-12 meters in height. The bark is grayish brown in colour with corky lenticels. The leaves, very large, 0.5-1.5 meter in length, 2-3 pinnate, leaflets 12 cm long and 8 cm broad. The flowers are reddish-purple outside and pale, pinkish-yellow within, numerous, in large erect racemes. The fruits are flat capsules, 0.33-1 meter long and 5-10 cm broad, sword-shaped (The Wealth of India, 1997). The seeds are numerous, flat and winged all around, except at the base. The plant flowers in June-July and bears fruits in November.

Sheonak is mainly used as a constituent of the ayurvedic preparation Dasmularista. The popular preparation Dasmularista is used by Ayurvedic physicians since ages, for the treatment of vitiated conditions of vata dosha, like rheumatic disorders. Sheonak is one of the herbs mentioned in all ancient scriptures of ayurveda. It possesses analgesic, antibacterial, anticancerous, antioxidant, hepatoprotective, gastroprotective and immunomodulatory properties. Many flavones and traces of alkaloids are present in pods, seeds, stem and root barks. The plant contains flavonoids like chrysin, oroxylin and baicalein as active principles. A flavone glucuronide – oroxindin is also isolated from seeds and characterized.

Kachnar (*Bauhinia Variegata*)

Bauhinia variegata Linn. (Hindi: Kachnar) belongs to family Caesalpiniaceae is a small to medium sized deciduous tree with a short bole and spreading crown, attaining a height of up to 15 m and diameter of 50 cm. In dry forests, the size is much smaller. The bark is light brownish grey, smooth to slightly fissured and scaly. Inner bark is pinkish, fibrous and bitter (Anonymous, 1959). The twigs are slender, zigzag; when young, light green, slightly hairy and angled, becoming brownish grey. It is distributed throughout **India growing wild and as a garden plant.** The various parts of the plant viz., flower buds, flowers, stem, stem bark, leaves, seeds and roots are practiced in various indigenous systems of medicine and popular among the various ethnic groups in India for the cure of variety of ailments. The flower buds are used for the treatment of diarrhoea, dysentery and haemorrhoids. The flowers are used in piles, oedema, dysentery, as laxative and anthelmintic. The bark is used in fever as tonic and astringent, as antileprotic, in skin diseases and wound healing, antigoitrogenic and as antitumour. It is also reported to be useful as antitumour and in obesity. The leaves are used in treatment of skin diseases and stomatitis. The roots of the plant are used as an antidote for snake poisoning, in dyspepsia, flatulence and as carminative. The stem bark is reported to contain 5,7 dihydroxy and 5,7 dimethoxy flavanone-4-O-□-L rhamnopyrosyl-□-D-glycopyranosides, Kaempferol-3-glucoside, lupeol and betasitosterol. Seeds contain protein, fatty oil-containing oleic acid, linoleic acid, palmitic acid and stearic acid. Flowers contain cyanidin, malvidin, peonidin and kaempferol. Root contains flavanol glycosides.

Ashoka (*Saraca Ashoka*)

Saraca ashoka (Roxb.), De.wild (Ashoka) is a small or medium sized tree with beautiful dense clusters of yellow and orange-red flowers belongs to the Caesalpineaceae family. Ashoka is sacred to the Hindus and the Buddhists. It is among the trees that add beauty to the outdoors. Its leaves are peri-pinnate, 15-20 cm long, leaflets 6-12, oblong, lanceolate, pods flat, leathery, seeds 4-8, ellipsoid-oblong. The yellow and red colours of the flowers contrast well with the deep green colour of the leaves. Flowering starts from January and continues till May, though sometimes the flowers are visible during other months also. Ashoka means "without sorrow", possesses several medicinal properties. Its bark is reputated for keeping women healthy and youthful. Crushed flowers and leaves are rubbed on the skin to get relief from skin diseases. The plant is used also in dysmenorrhoea and for depression in women. It is also reported to cure biliousness dyspepsia, dysentery, colic, piles and pimples. Leaves possess blood purifying properties. Flowers are used in dysentery and diabetes (Anonymous, 1959).

Ashoka is well known for its use in treating gynecological disorders. Many Ayurvedic physicians believe that women should use this herb frequently to avoid gynecological and reproductive disorders. Bark is removed and sun dried for use in preparation of various herbal medicines. Domestic consumption of bark is quite high in pharmaceutical industries. It also has good export potential. Decoction, Ghrit, Arishta and many other formulations like Sundareekalp, M2 Tone, Leukonil, Ashokarishta, Ashokaghrita are available in the market. This increased demand of the bark has threatened this beautiful tree from the wild. It needs conservation and the only way to conserve this valuable species is non-destructive harvesting and sustainable utilization.

Methodology and Experimental Layout Study Areas

Study areas were selected in the states of Madhya Pradesh, Chhattisgarh, Maharashtra and Odisha, India. The surveys were conducted in different forest areas of central India to select growing areas of targeted tree species. Populations of selected species were identified with the help of local people and forest officials. Experiments were laid out for standardization of sustainable harvesting of selected species in different forest areas of Jabalpur, Rewa, Balaghat, Mandla (Madhya Pradesh); Harishankar, Khurda, Champagarh (Odisha); Bilaspur, Keochi, Raigarh, Pendra, Kawardha (Chhattisgarh) and Chandrapur, Nasik (Maharashtra). Trees of different age group and girth size were selected for laying out the experiments.

Methodology

Bark Harvesting

Healthy trees of different age groups and girth sizes were selected for laying out the experiments in randomized block design (RBD) in five replications. Care was taken not to include trees with pollarded crown, broken branches or those infected with fungi and insects. Different bark harvesting methods have been experimented. In these methods tree stem diameter was divided in 3 or 4 equal parts and bark was extracted from one part. The bark was also extracted by removing longitudinal alternate strips along the main stem. A tool with a thin blade was used to harvest the bark. The bark was extracted by scraping it from the tool at an angle to ensure that only outer and middle bark peels off upto the desired length and width.

Following bark harvesting methods were experimented –

(a) Method I: Strip harvesting by removing ⅓ part (diameter) of stem bark

(b) Method II: Strip harvesting by removing ¼¼ part (diameter) of stem bark

(c) Method III: Longitudinal alternate strip bark harvesting along the diameter of stem

(d) Method IV: Longitudinal alternate strip bark harvesting along the length of stem

Phytochemical Analysis

The harvested bark samples were brought to the laboratory for chemical analysis. The harvested samples were dried under shade. The fresh and dry weights of the bark were recorded. The dried bark samples were ground into coarse powder and used for chemical analysis. Bark samples were analysed for their active chemical ingredients. Total phenols in the samples were estimated by Folin-Ciocalteau method (McDonald et al., 2001), tannins by Folin-Denis method (Schanderi, 1970), total flavonoids by aluminium chloride colorimetric technique method (Chang et al., 2002) and for estimation of mucilage content standard method reported by Klein, 1932 were used.

Statistical Analysis

Data on bark recovery of all six targeted species were analysed statistically using multivariate ANOVA and variation in the quality characteristics of bark were tested by one way ANOVA using SPSS (Statistical Package for the Social Sciences, Version 14.0) and values of $P \leq 0.05$

were taken to imply statistical significance. Statistically best harvesting method and season were determined using Duncan's Multiple Range Test (DMRT). Means were calculated from five replications and results were expressed as the mean ± SD.

Observations

Data on regrowth (regeneration of bark) was recorded half yearly. The bark's regenerative properties were determined by the time taken to regenerate the bark. The stage of bark recovery varied from tree to tree. The physical appearance of bark regrowth was recorded. Two types of bark regrowth were observed i.e. edge growth and sheet growth in all six species.

Results and Discussion

Bark regeneration percentage in targeted species with respect to GBH, bark harvesting methods and time taken for regeneration is represented in Table 25.1. Bark regrowth was represented as regeneration percentage observed at six monthly intervals. In younger trees which have GBH group 10-50cm bark regeneration percentage was faster in strip harvesting method during initial 6 months period in all tree species. Similar trends were observed during consecutive period and complete regeneration was achieved within 18 months after harvest in smaller GBH group and within 24 months in higher GBH group. Similar bark regeneration pattern was observed in all species.

Table 25.1 Bark recovery in Arjuna, Kutaj, Kachanr, Sheonak, Maida and Asoka

Species	GBH (cm)	Regeneration of bark (%)			
		6 months	**12 months**	**18 months**	**24 months**
Arjuna	50-100	30.28±2.65[a]	35.26±1.69[a]	33.98±1.89[a]	
	101-150	20.52±1.65[b]	30.52±1.49[b]	30.52±2.92[ab]	18.12±1.08[b]
	151-200	18.75±1.68[b]	26.52±1.45[c]	26.85±1.06[b]	27.52±1.02[a]
Kutaj	10-40	35.64±1.31[a]	39.52±2.51[a]	24.59±1.58[c]	
	41-80	33.78±2.41[ab]	35.92±1.38[b]	29.63±1.46[a]	
	81-120	31.52±1.28[b]	33.89±2.81[b]	27.52±1.02[ab]	6.52±0.26[a]
Sheonak	10-50	38.57±2.61[a]	37.52±1.59[a]	23.52±1.22[b]	
	51-100	33.63±1.52[b]	36.52±1.30[a]	30.52±1.23[a]	
	101-150	20.52±1.24[c]	30.52±1.65[b]	30.52±1.98[a]	18.12±0.89[a]
Kachnar	15-35	38.57±1.38[a]	37.52±1.27[a]	23.52±1.63[b]	
	36-55	30.63±1.69[b]	35.52±1.56[a]	29.52±1.85[a]	6.58±0.58[b]
	56-75	25.36±1.64[c]	30.98±2.49[b]	28.52±1.39[a]	13.12±0.34[a]

Species	GBH (cm)	Regeneration of bark (%)			
		6 months	12 months	18 months	24 months
Ashok	10-30	33.63±2.95[a]	36.52±1.58[a]	30.52±1.32[a]	
	31-60	25.36±1.09[b]	34.98±1.67[ab]	30.52±1.69[a]	7.58±0.26[b]
	61-90	24.89±1.52[c]	28.63±1.82[b]	31.56±1.19[b]	14.98±1.27[a]
Maida	10-30	33.64±1.15[a]	35.91±1.41[a]	31.85±1.52[a]	
	31-60	30.56±1.28[b]	33.57±1.29[ab]	29.57±1.26[a]	6.45±0.25[b]
	61-90	26.52±1.69[c]	32.68±1.98[b]	24.65±1.29[b]	18.63±1.41[a]

Values are presented as Mean±SD (n=5). Mean value within each column followed by different letter differ significantly at $p<0.05$

The data revealed significant variation in total phenols, total flavonoids and tannins with regard to different GBH groups. In Arjuna, maximum concentration of total phenols (15.95±1.58), total flavonoids (0.55±0.02) and tannins (11.67±0.81) were found in 100-150cm GBH group in March. In Kachnar, maximum concentration of total phenols (55.38±6.64), total flavonoids (0.02±0.00) and tannins (24.12±1.77) were found in 36-55cm GBH group in March. In Ashok, maximum concentration of total phenols (7.25±0.94), total flavonoids (0.23±0.04) and tannins (40.15±3.55) were found in 61-90cm GBH group in March. In Kutaj, maximum concentration of total phenols (9.21±0.32), total flavonoids (0.23±0.04) and tannins (40.15±3.55) were found in 81-120cm GBH group in March. In Sheonak, maximum concentration of total phenols (3.69±0.05), total flavonoids (1.09±0.15) and tannins (2.74±0.08) were found in 100-150cm GBH group in March. Total phenols, total flavonoids and tannins content in stem bark of all selected species are presented in Table 25.2.

Table 25.2 Phytochemical analysis of stem bark of selected species

Species	GBH group (cm)	Harvesting season	Total phenols %	Total flavonoids %	Tannins %
Arjuna	50-100	March	15.27±0.40[a]	0.38±0.01[a]	10.20±0.46[a]
		June	9.27±0.21[d]	0.19±0.02[d]	5.64±0.14[d]
		September	11.58±0.28[c]	0.24±0.02[c]	7.26±0.07[c]
		December	14.34±0.26[b]	0.31±0.01[b]	9.56±0.19[b]
	101-150	March	16.20±4.04[a]	0.36±0.06[a]	12.50±0.30[a]
		June	8.65±0.27[d]	0.19±0.04[d]	5.84±0.12[d]
		September	11.58±1.45[c]	0.24±0.02[c]	8.56±0.24[c]
		December	14.54±2.68[b]	0.31±0.03[b]	10.25±0.19[b]
	151-200	March	15.95±1.58[a]	0.55±0.02[a]	11.67±0.81[a]
		June	9.65±1.25[cd]	0.29±0.01[c]	5.49±0.26[cd]
		September	12.24±0.98[b]	0.42±0.02[b]	8.34±0.49[b]
		December	14.51±1.29[a]	0.51±0.01[b]	9.28±0.61[b]

Species	GBH group (cm)	Harvesting season	Total phenols %	Total flavonoids %	Tannins %
Kachnar	15-35	March	22.48±7.57 [a]	0.01±0.00 [a]	15.71±0.88 [a]
		June	15.87±1.08 [cd]	0.01±0.00 [a]	10.54±0.34 [cd]
		September	17.64±4.67 [b]	0.01±0.00 [a]	12.98±0.25 [b]
		December	20.37±5.61 [a]	0.01±0.00 [a]	14.65±0.28 [a]
	36-55	March	55.38±6.64 [a]	0.02±0.00 [a]	24.12±1.77 [a]
		June	45.87±2.62 [cd]	0.01±0.00 [a]	15.64±0.87 [d]
		September	49.67±2.29 [b]	0.01±0.00 [a]	19.58±0.58 [c]
		December	52.58±5.67 [b]	0.02±0.00 [a]	22.57±0.99 [b]
	56-75	March	33.99±3.87 [a]	0.02±0.00 [a]	16.00±0.36 [a]
		June	25.40±1.27 [cd]	0.01±0.00 [a]	9.52±0.12 [cd]
		September	29.67±2.48 [b]	0.02±0.00 [a]	12.67±0.31 [b]
		December	32.59±2.48 [a]	0.02±0.00 [a]	15.25±0.21 [b]
Ashok	10-30	March	6.54±0.71 [a]	0.17±0.01 [a]	29.92±4.58 [a]
		June	2.59±0.07 [c]	0.09±0.01 [d]	21.47±1.39 [d]
		September	4.59±0.13 [b]	0.11±0.01 [c]	25.17±1.85 [c]
		December	5.29±0.25 [a]	0.13±0.01 [b]	27.45±2.58 [b]
	31-60	March	6.67±0.41 [a]	0.19±0.02 [a]	36.40±2.91 [a]
		June	2.67±0.12 [c]	0.12±0.01 [d]	27.25±1.31 [d]
		September	4.52±0.17 [b]	0.15±0.01 [c]	31.58±0.28 [c]
		December	5.89±0.34 [b]	0.18±0.02 [b]	35.28±2.08 [b]
	61-90	March	7.25±0.94 [a]	0.23±0.04 [a]	40.15±3.55 [a]
		June	3.65±0.18 [c]	0.11±0.01 [d]	29.14±0.25 [d]
		September	5.48±0.27 [b]	0.15±0.02 [c]	34.21±1.24 [c]
		December	6.57±0.24 [b]	0.19±0.02 [b]	38.27±2.16 [b]
Kutaj	10-40	March	6.48±0.12 [a]	0.16±0.08 [a]	7.65±0.16 [a]
		June	3.12±0.05 [d]	0.05±0.01 [d]	4.89±0.04 [d]
		September	3.54±0.09 [c]	0.09±0.03 [c]	5.45±0.07 [c]
		December	4.86±0.15 [b]	0.14±0.05 [b]	6.98±0.12 [b]
	41-80	March	8.61±0.25 [a]	0.29±0.11 [a]	9.74±0.17 [a]
		June	4.25±0.12 [c]	0.11±0.02 [d]	5.28±0.10 [d]
		September	4.96±0.17 [c]	0.19±0.08 [c]	6.98±0.13 [c]
		December	7.63±0.21 [b]	0.24±0.14 [b]	7.54±0.20 [b]
	81-120	March	9.21±0.32 [a]	0.30±0.08 [a]	9.89±0.05 [a]
		June	4.65±0.08 [d]	0.05±0.02 [d]	6.09±0.08 [c]
		September	6.52±0.14 [c]	0.15±0.07 [c]	6.21±0.11 [c]
		December	8.04±0.13 [b]	0.21±0.05 [b]	7.98±0.09 [b]

Species	GBH group (cm)	Harvesting season	Total phenols %	Total flavonoids %	Tannins %
Sheonak	10-50	March	2.28±0.06[a]	0.68±0.07 [a]	2.45±0.12[a]
		June	1.12±0.05[c]	0.15±0.01[d]	1.08±0.04[cd]
		September	1.54±0.09[c]	0.38±0.03[c]	1.85±0.07[c]
		December	2.01±0.11[ab]	0.54±0.04[b]	2.11±0.19[ab]
	51-100	March	3.69±0.05[a]	1.09±0.15[a]	2.74±0.08[a]
		June	2.53±0.13[c]	0.19±0.02[c]	1.28±0.07[d]
		September	2.68±0.18[c]	0.53±0.05[c]	1.10±0.03[c]
		December	3.41±0.26[b]	0.91±0.11[b]	2.12±0.04[b]
	101-150	March	3.16±0.12[a]	1.00±0.08[a]	2.68±0.01[a]
		June	1.15±0.08[d]	0.16±0.02[d]	0.24±0.01[c]
		September	1.52±0.14[c]	0.24±0.07[c]	0.67±0.07[c]
		December	2.04±0.13[b]	0.34±0.05[b]	1.03±0.01[b]

Values are presented as Mean±SD (n=5). Mean value within each column followed by different letter differ significantly at $p<0.05$

Chemical analysis of Maida bark was conducted and data is presented in Table 25.3. Maximum amount of mucilage content (3.91±0.01) and tannins (4.75±0.02) were found in 10-30cm GBH group in the month of March. Younger trees contain higher amount of mucilage in comparison to mature trees. However, bark thickness was much less in younger trees in comparison to mature trees.

Table 25.3 Phytochemical analysis of Litsea glutinosa (Maida) bark

GBH group (cm)	Harvesting season	Mucilage %	Tannins %
10-30	March	3.91±0.01[a]	4.75±0.02[a]
	June	2.45±0.02[b]	2.65±0.02[c]
	September	2.89±0.04[b]	3.65±0.02[b]
	December	3.87±0.01[a]	4.23±0.03[a]
31-60	March	3.48±0.01[a]	3.56±0.02[a]
	June	1.87±0.01[c]	1.78±0.01[c]
	September	2.40±0.01[b]	2.27±0.02[b]
	December	2.56±0.02[b]	2.74±0.01[b]
61-90	March	3.76±0.02[a]	4.07±0.02[a]
	June	2.15±0.01[b]	2.54±0.02[c]
	September	2.89±0.01[b]	3.24±0.01[b]
	December	3.12±0.03[a]	3.86±0.02[a]

Values are presented as Mean±SD (n=5). Mean value within each column followed by different letter differ significantly at $p<0.05$.

Bark recovery capacity varies among different species. Kutaj and Sheonak barks recover faster whereas Arjuna and Maida have medium recovery rate. Kachnar and Ashok have slower bark recovery rates. Bark recovery of studied species is depicted in Table 25.4.

Table 25.4 Bark recovery capacity of studied species

Species	**Bark recovery capacity**
Bauhinia variegata (Kachnar)	Slow
Saraca asoka (Ashok)	Slow
Litsea glutinosa (Maida)	Medium
Terminalia arjuna (Arjuna)	Medium
Hollarrhena antidysentrica (Kutaj)	Fast
Oroxylum indicum (Sheonak)	Fast

The results revealed that bark regeneration was faster in younger and middle aged trees which corroborates with the findings of Delvaux et al., 2010 in which they reported that trees of *Pseudocedrela kotschyi* had similar pattern i.e. medium sized trees (21–30cm dbh) had a faster bark recovery than the other studied dbh classes.

Strip harvesting (method III) showed faster bark regeneration in all the GBH groups in all selected tree species because in this method only small portion of bark was removed, resulting in smaller wound. Moreover, bark regeneration was also faster during initial 6 months due to plant wound closure mechanisms that occur during initial few months after wounding (Schmitt and Liese, 1993; Oven and Torelli, 1994). In trees of higher girth classes and large blazes the size of wound is bigger resulting in more exposed surface area, which takes long time to recover. In first 6 months after harvest mostly edge growth was observed during bark regeneration process there after both edge and sheet growth were observed that are in accordance to the findings of Delvaux et al., 2009 where they reported edge and sheet bark regrowth in some medicinal trees species of Benin, West Africa. This could be explained by a higher hormonal activity stimulated by stress in order to restore water conductivity and thus to close the wound as soon as possible (Mohr and Schopfer, 1995).

In our study we found that bark regrowth also varies with sites, season and microclimate. Cunningham, 2001 also reported the same. Geldenhuys et al., 2002 and Vermeulen and Geldenhuys, 2004 also reported that response to bark stripping could be affected by season of harvesting and this varies between species. The affect of harvesting season on bark regeneration showed when the bark was harvested in the month of March, the bark regeneration was faster. However, the bark regeneration was slower when the bark was harvested in the month of June.

Phytochemical content showed remarkable variation with the girth of the tree i.e. it is higher in middle aged trees and lower in younger trees. Berrocal et al., 2004 also showed that the chemical composition of *Pinus radiata* trees varied significantly with the age of tree. On the basis of quality of the bark with respect to their phytoconstituents, the bark harvested in the month of March has higher concentration of constituents as compared to the bark harvested in the month of June. Therefore ideal time for bark harvesting to get quality produce is from February to March for the all studied tree species.

Conclusion

Stem bark can be obtained on sustainable basis if the bark is harvested through non-destructive harvesting techniques and sufficient time is allowed between two successive harvests for the plant to regenerate new bark. Bark should be harvested longitudinally, not all over the circumference of trunk and branches. In younger trees (having GBH less than 30cm) bark should be extracted by removing 5-6 cm wide strips on the main trunk of the tree. For sustainable harvest, strip harvesting should be done on the tree trunk. Only outer and middle bark should be removed leaving the inner bark for regeneration. Sustainable bark harvesting can be done after every 18 months by extracting opposite strip of the trunk bark. All trees in an area should not be harvested at a time, only 30-40% trees from the population should be harvested. The affect of harvesting season on bark regeneration and quality showed that the bark recovery was faster when the bark was harvested in the month of March vis-a-vis provided best quality produce. Among all selected species Kutaj and Sheonak have faster; Arjuna and Maida have medium; Kachnar and Ashok have slower bark recovery. We involved local people while developing sustainable harvesting practices. Adoption of sustainable harvesting practices had resulted in reduced incidences of destructive harvesting leading to conservation and sustainable management of important NTFP resources. Sustainable bark harvesting techniques should be practiced in order to conserve and sustainably utilize the resources.

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Conservation and Cultivation Strategies for Medicinal Plants Using Rural Ecosystem Waste Produce and its Effect on Antioxidant Content of the Medicinal Plants Studied

— *Shubha*

ABSTRACT

The human health and its problems are resolved by medicinal plants which can be traced back to ancient time. In the course of human evolution these herbs have made a permanent place in the human society. Because of their curative efficacy they are used extensively which has created a great demand for medicinal plants. This has reasoned out to go for commercial cultivation employing organic farming techniques with composts and bioinoculants or treating the micropropagated plants with bioinoculants. Rural ecosystem may be a balanced ecosystem if the organic waste generated is recycled efficiently. At the same time excessive use of chemical fertilizers and pesticides by farmers is creating imbalance in our rural ecosystem making it unsuitable for cultivation in future. Medicinal plants like *Alternanthera sessilis,*and *Sauropus androgynus,* were treated with various types of bioinoculants, farm yard Manure(FYM), vermicompost to analyse the growth, antioxidant content of these medicinal plants. The micropropagated *Costus pictus* was treated with compost of neem and pongamia leaves fortified with bioinoculants. The efficacy of the bioinoculants , FYM, vermicompost,compost treated with bioinoculants on medicinal plants were compared with untreated control plants. FYM treated Alternanthera *sessilis, Sauropus androgynus* showed statistically significant results followed by vermicompost treated plants where as in the case of micropropagated *Costus pictus* combined inoculation gave the better results. When the cost per gram fresh weight was worked out, FYM treated plants were more cost effective and high in nutrient content compared to other treated plants and untreated control with respect to *Alternanthera sessilis* and *Sauropus androgynus*.

Key words: Biofertilisers, compost, *Alternanthera sessilis, , Sauropus androgynus, Costus pictus*

Introduction

Medicinal plants constitute a very important national resource since India is one of the richest plant based ethnomedicinal traditions in the world. Many plants have attracted the herbologists who have put these plants in use from ancient times. Since allopathic medicines cause side effects the popularity of the plant based therapeutic systems is magnifying enormously. Medicinal herbs are exclusively used in many systems of medicine like Ayurveda, Unani, Homeopathy and Siddha. The demand for these traditional remedies and other plant based health products (the so called botanicals) are increasing worldwide, particularly in rapidly expanding urban societies. Increased consumption of medicinal plants through expansion of local, regional and global markets has increased pressure to cultivate more plants on a source that is being largely harvested from depleted wild population which is shrinking in world habitats.

In modern pharmaceutical companies, drugs are derived from plants and ingredients of many others are synthetic replacements built on related plant compounds.

Medicinal and aromatic plants provide crucial livelihood options for millions of rural people especially tribal people and very poor farmers, many of whom are women. The collection, simple processing and trading of medicinal plants contribute cash income to the poor in general. This has resulted in relentless extraction of medicinal plants from the wild resources for several decades which have rendered their natural occurrence in jeopardy. More than 95 per cent of the medicinal plants are obtained from the wild resources and not cultivated. Hence many plant species in India which once grown abundantly in our forests are at risk as they are exploited indiscriminately from the wild living little room for their regeneration. The ever-increasing demand for herbs and herb based products calls for going in for cultivation on commercial scale. But the commercial cultivation of medicinal plants has not been fully explored, as there is a continuous supply of medicinal plants from the forests. Traditional use of medicinal plants is the corner stone of Global health care (Cordell, 2008).

Excessive use of chemical fertilizers is depleting the fertility of soil which may finally lead to sterile soil where crops cannot be grown. Hence plants can be cultivated using biofertilisers which not only enhances soil productivity but is also environment friendly. Organic agriculture is a production system which avoids or largely excludes the use of synthetic compounded fertilizers, pesticides, growth regulators and live stock feed additives (Lampin, 1990). Organic farming system relies on crop rotations, crop residues, animal manures, legumes, green manures farm waste and aspects of biological pest control to maintain soil fertility and crop productivity.

Organic manure is eco-friendly, low cost-effective, less bulky and it sustains crop productivity, soil fertility and also maintains physico-chemical properties of soil. Composting is one of the oldest methods of preparation of organic manure and has developed into a key technology for disposal and recycling of rural residues. The leaf litter of pongamia and neem has a very high potential of becoming good compost. Main objective of our study is utilization of this rural waste that is leaf litter of pongamia and neem mixed with cattle manure and beneficial bioinoculants for the growth of few rare and endangered medicinal plants, their nutritive value and anti-oxidant content.

In modern day, intensive crop cultivation requires the use of chemical fertilizers but they are expensive. Therefore, the current objective is to explore the possibilities of supplementing chemical fertilizers with organic inputs, particularly biofertilizers of microbial origin since, future for inoculant industry in developing countries is bright. It is this kind of technology which is useful for planning future strategies in medicinal plants to save chemical fertilizers as costly inputs. Hence the present study was made to formulate multiple benefits to medicinal plants.

Compost is the only amendment that can trigger the biological activity in the soil and restore the soil characteristics in a productive manner. The problem lies in the practices followed by the farmers to make the compost and their inability to identify the materials that can be used for composting.

Among the different types of wastes viz., crop residues, cereal wastes, cattle shed wastes, tree litter and green manures, tree litter was selected for the present study. Leaf litter fallen from trees like pongamia and neem were used for composting. The scientific principle behind the process of composting is not properly understood. This has lead to improper handling of waste and recovery of poor quality compost.

Soil microorganisms play an important role in the supply of nutrients, improving quality and yield of crops. The term Biofertilizers or which can be more appropriately called microbial inoculants can be generally defined as preparations containing live or latent strains of efficient strains of nitrogen fixing, phosphorus solubilising or cellulolytic microorganisms and mycorrhizal fungi used for seed application, soil or compost enrichment. The objective of the present study is to enhance the number of such microorganisms to increase the availability of nutrients which can be easily assimilated by plants.

The use of organic manure alone is not sufficient for plants growth hence it needs to be compensated with suitable enrichment techniques. Completely decomposed organic materials can be profitably enriched by supplementing with different beneficial liquid bioinoculants viz., nitrogen fixing bacteria, phosphate solubilisers and potassium mobilizing bacteria, to enhance nutrient status of organic residues along with growth promoting AM fungi as soil inoculum. Since not much work has been done on the utilization of composts, different combinations of bioinoculants that can supplement NPK to enhance growth and yield without using synthetic fertilizers on medicinal plants our main objective was to find out a suitable technology which is ecofriendly selected medicinal plants and synergistic effect on the growth and antioxidant content.

Alternanthera sessilis is a prostrate or procumbent, annual or perennial herb belonging to family Amaranthaceae A creeping, often widely branched, with robust taproot system. Stem striate, terete below, Leaves opposite, simple; petiole up to 5 mm long; blade linear-lanceolate, oblong to ovate or obovate, glabrous to sparsely pilose. Inflorescence an axillary, sessile, subglobose head . solitary or in clusters of up to 5. Flowers bisexual, regular pentamerous, stamens united at base into a very short cup, 2 without anthers; ovary superior.. Fruit is an indehiscent capsule *Alternanthera sessilis* possibly originates from tropical America but is now widespread in the tropics and subtropics of the world. It is commonly called Joyweed, dwarf copperleaf.. In many places of the world, the leaves of *Alternanthera sessilis* are eaten as a cooked vegetable or raw as a salad. Bundles of the twigs are sold in the vegetable market in various places of Karnataka, India.

Alternanthera sessilis is used for simple stomach disorders, diarrhoea, dysentery and as a plaster for diseased or wounded skin parts and against fever. The Plant extract common salt is used to stop vomiting blood. In some places the pounded plant is used against headache and vertigo, and leaf sap is sniffed up the nose to treat neuralgia. Dry and powdered leaves are applied against snakebites. It is also used to treat disorders related to eyes., bronchitis, asthma and other lung troubles, to stop bleeding and as a hair tonic.

Sauropus Androgynus

Sauropus androgynus a member of the family Phyllanthaceae is commonly called as multivitamin plant, tropical asparagus, star gooseberry, sweet leaf bush, chakkerumuni. In Karnataka it is called as Chakramuni soppu and is used in making many delicacies and leaves are eaten raw as it has a nutty taste. *Sauropus androgynus* is a shrub grown in some tropical regions as a leaf vegetable. In Chinese it is called Mani cai, in Malay it is called cekur manis or sayur manis.

It is one of the most popular leafy vegetables in South Asia and Southeast Asia and is notable for high yields and palatability. The shoot tips have been sold as tropical asparagus.

The dark-green leaves provide a rich source of chlorophyll which is a valuable blood building element, cell rejuvenator, and beneficial to the circulation, intestinal flora, and for regular bowel elimination. Any plant with high nutritional value, like sweet leaf, that helps to detoxify the body, is valuable in our daily diet. It is an excellent source of potassium. Potassium is vital to muscles including the heart muscles; blood and oxygen circulation and the body's strength. An infusion made of the leaves, is used as a poultice to treat fevers and ulcers. A folk remedy for snoring and teeth grinding during sleep, is to eat sweet leaf regularly, as a food, in soups and other dishes. It is a rich source of antioxidants

Costus pictus D.Don syn. *Costus mexicanus* (DC) Greene is a member of the family, Costaceae. It is commonly known as Spiral ginger, Stepladder or Insulin plant and originated from Mexico..The genus was originally placed under the family Scitaminae and then shifted to Zingiberaceae. Nakai, placed it under a separate family Costaceae, because of the spiral arrangement of the leaves and rhizome being free from aromatic essential oils. The plant grows to a height of 2-3 metres and spread to 1.5 to 2 m. Flowers are not aromatic. Nodal and underground rhizomes are present which are formed in acropetalous successionPeople of Kerala and Karnataka eat the leaves to cure diabetes and the roots are used as tonic and anthelmenthic and proved the antihyperglycaemic activity of this plant (Merina Benny, 2004). Nandhakumar et al. (2007) reported the presence of pentacyclic triterpene compound, β-amyrin which is an active principle present in *Costus pictus* D.Don contributing to the anti-diabetic activity.

Bacillus Megaterium

Bacillus megaterium is a rod-shaped, Gram-positive, endospore forming, aerotolerant species of bacteria used as a soil inoculant in agriculture and horticulture. It is a very efficient phosphate solubilizer for crop plants but its efficacy on medicinal plants has not been tried.

Azospirillum Brasilense

Motile, free-living, gram-negative bacteria that occur in the soil. They are aerobic or microaerophilic and are sometimes capable of nitrogen fixation. Azospirillum has been found to colonize, promote growth and increase the yield of numerous plant species. It is a free living nitrogen fixer.

Farm Yard Manure (FYM)

Manure is organic matter used as organic fertilizer in agriculture. Farm yard manure contributes to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are trapped by bacteria in the soil. Higher organisms then feed on the fungi and bacteria in a chain of life that comprises the soil food web. It is also a product obtained after decomposition of organic matter like cow-dung which replenishes the soil with essential elements and adds humus to the soil. For our experiments FYM used contained cow dung, urine and plant material that is straw mixed with soil. This is the traditional manure and is most rapidly available to the farmers and very less cost effective. Farm yard manure is a decomposed mixture of cow dung and urine with straw and litter used as bedding material and residues. It is highly useful. Farm yard manure is rich in nutrients and its application improves soil fertility. It contains all the plant nutrients needed for crop growth and the availability of the potassium and phosphorus is similar to the application from inorganic sources.

Vermicompost

Vermicompost is an organic manure (bio-fertilizer) produced as the vermicast by earth worm feeding on biological waste material; plant residues. This compost is an odorless, clean, organic material containing adequate quantities of N, P, K and several micronutrients essential for plant growth. Vermicompost is a preferred nutrient source for organic farming. It is eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product.

My Corrhiza

AM fungi enhance the growth of the plants by phosphate mobilization. In addition AM also enhances the uptake of other macronutrients viz., potassium, sodium, copper, zinc and other micronutrients. Mycorrhizal colonization helps harmone accumulation in host thus increasing the levels of cytokinins and gibberelin like substances. AM infection reduces susceptibility to root pathogens. These AM fungi or endomycorrhizal fungi belong to the order Glomales and class zygomycetes. The AM fungi is characterized by the formation of branched haustorial structures called arbuscules within the cortex cells and by a mycelium which extends well into the surrounding soil (extraradical mycelium). Arbuscules are the main sites of solute exchange with the host. Many endomycorrhizal fungi form vesicles which are lipid storage organs. The most distinct growth enhancement effect by AM occurs by improved supply of mineral nutrients predominantly phosphorus.

Azotobacter

Free living nitrogen fixer viz., *Azotobacter vinelandii* naturally fixes atmospheric nitrogen in the rhizosphere. *Azotobacter* uses carbon for its metabolism from simple or compound substances of carbonaceous in nature. Besides carbon, *Azotobacter* also requires calcium for nitrogen fixation. In addition to nitrogen fixation, *Azotobacter* has the capacity to produce aminoacids and growth hormones like Thiamin, Riboflavin, Nicotin, Indole acetic acid and gibberlin. *Azotobacter* as seed application improves seed germination to a considerable extent.

Aspergillus Awamori

Aspergillus awamori is an efficient phosphate mobilizing fungus, which has been widely used as biofertiliser to supplement phosphorus.

Frateuria Aurentia

Frateuria aurentia is a newly defined gram negative, motile rod type, aerobic and acid tolerant bacteria and can grow at pH 3.5-8.

Trichodema Viride

Trichodema viride is an aggressive, toxin producing mycoparasite which grow rapidly in field under favourable moisture, soil and temperature. It is a very potent biopesticide and used extensively as a biocontrol agent against soil borne plant pathogens.

Materials and Methods

Collection of medicinal plants. The medicinal plants *Alternanthera sessilis* and *Sauropus androgynus* were brought from Dhanvanthri Vana, Jnana Bharathi Campus, Bengaluru University and planted at Vedic Biofarm at Kaggali Pura, off Kanakapura Road, Bangalore. Plot for all the medicinal plants were made at the farm with the help of local farmers. For each medicinal plant separate plot was made. All the experiments were carried out on land with 10 replicates for each plant. *Costus pictus* was collected from GKVK, Bangalore and was micropropagated using MS media at various concentrations of growth harmones.Then micropropagated *Costus pictus* was hardened.Then the micropropagated plants were treated with pongamia and neem leaf compost containing bioinoculants.

Following treatment was given on after two days of planting the medicinal plants, *Alternanthera sessilis* and *Sauropus androgynus*. Then at 90 days growth parameters were recorded and plant samples were analysed for enzymic and nonenzymic antioxidants. T_1 = Azospirillum,T_2 = Bacillus megaterium,T_3 = Vermicompost,T_4= Farm yard manure (FYM)

$T_5 = T_1 + T_2 + T_3 + T_4$ C=Control

For the micropropagated *Costus pictus* plants following bioinoculants treatments were given singly and in combination which are as follows; T1=Glomus mosseae(Gm) + Azotobacter chroococcum (Az.c) + Aspergillus awamori (Aa) + Frateutria aurentia (Fa)+ Trichoderma viride (Tv) Gm+Azoto+Aa+Fa+Tv, T2=Glomus fasciculatum(Gf) + Azotobacter chroococcum (Az.c) + Aspergillus awamori (Aa) + Frateutria aurentia(Fa)+T richodermaviride(Tv)T3=Gm+Gf+Azoto+Aa+Fa+Tv,T4=Azoto+Aa+Fa+Tv,T5=Gm,T6=Gf, T7=Azoto,T8=FaT9=Aa,T10=Tv and C= Control.

At 90 days after treatment growth parameters were analysed

Antioxidant Content Analysis

Antioxidants analysis was done at 90 days of treatment

Estimation of Phenolics (Nitsch and Nitsch, 1962)

0.5 mg of dried powdered plant sample was mixed with methanolic HCl and boiled in water bath for few minutes. This was allowed to stand for 2 hrs and filtered through

Whatman no.1 filter paper. To 0.1 ml phenolic extract, 35 per cent sodium carbonate, distilled water and Folin Denis reagent were added, incubated at room temperature for one minute. O.D. values were recorded at 640nm.The standard graph was made using caffeic acid as standard using a standard solution of 100 µg /ml caffeic acid. Dilutions are made at the range of 10 µg/ml.

Estimation of Vitamin A (Total Carotenoids)

Plant tissue was homogenized in 80 per cent acetone and a pinch of $CaCO_3$. The homogenate was centrifuged and supernatant was collected. Supernatant was made up to 10ml with 80per cent acetone. Then OD values were recorded at 480nm and 510 nm and mg/g of carotenoids was calculated (Sadasivam and Manickam, 1996).

Estimation of Vitamin C (Ascorbic Acid)

Vitamin C was determined by the method given by Varley et al. (1984). Required quantity of tissue was homogenized in distilled water and filtered. To the filtrate glacial acetic acid was added and titrated against DCPIP (Dichlorophenol indophenol). Standard titration was done by using ascorbic acid and distilled water as blank and then the quantity of ascorbic acid was determined.

Estimation of Total Antioxidants Present in the Sample by Ferric Reducing Ability of Plasma (FRAP)

The total antioxidants or antioxidant capacity of medicinal plants was estimated using the FRAP assay (Connor et al. 2002). The plant extraction was done by acidic methanol. This was centrifuged and the supernatant was used for the estimation of antioxidants. To the FRAP solution (Acetate buffer,ferric chloride and 2,4,6-Tripyridyl-S-Triazine(TPTZ) in the ratio 10:1:1) solution sample was added.Abrorbance was recorded at 593nm. Ascorbic acid was used as the standard.

Mycorrhizal Studies on *Costus Pictus.*

(a) Percentage mycorrhizal infection of roots (Philips and Haymann, 1970).

Roots were collected and washed roots were cut into 1 cm bits. 30-40 bits were fixed in FAA in screw cap bottles for 4-10 hours. Then the root bits were removed, suspended in 10 per cent KOH solution and autoclaved at a15 lb pressure and 121°C for 15 minutes, then KOH solution was decanted and neutralized with 1 per cent HCl for 5 minutes. The root bits were stained with 0.05 per cent trypan blue in lactophenol and were examined for the presence of arbuscules and vesicles, Per cent root infection by AM fungi was calculated.

(b) Estimation of mycorrhizal spores (Gerdeman and Nicolson, 1963)

Extramatrical chlamydospores produced by the mycorrhizal fungus were estimated by the wet sieving and decanting method outlined by Gerdeman and Nicolson (1963). Required quantity of representative soil samples from each treatment was suspended in sufficient quantity of water and stirred thoroughly. The resulting soil suspension was passed through sieves kept one below the other in the same order. The soil and the spores from the bottom of two sieves were transferred to a nylon mesh of the same size as the last sieve. The nylon mesh with spores was placed in a petri plate and the spores were counted under stereomicroscope.

Statistical Analysis

Data obtained were analysed by two way ANOVA. (Usinh graphpad prism software:www,graphpad.com)

Major Findings:

Alternanthera Sessilis

According to Shubha *et al.,* statistically significant increase in the shoot length, no.of branches, fresh weight and dry weight was recorded in T_4 treated plants compared to other treatments and control(C). T1 recorded maximum root length. Carotenoids, ascorbic acid content, total phenolic content, maximum in T_4 treated plants Hence, FYM is the best manure for cultivating *Alternanthera sessilis* which can enhance qualitative and quantitative properties of the plant. Petropolous (2002), reported that fenugreek grows well in sewage fed land or under organic farming situations where kitchen waste compost, FYM or agricultural field waste are added to the soil.Table 26.1)

Table 26.1 Influence of biofertlisers, vermicompost, FYM and combined treatment on growth and biomass of *Alternanthera sessilis*

Treatment	Shoot length (in)	Root length(in)	No.of branches	Fresh weight (g)	Dry weight (g)
T_1	13	15.5*	16	250	66
T_2	11.8	9.6	11	225	59
T_3	15	11	10	305*	66
T_4	19.4*	14*	17	575*	106*
T_5	17.6*	14.9*	13	535*	105*
C	11.2	7	9	125	63

*Significant at $P< 0.05$

$\mathbf{T_1}$ = *Azospirillum,* $\mathbf{T_2}$ = *Bacillus megaterium,* $\mathbf{T_3}$ = Vermicompost, $\mathbf{T_4}$= Farm yard manure (FYM)

$\mathbf{T_5}$= $T_1 + T_2 + T_3 + T_4$, **C**=Control(Shubha *et al.,* 2012).

Table 26.2 Influence of biofertlisers, vermicompost, FYM and combined treatment on antioxidant content of *Alternanthera sessilis*

Treatment	Carotenoids (mg/g)	Ascorbic acid(mg/g)	Total phenols(%)
T_1	3.117	0.72*	4.0
T_2	2.640	0.6	3.8
T_3	2.719	0.43	4.5
T_4	4.418*	0.74*	4.6
T_5	4.0	0.49	4.1
C	2.128	0.42	3.8

*Significant at P< 0.05

T_1 = *Azospirillum,* T_2 = *Bacillus megaterium,* T_3 = Vermicompost, T_4= Farm yard manure (FYM), T_5= T_1 + T_2 + T_3 + T_4, C=Control (Shubha *et al.,* 2012)

Sauropus Androgynus

Table 26.3 Influence of biofertlisers, vermicompost, FYM and combined treatment on growth and biomass of *Sauropus androgynus*

Treatment	Shoot length (in)	No.of branches	No.of leaves
Azospirillum(T1)	23.92	2	29.6
Bacillus megaterium(T2)	26.5	2	35.6*
Vermicompost (T3)	29.58*	3	37.2*
Farm yard manure(FYM) (T4)	36.76*	3	38*
T1+ T2 + T3 + T4 (T5)	25.7	2	34
Control	23.6	2	27

*Significant at P< 0.05

(Shubha *et al.* 2011)

Table 26.4 Influence of biofertlisers, vermicompost, FYM and combined treatment on antioxidant content of *Sauropus androgynus*

Treatment	Carotenoids (mg/g)	Ascorbic acid (mg/g)	Total phenols (%)
Azospirillum(T1)	1.07	5.3	4.0
Bacillus megaterium(T2)	1.50	5.3	4.0
Vermicompost (T3)	1.62	6.3	4.3
Farm yard manure(FYM) (T4)	2.10*	6.9	4.7
T1+ T2 + T3 + T4 (T5)	1.90	6.6	4.2
Control	1.50	5.1	3.8

*Significant at P< 0.05
(Shubha *et al.,)2011*

According to the Table 26.3 *Sauropus androgynus* treated with farm yard manure (T4) showed maximum shoot length, and number of leaves followed by vermicompost treated plants compared to other treatments and control. In *Sauropus androgynus* not much difference was observed with respect to the number of leaves among different treatments.T4 recorded maximum number of leaves followed by T3. Other biofertiliser applications viz., Bacillus megaterium (T2), Azospirillum (T1) and combined inoculation (T5) also showed increase in number of leaves compared to control. These results are in accordance with the reports of medicinal plants inoculated with PGPR improved plant growth and biomass in Piper nigrum (Anandraj and Sharma,1994), Neem (Mohan et al.1994) and Turmeric (Sena and Das, 1998.Plants given treatments such as vermicompost, Bacillus megaterium and Azospirillum also recorded higher antioxidant content compared to control.

Herbal medicines are a rich source of antioxidants, which are responsible for the therapeutic property of these plants. Our study has reflected the fact that the farm yard manure application comparatively enhanced the leaf produce and antioxidant level of *Sauropus androgynus*. As *Sauropus androgynus* has high therapeutic value and used as green leafy vegetable, this is a better cultivation strategy to grow plants having higher antioxidant content and better growth. It is this kind of technology which is useful for planning future strategies in medicinal plants to save chemical fertilizers as costly inputs and to formulate multiple benefits to the plant

Mcropropagated *Costus Pictus*

Table 26.5 Synergistic effect of bioinoculants on number of vesicles, arbuscules, per cent root colonization, spore number in rhizosphere soil of Costus pictus D.Don. (90 days)

Treatments	No.of arbuscules	No. of vesicles	Per cent root colonisation	No.of spores in 25ml of rhizosphere soil
T_1	16*	32*	60*	92*
T_2	24*	57*	65*	89*
T_3	26*	55*	65*	98*
T_4	8*	10*	20*	44*
T_5	17*	38*	30*	61*
T_6	12*	34*	25*	58*
T_7	13*	27*	15*	31*
T_8	8*	29*	15*	28
T_9	7*	34*	15*	25
T_{10}	8*	16*	7*	26
C	0	0	0	24

*Significant at $P < 0.05$

$\mathbf{T_1}$= G.m + Azo + A.a + F.a + T.v, $\mathbf{T_2}$= G.f + Azo + A.a.+.F.a + T.v,

$\mathbf{T_3}$= G.m + G.f + Azo + A. a + F.a + T. v, $\mathbf{T_4}$= Azo + A.a + F.a + T.v, $\mathbf{T_5}$ =G.m, $\mathbf{T_6}$=G. f,

$\mathbf{T_7}$=Azo , $\mathbf{T_8}$ = F.a, $\mathbf{T_9}$ =A.a, $\mathbf{T_{10}}$=T.v and **C**=control (Shubha and Anusuya, 2010)

Table 26.6 Growth parameters of Costus pictus D.Don. as influenced by bioinoculants (90 days)

Treatments	Height (cm)	Root length (cm)	No.of leaves	No.of rhizome
T_1	21.2*	35.5*	35*	4
T_2	38*	64.3*	54*	5
T_3	38.5*	62*	52*	5
T_4	17.5	34	25	3
T_5	18	38*	18	2
T_6	10.6	24	14	2
T_7	30*	28	24	4
T_8	33*	37.25*	33*	6
T_9	29.8*	48.5*	38*	5
T_{10}	27.3*	27.5	24	5
C	16.2	32.2	22	2

*Significant at $P < 0.05$

$\mathbf{T_1}$= G.m + Azo + A.a + F.a + T.v, $\mathbf{T_2}$= G.f + Azo + A.a.+.F.a + T.v,

$\mathbf{T_3}$= G.m + G.f + Azo + A. a + F.a + T. v, $\mathbf{T_4}$= Azo + A.a + F.a + T.v, $\mathbf{T_5}$ =G.m, $\mathbf{T_6}$=G. f, $\mathbf{T_7}$=Azo , $\mathbf{T_8}$ = F.a, $\mathbf{T_9}$ =A.a, $\mathbf{T_{10}}$=T.v and **C**=control(Shubha and Anusuya, 2010)

Table 26.7 Influence of bioinoculants on biomass of Costus pictus D.Don. (90 days)

Treatments	Fw** of the plant (g)	Dw*** of the plant (g)	Fw** of the leaf (g)	Dw** of the leaf (g)
T_1	79.1*	7.9*	27*	1.7
T_2	161.4*	14.1*	55.5*	2.7*
T_3	161*	14.1*	55.7*	2.8*
T_4	42.1	5.4	18.5*	1.9
T_5	47.5*	5.7	12.1	0.78
T_6	27.5	4.36	10.1	0.86
T_7	84.6*	7.7*	23*	1.6
T_8	103.5*	9.8*	31*	1.7
T_9	106.3*	8.38*	33.5*	1.38
T_{10}	88.5*	7.9*	22*	2.28*
C	41	5.4	13.25	0.75

*Significant at $P < 0.05$

$\mathbf{T_1}$= G.m + Azo + A.a + F.a + T.v, $\mathbf{T_2}$= G.f + Azo + A.a.+.F.a + T.v,

$\mathbf{T_3}$= G.m + G.f + Azo + A. a + F.a + T. v, $\mathbf{T_4}$= Azo + A.a + F.a + T.v, $\mathbf{T_5}$ =G.m, $\mathbf{T_6}$=G. f,

$\mathbf{T_7}$=Azo , $\mathbf{T_8}$ = F.a, $\mathbf{T_9}$ =A.a, $\mathbf{T_{10}}$=T.v and **C**=control

**Fw = Fresh weight ***D w = Dry weight(Shubha and Anusuya, 2010)

Table 26.8 Influence of bioinoculants on antioxidant content of Costus pictus D.Don. (90 days)

Treatment	Vitamin-A (mg/g)	Vitamin-C (mg/g)	FRAP**	Total Phenols
T_1	16.6	19.9	0.5	156*
T_2	16.303	19.9	0.525	149*
T_3	16.6	21.4	0.525	184*
T_4	15.7	18.4	0.425	103
T_5	15.84	18.4	0.4	110
T_6	15.84	17.14	0.4	109
T_7	15.01	18.14	0.375	76
T_8	15.2	13.845	0.35	94
T_9	15.01	13.845	0.35	98
T_{10}	15	13.845	0.375	78
C	14.32	13.845	0.315	64

*Significant at $P < 0.05$

****FRAP** = Ferrous Reducing Ability of Plasma

$\mathbf{T_1}$= G.m + Azo + A.a + F.a + T.v, $\mathbf{T_2}$= G.f + Azo + A.a.+.F.a + T.v,

$\mathbf{T_3}$= G.m + G.f + Azo + A. a + F.a + T. v, $\mathbf{T_4}$= Azo + A.a + F.a + T.v, $\mathbf{T_5}$ =G.m, $\mathbf{T_6}$=G. f, $\mathbf{T_7}$=Azo , $\mathbf{T_8}$ = F.a, $\mathbf{T_9}$ =A.a, $\mathbf{T_{10}}$=T.v and **C**=control (Shubha and Anusuya, 2010)

According to Shubha and Anusuya (2010)Maximum fresh weight of the plant was observed in T2 and T3 plants which were more than four times greater than control plants. This was followed by T9 and T8. Least fresh weight .Meenu and Saralabai (2001) reported that combined inoculation of mycorrhiza, Azospirillum and Azotobacter resulted in significant increase in dry matter than individual inoculations..

As the leaves of *Costus pictus* are used as medicine, the combination Glomus fasciculatum, Azotobacter chroococcum, Aspergillus awamori, Frateuria aurentia and Trichoderma viride has been proved to be an excellent combination of bioinoculants compared to other single, combined inoculations and control plants. It may be due to synergistic interaction of VAM fungi with other bioinoculants in the rhizosphere of *Costus pictus*. To maximize the beneficial plant growth responses, multiple inoculation of effective microbes is normally adopted to enhance the growth and yield of crop plants and this holds good for medicinal plants also. By this study we can conclude that combined inoculation with beneficial bioinoculants to *Costus pictus* proved to be the best to get maximum growth and high antioxidant content in the plants than single inoculation and control.

Cost Economics

Cost worked out per gram fresh weight and dry weight of the medicinal plants studied for the best treatment

Table 26.9 Coat Economics

Name of the medicinal plant	Cost /g fresh weight of the sample (paise)	Cost /g dry weight of the sample (paise)
Alternanthera sessilis(T4)	4	26
Sauropus androgynus(T4)	6	30
Costus pictus(T3)	8	60

The cost per unit gram of the medicinal plants studied indicated that FYM which is a waste product of the village ecosystem is more cost effective (Table 26.9) for the medicinal plants *Alternanthera sessilis and Sauropus androgynus*. For *Costus pictus* combined inoculation was best.

Conclusion

The diverse wealth of medicinal plants in our country is getting depleted because of the indiscriminate use of these plants. This has motivated us to make a strategy wherein we can conserve our wealth of medicinal plants without polluting the environment. The use of Farm Yard Manure, a consortium of all the fertilizers used and vermicompost has resulted in significant increase in the qualitative and quantitative parameters of the medicinal plants studied. This kind of cultivation technology or organic farming can be extended to other medicinal plants as this is economical. As farm yard manure is affordable it can be adopted to grow medicinal plants at a cheaper cost. Women farmers with a small patch of land and cattle can definitely.

We have to cultivate medicinal plants to reduce the pressure on wild medicinal plants. At the same time we have to grow them in a very natural way which simulates the forest soil. In this context chemical fertilizers may not be a better option as it is not natural, ecofriendly. and economical. Hence Organic agriculture of medicinal plants is the need of the hour as our soil is getting depleted due to excessive use of chemical fertilizers. Our research is mainly focused on enhancement of both qualitative and quantitative characters of the medicinal plants studied in a ecofriendly way and it is very cost effective also. If this method is adopted by our small farmers and woman farmers they can add thousands of rupees to their income with less cost input in a shorter period. Hence this work has contributed to the society in three important lines

1. The method is ecofriendly
2. The organic agriculture of the medicinal plants reduces the pressure on wild plants and hence our wild medicinal plants are conserved in nature and avoided from becoming endangered.
3. Improves the economic status of the small farmers.
4. Improves the qualitative and quantitative characters of the medicinal plants studied.

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An Analytical Agenda for the Study of Medicinal and Herbal Plants in South Asia Context: Market and Institutional Issues

— Dinesh K Marothia

ABSTRACT

A host of dimensions *inter alia* social, psychological, cultural, economic institutional shape the effective demand for herbal medicines and their products. The information or knowledge base regarding medicinal plants is a vital factor and a key for market perfections, the benefits of which can reach all those involved in traditional health care. In the context of the new economic policy and the regime of WTO, conservation and sustainable use of medicinal flora should be directed and enforced by the interplay of property and patent regimes. Some important research and policy issues are suggested herein to set up future study agenda.

Keywords: Traditional medicinal flora, psychological, institutional, cultural

Introduction

Medicinal plants have been escaping the attention of both researchers ad policy-makers while addressing the issues of livelihood , healthy food /medicine and linking them to forest food gatherers/farmers, traders and processors. Despite convincing progress in Synthetic Chemistry and Biotechnology, plants are the most important sources for preventive and curative medical preparations. WHO has estimated that at least 80% of all the global inhabitants rely on traditional systems of medicine for their primary health needs and these systems are largely plant based. All the oldest cultures of the world traditionally use plant medicines both for primary health care and as household remedies. In many of these cultures like, those of India Nepal, Bhutan, Bangladesh and China the cultural knowledge is well documented regards identification, base processing and to some extent value addition. The economics of health care in the traditional system of medicine is the opportunity cost of health care in the modern system of medicine. Also economics of medicinal plant cultivation or gathering are weak representations of the economic of health care in the traditional system since their valuation and contribution are grossly underestimated due to In this sense market imperfections. The cost of health care are discernible when compared with market imperfections in the trade of medicinal plants. It is as much the physical availability of medicinal plants as the knowledge of medicinal plants (source of availability, identification, recognition, belief and end use and hidden marketing channels) which is eroding and vanishing. The quality of medicinal plant products, which are heavily advertised and have a large market share, is under suspicion. Threats to current supplies of major medicinal plants (by quantity) sourced by industry are modest in comparison to endemic and economically scarce medicinal plants and medicinal plants which are substitutes Natural factors-forest fire, and other calamities – are the causes of degradation of medicinal plants in the heavily wooded forests rather than anthropocentric forces. Majority of the weeds in non-forest areas have medicinal properties which can be gathered to augment the supply of medicinal plants and incomes of farmers. Majority of the endemic medicinal plants are economic substitutes for other medicinal plants. Knowledge of medicinal plants and their uses are dwindling among the local communities, villagers and tribals as they are switching to the modern system of medicine. The loss of medicinal flora entails huge transaction costs and intra-and inter-generational inequities. Market imperfections in medicinal plants are manifested due to lack of transparency in the trade, prices, margins, existing knowledge base skewed distribution of services of traditional medicine, doctors and retail outlets.

Thus the subject of the economics of medicinal plants is intricate, intriguing, puzzling, opaque and esoteric. In fact, market imperfections in medicinal plants are overplayed in relation to the valuation of medicinal plants. This needs to be appreciated in the light of the fact that most medicinal plants are low-priced in relation to their true value in health care, health cure and overall health security. When we consider alternative systems of health care, the transaction costs involved shape the relative demand for medicinal plants. In the herbal-based system, ecological and economic scarcity overlap and hence complicate estimation of resource scarcity. The effective demand for medicinal plants and medicines is caught in the rigmarole of sourcing, valuation, pricing, trade, consumer or patient response, which are directly related to the level and degree of information regarding the medicinal plants, their products and their uses. The institutional and economic dimensions involved in the use of herbal medicines mould the effective demand for herbal medicines. It is a paradox that even through 80 percent or more of the population is cared by traditional medical practitioners and birth attendants the demand for the modern medicine is increasing by leaps and bounds despite the prohibitive costs – of consultation, health care, health cure, health education and externalities. The issue of scarcity of medicinal plants, ecological or economic or both, is a challenge and provides an excellent research opportunity for natural resource economists. Here, the ecological scarcity is often not reflected in or transmitted to economic scarcity. Ecological scarcity of medicinal plants is due to their endemic nature, while economic scarcity is due to (i) non-availability of substitutes, (ii) the type of diseases/disorders cured, and (iii) the commercial importance.

Market imperfections and Transactions Costs

The transaction costs (read cost of information, contract and enforcement) in the economy of medicinal plants and plant products arise because of inherent market imperfections and due to the very nature of medicinal plant resource and the science and art of Ayurvedic. Hypothesizing about market imperfection in medicinal plants and plant product rather than market perfection is a question the economist needs to address, since both the supply side and the demand side market imperfections are apparent in medicinal plants. The bottom line for market perfection is marginal cost pricing. If there is a wide gap between marginal cost and price and the gap is unaccountable by the market functions, then there is a *prima facie* case for market imperfection. Market imperfections are implicit in the trade of any natural resources and medicinal plant are no exception to this phenomenon due to (i) absence of well-defined property rights, (ii) complexity in arriving at a convincing patent regime (iii) uniqueness, uncertainty and irreversibility and (iv) knowledge of medicinal plants is limited to certain population and communities.

Another problem in bridging the supply and demand is the lack of buy back arrangement between the medicinal firms and the suppliers. On the one hand the medicinal plant dealers complain that they are not getting the cooperation of the State Forest Department in allotment of areas for harvesting medicinal plants, while on the other farmers say they are willing to cultivate to supply any quantity of the required medicinal plants as long as they are assured of the market.

Further the shallow knowledge base of consumers regarding medicinal plants, the niche market for medicinal plants and products, the difference between the proprietary and classical preparations, oral tradition and `Goupya' (desirable secrecy's), shallow knowledge about the practitioners, availability and accessibility of medicinal plants and plant product outlets add to the complexity of imperfection. This gap can be appreciated only if the procedures followed in preparing the drug are monitorable by an authority like `drug control inspectorate' so that the consumers are assured of quality.

It is to be noted that a large number of Ayurvedic drugs have multi-ingredients and involve multi-processes, both of which are difficult to monitor/supervise. Further, when the efficacies of plant-based medicines are compared with the alternative systems of medicine like allopathy, there are some treatments in Ayurvedic for which there is no substitute in other systems of medicine, for which there can be no relative economics. This is also a market imperfection, since the opportunity cost of treatment with traditional system of medicine is so huge that it is difficult to be valued. The difference in the price of the gathered medicinal plant and that of the cultivated medicinal plant also adds to market imperfection. Pricing of medicinal plants should include not only the cost of gathering/ cultivation, but also the ecological cost of irreversibility, uncertainty and uniqueness, so that the resource gets duly valued. Often, most medicinal plants (the raw materials) are priced cheaply due to the ignorance and the social stigma associated with the medicinal plant gatherers.

Medicinal and Herbal Plants Trade Related issues

The domestic market for medicinal and herbal products in India is estimated at Rs. 8,000 million per year (1977). The global market for herbal medicines is Rs.315,000 million and has reached to around Rs. 1,400,000 million by 2010, at a compound growth rate of 12.15 percent . The potential in the European market is Rs. 94, 500 million. Considering the quantity and value of medicinal plants exported, China tops with an average annual export of 1,21,900 tonnes worth $ 264.5 million and India stands second with an export of 32,600 tonnes ($45.9 million). Hongkong imports the highest quantity of 77,250 tonnes of medicinal plants ($114.5 million). Germany imports 42,800 tonnes ($96.25 million). USA imports 35,000 tonnes of medicinal plants ($95.2 million (DGCIS, Calcuta,1997). The largest imports by Hongkong may be for exports as medicinal plant products.

The Plantago species (Isabgol) tops the exports from India among the medicinal plants (70 percent, Rs. 1,040 million), followed by Ginseng roots (Withania somnifera – Ashwagandha, Rs. 142 million) and others, totaling Rs. 1,470 million during 1994-95. the highest compound growth rate of exports between the period 1987 and 1994) is in the case of Sarsaparilla roots (Hemidesmus indicus) which registered 87 percent per annum, followed by Psyllium (Isabgol) which registered 68 per cent. Other promising medicinal plants for exports are Zedovary roots (33 percent), ginseng roots (27 per cent) and Piper cubeba (25 percent). One of the reasons for large exports of Isabgol abroad is due to the problem of constipation. This can be attributed to the consumption of low-fibre food which is complicated by the sedentary work habits and consumption of junk food. Through India is the second biggest exporter of medicinal plants and is next to China, it also imports a host of medicinal plants. Glycyrrhiza glabra (Liqucrice-Athimadhura/ Jyeshta madhu) imports are Rs.54 million (58 percent of the value of total imports of Rs. 111 millions) followed by Kuth roots (Saussurea lappa) Rs. 28 million (25 percent), Ayurveda and Unani herbs Rs. 11.44 million (10 percent) and others. Regarding imports of medicinal plants, the highest compound growth rate of imports is for Galand roots (71.5 percent) followed by Poppy flowers (52 percent) and Athimadhura (42 percent). The Kuth roots cost Rs. 1997 per kg. followed by Ginseng roots Rs. 1,672 per kg. and Rs. 714 per kg, for Liquorice. There are about 87 medicinal plant species being sourced by the drug manufacturing industries, in quantities more than 10 tonnes each per annum. Other medicinal plants being sourced are less than 10 tonnes each per annum by the industry.

Export Promotion and Quality Control

India represents one of the eight important Vavilovian centers of origin and crop plant diversity of cultivated plants and their wild relatives. It is immensely rich in medicinal , herbal , and aromatic plants occurring in diverse ecosystems. World Health Organization (WHO) has listed over 21,000 plant species used around the world for medicinal purposes. It has been estimated that India has 47,000 species of plants and ranks eighth in the world biodiversity composition. Out of these plant species, medicinal plants comprise of 8,000 species. Indian Systems of Medicine (ISM) use around 2,500 plant species belonging to more than 1,000 genera. About 800 species are used by industry of which approximately 25% are cultivated. In India there are four well-recognized system of traditional medicine namely, Ayurveda, Unani, Siddha and Yoga & Naturopathy. Till recently, the trend in India was collection of medicinal plant material from the wild habitat rather than its cultivation. Till the early part of this century, it worked out to be economical, as the resources were plentiful. Hence no efforts were undertaken to cultivate medicinal plants. But in the latter part of the present century, many important medicinal plants either disappeared or become endangered in their natural habitats due to use of extensive and non-scientific collection methods.

It is to be realized that many of the Ayurvedic medicinal plants and trees can be cultivated, if there is a conscious efforts in developing (i) propagation techniques and (ii) buy-back arrangements. The Government of India has banned the export of some 50 or more medicinal plants like Jatamansi (Nardistachys jatamansi), Guggula (Commiphora mukul), Katiki (Picrorrhiza kurrha), and the drugs like Livomin, Liv 52, Mental, Rymanyl, Rhumayog, becamine, Traquinyl and Obenyl (to reduce obesity (among propriety drugs). Mahayogiraja guggula, Kanchanara guggula (used to cure thyroid, ovarian and breast tumour), Kaishora guggulu, Dasha moolarishta, Arjunarishta and others. Unfortunately most of the medicinal plants use in many of these preparations which have been banned can be cultivated and the country can reap precious foreign exchange. Obviously this promotes smuggling of Ayurvedic preparations out of the country since the exports have been banned without carefully examining whether there is nay real scarcity of medicinal plants. The demand for establishing new herbal/ayurvedic firms is governed by strict quality control, though there is a great difficulty in monitoring the verification of drug formulations. With all the complexities and inherent imperfections in the plant-based medicines, according to the Drug Licensing Authority of Ayurveda the quality of Ayurvedic formulations has been largely maintained by the efforts as quality control of the Government.

Interplay of Property and Patent Regimes for the Conservation of Medicinal Plants

With the advent of the New Economic Policy (NEP) and the World Trade Organization (WTO) regime, the conservation and use of medicinal plants in India, Nepal, Bhutan, Bangladesh and Pakistan will increasingly be influenced by the interplay of the property regime and the patent regime and their enforceability. A heuristic scenario of the interplay indicates that in the open access resource regime, patent rights will help in declaring national sovereignty over the flora and fauna Australia, Peru, Costs Rica and a few other countries have declared national sovereignty over their germplasm (flora and fauna) by legislation. India and other south-east countries are also contemplating in this direction. Within these countries several areas or states have been declared as herbal states and medicinal and herbal plants boards have been constituted to formulate market and institutional policies for promotion of medicinal and herbal plants. In India Chhattisgarh Government has declared the state as `Herbal State' and designed a mechanism for public - private partnership to take care of market imperfections. The derivatives of such mechanism might be existing in other neighboring countries. Cross learning's can mutually help south Asian countries.

Key Issues

A host of dimensions *inter alia* social, psychological, cultural, economic institutional shape the effective demand for herbal medicines and their products. The information or knowledge base regarding medicinal plants is a vital factor and a key for market perfections, the benefits of which can reach all those involved in traditional health care. In the context of the new economic policy and the regime of WTO, conservation and sustainable use of medicinal flora should be directed and enforced by the interplay of property and patent regimes. Some important research and policy issues are suggested herein to set up future study agenda.

1. To understand dynamics of medicinal and herbal plants domestic trade in India, Bangladesh, Bhutan, Nepal and Pakistan in relation to World transactions (may be initially based on review of literature and best practices).

2. Mapping of major medicinal and herbal plants which are in the priority lists of respective governments (India, Bangladesh, Nepal, Bhutan, Pakistan) for understanding marketing, processing and value addition.

3. Examine the potentiality of new initiatives taken by the respective governments to link medicinal and herbal plants to farmers, processors, and pharmaceutical/drug industries.

4. Highlight the community-based approaches used by rural communes , NGO, local healer's and village biologist to forge linkages between local knowledge(un-codified folk systems) with the formal sciences (botany and ecology) and generate positive impacts at various levels of government.

5. Work out the comparative economics of in situ /ex-situ cultivation ,production, gathering, of important medicinal plants in the micro climatic conditions in South Asian counties.

6. To relate medicinal and herbal, domestic trade with the international markets within the framework of WTO.
7. To evolve mechanism, based on research and policy input, to form South Asian forum for R&D Consortium to promote medicinal plants sector.

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Potential of Flavanoidal Rich Herbal Formulation in Treating Skin Aging Complications

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ABSTRACT

Herbs containing flavanoids are known to have effectiveness on wrinkling, dry rough skin, red blotchiness and hyperpigmented spots in aging skin. Hyaluronidase and elastase are considered to be 'spreading factors' and play a crucial role in degradation of Extracellular Matrix components (ECM) leading to bacterial invasion, envenomation of various toxins among others. This study potentiate that herbal formulation could be used as potential skin rejuvenating agent and with significant hyaluronidase and elastase inhibition and thus reducing the age related complications of the skin. Most of the widely distributed medicinal plants, vegetables, fruit juices and a variety of beverages (tea, coffee, wines and fruit drinks) are found to have flavanoid as main component. Such herbs when incorporated into a suitable formulation exhibit a number of therapeutic actions at cellular level as well as at the Extracellular matrix (ECM) level. In order to maintain the appearance of the skin, matrix protein degrading enzymes like hyaluronidase and elastase are to be inhibited. The present communication reports the ability of a herbal formulation rich in flavanoidal content as a promoter to collagen synthesis by inhibiting hyaluronidase and elastase activities and therefore, prolonging youthful skin.

Keywords: Extracellular Matrix, Hyaluronidase, Elastase, Flavanoids, Herbal formulation.

Introduction

The process of aging is a multistep event occurring in different level of the body. It can be designated as a cumulative destruction caused by the reactive oxygen species generation in response to the different pathological, chronological and environmental factors. UV radiation on long-term exposure to the skin causes acute and chronic effects in the human skin. The UV radiation causes generation of ROS and reactive nitrogen species which ultimately leads to alteration in the structure and function of proteins which constitutes the extracellular matrix, for example collagen, elastin and glycosaminoglycans, [1] etc. The increased level of reactive oxygen species causes the formation of oxidative stress which further leads to DNA damage. All these consequences contributes in the development of skin related complications as the skin grows old like black patches, wrinkles and pits formation, dry and rough skin disorders etc.

Herbal drugs are being used from a long time to treat age related disorders. The main reason behind this approach is the synergistic approach which these herbs exist while treating any complications. Herbs rich in flavanoids serves to be an efficient agent which provide skin with desired strength and elasticity.[2] Current therapy of conventional drugs utilized for dermatological disorders are mainly based on topical preparations. These formulations relay on the passive diffusion of lipophilic and low molecular weight molecular components across the skin. In recent decades there has been a concerted effort to develop a novel and optimized formulation for enhancing topical effect. Stressed has been laid to develop such a herbal formulation that can treat all the associated disorders of the skin.[4-5] Hence, the objective of the present study is to formulate such a herbal formulation which can be helpful in treating various skin related complications manifestated during the process of aging.

Materials and Methods

Quercetin pure isolated was procured from Sigma Aldrich, cetyl alcohol was procured from Himedia, glycerine (Merck), etc . Hyaluronidase type-1S from Bovine testes (999 units/mg solid) and Hyaluronic acid sodium salt from human umbilical cord, Elastase type IV from porcine pancreas, N-Succinyl-Ala-Ala-Ala-p nitroanilide (SANA) were purchased from Sigma Aldrich, USA. Dulbecco's Modified Eagle's Medium [Himedia ATO 68], Gentamycin [Nicholas Piramal]. All the chemicals used for the assay were of analytical grade (Merck and Qauligen).

Preparation of herbal cream:

All the ingredients were accurately weighed in order to formulate oil in water (O/W) cream by phase inversion method. The formulations were divided into two group (HC1, and HC2) One containing active drug herbal cream and another plain herbal cream. The solid phase was melted at 75°C . (Table No.1)To this the oil soluble were added and heated to 60°C. The pure isolated form of the drug was added. [6-7] when the temperature of both the phases reached 60°C. The aqueous phase was added gradually into oily phase with continuous stirring at 1500 rpm under magnetic stirring for homogenous mixing of the ingredients.

Determination of tyrosinase inhibitory activity

The method has been adoptated with slight modification from the tyrosinase inhibitory bioassay as discussed by Sharma et al. 2004 and Leu et al. 2008. In the present study we dissolved a significant amount of the herbal cream (10µL) in 0.1 ml of 10% dimethyl sulfoxide (DMSO) in an aqueous solution and incubated with 0.1 ml of L-tyrosinase (135 U/ml phosphate buffered solution [PBS], pH 6.8) at 37°C for 20 min. [7-8]To this 0.1 ml of 0.5 mM L-DOPA in a (PBS, pH 6.8) was added and further incubated the reaction mixture for 5 min. The amount of dopachrome in the mixture is determined by the optical density (OD) using microplate reader at 490 nm and the percent of tyrosinase activity inhibition was calculated according to given formula

Inhibition (%) = {(A–B)–(C–D)}/(A–B) × 100

Where A is the OD at 490 nm without herbal cream, B is the OD at 490 nm without the herbal cream but with tyrosinase, C is the OD at 475 nm with the herbal cream and D is the OD at 475 nm with the herbal cream, but without tyrosinase.

Determination of elastase inhibition

The above study was done with slight modification by Sahasrabudhe and Deodhar, 2010 in which Porcine pancreatic elastase was assayed spectrophotometrically using N-Succ-(Ala) 3-nitroanilide (SANA) as the substrate here the release of p-nitroanilineis is estimated by measuring the absorbance for 15 min at 25°C at 410 nm. Different concentration of herbal cream (Ranging from 10-50µL) was dissolved in Tris-HCl buffer with the reaction mixture containing 800 µl of 0.2 M Tris buffer (pH 8.0), 100 µl of enzyme elastase and 100 µl of 0.8 mM SANA as substrate. The herbal cream was preincubated with the enzyme for 20 min at 25°C .The reaction started when substrate was added to the reaction mixture. [9-12]As the reaction proceeds, the change in absorbance is monitored using UV spectrophotometer at 410 nm. Inhibitory effect of the samples on the Elastase activity calculated as:

Inhibition (%) = (A-B)/ A × 100

Where A, is the absorbance at 410 nm without test sample, and B is the change in absorbance at 410 nm with the test sample.

Determination of hyaluronidase inhibition

Hyaluronidases are considered to be 'spreading factors' and play a crucial role in degradation of ECM leading to bacterial invasion, envenomation of various toxins including honeybee toxins, snake toxins etc., promote tumor growth and angiogenesis. [13]

The experiment was carried out according to the procedure described by Sahasrabudhe and Deodhar, 2010 with slight modification. In the study hyaluronidase inhibition was determined by measuring the amount of N-acetylglucosamine splited from sodium hyaluronate. A concentration of 50 µL of herbal cream was dissolved in 5% DMSO and was mixed with 50mµL of hyaluronidase (7900 units ml−1) dissolved in 0.1 M acetate buffer having a of pH 3.6. The control was treated with 5% DMSO with the herbal cream and was incubated at 37°C for 20 minutes followed by a reincubation to the same stated condition with successive addition of 50µl of calcium chloride. This reaction mixture is further treated with 250 µl sodium hyaluronate and again incubated at 37°C for 40 min. [14-18]To the above reaction mixture, addition of 50 µl of 0.4 M sodium hydroxide and 100 µl of 0.2 M sodium borate was done and it was kept in the boiling water bath for 3 min and incubated. The reaction mixture was allowed to cool at room temperature and to this 1.5 ml of p-Dimethylaminobenzaldehyde solution was added. When this mixtureis incubated for 20 min at 37°C, in a water bath, the colour change takes place which can be measured spectrophotometerically, at 585nm.[19]

Statistical analysis: The experimental results obtained were expressed as mean±standard error of mean (SEM). All measurements were carried out in triplicate.

Result

The result shows that the herbal cream formulated has the potential to treat the aging related complications. The HC1 when compared to HC2 taken as control, showed that the formulation significantly reduces the hyaluronidase activity, which is largely responsible for the degradation of the extracellular matrix components.(Table.2) The experiment showed that on increasing the drug concentration the desired effect can be achieved. Similarly the formulation was also found significant against inhibiting the elastase enzyme. The obtained value for tyrosinase activity inhibition is also encouraging. Both the activity varies significantly on varying the concentration of the drug sample.

Discussion

Quercetin is a naturaly occurring flavanoid having higher impact on restoring the vitality of skin components as the drug encompass various inherent properties in itself. The drug is antiproliferative, anticancer, antioxidant, etc. All these properties aids to redefine its role in preservation of skin in due course of aging. Elastin is an Extracellular Matrix protein which provides elasticity to the skin by causing the formation of elastic fiber in the dermis of the skin.In the due course of the aging and due to environmental factors the skin loses its vitality due to deformation of the elastin protein. Damage to the elastin fibers causes decrease in skin flexibility. The skin contains enzyme called "proteinase" which is responsible for the degradation of the elastin. Therefore, to restore the suppleness and elegance of the skin elastase inhibition is of the major concerned to fight against skin aging complications. Similarly, Hyaluronic acid is key player in maintaining the luster of body. But it is short lived because of the activity of hyaluronidase enzyme. Hyaluronic acid keeps the body moist and that is the reason why dryness and roughness is remarkably noticed in aged skin. So, in order to maintain a balance between the body's regulation in growing age it is very important to keep a check on excessive hyaluronidase enzyme activity. The tyrosinase is involved in the regulation of melanin pigment in the skin. Its excessive production causes darkening of the skin. Herbal drugs often possess cure to a series of disregularities occurring at different level because they have the unique nature to act synergistically. Quercetin, being an antioxidant can show its vitality at multiple steps. Its potentiality can be estimated by the above experiment which clearly shows that it can be prove beneficial in treating cosmetic complications in aging skin.

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Annexure-I

Table 1. Composition of Anti-aging herbal cream

S.No.	Name of the Ingredients	Percent
1.	Sesame oil	10%
2.	Tamarind gum	4%
3.	Isolated Quercetin	10%
4.	Cetyl alcohol	1%
5.	Glycerine	4%
6.	Rose oil	1%
7.	Water	70%

Table 2. The effect of anti-aging herbal cream on hyaluronidae, elastase and tyrosinase Inhibition.

Sample	Hyaluronidase Inhibition	Elastase Inhibition	Tyrosinase Inhibition
HC1 (with drug)	52.32 ± 5.73	70.82±5.12	62.82±0.05
HC2 (without drug)	2.08±0.62	3.45±0.55	1.09±0.34