(ISSN 2395 - 468X)

Year - 2017 Vol. 4, No. 5 Issue: May 2017

Van Sangyan

A monthly open access e-magazine

Indexed in:

COSMOS Foundation (Germany)

International Inst. of Org. Res. (Australia)

Tropical Forest Research Institute

(Indian Council of Forestry Research and Education)

Ministry of Environment, Forests and Climate Change (MoEFCC)

PO RFRC, Mandla Road, Jabalpur – 482021. India

Van Sangyan

Editorial Board

Patron: Dr. U. Prakasham, IFS

Vice Patron: P. Subramanyam, IFS

Chief Editor: Dr. N. Roychoudhury

Editor & Coordinator: Dr. Naseer Mohammad

Assistant Editor: Dr. Rajesh Kumar Mishra

Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

by e-mail to vansangyan_tfri@icfre.org

or, through post to The Editor, Van Sangyan,
Tropical Forest Research Institute,
PO-RFRC, Mandla Road,
Jabalpur (M.P.) - 482021.

The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number.

TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve
Photo credit: Dr. N. Roychoudhury and Dr. Rajesh Kumar Mishra, TFRI, Jabalpur (M.P.)

From the Editor's desk

Mining is the extraction of valuable minerals or other geological materials from the earth, usually from an ore body, vein or (coal) seam. Materials recovered by mining include base metals, precious metals, iron, uranium, coal, diamonds, limestone, oil shale, rock salt and potash. Any material that cannot be grown through agricultural processes, or created artificially in a laboratory or factory, is usually mined. Mining in a wider sense comprises extraction of any non-renewable resource (e.g., petroleum, natural gas, or even water).

Mining of stone and metal has been done since pre-historic times. Modern mining processes involve prospecting for ore bodies, analysis of the profit potential of a proposed mine, extraction of the desired materials and finally reclamation of the land to prepare it for other uses once the mine is closed. The nature of mining processes creates a potential negative impact on the environment both during the mining operations and for years after the mine is closed. This impact has led to most of the world's nations adopting regulations to moderate the negative effects of mining operations. Safety has long been a concern as well, though modern practices have improved safety in mines significantly.

Mining is a very profitable business and it also creates employment opportunities. It benefits everyone including the government and that is why the mining industry is widely supported. There are several negative effects of mining for the environment. To make mining possible, several forests are cleared and this leads to deforestation. The vegetation is cleared in order to build the mining facility and laying roads. Several organisms and animals live in these forests. With the deforestation, these organisms and animals lose their natural habitat. So, they start looking for a new habitat in order to survive. However, most organisms and animals do not respond very well this change and end up dying. The biodiversity is lost in this process. A number of smaller plants and creepers that grow with the support of the trees also die due to deforestation.

Every single forest in the world is a biosphere of its own. It is impossible to create a biosphere artificially as the various processes and inter-dependence of organisms is too complicated. In addition, mining causes a lot of pollution as a lot of chemical waste incurred due to the various processed involved. This waste is released into water bodies, rivers and sea. The chemical composition of the soil also changes in the mining area. It becomes a desert-like environment where nothing grows.

This issue of Van Sangyan contains an article on Assessing effects of mining and post-mining land rehabilitation on biodiversity and habitats. There are also useful articles, such as Biological reclamation of bare soils, erosion prone slopes and degraded lands using Erosion Control Blankets, Ethno-medicinal uses of plant in folk–medicines in Madhya Pradesh, Climate change: mitigation through interventions of tree improvement, प्राकृतिक एवं ऐतिहासिक धरोहरो की भूमि: बुन्देलखण्ड (in Hindi), Soil carbon sequestration, Mahul leaves collection as livelihood option of tribal people in Achanakmar-Amarkantak biosphere reserve, Occurrence of defoliator, Dichromia sagitta (Fabricius) (Lepidoptera: Noctuidae) on Tylophora indica and Biodiversity of Machlolophus xanthogenys and Physochlaina praealta.

I hope that readers would find all information in this issue relevant and valuable. Van Sangyan welcomes articles, views and queries on various issues in the field of forest science.

Looking forward to meet you all through forthcoming issues.

Dr. N. Roychoudhury
Scientist G & Chief Editor

Contents

		Page
1.	**Assessing effects of mining and post-mining land rehabilitation on biodiversity and habitats** - A. A. Otesile, I. Bakarr, M. Fayiah and M. S.Kamara	1
2.	**Biological reclamation of bare soils, erosion prone slopes and degraded lands using Erosion Control Blankets** - Nidhi Mehta and Avinash Jain	17
3.	**Ethno-medicinal uses of plant in folk–medicines in Madhya Pradesh** - Nikita Rai, Sourabh Dubey and Rajiv Rai	26
4.	**Climate change: Mitigation through interventions of tree improvement** - Sheeraz Saleem Bhat, Anees K and Vibha Singhal	37
5.	**प्राकृतिक एवं ऐतिहासिक धरोहरो की भूमि: बुन्देलखण्ड** - सौरभ दुबे एवं निकिता राय	43
6.	**Soil carbon sequestration** - S. Suresh Ramanan	48
7.	**Mahul leaves collection as livelihood option of tribal people in Achanakmar-Amarkantak biosphere reserve** - Neelu Singh, Rajesh Kumar Mishra and N. Roychoudhury	51
8.	**Occurrence of defoliator, *Dichromia sagitta* (Fabricius) (Lepidoptera: Noctuidae) on *Tylophora indica*** - P.B. Meshram, Shashi Kiran Barve and Nahar Singh Mawai	53
9.	**Know your biodiversity** - Swaran Lata and Preeti Kaushal	56

Assessing effects of mining and post-mining land rehabilitation on biodiversity and habitats

A. A. Otesile[1], I. Bakarr[2], M. Fayiah[1] and M. S. Kamara[3]
[1]Department of Forestry, Njala University, Sierra Leone
[2]Department of Wildlife, Ecotourism and Biodiversity Conservation, Njala University, Sierra Leone
[3]Analytical Services Laboratory, Njala Agricultural Research Centre, Sierra Leone

Abstract
The study investigated the effects of post-mining land rehabilitation and anthropogenic factors on wildlife habitats in the study area. Key conservation problems addressed included; assessing effects of habitat fragmentations on wildlife communities and suitability of resulting sand tailings from mined-out areas to support post-mining natural vegetation regeneration. Also, prospects of restoring High Conservation Value plant species and/or habitats through post-mining land rehabilitation; and challenges from anthropogenic sources are addressed. Soil laboratory analyses; coupled with soil profile and bulk density analyses through dug trenches were done to identify edaphic factors affecting vegetation growth. Also, physical evaluations; through reconnaissance surveys and oral interviews with inhabitants of host communities were done to assess prospects of ecological rehabilitation and challenges from anthropogenic sources. The resulting post-mining sand tailings lacked requisite soil nutrients and structure to support immediate natural vegetation regeneration without 'committed intensive managements'. Nevertheless, despite damages done to the ecosystems, there still appeared to be high varieties of mammals (mostly small and medium) and avian species within and around the study areas. Mineral sand' mining destroys vegetation and habitats; and in turn generates structure less sand tailings; making natural vegetation regeneration difficult. Results revealed these effects and prospects of hastening restoration of damaged biodiversity and fragmented habitats in mined-out areas. This is also with a view to connecting green corridors used for migration.

Keywords: Biodiversity, Land Rehabilitation, Post-mining, Habitat, Restoration, Sierra Leone.

Introduction

Mining is only a temporary use of land. Rehabilitation of land is therefore vital once mining operations stops. Mining of mineral resources often results in extensive soil damage, altering microbial communities and affecting vegetation; leading to destruction of vast amounts of land (Sheoran et al., 2010). As a result, as mining operations cease in one section, the mined area must undergo rehabilitation to restore the land to its pre-mining status or other predetermined land uses. However, the overall long-term sustainability of any mining operation is heavily dependent upon the quality of the post-mining landscape in relation to landowner, regulatory and general societal expectations (Daniels et al., 2012). This sustainability can be achieved through an enduring rehabilitation programme; key to the success of which lies in achieving a substrate (soil) suitable for the establishment of the target vegetation (Hattingh et al., 2007). In this line, Pillai-

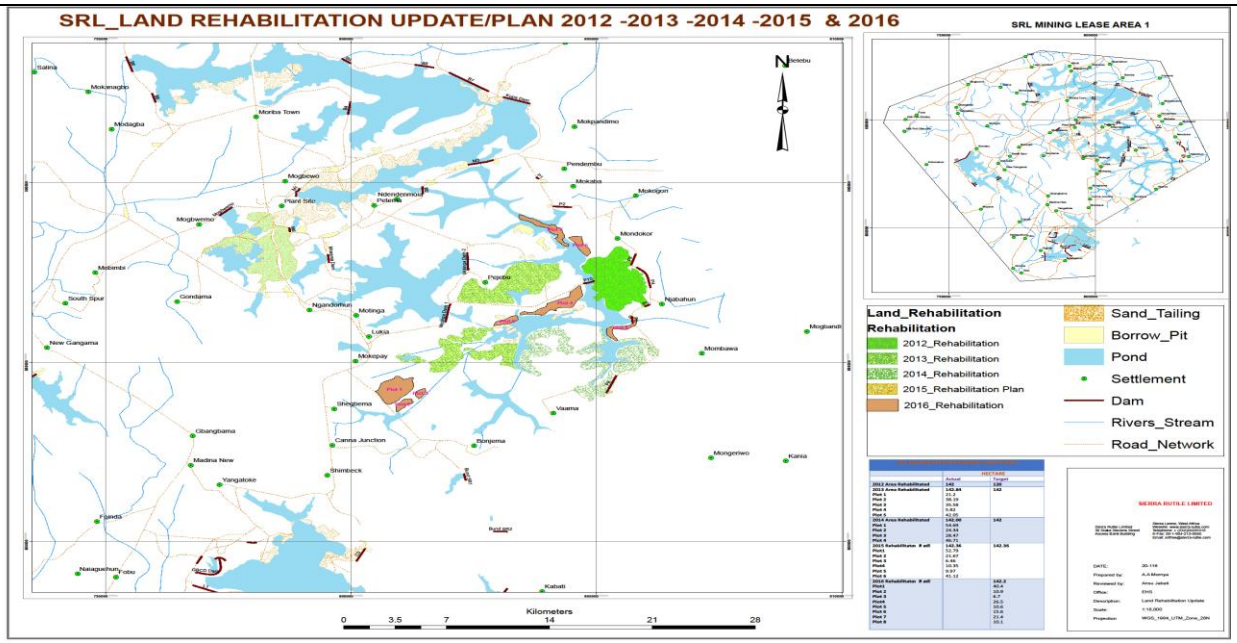
McGarry et al. (2010) suggests that vegetation root and weed population may be influenced by top/sub soil texture and moisture content. Consequently, choice of selected tree species with natural biophysical limits capable of tolerating the poor soil conditions is of equal importance. For instance, as cited by (Otesile, 2000); (Okafor, 1987) stated that *Gmelina arborea, Gliricidia sepium, Azardirachta indica, Casuarina equisetifolia* and *Leucaena leucocephala* were found suitable for soil fertility restoration and erosion control in Nigeria. Their rapid growth and high litter production potentials are factors that make the species good catalysts for hastening topsoil formation through high biomass deposits, reduced ground surface runoff and improved percolation. Hamilton, (1986) affirmed that the development and maintenance of litter and understory vegetation give a high degree of soil protection.

Mineral sands mining started in southern Sierra Leone in the 1960s, although retiles was first discovered in the early 1920s. Corporate ore mining started at the Imperi Chiefdon in Moyamba district in 1967, but land rehabilitation by the company did not commence until after the company signed an Agreement (Ratification) Act, in 2002 with the government. This requires the company to prepare a comprehensive master plan that will address the issues of reclamation and rehabilitation of mined-out areas and it will do this in consultation with appropriate Government Agencies to undertake suitable reforestation, agricultural and other projects within the Mining Lease Area. Consequently, active vegetation of about 1.3 ha of sites mined out between 1987 and 1989 commenced after entering into the agreement (Cemmats, 2012). This was followed by the rehabilitation of an estimated 269ha of mined out land between 1990 and 1994 and another 568.84 ha of sand tails and borrow-pits between 2012 and 2015. The mining operations of the company generate coarse sand tailings along with an abundance of slimes which needs to be recombined for effective post mining rehabilitation. During mineral extraction, the top soil gets seriously damaged; so much that it loses its basic nutrients; such as Nitrogen and Phosphorus crucial for vegetation growth (Sheoran et al., 2010). The physical, chemical and biological disturbances that the soil undergoes, such as in; soil pH, fertility, microbial community and the distortion of various nutrient cycles; makes the degraded soil unproductive after mining. This leads to further livelihood deprivation to farmers and others whose living greatly depends on the productivity of the land. Also, without the vegetation of the mined land, restoration of fragmented wildlife habitats in the mined area may be greatly delayed and this may threaten the survival of vulnerable species.

Methodology

Study area

The study was conducted within the land rehabilitation area of a major mining company in the Imperi Chiefdom, Southern Province of Sierra Leone. The rehabilitation area is part of the company's mine closure plan and the total size of study area was 568.84 ha of sand tails and borrow-pits; rehabilitated between 2012 and 2015 (142 ha in 2012, 142.84 ha in 2013 & 142 ha in 2014 and 142 in 2015).



Source: SRL, 2016

Rehabilitation update plan

Different methods were combined to evaluate the soil, vegetation, ecosystems and to interview inhabitants of host communities.

General field survey

In a preliminary field visit, the survey team visited each of the sites rehabilitated between years 2012 – 2015, to get an understanding of the different site characteristics; regarding, soil profile, topography of the land, species diversity and the host communities. Based on this first visit, field visits were planned, taking care that parameters required to address objectives of the study were represented. However, to enable evaluation of wildlife presence in the study area, focus was placed on potential good-quality habitats with close to natural vegetation (inland valley swamps "IVSs" and vegetation near dredge lakes). Also potential sample plots for vegetating and soil assessment were identified.

Soil sampling

A simple random sampling design was adopted to collect soil samples and select locations where trenches will be dug for the analysis of the edaphic factors affecting tree growth on the rehabilitation sites; based on assessment of soil physical properties (texture and structure), laboratory analysis of soil samples; to obtain vital information on the physical and chemical status of the soil medium at the different rehabilitation sites.

Species identification and sampling

Tree species identification neither followed the conventional method of recording unknown species in local names for later taxonomic classification, nor required subsequent translations, as species used for the rehabilitation project were already known through preliminary information obtained from the company staff who are directly in charge of the rehabilitation project and identification was easy, as the mosaic of species are familiar exotics. A systematic design based on randomly placed line transects was used for vegetation sampling in each of the yearly rehabilitation projects. In each of these, 4 (10m radius) sample plots

were constructed along each of 2 separate 100m randomly laid transect lines; to investigate species physical status, diversity, survival rate and frequency within each yearly rehabilitation project.

Reconnaissance walks

For a rapid wildlife ecological assessment approach, it is important to maximize the survey effort and cover all representative rehabilitated areas. Therefore, a strict random or systematic design is not appropriate. For that reason, reconnaissance walks (short: race walks) with pre-identified start and intended end points were conducted. Reconnaissance walks were conducted to observe the rehabilitated landscapes and record any fauna signs including calls, dung, footprints and feeding sites. Attempt was made to record all signs (direct and indirect) of large mammals, birds and hunting. Since all identification activities were conducted in parallel, the survey was conducted by moving reasonably slow and included regular stops to reduce noise and increase detection probability to account for more low-voiced and shy bird species. As race walks are not based on a systematic design, the data cannot be considered for quantitative analyses, such as population estimation. Although race walks aim to gather as many encounters as possible by increasing the survey effort (walked distance), they cannot work around the fact that species with low population densities are hard to detect. Therefore, race walks within a rapid biodiversity assessment can give an indication of what is present (true positives), but not what is not present (false negatives).

Community interviews

This complemented the reconnaissance walks. Interviews were conducted with the company staff in charge of the rehabilitation project and local community groups of between 5-10 people; living in the area, to gauge their views about the rehabilitation project and wildlife species presence. Interviews lasted 1-1.5 hours and focused on the following two components:

1. Qualitative questions about when rehabilitation started at each site, reasons for the choice of species of seedlings selected for planting, acceptability of the selected species by community stakeholders, participation in the species selection decision making process, community perception of the land rehabilitation process, challenges faced during the process and perceived benefits of the rehabilitation project by community stakeholders: The objective of this component was to assess the potential impacts of the rehabilitation project on livelihoods as well as prospects for continuity.
2. Observation of species: During the interviews, the company staff and community groups were asked about and the presence of wildlife in the area. When an animal was recognized, people were asked about the last time, frequency and location of observation.

The species list was developed after the first field visits and initial conversations with the company staff and some inhabitants from surrounding communities. The species included on the list were selected based on the following criteria:

- Likelihood of presence in the region: Species that are likely to occur based on the biophysical conditions, the geographical location and the results of

the previous studies conducted in the area.

- Conservation status: Species listed as rare or endangered according to the IUCN red list of species.
- Ease of recognition: Species that exhibit unusual and easily recognizable features or are easy to spot, while being representative for a group of species and / or habitat quality.

Table 1: Communities interviewed

S. N.	Name of place
1	Mondokor
2	Njabahun
3	Mokaba
4	Pejebu
5	Mogbwemo

Physical rehabilitation

The edaphic factors affecting tree growth on the rehabilitation sites were analyzed; based on assessment of soil physical and chemical properties of soil samples and profile. Soil samples were taken from 15cm and 30cm depths.

The soil analyses were carried out using methods described jointly by the International Soil Reference and Information Center (ISRIC), Laboratory Guide for Conducting Soil Tests and Plants Analysis (Benton Jones, 2001), Guide to Laboratory establishment for plant nutrient analysis (Motsara and Roy, 2008) and the FAO (ISRIC/FAO, 2002).

Data analysis

Data collected was analyzed using descriptive analysis and presented in table and graphs.

Results and discussions

Physical rehabilitation

Soil structure and texture: 2012 – 2015 Land rehabilitation project area

Particle size distribution was determined by the Hydrometer Method. Generally, there is high percentage of sand in soil samples collected from all the sites, with the highest being 98% and the least; 94%. On the textural triangle, all of the samples were categorized as sandy soils. Further structural classification puts all the samples as being structure less (Brady and Weil, 2002). The soil therefore is poor in water holding capacity as indicated by the moisture retention percentages, nutrient retention is also low as indicated in the results from the cation exchange capacity.

Samples of soil types in each RA

Laboratory analysis: 2012 – 2015

Land rehabilitation project area

- pH analysis of soil samples taken from each of the rehabilitated areas was determined on 1:1 soil: water extracts. The results show that samples taken from the 2012 rehabilitation areas were slightly alkaline in nature; with pH ranging between 7.2–7.6, with the exception of sample obtained from 15cm depth of plot 1, which were 6.0. On the other hand, the 2013, 2014 and 2015 soil samples were slightly acidic (5.2–6.5).
- Electrical conductivity was carried out on 1:1 soil: water extracts. The electrical conductivity of all the soils analyzed are very low; ranging between 0.009- 0.0273.
- The Kjeldhal distillation method was employed in the determination of available nitrogen. The available nitrogen content is very low in all the sites sampled; (range: 6.31g/kg soil – 12.56 g/kg soil). This could be associated with the high mobility of the nutrient under high porous conditions.
- Available Phosphorus was determined using the Bray No. 1 extraction method (Bray and Kurtz, 1945). The quantity of Phosphorus in the extract was determined by colorimetric method. The content of this nutrient was also found to be generally very low (range: 0.6 ppm – 2.3 ppm) in all sites; with samples from the 2012 and 2013 rehabilitated areas being slightly higher (range: 1.5 ppm – 2.3 ppm); indicating probable signs of reclamation activities being carried out.
- Potassium was determined by ammonium acetate extraction and the content in the extract was determined by flame photometry. The content in all samples was generally low (range: 10ppm – 15ppm); with slightly higher proportions observed in samples obtained from plots within the 2012 and 2013 rehabilitation areas.

Soil samples collection for laboratory analysis

- The Walkley Black procedure was used in the determination of the carbon content. The quantities of carbon were low throughout the soils sampled (range: 1.7% – 2.4%). The result did not show any variations in carbon content across the rehabilitated areas.
- Bulk densities, CEC, exchangeable acidity and Al, Ca and Mg contents were also very low in all the sites studied. These implies that soil samples in the Ras are generally very porous and thus low in water content, low in major available supply of many plant nutrients and low in the degree to which sites for acid exchange are saturated respectively. Similarly, low levels of Al, Ca and Mg in the soil results in shortened and thickened root formation; chlorosis and stunted foliage respectively.

Underdeveloped roots of 4 years old plant

A trench showing typical soil profile

Fig. 4: Trenches for soil depth and bulk density investigation

2012 RA

Summary

Both soil physical and chemical properties are critical factors that affect tree growth and the mining process damage both. For soil to support tree growth, its physical status (texture and structure); constituted by varying aggregates of sand, silt and clay must be such that it allows optimum aeration, coupled with water and nutrient drainage and retention capacity. The mined out lands at mining sites, are left with tailings that are pure sand and structure less. Organic matter, which is a key component that helps improve soil structure, as well as increase water holding capacity and percolation rate; is missing in the tailings produced and the rehabilitation project have not succeeded in producing enough organic matter through the approaches adopted. The lack of formation of essential topsoil that contains optimum organic matter at the 2012-2015 rehabilitation sites therefore causes setbacks for the project.

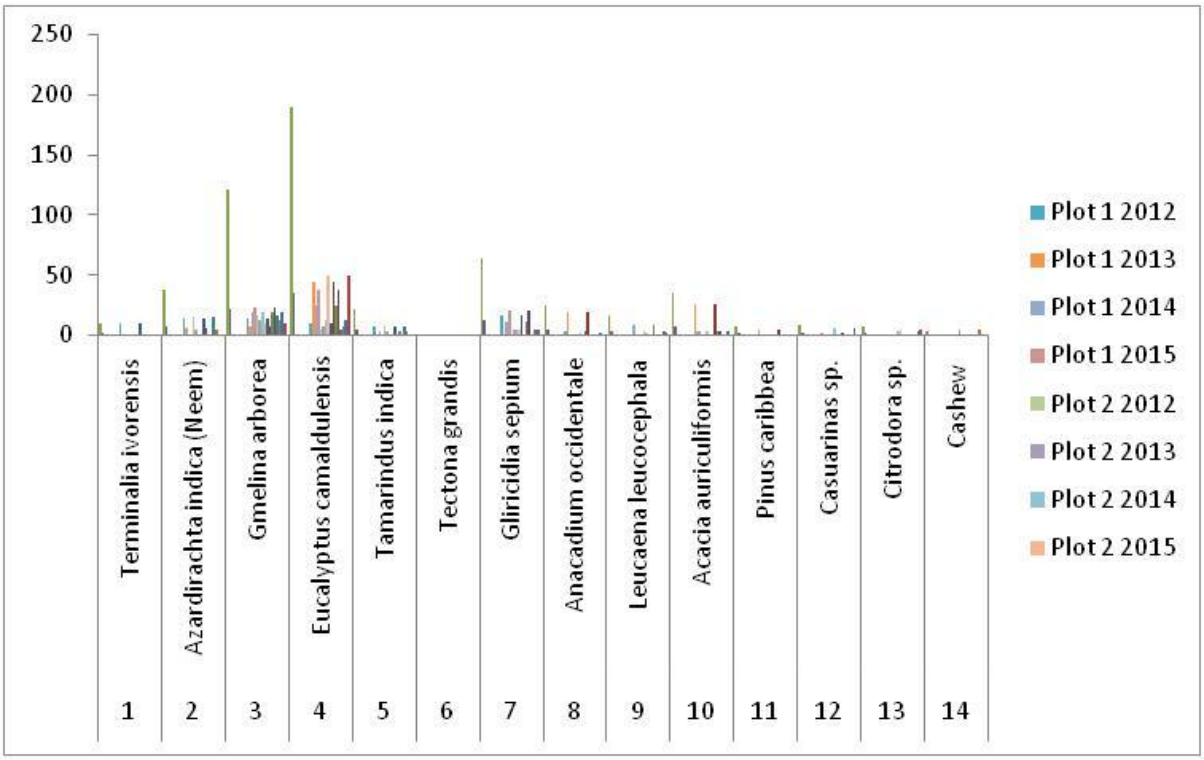
The soil chemical properties of importance in tropical tree growth are the mineral content or the pH level, and the cation exchange capacity of the soil. The capacity of these to enhance tree growth has in turn been greatly hindered by the absence of organic matter. Furthermore, in spite of non-compact nature of the soil in the RAs, depth of root penetration by the planted seedlings was shallow as a result of the deficiencies in Al (affecting root development) and other primary and

secondary nutrients e.g. N, P, K, Ca, Mg etc and exchangeable cation and acidity (affecting plant growth and leaf development).

Despite high probability of the soil samples having high acidity and alkalinity contents due to the mining process, the general pH of soil samples collected does not warrant for immediate acidity or alkalinity amendment options; however, this may become an additional requirement if actions are not taken now; and the situation are allowed to deteriorate over the coming years.

Results of the electrical conductivity of the soil samples implies that the soluble salt content is extremely low, hence there are no immediate concerns about salinity issues in all the sites sampled.

The low levels of nitrogen, phosphorus and potassium in the soil samples analyzed, underpins the high need for the artificial application of these nutrients at the RP sites; in order to supplement the shortfalls being experienced. However, without the adoption of appropriate application regimes, this may end as a futile attempt; as these nutrients may easily leach as a result of the poor soil physical status.

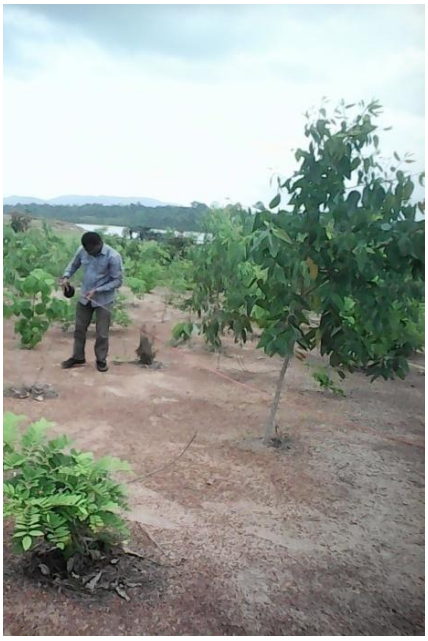


Species availability per sample plots (live trees)

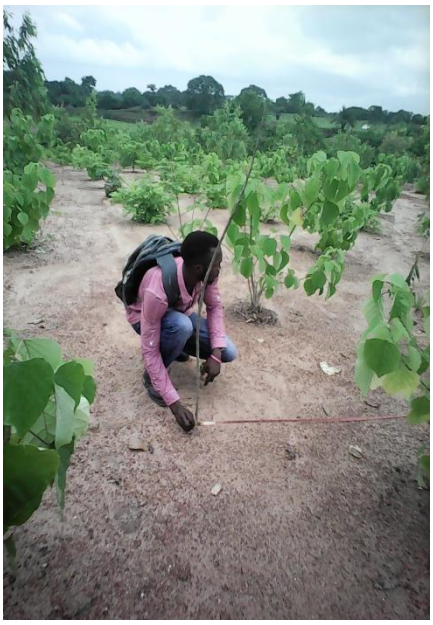
Low levels of carbon in the soil samples analyzed indicate presence of low organic matter content in the soil. The most efficient remedy to low organic carbon is the addition of organic matter. Organic matter is a good source of plant nutrients, particularly nitrogen, phosphorus and sulphur. The importance of this material in tree nutrition is very high; as the fertility of most tropical soils depends largely on the rapidity, type and extent of decomposition and incorporation of the organic debris added to it from time to time. Furthermore, the unincorporated organic material protects the soil from the compacting effects of heavy rainfall, checks runoff and encourages percolation.

Vegetation rehabilitation

Collectively, a total of 13 various tree species that are useful for timber, charcoal and fuel wood and 1 agricultural woody Two 20 m diameter plots were constructed along 2 separate 70 m transect lines; in randomly selected locations in each of the RAs for the investigation of vegetation cover restoration. There were between 32 and 113 stands of mixed species in each of the plots sampled (indicating probable high mortality rates in some plots; assuming 3 m x 3 m spacing is maintained in all RAs); with representative smallest tree height at 20 cm and medium height at 176 cm across the RA. Observed mortality was between 1 to 3 dead standing trees in some of the plots sampled.



fruit tree species were identified in the entire 16 (20m diameter) plots constructed across the areas rehabilitated between 2012 and 2015.



Plots laying and data collection

Areas rehabilitated between 2012 and 2013 were generally characterized by a mosaic of stunted and yellow leaved trees; indicating acute nutrient deficiencies and confirming results of the soil test. In addition to this, trees in 2013 RA were often affected by seasonal fire outbreaks, which contribute further to poor tree growth performances. Furthermore, although trees encountered in 2014 and 2015 RAs were generally taller; they nonetheless exhibited significant symptoms of nutrient deficiencies as in earlier RAs. Consequently, majority of

trees encountered within the sample plots exhibited symptoms indicating a combination of deficiencies in 2 or more of the important plant nutrients.

Trees deficient in key nutrients such as nitrogen, phosphorus and potassium often exhibit symptoms such as poor tree growth, pale green or chlorosis (yellowing of leaves), gradual firing starting at leaf tips, leaf size reduction, yellowing between leaf veins, brown scorching and curling of leaf tips.

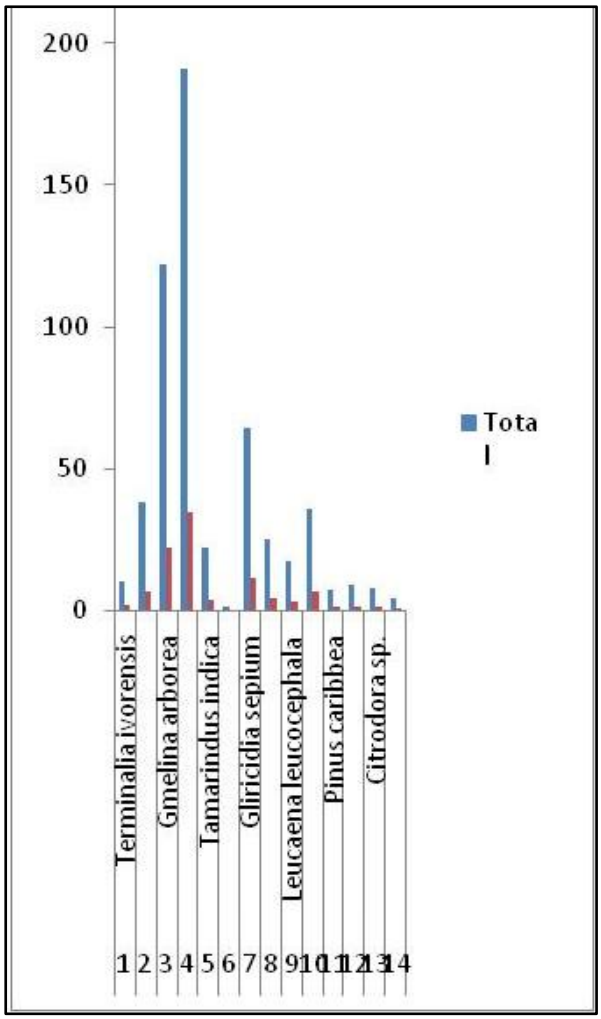
Defects caused by nutrient deficiency

Agriculture was observed to be the most common land use and economic activity within the project area and population growth in the area continues to place more demand for agricultural land. Cultivated or farming areas are always less than 1 acre and are common in both upland and low-lying areas. Farm size depended on the type of crops cultivated. The main crops cultivated include rice, cassava, groundnut and maize. The harvested rice, groundnut and maize are mostly utilized for household consumption, while cassava is mostly processed into gari and foofoo for sale elsewhere. Fishing was also observed to be a common activity in the project area. Male children and adults were observed fishing in dredge lakes.

Community interviews, species, ecosystem and habitat

Local community people confirmed previous occurrence of the threatened Western red colobus monkey in the area.

This species is forest dependant and is noted to have since disappeared in the area as a result of habitat degradation. However, despite such apparent degradation in all the four sites, personal observations and discussion with local people revealed that surprisingly high numbers of mammal and avian species continue to occur in the project area (Table 2). For example, one of the villagers interviewed, mentioned seeing 4 chimpanzees moving in a group in the 2013 RA in March 2016. In fact, the mosaic of different habitats is particularly important for the endangered chimpanzee, a ‘flagship’ mammal species of the project area. We also observed several foot prints of a large bushbuck in the same site. Water in the dredge ponds serve as potential drinking source for the wildlife. A couple of different animal foot prints were also



Natural and anthropological effects on wildlife habitats in the study area

observed along some of these ponds. The mature farm bushes and woodland savannah in the project area provide ecological requirements such as food and shelter for the resident wildlife.

2012 RA

This site is 142 ha in size and is located in the Mondokoh RA. Rehabilitation work in this site was done in 2012. Major challenges include:

Percentage availability of species per sample plot (live trees)

i) The formation of several gullies resulting from heavy down pour of rain destroys the planted seedlings.

ii) Cutting down the planted *Azardirachta indica* (Neem) seedlings by community people for medicinal purposes.

2013 RA

This site is 142 ha and is located in the Pejebu RA. Rehabilitation work was done in 2013. Major challenges include:

Table 2: List of mammals and birds recorded during field work or reported to be present in the Project Area. Scientific names are based on Kingdon (1997), Oates (2011) and Borrow and Demey (2004).

S/N	Species	Common Name
1	*Pan troglodytes verus*	Western chimpanzee
2	*Cercopithecuscampbellicampbelli*	Campbell's monkey
3	*Cercocebusatys*	Sooty mangabey
4	*Cercopithecuspetaurista*	Spot-nosed monkey
5	*Cercopithecusaethiopssabaeus*	Green/Vervet monkey
6	*Paraxeruspoensis*	Green squirrel
7	*Thryonomysswinderianus*	Cane rat
8	*Cephalophusmaxwelli*	Maxwell's duiker
9	*Tragelaphusscriptus*	Bushbuck
10	*Neotraguspygmaeus*	Royal antelope
11	*Synceruscaffer*	African buffalo
12	*Civettictiscivetta*	African civet

13	*Atherurusafricanus*	Brush-tailed porcupine
14	*Potamochoeruslarvatus*	Bush pig
15	*?*	Bats
16	*Herpestessan guinea*	Slender Mongoose
17	*Scopus umbretta*	Hammerkop
18	*Egrettagarzetta*	Little egret
19	*Bubulcus ibis*	Cattle egret
20	*Centropussenegalensis*	Senegal coucal
21	*Trigonocepsoccipitalis*	White-headed vulture
22	*Macrodipterylongipennis*	Standard-winged nightjar
23	*Ploceuscucullatus*	Village weaver

i) Bush fires resulting from cigarette butts carelessly dropped by smokers walking through a major foot path passing through this site, burning of newly cleared farms close to this site, willful fire set by passersby to clear footpaths; instead of slashing and hunters flushing out animals in bushes close to this site.

ii) The formation of several gullies resulting from heavy down pour of rain destroys the planted seedlings.

iii) Cutting down the planted *Azardirachta indica* (Neem) seedlings by community people for medicinal purposes.

Effects of bush fire and erosion

Soil erosion and *Azardirachta indica* species harvested by community people (2012 RA).

2014 RA

This site is 142 ha and is located in the Mondokoh rehabilitated area and borders with 2012 RA. This site also includes a large 'borrow pit' i.e. an area whose top soil was removed for road construction elsewhere in the mine. Rehabilitation work was done in 2014. Major challenges include:

a) The formation of several gullies resulting from heavy down pour of rain destroys the planted seedlings.

b) Cutting down the planted *Azardirachta indica* (Neem) seedlings by community people for medicinal purposes.

Gully erosion

2015 RA

This site is 142 ha and is located in the Mogbwemo RA. It is on the main road on the way to the main SRL camp site. Rehabilitation work was done in 2015.

Major challenges include:

Flood plane and dredge lake

a) The area is a floodplain and is prone to water logging due to its proximity to massive dredge lakes.

b) Cutting down the planted *Azardirachta indica* (Neem) seedlings by community people for medicinal purposes.

Conclusion

In spite of evidences of premature harvesting of immature *Azardirachta indica* in the 2012 and 2013 RAs and the willful bush burning along footpaths in the 2013 RA by passersby; the rates of occurrence are insignificant.

Despite damages done to the ecosystems as a result of mining activities within mining concessions, there appears to be

high varieties of mammal and avian species within and around the study area; this is believed to be influenced by the presence of dredge lakes and some high and secondary forest fragments in the entire region, serving as important key habitats for remaining native wildlife and avian species.

The use of topsoil obtained from neighboring farm bushes for tree planting is neither a sustainable practice nor environmentally friendly. The approach seeks to solve a problem while creating many others. The removal of topsoil from a particular location or different locations may leads to destruction of some ecosystems critical to the survival of different flora and fauna life forms (including microorganisms) in such areas. Topsoil removal may also lead to erosion and nutrient leaching in areas affected.

The distribution of wildlife species are reported throughout the project area. All of the monkeys and other mammals reported and observed to be present in the project area are adaptable species. Amongst all the reported and observed mammals, only small rodents continue to be recurrent in the RAs. The large/medium sized animals (especially ungulates and primates) mostly use the rehabilitated mined-out areas as connecting corridors between the global degraded and fragmented environments. The absence of forest-dependent species within the project area suggests that significant damage to the forest environment has already occurred, and that the remaining species are unlikely to be seriously affected by the further loss of essential habitats. Remaining resident species are presently at lower risk, and in addition to the rehabilitated mined-out areas, they can also survive in the already degraded and highly fragmented environments.

Nonetheless, further expansion of mining activities would certainly be damaging; due to further loss of ecosystems and cultivation of the remaining habitats. Mining will lead to further shortening of fallow periods due to loss of agricultural land in the project are, thereby leading to land hunger and the increased intensity of its use elsewhere. This consequently results in reduction of mature farm bushes available for wildlife habitation.

References

Benton J., (2000): Laboratory Guide for Conducting Soil Tests and Plants Analysis.

Borrow, N. and Demey R., (2004): Field Guide to the Birds of Western Africa. Christopher Helm, London

Brady, N. and Weil, R. (2002a): Elements of the nature and properties of Soils.

Brady, N. and Weil, R. (2002b): The Nature and Properties of Soils. 13th ed. 2002

CEMMATS Group Ltd. (2012): Sierra Rutile Limited. Environmental and Social Action Plan. Volume 2/Report 1

Daniels, W. L, Stilson, C. and Zimmerman, C. (2012): Development of Effective Rehabilitation

Protocols for Mineral Sands Mining in Virginia, USA. LIFE-OF-MINE CONFERENCE / BRISBANE, QLD, 10 - 12 JULY 2012. P 99

Hamilton, B.E. (1986): Land Use and Soil Conservation Processes. Smithsonia Press pp 54

Hattingh, R.P., Beukes, I., Krause, B. and Kotze, H. (2007): Soil reconstitution as a key driver for successful rehabilitation at Hillendale Mine. The 6th International Heavy Minerals Conference 'Back to Basics', The Southern African Institute of Mining and Metallurgy, 2007. p. 31-32

Kindon, J. (1997): The Kindon Field Guide to African Mammals. Academic Press.

Motsara and Roy, (2008): Guide to Laboratory establishment for plant nutrient analysis.

FAO (ISRIC/FAO, 2002, Procedures for Soil Analysis. Technical Paper 9, 6th Edition

Woboshi, L.C. (1982): Tropical Silviculture; Principles and Techniques.pp 258-259

Okafor, J.C. (1987): Flora of Miliken Hill, Enugu, Nigeria. Pp. 20-21

Oates, J. F. (2011): Primates of West Africa: A field guide and natural history. Conservation International

Orwa, C., Mutual, A., Kindt, R., Jamnadass, R. and Anthony, S. (2009): Agroforestry Database. World Agroforestry Centre

Oesile, A.A. (2000): Vegeation Survey of the Natural Forest Block in the Botanical Gardens,
University of Ibadan; p. 32

Pillai-McGarry, U. P., Lockhart, C., and Mulligan, D. (2010): Soil factors affecting vegetation establishment after sand mining on North Stradbroke Island. The 19th World Congress of Soil Science, Soil Solutions for a Changing World. 1–6 August, 2010 Brisbane, Australia. P.49

Sheoran, V., Sheoran, A. S., and Poonia, P. (2010): Soil Reclamation of Abandoned Mine Land by Revegetation: A Review. International Journal of Soil, Sediment and Water, Vol. 3 [2010], Iss. 2, Art. 13 ISSN: 1940-3259. p.1. Produced by The Berkeley Electronic Press, 2010.
http://scholarworks.umass.edu/intljssw/vol3/iss2/13

Sierra Rutile Limited. (2015): Annual Report and Accounts.

Biological reclamation of bare soils, erosion prone slopes and degraded lands using erosion control blankets

Nidhi Mehta*and Avinash Jain
Tropical Forest Research Institute
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
P.O. – RFRC, Mandla Road, Jabalpur (M.P.)
*E-mail: mehtan@icfre.org

Abstract

Erosion Control Blankets (ECBs) are degradable rolled products, made up of processed natural or polymer fibres forming a continuous matrix to provide erosion control and facilitate vegetation establishment. These blankets function as shield to bare soil and newly seeded areas against raindrops and wind erosion stabilizing and supporting emergent vegetation. Post germination of the seeded areas, the blanket decomposes providing organic matter to soil, increasing precipitation infiltration, decreasing soil compaction and further helping plant growth. ECBS are of different types based on their fibre material, site requirements and uses. They are becoming increasingly popular eco-friendly solution to reclaim degraded lands, problem soils and erosion prone areas

Introduction

Soil erosion is a worldwide problem that washes away fertile farmlands, slopes of roadway cuts and embankments, producing undesirable deposits in rivers and reservoirs and at a larger scale resulting to landslides and land degradation (Kothyari, 1996 and Thakur, 1996). Accumulation of huge amount of flyash from thermal power stations, overburden dumps due to mining and huge amount of other developmental activities degrades land, atmosphere and water bodies impacting soil, vegetation and fauna which results in loss of biodiversity and habitat fragmentation (Sort and Alca˜niz, 1996; Clemente et al., 2004; Moreno-Pe˜naranda et al., 2004). Unprotected soils at construction sites are 10 to 20 times more vulnerable to erosion as compared to that of agricultural lands (Faucette et al., 2006; Benik et al., 2003). About 121 m ha *i.e.*, one third land of the total geographical area (328.73 m ha) of India is reportedly degraded and is posing a major threat to India's food security and loss in productive capacity of the soil (ICAR-NAAS, 2010).

Vegetation cover protects the soil surface and provides supplemental soil stability (Morgan, 2005). The sites with shorn of topsoil also loses its complex community of micro flora and fauna that nourishes and sustains plant growth, leaving behind unhealthy soils with little or no biological activity (Northcutt, 2003). Reclamation, despite being an environmental necessity and mandatory in many areas, has had limited success particularly when the goal is to achieve it in disturbed lands (Bonifazi et al., 2003; Allen et al., 2005 and Wunderle, 1997). Unfavorable soil conditions typically found in these areas add up to the problem of reclamation (Toy, *et al.*, 2002), because the seed bank has been removed or damaged (Wheater and Cullen, 1997; Cooper and MacDonald, 2000). Reclamation can succeed only when soil is placed on the rock spoil; however soil at degraded lands is scarce, coarse and nutrient deficient (Bradshaw

and Chadwick, 1980; Davis et al., 1985). Covering bare soils with Erosion Control Blankets (ECBs) is innovative and ecofriendly solution which not only saves the energy used in transporting soil from one fertile or agricultural lands to problem land but also helps in protecting lands from further degradation. ECBs are biodegradable, open-weave blankets that provide temporary cover and support for establishing vegetation on bare soil areas.

Erosion control blankets (ECBs):

Purpose and function

They are temporary degradable rolled erosion control products (Fig: 1) composed of processed natural or polymer fibres mechanically, structurally or chemically

Fig 1: Degradable rolled Erosion

bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment (Jerald, 2004). They are also known as Mulch Blanket or Erosion Control Matting. ECBs, mulch, and a variety of geotextiles materials (i.e. a variety of polypropylene or polyester fabrics) are used to reduce potential surface erosion and enhance soil moisture retention during vegetation establishment.

ECBs function by shielding bare soils and newly seeded areas against raindrop and wind erosion, providing dense matrix of biodegradable material (e.g., straw, coconut) that stabilizes and supports emerging vegetation and further decomposes aiding plant growth. They also increase precipitation infiltration and decrease soil crusting and compaction (Minnesota Stormwater Manual, 2017).

Applications of erosion control blankets

Degradable ECBs are appropriate for any bare soil area where temporary protection from erosion is needed or where newly seeded grass requires short-term cover and support prior to germination during early growth and full establishment. ECBs are generally used in reclamation of bare lands which are highly susceptible to erosion such as steep slopes, channels, mining areas, flyash dump and lagoons and in locations where establishing vegetation may otherwise be difficult They are also effective in establishing vegetation on relatively flat shoreline areas, swales, ditches, athletic fields and grassy areas where long term plastic netting may cause tripping hazard and environmental pollution (Scherer,2016; Minnesota Stormwater Manual, 2017).

Types of erosion control blankets

Erosion control blankets are composed of processed natural or polymer fibres. They come in many forms and materials and serve different purposes. ECBs are designed and fabricated in a variety of types and the lifespan of the blankets last from a few months to approximately three years. Based on the parent material used in manufacturing, major types of ECBs are described below:

Open weave coir bhoo vastra (CBV)

They are made from coir fiber extracted from coconut husk either by natural retting or by mechanical process. They are used for stabilization of soil through vegetation against erosion of landscape and soil

slopes as well as protection of river and canal banks, roads and railway embankments and reinforcement of mud of stream against erosion and other applications involving separation and filtration. According to BIS 15869:2008 Textiles-Open Weave Coir Bhoovastra-Specifications, the coir blankets have the following grades based on the mass:

a) Grade I- 400g/m^2

b) Grade II-700g/m^2

c) Grade-III 900g/m^2

Each coir mat is designed for a specified range of erosion control depending upon the vegetation and geological conditions. Coir blankets are supplied in the form of rolls with a maximum width of 2.4 m and length of 50 m. Each roll is packed with impermeable wrapping which shall not undergo deterioration or damage during handling, transportation, storage and placing (Deshmukh *et al.*, 2013 and Nair *et al.*, 2014).

Straw erosion control blankets

These blankets are made up of agricultural by products and the dry stalks of a number of cereal plants such as barley, oats, rice and wheat. Such ECBs are single or double sided by means of photodegradable or biodegradable exterior netting depending on the design.

Jute erosion control blankets

Jute fiber is used to make such Erosion Control Blankets. These are 100 percent bio-degradable, recyclable, environment friendly and lightly woven fabric used for soil erosion control, seed protection, weed control and many other agricultural and landscaping uses.

Aspen shaving blanket

These blankets are made from aspen wood fiber mat designed to give support the river and canal banks, channels, roads and other low-flow areas. Such blankets have a lifespan of 12 to 18 months (Deshmukh et al., 2013 and Minnesota Stormwater Manual, 2017).

Site inspection, preparation and installation of blankets

1. The sites to be revegetated are inspected for slope gradient, soil condition, topography, flow velocity, vegetation types, maintenance requirements, sensitive adjacent areas and water availability which help in deciding the size and type of blanket to be used to vegetate the area successfully.
2. The type and weight of blanket is selected depending upon the requirements according to the site conditions.
3. Site preparation is done by preparing seed beds and adding top soil wherever necessary.
4. The beds are then fertilized and seeded immediately.
5. A minimum 12” deep and 12” wide small anchor trench (Fig:2) is dug on top of the slope where the top end of the material is anchored by folding the edge of the blanket underneath itself and then it is tucked and secured using staples.

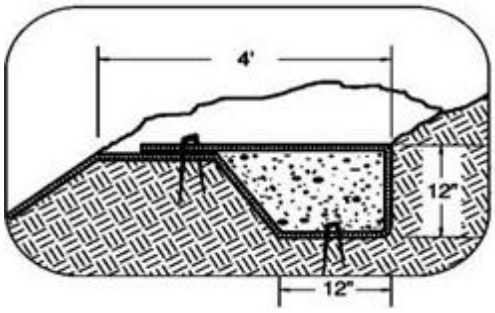


Fig. 2: Small trench dug at top of slope to anchor ECBs

*Source: http://www.nedia.com/Erosion_ control _ inst_ slopes.html

The trench is then back filled to the previous soil level.

6. Blankets are unrolled down slope in the direction of the water flow within 24 hours of seeding (Fig: 3). Care should be taken spread blanket with ease and to have full contact with the soil.
7. ECBs are anchored using live or dead stakes, or landscape staples, to reduce the effect of raindrop splash, retain soil moisture, reduce wind and water erosion and in some cases reduce scouring effect of flowing water.
8. Blankets are laid in the manner they are in continuous contact with the soil or upstream ones should overlap the lower ones by at least 8".
9. It usually involves driving 6"-8" wood or metal staples into the ground in a pattern determined by site conditions. Wood staples are preferable to metal staples as the former swell, hold better and are more eco-friendly (Giordanengo et al., 2016 and Burke et al., 1996).

Special considerations and maintenance

- Spreading thin layer of external soil on the degraded sites devoid of top soil can increase the success rate of reclamation of degraded lands. Although, care must be taken not to collect soil from fertile or agricultural land, converting them unfertile just to reclaim some other problem land.
- Use of native species should be promoted to revegetate degraded lands (Davis *et al.*, 1985; Wunderle, 1997; Alvarez-Aquino *et al.*, 2004; de Souza and Batista, 2004).
- The factors *viz.* slope and aspect of contoured embankments, depth and quality of soil covering the embankment, rockiness, potential for soil erosion and gulley formation, age of construction and surrounding vegetation should be taken care of during ecosystem development (Cohen-Fern´andez and Naeth, 2013).

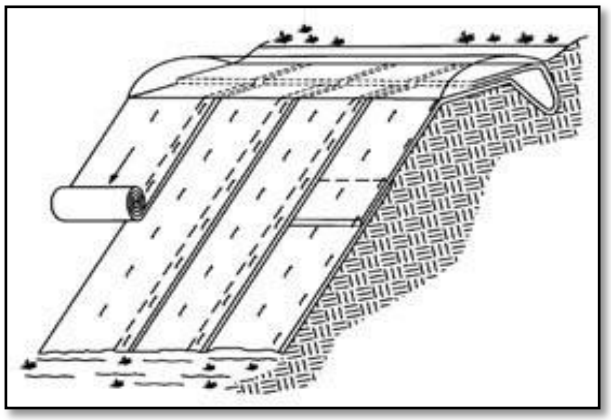


Fig. 3: Unrolling ECBs down slopes in the direction of water flow.

*Source: http://www.nedia.com/Erosion_control _ inst_ slopes.html

- The life of the blankets varies with material and the conditions of the installed area.
- Improper stapling or not using check slots leads to poor contact between the soil and blanket which will cause the water to flow under the blanket resulting in ineffective installation of the erosion blankets.
- Periodic inspection of the site should be carried out for check of erosion after each storm event during vegetation establishment.
- If erosion from any treated portion is reported, then blanket from that area is re-laid and stapled back after adding soil and seeds in the disturbed blanket.
- The revegetated sites should be periodically surveyed after

vegetation establishment (Burke *et al.*, 1996).

Examples stating application of erosion control blankets practice

In Singrauli, stabilization of overburden dumps at coal mines has been effectively achieved with the combination of Coir mat and Gabions. Coir mats were used to revegetate the area of flyash dumps, which is the major byproduct of the thermal power station posing serious environmental and health issues around the area (Iyer, 2009).

In Wayanad District of Kerala in high altitude cricket stadium prepared on highly undulating ground surface with hillocks and deep valleys.

Fig. 4: a) Layering and fixing of coir ECB during vegetation of slopes and problem soil at Wayanad cricket

stadium, Kerala. b) Comparison of growth of seeded Bermuda grass at the stadium with and without the use of geotextiles.

The cricket ground has been developed by cutting the hillocks in the northern area and filling the valley in southern side. Slope protection against surface runoff and rainwater splash was done with coir fiber geotextiles in conjunction with Bermuda grass. Full growth on the reclaimed land was obtained after five months (Fig: 4) of seeding and the plantation survived successfully (Balan *et al.*, 2011).

Desirable vegetation cover was achieved at Canadian limestone quarry and lime processing plant with erosion control blankets and organic amendments. The study involved evaluation of season of seeding and soil amendment with manure, mix, wood shavings and ECBs over two growing seasons to determine their effect on soil properties and native grass establishment. It was observed that the use of blankets facilitated native grass establishment despite not changing chemical properties of constructed soils. Manure was found to be more effective than wood shavings improving soil properties and plant establishment. Site characteristics such as slope, aspect and soil nutrients influenced early plant community development and treatment effects. Increasing total nitrogen and carbon in soil increased density and establishment of planted species. The study showed that a combined approach of soil nutrient enrichment with manure and protection with erosion control blankets increased revegetation success (Cohen-Fern´andez and Naeth, 2013).

Benefits of erosion control blankets

1. ECBs are eco-friendly solution to reclaim degraded lands that provides some degree of immediate stabilization for vegetation establishment in degraded and

erosion prone areas acting as a ground cover or mulch.

2. Stabilize disturbed, steep slopes and protect surface from erosive forces of raindrop impact.
3. ECBs have proven extremely effective in retaining moisture and contouring soil surface irregularities.
4. The blankets hold the ground for seeds and seedling provides mechanical support against water, helps in germination of seeds, retains moisture and enriches soil with soil organic matter of the degraded soil.
5. ECBs are good insulators and are resistant to dampness and moths.
6. Erosion control blankets prevent loss of nitrogen, phosphorus and potassium from the soil.
7. Biodegradable ECBs degrade over time, eliminating potential maintenance issue thereby reducing labor costs.
8. Natural products used in ECBs have reduced deleterious effects on birds, snakes, rodents, aquatic organisms and other wildlife, caused by use of synthetic materials.
9. Photodegradable mesh incorporated with natural fibres enhance the strength of an ECB providing prolong support (MDEQ NPS BMP, 2010, Nair et al., 2014, Deshmukh et al., 2013 and Giordanengo, 2016).

Limitations

1. Different design and construction standards manufactured by different companies and result in dependency of user on designer or manufacturer.
2. Slope gradient and various edaphic factors may acts as limiting factor for establishment and installation of ECBs.
3. Permanent stabilization and protection is dependent on the establishment of vegetation (MDEQ NPS BMP, 2010).

Conclusion

The rate at which we are losing fertile land is not only posing serious problem to the country's valuable land resource but also challenging the increasing demand of population needs and food security. The site with washed away top soil is coarse, deficient in nutrients and its associated micro organisms. Vegetating and reclaiming degraded lands with contemporary techniques is labour intensive and often results in less success because of adverse soil conditions. Use of biodegradable Erosion control blankets can generate miraculous results by stabilizing the land and providing optimum environment for germination and establishment of vegetation on degraded lands, mining and flyash dumps. The installation of blanket provides optimum environment for growth of vegetation in problem soils. ECBs provide support for anchorage of seeds, helps in retaining moisture and nutrients for restoring natural micro floral growth and organic content in soils and eventually solving the problem of soil erosion. The success obtained in reclamation of degraded lands by the use of various biodegradable geotextiles should be further explored and their use should be intensified in mitigating erosion caused by various natural and manmade activities. Combination of other soil amendments techniques like hydroseeding, mulching, soil engineering in combination with erosion control blankets has also

proved beneficial in ameliorate these problem soils.

Although a number of experiments have been conducted around the world verifying the success of use of Erosion Control Blankets in reclaiming various slopes, embankments, flyash dumps, mining and quarrying areas but the technique is less explored and is relatively new for India. Few success stories of vegetation using geotextiles have been reported from the state of Kerala and Madhya Pradesh where it was used to reclaim roadways slopes, embankments and thermal power dumps. National Green Highway Mission (NGHM) is planning to adopt this technique to revegetate slopes along highways of the country. Tropical Forest Research Institute, Jabalpur is going to conduct studies to vegetate flyash dykes created by dumping of flyash produced during the process of generating electricity by burning coal using erosion control blankets.

References

Allen, M. F., Allen, E. B., and G´omez-Pompa, A. (2005). Effects of mycorrhizae and nontarget organisms on restoration of a seasonal tropical forest in Quintana Roo, Mexico: factors limiting tree establishment, Restor. Ecol., 13, 325–333.

Alvarez-Aquino, C., Williams-Linera, G., and Newton, A. C. (2004) Experimental native tree seedling establishment for the restoration of a Mexican cloud forest, Restor. Ecol., 12, 412–418.

Balan, K. and Sibi, J. (2011). A case study on soil bioengineering application using stitched erosion control blankets from coir fiber. Proceedings of Indian Geotechnical Conference, Kochi. Paper No.J-342, 607-610.

Benik, S. R. , Wilson, B. N., Biesboer, D. D., Hansen, B., Stenlund, D. (2003). Performance of erosion control products on a highway embankment. ASAE. Vol. 46(4): 1113–1119.

Bonifazi, G., Cutaia, L., Massacci, P., and Roselli, I. (2003). Monitoring of abandoned quarries by remote sensing and in situ surveying. Ecol. Model., 170, 213–218.

Bradshaw, A. D. and Chadwick, M. J. (1980). The restoration of land: The ecology and reclamation of derelict and degraded land, University of California Press, Berkeley, California, pp.317.

Burke, B. B., Beik, E. S., Daily, M. K., O'Leary, J. M., Stolz, D. J., Anderson, M. J. and Eichelberger, A. E. (1996). Indiana Drainage Handbook. Revegetation and site stabilization. Sec 5.1104., 1-2.

Cohen-Fern´andez, C. A. and Naeth, A. M. (2013). Erosion control blankets, organic amendments and site variability influenced the initial plant community at a limestone quarry in the Canadian Rocky Mountains. Biogeosciences, 10, 5243–5253.

Cooper, D. J. and MacDonald, L. H. (2000). Restoring the vegetation of mined peatlands in the southern Rocky Mountains of Colorado, U.S.A., Restor. Ecol., 8, 103–111.

Clemente, A. S., Werner, C., Maguas, C., Cabral, M. S., Martins- Loucao, M. A., and Correia, O. (2004). Restoration of a limestone quarry: effect of soil amendments on the establishment of native Mediterranean sclerophyllous shrubs, Restor. Ecol., 12, 20–28.

Davis, B. N. K., Lakhani, K. H., Brown, M. C., and Park, D. G. (1985) Early seral communities in a limestone quarry: an experimental study of treatment effects on cover and richness of vegetation, J. Appl. Ecol., 22, 473–490.

de Souza, F. M. and Batista, J. L. F. (2004). Restoration of seasonal

semideciduous forests in Brazil: influence of age and restoration design on forest structure, Forest Ecol. Manag., 191, 185–200.

Deshmukh, A., Sikdar, P., Sahu, A. (2013). A Study on Erosion Control Blankets made of Rice Straw. International Journal of Science and Research (IJSR). 408-409.

Faucette, B.L., Risse, M. L., Jordan, C.F., Cabrera, M. L., Coleman, D.C., West, L.T. (2006). Vegetation and soil quality effects from hydroseed and compost blankets used for erosion control in construction activities. Journal of Soil and Water Conservation vol. 61 no. 6, 355-362.

Giordanengo, J. H., Mandel, R. H., Spitz, W. J, Bossler, M. C., Blazewicz, M. J., Yochum, S. E., Jagt, K. R., LaBarre, W. J., Gurnee, G. E., Humphries, R., Uhing, K. T. (2016). A Manual of Bioengineering Treatments for Colorado Streams, State of Colorado, Colorado Water Conservation Board.

Jerald, S. F. (2004). Designing for Effective Sediment and Erosion Control on Construction Sites. Santa Barbara, California: Forester Press.

ICAR-NAAS (2010). Degraded and Wastelands of India, Indian Council of Agricultural Research, New Delhi, p.158.

Iyer, A. (2009). CONTROL SOIL EROSION WITH NATURE'S OWN PRODUCTS. Indian Geotechnical Conference, Guntur. Geotide, Indian geotechnical Society. 541-544.

Kothyari, U.C. (1996). Erosion and Sedimentation Problems in India. Erosion and Sediment Yield: Global and Regional Perspectives (Proceedings of the Exeter Symposium, July 1996).

MDEQ NPS BMP (Michigan Nonpoint Source Best Management Practices) Manual (2010). Department of Environmental Quality Environmental Assistance Center. Rolled Erosion Control Products. 9.9.p 1-8.

Morgan, R.P.C. (2005). Soil Erosion and Conservation, 3rd Ed. Blackwell Publishing, USA. Sutherland, R. and Ziegler, A. (2007) Effectiveness of coir-based rolled erosion control system in reducing sediment transport from Hillslope. University of Hawaii, Hawaii, USA.

Moreno-Pe˜naranda, R., Lloret, F., and Alca˜niz, J. M. (2004). Effects of sewage sludge on plant community composition in restored limestone quarries, Restor. Ecol., 12, 290–296.

Nair, L., Ravi, K. P. and Sarma, S. U. (2014). Bureau of Indian Standards for Coir Textiles.

Northcutt, G. (2003). Improve Hydroseeding Success By Breathing New Life into Barren, https://www. landandwater.com /features/vol48no2/ vol48no2_2.html

Scherer, J. E., Steele, J., Migliore, B., Lafaille, B., Oakley, H., & Bailer, W. (2016). Rhode Island Soil Erosion and Sediment Control Handbook. Rhode Island State Conservation Committee.

Sort, X. and Alca˜niz, J. M. (1996). Contribution of sewage sludge to erosion control in the rehabilitation of limestone quarries, Land Degrad. Dev., 7, 69–76.

Thakur, V.C. (1996). Landslide Hazard Management and Control in India. International Centre for Integrated Mountain Development, Kathmandu.

Toy, T.J., Foster, G.R., Renard, K.G. (2002). Soil Erosion: Processes, Prediction, Measurement, and Control. John Wiley and Sons.

Wheater, C. P. and Cullen,W. R.: The flora and invertebrate fauna of abandoned

limestone quarries in Derbyshire, United Kingdom, Restor. Ecol., 5, 77–84, 1997.

Wunderle, Jr J. M. (1997). The role of animal seed dispersal in accelerating native forest regeneration on degraded tropical lands, Forest Ecol. Manag., 99, 223–235.

Websites:Minnesota Stormwater Manual contributors, 'Erosion prevention practices - erosion control blankets and anchoring devices', Minnesota Stormwater Manual, 24 January 2017, 14:58 UTC, <https://stormwater.pca.state.mn.us/index.php?title=Erosion_prevention_practices_-_erosion_control_blankets_and_anchoring_devices&oldid=31136> [accessed 15 February 2017]

Nedia Enterprises, Erosion Control Blankets & Composite TRM - Installation on Slopes http://www.nedia.com/Erosion_control_inst_slopes.html> [accessed 15 February 2017]

Ethno-medicinal uses of plants in folk–medicines in Madhya Pradesh

Nikita Rai, Sourabh Dubey and Rajiv Rai
Agro-forestry Division
Tropical Forest Research Institute, Jabalpur
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
E-mail: rai_rajiv_57@hotmail.com

Abstract
Folk medicines play a key role among ethnic communities for their primary health care. Traditional wisdom and knowledge is associated with cultural heritage of particular ethic community. Bark of trees and shrubs is used in cure of 29 ailments utilizing 31 plant species from 22 plant families prevalent in folk medicines to cure ailments such as Toothache, Weakness, Wound, Jaundice, Arthritis, Malaria fever, Cough & cold, Intestinal worms, Excess menstruation, Snake bite, Fever, Diabetes, Asthma, Backbone pain, Diarrhoea, Leucoderma, Irregular menstruation cycle, Blood pressure, Fracture, Joint Pain, Rheumatic Pain, Skin diseases, Acidity, Dysentery, Heart Problem, Leucorrhoea, Anemia, Constipation and Baldness, in different tribal clusters in six districts of Chattarpur (Bediya and Gond tribe), Satna (Kol tribe) , Jabalpur (Gond tribe) , Seoni (Gond and Khairwar tribe), Chhindwara (Bhariya and Gond tribe) and Hoshangabad (Pardhi, Korku and Bhilala tribe) in state of Madhya Pradesh .

Keywords: Bark, Ethno-medicinal, Folk – Medicines, Ethnic community.

Introduction

Medicinal plants play vital role in human life to combat diseases since ancient times. The history of herbal medicines is as old as several thousands of years, dated back several years to Rigveda, per hence the oldest use of plants had been documented in Hindu Scriptures like Rigveda (4500-1600 BC), Charka Samhita (1000-800 BC), Sushruta Samhita (800-700 BC) the use of plant as medicine is wide spread across the globe.

Globally, about 85% of the traditional medicines used for primary healthcare derived from plants (Fransworth, 1988). Over 7500 plant species are used by 4635 communities for human and veterinary healthcare. It is estimated that of 20,000 species of agricultural forms in India alone, about 9,500 species are of ethnobotanical and medicinal importance. World Health Organization has listed over 21,000 plant species used around the world for medicinal purposes (Tewari, 1999). In India, about 2,500 plant species belonging to more than 1000 genera are being used in Indigenous systems of Medicine. The majority of medicinal plants are higher flowering plants representing about 158 families (Tewari, 1999). India is tenth among the plant rich countries of the world and fourth among the Asian countries (Rajasekharan and Ganeshan, 2002). Much of this wealth of knowledge is totally becoming lost as traditional culture is gradually disappearing in modern era (Hamiltion, 1995). Ethno -medicinal studies have become the subject of great medicinal importance. Frequent ethno-medicinal surveys made during past few years, indicate that valuable information about medicinal uses of plants may be obtained

by personal interviews and field visits with inhabitants of particular locality. There are valuable regional records of indigenous plants to treat different ailments (Fransworth, 1988).

The state of Madhya Pradesh accounts for 31% of its geographical area under forest and is home of 1/9th of the total tribal population of the country comprising if 28 ethnic communities (Shukla, 2004). The large tribal population is living in forest fringe area and depended on forest flora for food, fodder, medicine, timer and many non wood forest products which are their source of livelihood and income generation. During the last one decade lot of emphasis has been given to indigenous knowledge their documentation and utilization of local plants growing across the habitat of the ethnic communities.

The review of literature reveal's that much work has been done on ethno-medicinal plants in Madhya Pradesh along with the documentation of floristic study and herbal medicines which were being carried out by numerous ethnobotanist's (Bhalla et al., 1986, Dwivedi and Singh 1984, Dubey et al. 2008, Farnsworth 1988 , (Jain 1962, 1963 a, 1963 b , 1965, 1981, 1991), Maheshwari and Dwivedi 1985 , Maheshwari 1996, Oomachan and Masih 1987, Sahu 1996, Jayson 1991, Jain and Virale 2007 , Jain et al. 2010 &2011, Rai 2006 , Rai et al. 2004 , Rai and Nath 2004 , Mahajan 2007, Kala 2009 , 2010, Shrivastava et al. 2000 , Shukla 2004, Mahjan 2007, Rai 2008, Kala 2010, Jain 2011, Wagh and Jain 2014) but, still there are some interior areas which needs to be surveyed intensively like Chattarpur, Satna, Jabalpur, Seoni, Chhindwara and Hoshangabad in state of Madhya Pradesh with new formulations and doses in cure of diseases. The paper focuses on some of the districts for intensive survey to document valuable information in folk medicines.

Material and method

The information has been documented as below:

Study site

The present study had been carried out in state of Madhya Pradesh in India, lies between where by large number of tribal communities latitude 21.2°˙ ' N and 26 ° 87 ' N and between longitude 74 ° - 2' E to 82 ° 49 ' E in state of Madhya Pradesh. Ethno- medicinal data was collected in during survey conducted between the years 2013 -2016 in six tribal dominated districts of Jabalpur, Seoni, Chhattarpur Satna, Hoshangabad and Chhindwara in states of Madhya Pradesh , India between 2013 September to 2016 February as shown in Fig-1 .

Data collection

The study was conducted by interviews followed by focus group discussions with local indigenous communities. During the visits a number of traditional herbal healers and elderly persons of tribal communities, were contacted and information was collected through interview, observations and discussion held during field survey. These medicinal plants were collected from wild. The local traditional herbal healers (vaids) had specialized knowledge about availability of these plants (trees, shrubs, herbs, and climbers) as well as their seasonal availability and time of collection of bark in cure of various ailments and preparation of herbal formulations.

Study districts : Chhatarpur, Satna, Jabalpur, Seoni, Chhindwara & Hoshanagabad : Fig-1

Interview with informants of knowledge

The informants were asked about ethno-botanical uses from 25 respondents i.e. vaidraj or traditional healers and elderly persons who were had habitat in tribal pockets in districts of Jabalpur, Seoni, Chhattarpur , Satna, Hoshanagabad and Chhindwada comprising of local vaidraj, traditional healers for 29 ailments and prescription presented in table 1 for the ethno- botanical data (Local name of plant, Family, in cure of ailments were recorded for descriptive response. More over, these findings indicate awareness about folk medicines prevalent among ethnic communities in different tribal localities. The information is presented in table-1.

Analysis of data and tabulation

The specimens were collected, processed and identified with the help of flora. The data collected was analysed, field information recorded and further screened in laboratory as per work carried out pertaining to Indian ethno-botany Chopra et al. (1965, 1982), Nadkarni (1982), Kapur (1990), Jain (1981, 1991, 1996) , Sathpathy and Panda (1992). The unreported information or unpublished data are only presented in table -1.

Result and discussion

The ethno-medicinal survey was conducted in different tribal clusters in six districts of Chattarpur (Bediya and Gond tribe) , Satna (Kol tribe) , Jabalpur (Gond tribe) , Seoni (Gond and Khairwar tribe), Chhindwara (Bhariya and Gond tribe) and Hoshangabad (Pardhi, Korku and Bhilala tribe) in state of Madhya Pradesh having predominance of local tribal communities the information was documented from traditional healers who were utilizing bark in folk medicines from 31 plant species mostly comprising of tree and shrubs to cure ailment and diseases viz. Toothache, Weakness, Wound, Jaundice, Arthritis, Malaria fever , Cough &cold, Intestinal worms, Excess menstruation, Snake bite, Fever, Diabetes, Asthma, Backbone pain , Diarrhoea, Leucoderma, Irregular menstruation cycle, Blood pressure, Fracture, Joint Pain, Rheumatic Pain, Skin diseases, Acidity, Dysentery, Heart Problem, Leucorrhoea, Anemia, Constipation and Baldness as documented in table-1 and fig-2 .

Table-1 Ethno-medicinal uses of plant bark in folk–medicines

S. No	Plant Spices	Family	Local Name	Plant Category	Tribe associated	In cure of Ailments/ Diseases
1.	*Acacia catechu* Linn.	Mimosaceae	Khair	Tree	Gond tribe	Toothache
2.	*Acacia nilotica* Linn. Del.	Mimosaceae	Babool	Tree	Kol tribe	Baldness
3.	*Ailanthus excels* Roxb.	Simaroubaceae	Mahaneem	Tree	Korku tribe	Leucorrhoea and Diarrhoea
4.	*Anogessus ltifolia* (DC.) Wall.	Combrataceae	Dhawa	Tree	Bediya and Gond tribe	Cough & Cold
5.	*Azadiracha indica* A. Juss.	Meliaceae	Neem	Tree	Pardhi, Korku and Bhilala tribe	Diabetes, Arthritis, wound and Skin Diseases
6.	*Bombax ceiba* Roxb.	Bombaceae	Semal	Tree	Pardhi, Korku and Bhilala tribe	Excess mensuration cycle , Leucoderma and Constipation
7.	*Boswellia serrata Roxb. ex. Cobber*	Burseraceae	Salai	Tree	Bediya and Gond tribe	Toothache and Wound
8.	*Careya arborea* Linn.	Lecythidaceae	Kumhi	Tree	Bhilala tribe	Excess mensuration cycle, Cough & Cold
9.	*Cassia fistula* Linn.	Caesalpiniaceae	Amaltas	Tree	Gond and Bhariya tribe	Weakness and Malaria Fever
10.	*Cordia macleodii* (Griff.) Hook. f. & Thomso.	Boraginaceae	Dahiman Lasora	Tree	Bediya and Gond tribe	Backbone gap and Fracture
11.	*Dillenea pentagyana*	Dilleniaceae	Suarukh	Tree	Gond tribe	Joint Pain
12.	*Emblica officinalis* Gaertn.	Euphorbiaceae	Aonla	Tree	Kol tribe	Toothache
13.	*Ficus infectoria* Roxb.	Moraceae	Pakar	Tree	Korku tribe	Wound
14.	*Gmelina arboria* Linn.	Verbenaceae	Khamher	Tree	Bhariya tribe	Rheumatic Pain
15.	*Lawsonia alba* Linn.	Lythraceae	Menhdi	Shrub	Bediya tribe	Arthritis

16.	*Legistroemia perviflora* Roxb.	Lythraceae	Lendia	Tree	Bediya and Gond tribe	Intestinal Diseases and Acidity
17.	*Litsea glutinosa* Lour.	Lauraceae	Menda	Tree	Korku and Bhilala tribe	Weakness, Diarrhoea and Irregular Mensuration cycle
18.	*Madhuca latifolia* Linn.	Sapotaceae	Mahua	Tree	Bhariya tribe	Toothache
19.	*Mangifera indica* Linn.	Anacardiaceae	Aam	Tree	Pardhi tribe	Intestinal worm and Diseases
20.	*Oroxylum indicum*	Bignoniaceae	Jaymangal	Tree	Khairwar tribe	Fever
21.	*Ougeinia oogeinisis* Roxb.	Fabaceae	Tinsa	Tree	Kol tribe	Anemia
22.	*Pongammia pinnata* (Linn.) Merr.	Fabaceae	Karanj	Tree	Korku tribe	Asthma
23.	*Punica granatum* Linn.	Lythraceae	Anar	Tree	Khairwar tribe	Malaria Fever
24.	*Rubia cordifolia* Linn.	Rubiaceae	Moyan	Tree	Kol tribe	Dysentery
25.	*Holarrhena antidtsentrica* (Roth.) A.Dc.	Apocynaceae	Badi Karai	Shrub	Gond tribe	Arthritis
26.	*Soymida febrifuge* (Roxb.)	Meliaceae	Rohan	Tree	Bhariya and Gond tribe	Wound
27.	*Sterospermum suaveolens* DC.	Bignoniaceae	Padar	Tree	Kol tribe	Jaundice
28.	*Stereospermum xylocarpum*	Bignonoaceae	Garun	Tree	Bediya tribe	Snake Bite
29.	*Syzygium cumini* (Linn.) Skeels	Mytraceae	Jamun	Tree	Gond tribe	Jaundice
30.	*Terminalia arjuna* (Roxb.) Wgt & Arn.	Combrataceae	Arjun	Tree	Bhariya, Korku and Bhilala tribe	Weakness, Jaundice, Blood Pressure and Heart Problem
31.	*Terminallia tomentosa* (Roxb.) Wgt & Arn.	Combrataceae	Saja	Tree	Gond trine	Weakness

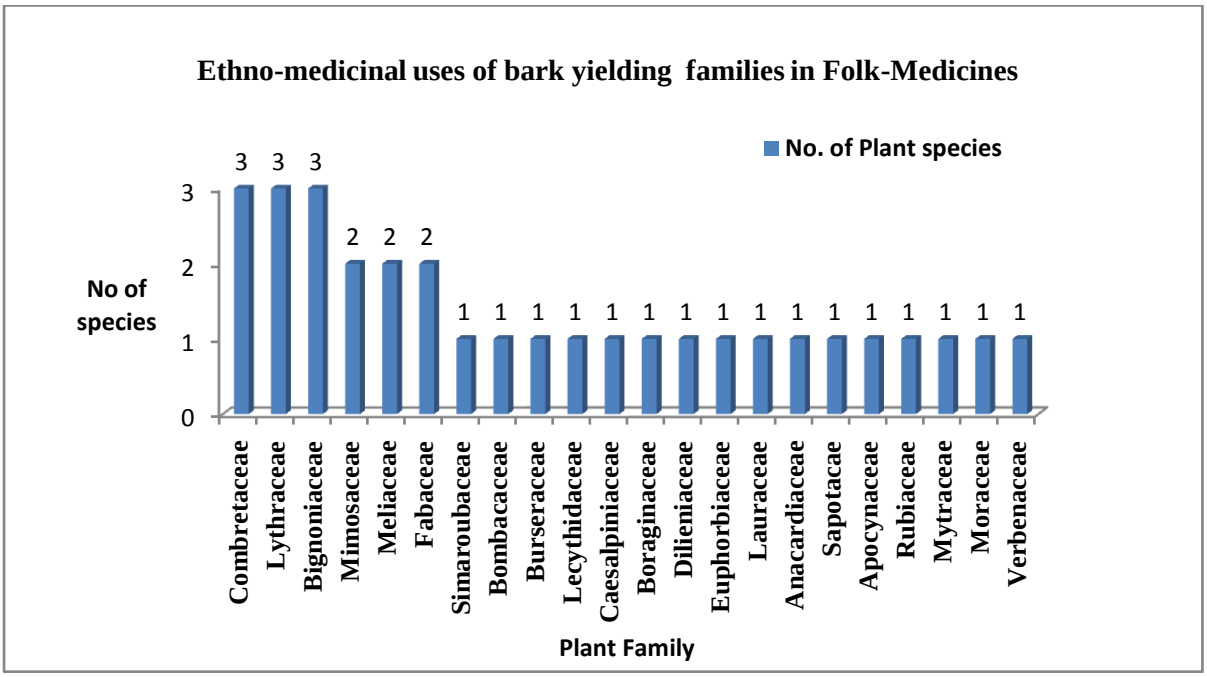


Fig.2. Ethno-medicinal uses of bark yielding families in folk medicines

The plant species as presented in the above table comprise of 22 plant families yielding bark as shown in (Fig. 2). The figure also represents a list of 31 plant species prevalent in folk medicines to cure 29 ailments (Fig.3). The table-1 further depicts that bark of many plant species are used to cure more than one ailment / disease as per their culture and indigenous knowledge prevalent around their habitat. It is evident from fig. 2, bark of four (04) different species are used in cure of toothache, weakness, healing of wounds , where as bark of three (03) species in cure of jaundice, arthritis, whereas bark of two (02) species are used in cure of malarial fever , cold and cough , intestinal disease due to worms and in cure of excess flow of blood in menstruation cycle of women. The study further reveals that bark of a different species is used to cure particular ailments by different tribal communities such as bark of *Sterospermum suaveolens* DC is used by Kol tribes of Satna to cure jaundice and bark of *Syzygiumcumini* (Linn.) Skeels is used in Seoni and Jabalpur to cure jaundice by Gond tribes, similarly *Lawsonia alba* Linn is used by Bediya tribe of Chhattarpur to cure Arthritis, whereas *Holarrhena antidtsentrica* (Roth.) A.Dc. is used by Gond tribe in Jabalpur and Chhattarpur districts to cure Arthritis, as these different species are having predominance in and around the habitat of ethnic communities residing in tribal localities to cure ailments (Rai 2005, 2016, 2017).

It is very clear from the results as depicted from table-1 and fig. 2 and 3, that the review of literature as citied in the paper different plant species yielding bark are being used by different ethnic communities residing in different tribal pockets of Madhya Pradesh as reported on use of local flora of based on Gond tribes of Bundelkhand region in Sagar district (Bhalla et al., 1986) , plants used by Kol tribes in Rewa district (Dwivedi

and Singh, 1984), plants used by Baiga and Gond tribes in Mandla district in MP (Jain, 1962; Jain, 1963), management of key medicinal plants local indigenous communities in Bori , Pachmarhi sanctuary and in Pachmarhi biospheres (Jayson, 1991), ethno-botanical documentation of plants in pockets of primitive tribes in MP (Maheahwari, 1996), plants in medicinal use by tribes in Khargone districts (Patel and Mahajan, 2004) , some traditional medicinal plants used by Sahariya and Baiga primitive tribes in Madhya Pradesh (Rai et al. , 2004; Rai, 2008), plants in herbal remedies among tribes of Bijagarh in West Nimar (Mahajan, 2007) medicinal plants used by Bheel tribes in Guna district (Jain et al. 2010) , medicinal plants used by Bheel tribes in Jhabua district (Kadel et al., 2011), plants used in cure of various ailments by Bhilala tribes in Alirajpur district (Jadav and Rawat, 2011), medicinal plants with indigenous uses by Sahariya tribe in Guna district (Kumar et al., 2015), Chambal eco -region (Jain and Virale, 2007), Bhil tribes in Jhabua district (Jain et al., 2011) and use of plants in folk medicines Gond, Bhriya and Korku tribes of Madhya Pradesh (Rai, 2016 and 2017) as were reviewed during literature survey.

Thus it is evident from the literature review and the information documented during the field survey lesser known uses of plant species utilizing bark has been documented from surveyed pockets having predominance of Gond, Bhariya, Pardhi, Kol, Korku, Bhilala and Bediya tribes of Madhya Pradesh.

Fig. 3. Folk medicines prevalent in cure of ailments using bark of plant species

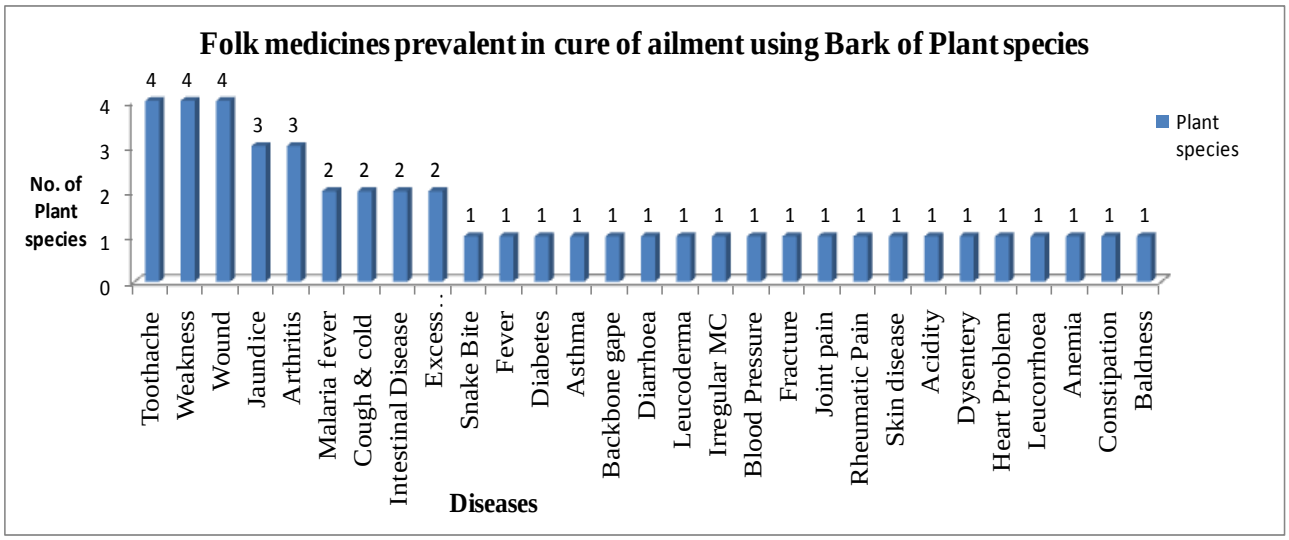


Fig. 4. Documentation of Information with Vaidraj /Traditional healers on folk - medicine

Conclusion

The above field study illustrates, use of medicinal plants possess tremendous therapeutic value and are most challenging efforts made by ethnic communities , who do not have access of modern hospitals and facilities to combat against the diseases to cure various ailments by utilizing bark of trees and shrubs. There is a need to conduct phyto-chemical analysis for discovery of new drugs and their formulations.

Acknowledgment

The authors are grateful to traditional healers and tribal communities who have provideded the information for systematic documentation. The authors are thankful to Director, Tropical Forest Research Institute, Jabalpur for providing necessary facilities for the study. The authors are also thankful to Director General, MP Council of Science and Technology for providing financial assistance to carry out the present study.

References

Bhalla N.P., Sahu T.R.., Mishra G.P. and Dakwale R.N. (1986) Traditional plant medicines of Sagar district, M.P. Journal of Economic and Taxonomic Botany, 3 (1): 23-32 .

Chopra, R.N., Chopara, S.L. and Chopra, I.C. (1965). Glossary of Indian Medicinal Plants .CSIR, New Delhi.

Chopra R..N., Chopra S.L., Handa, K.L. and Kapur, L.D. (1982). Indigenous Drugs of India. Second edition (Reprinted) Academic Publishers, New Delhi.

Dwivedi, S.N. and Singh, H., (1984) . Ethnobotany of Kols of Rewa Divison M.P. Proc. Natl. Sen Envir. EPCO II, pp : 37-44

Dubey, P.C., Khanna, K.K., Sikarwar R.L.S., Pandey, Tiwari B.L. and Arjuna P. (2008). Vindhya ki Ausidiya Avem Durlabh Vanaspattiyan, Van Vibhag Anusandhan Avem Vistar Vritt Riva (Madhya Pradesh).

Farnsworth, N.R. (1988) Biodiversity, by Wilson EO, (National Academy Press, Washington, DC), 1988, 83 p.

Gupta R. and Chadha K.L. (1995) . Medicinal and Aromatic Plants in India. In: Advances in Horticulture, Medicinal and Aromatic Plants (edited by .Chadha, K.L. and Gupta, R.) Malhotra Publishing House, New Delhi. pp 1-44.

Hamiltion, A. (1995). Ethnobotany: Methods Manual, (edited by Martin GJ) Published by WWF International, Chapman & Hall, London), 1995, 10

Jadhav, D. and Rawat, S.S. (2011) Ethnomedicinal plants used in treatment of various ailments by Bhilala tribe of Alirajpur district Madhya Pradesh. J. Econ Taxon Bot. 3 (5): 654 - 657.

Jagtap S.D., Deokule S.S. and Bhosle S.V. (2006). Some unique ethnomedicinal uses of plants used by the Korku tribe of Amravati district of Maharashtra, India. Journal of ethnopharmacology, 107 (3): 463-469

Jain, A. K. (1998). Tribal clans in Central India and their role in conservation. Env. Conservation, 15 (1) 368.

Jain, S.K. (1962). Studies on Indian Ethnobotany .Plants used in medicine by tribals of M.P. Bull. Reg. Res. Lab. Jammu, 1 : 126 -129.

Jain S.K. (1963 a). Studies in Indian Ethnobotany – Plants used in medicines by the tribals of Madhya Pradesh, Bull. Regional Research Lab., 2: 126-129.

Jain, S.K. (1963 b). Observation on Ethnobotany of tribals of M.P. Vanyajati, 11(4) : 177-187.

Jain, S.K. (1965). Medicinal plant lore of the tribals of Bastar . *Econ Bot*., 19 (3): 236- 250.

Jain, S.K. (1981). Glimpse of Indian Ethnobotany, Oxford and I.B.H Pub., New Delhi .

Jain, S.K. (1991). Dictionary of Indian Folk Medicines and Ethnobotany. Deep Publications , New Delhi.

Jain S.K,. (1994). Ethnobotany and Research on medicinal plants in India. Ethnoboany and Research on New Drugs . Johnson Wiley and Sons ,Chichster , pp 25-41.

Jain, S.P. (1996). Ethno- Medico –Botany cal survey of Chaibasa singbhum district, Bihar J. Econ .Tax. Bot. Addl Series, 12: 403-407.

Jain, A.K. and Virale M.G. (2007). Some Threatened Angiosperm Taxa of Chambal Eco-region. Phytotaxonomy, 07: 107-110.

Jain, S.P., Singh, S.C., Srivastava S., Singh, J., Mishra N.P. and Prakash A. (2010). Hitherto unreported ethnomedicinal uses of plants of Betul District of Madhya Pradesh. Indian Journal of Traditional Knowledge, 9 (3): 522-525.

Jain, A.K., Virale, G.M. and Singh, R. (2010). Folklore claims on some medicinal plants used by Bheel tribes of Guna district Madhya Pradesh. Indian Journal of Traditional knowledge, 9 (1): 105 -107.

Jain, A.K., Wagh, V. V. and Kadel, C. (2011). Some ethno-medicinal plants species of Jhabua district, Madhya Pradesh. Indian journal of traditional knowledge, 10 (3) : 538-540.

Jayson, E.A. (1991). An ecological survey at Satpura National Park, Pachmarhi and Bori sanctuaries, Madhya Pradesh. Indian Journal of Forestry, 13 (4): 288-294.

Kadel, C., Wagh, V.V. and Jain, A,K., Some Ethno - medicinal plants of Jhabua district (2011), Madhya Pradesh. Indian Journal of Traditional Knowledge, 10 (3): 538 -540.

Kapur, S.K. (1990). Review on Ethno-medico plants for skin affilications. Indian Drugs , 28 (5) : 210-223.

Kala C.P. (2009). Aboriginal uses and management of ethnobotanical species in deciduous forests of Chhattisgarh state in India. Journal of Ethnobiology and Ethnomedicine, 5: 1-12. http://www.ethnobiomed. com /content/5/1/20

Kala C.P. (2010). Home gardens and maganement of key species in the Pachmarhi Biosphere Reserve of India . *International Journal of Medicinal and Aromatic Plants* , 1 (2) : 153-161.

Maheshwari J.K. and Dwivedi R.P . (1985) . Ethnobotany of Abujhmarah tribe of Bastar District *J.Ind. Bot. Sco.* 64 : 53-56.

Maheshwar J.K. (1996) . Ethnobotanical documentation of primitive tribes of Madhya Pradesh. *J. Eco. Taxon.Bot. Additional series* , 12 : 206-213.

Mahajan S.K. (2007). Traditional herbal remedies among the tribes of Bijagarh of West Nimar district, Madhya Pradesh. Indian Journal of Traditional Knowledge, 6 (2): 375-377.

Nadkarni A.K. (1982). *Indian Materia Medica* , Popular Prakashan Bombay Vol I&II (reprinted).

Oommachan M.and Masih S.K . (1987) . Mul tiferous Uses of plants by the tribals of Bastar of M.P. 1. Medicinal plants. Indian J. Applied & Pure Bio , 2 (2) : 55-63.

Patel P and Mahajan SK (2004) . A note on medico ethnobotany of Vijagharh (Khargone) Madhya Pradesh . *Bull. Bot. Survey India*. 46 (1-4) : 398 - 402.

Rai, Rajiv .(2005) . Use of Medicinal Plants by traditional herbal healers in Central India . Indian Forestor :13 (3) : 463-468.

Rai, Rajiv . (2006) . Traditional Uses of Genus Curcuma in Folk Medicines prevalent in Central India. *Indian J. Trop .Biodiv*. 14 (2) : 153-159 .

Rai Rajiv. (2007) . Some Traditional Plants used in cold, cough &Fever by Tribals of Bastar (Chhattisgarh). *Indian Journal of Botanical Science* , 86 (1&2) : 27-36 .

Rai Rajiv. (2008) . Indigenous ad Herbal Medicines Prevalent among Tribal Communities in Madhya Pradesh , *Journal of Non-Timber Forest Products* , 15 (3) : 183-191.

Rai Rajiv. (2016). Ethno- Medicinal Uses of Promising Plants in Various Formulations in Cure of Ailments in Chhindwara District, Madhya Pradesh. Pharmacy & Pharmacology International Journal, 4 (7) 00100. DOI: 10.15406/ppij.2016.04.00100

Rai Rajiv. (2017). Folk Medicines in cure of ailments prevalent among ethnic communities in Madhya Pradesh. In abs. XIX Commonwealth forestry Conference 2017 : 25 p.

Rai Rajiv and Nath V. (2004) . Ethnobotanical studies in Patalkot Valley in Chhindawara district of Madhya Pradesh . *Journal of Tropical Forestry* , 20 (2) : 38-50.

Rai, Rajiv ; Nath V. and Shukla P.K . (2002) . Ethno-medicinal studies on Bhariya Tribes in Satpura plateau of Madhya Pradesh. *Agriculturist*, 13 (1 & 2) : 109-114..

Rai, Rajiv ; Nath V . and Shukla P.K . (2003) . Ethnobiology of Hill Korwa Tribes . *Journal of Tropical Forestry*, 19 (1& 2) :35-46 .

Rai, Rajiv , Nath V. and Shukla P.K . (2004) . Characteristics and Ethnobotanical studies on Primitive tribes of Madhya Pradesh" In " *Recent progress in Medicinal Plants"* , *'Ethno- medicine and Pharmacognosy'* (edited) Govils , Publisher : Researcho Book Centre, New Delhi 8(37) :543– 552 pp.

Rai Rajiv (2008) . Indigenous ad Herbal Medicines Prevalent among Tribal Communities in Madhya Pradesh , *Journal of Non-Timber Forest Products*, 15 (3) : 183 -191

Rajasekharan, P.E. and Ganeshan, S. (2002). Conservation of medicinal plant biodiversity – an Indian perspective, *J Med Aromat Plant Sci*, 24: 132.

Kumar, R ; Srivastava, P.N. and Manju Jain. (2015). Ethnobotanical study of Traditional Medicinal plants used by tribes of Guna district. International Journal of Current Microbiology and Applied Sciences. 4 (7): 466 - 471.

Sahu, T.R. (1996). Life support promising food plants among aboriginals of Bastar.(edited by S.K.Jain in "Ethnobiology in Human Welfare" Deep Publication, New delhi : 26-30 pp.

Sindiga I. (1994) . Indigenous (Medicinal) knowledge of Massai, Indigenous knowledge & development Monitor, 2 : 16-18.

Satpathy, K.B. and Panda P.C. (1992) . Medicinal use of some plants among tribals of Sundergarh district. J.Econ. Tax. Bot. Addl Series. 10 : 241- 249.

Srivastava JL. , Jain Seema and Dubey Abhlasha (2000) . Ethno - medicine for anti- fertility used by tribals in Bastar district of Madhya Pradesh. In Ethnobotany and Medicinal Plants of Indian Sub-continent. Scientific Publisher, Jodhpur: 297- 300 pp.

Shukla, P. K. (2004). Role of Research in sustainable and profitable management of NWFP .*Vaniki Sandesh* , 28 (2-3) :1-4 .

Wagh, V.V. and Jain, A.K. (2014) Herbal remedies used by the tribal people of jhabua district, madhya Pradesh for the treatment of joint diseases . *Inter J. of Phytotherapy* , 4 (2) : 63-66

Tewari D.N. (1999) . Medicinal plants for healthcare, *Yojana*, 26 (3): 8.

Climate change: Mitigation through interventions of tree improvement

Sheeraz Saleem Bhat[1], Anees K[1] and Vibha Singhal[2]
[1]ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand)-834010
[2]ICAR-Indian Institute of Soil and Water Conservation Dehradun-248195
E-mail: shrzbhat@gmail.com

Introduction

Climate change in general, refers to the long-term change in the weather parameters like temperature and precipitation of any place and at a certain time of the year, from one decade to the next or over centuries. This problem adds considerable stress to our society and to the environment. It has become a fundamental threat to sustainable development and the fight against poverty. From shifting weather patterns that threaten our food security, to rising sea levels that increase the risk of heavy flooding, the impacts of climate change are undoubtedly global in scope and unprecedented in scale, be it the ecological imbalances, biodiversity extinction and other undesirable environmental changes. Without taking any drastic action today, adapting to these impacts in the future will be more difficult as well as costly (UNEP, 2010).

Causes of climate change

It is a well-known fact that climate change is a normal part of the earth's natural variability, which is related to interactions among components ofits atmosphere, hydrosphere and the lithosphere, as well as changes in the amount of solar radiation reaching the earth (NOAA, 2007). Though the geologic record includes significant evidence for large-scale climate changes in Earth's past, but the rapid rate of increase in anthropogenic activities; through burning of fossil fuels, deforestation, livestock and agriculture, rapid industrialization, heavy transport system is adding CO_2 to the atmosphere, level of which is the highest in the past 650,000 years. Rising fossil fuel burning and land use changes have emitted, and continue to emit hugeamount of greenhouse gases into the earth's atmosphere. These greenhouse gases mainly include carbon dioxide, methane and nitrogen dioxide, and a rise in these gases has elevated thequantity of heat from the solar radiations being trapped in the earth's atmosphere, the heat that would normally had got radiated back into the space. This increased heat from the above processin the atmosphere has led to the greenhouse effect, which is resulting in climate change (UNFCCC, 2007). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change also concludes that the increase in anthropogenic greenhouse gas emissions is responsible for most of the observed increase in the global average temperature since the mid-20th century (IPCC, 2007).

Consequences of climate change

The consequences from climate change are very diverse, either directly or indirectly, both on biological world and the abiotic physical surroundings around. Globally, billions of people especially from developing countries are facing and shall face food and water shortages over the next decades as a result of climate change. Asia, the largest continent and spread over four climatic zones of the world (boreal,

arid and semi-arid, tropical and temperate), is no more an exception to the ill effects of climate change in terms of socio-economic and ecological aspects like food security, air, water and land quality, disasters like the 2004 Indian Ocean Tsunami, the 2006 landslides in the Philippines, devastating flash floods of Ladakh in 2010, the flashfloods of Uttarakhand in 2013 and recent erratic changes in weather across the different parts of the globe. Significant increases in the frequency and/or intensity of many extremelydevastating weather events such as flow of heat waves, prolonged dry spells, intense and erratic rainfall patterns, thunderstorms, tornadoes, tropical cyclones, snow avalanches, and severe dust storms has been found because of the climate change (Cruz et al. 2007). Climate change shall lay deep impact on the socioeconomic aspects like food security, land degradation and desertification, decreased grassland productivity in the semi-arid and arid regions of Asia; health and hygiene like epidemics of malaria, dengue, and other vector-borne diseases (Martens *et al*. 1999), decreased freshwater availability; monsoon rainfall distribution and frequency; and ecological aspects like floral and faunal diversity, forest area, glacial melting, coral reefs, aquaculture, of the region. As per Christensen et al. (2007), one billion people could face shortage of water which shall lead to drought and degradation of land by the 2050s, ultimately making them insecure and vulnerable to different hazards; thus overall impacting inimically the achievement of United Nations SustainableDevelopment Goals.

Adapting to climate change

Adaptation to climate change is a major cause of concern to cope up with the problem. However, human and financial resources present a constraint in the developing countries. In India, besides other Asian countries, local practices to manage the problem include soil and water conservation practices, their efficient use, erosion control, educational and extensionprograms on soil and water conservation and their management, introduction of new crops and cultivars, developing ideotypes, crop diversification, promoting afforestation and reforestation programs, agroforestry, Improvement of carbon storage in forests, raising new plantations, creation of national parks and reserves, protected areas and biodiversity corridors, socioeconomic factors in management policy, protecting, conserving and managing the coastal zones and marine ecosystems besides due concern to public health and hygiene management reforms and disaster monitoring, its awareness and management vis-a-vis adaptation (UNFCCC, 2005). We need to adapt to the different modes of production and consumption in a way that our future generations will not suffer. Multilateral and national concerns and cooperation regarding the local adoption measures, funding, insurance, sustainable development planning and practices, adaptation integration into policy and planning, capacity building, education, public awareness, trainings and finally implementing adaptation measure is the need of the hour to tackle the problem in the developing countries (UNFCCC, 2007).

Another solution is the mitigation of climate change through sequestration. Carbon sequestrations are the process of capturing and stocking of the atmospheric carbon dioxide to eitherdefer or mitigate the process of global

warming and thus enable to avoid theserious impacts of climate change. Carbon dioxide (CO_2) capture and storage (CCS) is a process which involves the separation of CO_2 from the emission sources like industries and transportation of the same to a storage location and long-term isolation from the atmosphere.

Tree improvement

Tree improvement is the most important aspect for any strategy aimed for increasing quality (resistance, adaptability, wood properties etc) & productivity of trees. It is concerned with determination of species or provenances for an area and the amount, kind, and causes of the variability within the species. It involves packaging of desired qualities into improved individuals and their mass production. It also aims at developing and maintaining a broad genetic base enough for needs in advanced generations. So there is need for continuous tree improvement to meet the challenges ahead in achieving these objectives. (Zobel and Talbert, 1984).These objectives can be achieved through either traditional methods of breeding, which include individual tree selection, mass selection, progeny testing, family selection etc or use of biotechnological and physiological interventions, which include the use of metabolites like phenolics, terpenoides, isozymes, allozymes and the modern age DNA based markers like microsatellites and others.

Tree breeding is the art, science and technology of improving the genetic makeup of trees in relation to their economic use. Selection and breeding has been carried out from the past civilization by taking seed and cutting from the productive and vigorous individuals for generating quality planting stock. This process is called selection and may be formally defined as 'the non random differential reproduction of genotypes' or alternatively, the actual procedure by which discrimination between individuals is arrived at. Hence forth, only the best individuals are allowed for the transmission of hereditary material to the next generation. It is the first step in any tree improvement programme and it determines how much genetic gain can be obtained. The gains can be no greater than the quality of parents used (Zobel and Talbert, 1984). Selection and improvement of forest trees is important because of long generation interval and greater exposure to diverse environmental stresses; both biotic (insects pests diseases) and abiotic (drought etc). Thus, once the better and improved planting stock is generated, gains can become higher. Tree breeding strategy should aim at packaging of desired qualities into the improved individuals, while developing and maintaining a broad genetic base enough for needs in advanced generations. The selection, inter-mating and other activities of tree improvement programs of cross breeding plants can be summarized using the conceptual approach of breeding cycle, taking under consideration breeding population, base population and selected population after selection process (White et al. 2007).

There are three main things which an improvement strategy should take under consideration before implementation of the programme. There should be variation in the concerned trait in the population, the variation should be heritable and the trait which is under consideration should have some economic value (McKinley and Van Buijtenen, 1998).

Carbon sequestration and tree improvement

Since carbon sequestration is the capturing of atmospheric carbon dioxide by the plants and its stocking in the plant tissues and the soil, improvement in tree biomass traits shall have profound effect on increased carbon sequestration. Biomass improvement can be achieved through conventional selection procedures like selection on the basis of genetic parameters of different growth traits in a population and selection of the best genotypes amongst the population for mass multiplication and advanced breeding programs. Based on whether the population is even-aged or not, appropriate methods for selection are followed. Different methods involved depend on the nature and size of the population, genetic variation for the traits of concern and the economic value of the trait. These include Family selection, Within family selection and Within family and family selection for considering single traits. For multiple trait selection, independent culling level, tandem selection and selection index are used. Other low input breeding approaches in forestry include indirect selection which may be early testing (Juvenile-Mature correlation). Besides these approaches, while evaluating candidate trees in the field, comparison tree system in even agedand regression/ individual tree system can also be used. Mother tree system also provides better gains at low input. These conventional approaches can be used for deployment, through the establishment of seed orchards, raised either clonally (Clonal seed orchard) or from seeds (Seedling seed orchard). Characters which exhibit high heritability followed by higher genetic gain show additive genetic variation and can be exploited quiet well in advanced breeding programs.

Use of biochemical approaches is also being done to study the different growth traits and the adaptability of a species in the era of climate change. Stress related bio-chemicals like proline etc are worthy to mention in such studies. However, protein markers are also limited by being influenced by the environment and changes in different developmental stages. Even so, they are robust complement to the morphological assessment of variation among individuals.

DNA (molecular) markers are a potential tool to study the growth traits, their association with different molecular markers and identifying elite genotypes with higher productivity and adaptability. Molecular markers are DNA sequences that are readily detected and whose inheritance can easily be monitored. DNA polymorphisms can be detected in nuclear and organelle DNA, which is found in mitochondria and chloroplasts. Molecular markers concern the DNA molecule itself and, as such, analyze variation at the genetic level directly. Molecular markers reveal neutral sites of variation at the DNA sequence level. These variations do not necessarily show themselves in the phenotypes. They can also provide information about a specific character such as resistance to a disease, tolerance etc. Molecular markers are not subject to environmental influences and are potentially unlimited in number unlike morphological and protein based markers, covering the entire genome. They are the feasible markers to use for studying linkages with Quantitative trait loci and have greater versatility and resolving power.

Marker assisted selection is being carried out in crop plants as well as trees It is based on the concept that it is possible to infer the presence of a gene from the presence of a marker that is tightly linked to the gene. If the marker and the gene are located far apart then the possibility that will be transmitted together to the progeny individuals will be reduced due to double crossover recombination events. Thus, a tight linkage between marker and gene of interest and high heritability of the gene of interest is pre-requisite for marker assisted selection. This can be achieved by increasing selection intensity as more individuals can possibly be evaluated for the different growth traits for increased biomass productivity. Early selection that can potentially decrease the breeding cycle can be done. Such tools provide a base for a tree breeder or a manager that even at seedling stage, advance growth of the genotypes can be predicted and mitigation strategy formulated.

Thus, climate change mitigation has a potential, but partial, solution through tree improvement wherein, one of the major green house gases, carbon dioxide, can be stored, deferred-released and/or can be converted into useful biomass for future generations.

References

Christensen J H, Hewitson B. and Busuioc A. (2007). Regional climate projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt K B, Tignor M and Miller H L (eds)]. Cambridge University Press. Cambridge, United Kingdom and New York, NY, USA

Cruz R V, Harasawa H, Lal M, et al. (2007). Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; Parry M L, Canziani O F, Palutikof J P, van der Linden P J and Hanson C E (eds). Cambridge University Press. Cambridge, UK. pp. 469-506.

IPCC. (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.104 pp.

Martens P, Kovats R S, Nijhof S et al. (1999). Climate change and future populations at risk of malaria. Global Environmental Change. 9: pp. S89 - S107.

NOAA. 2007. Climate change, NOAA National Weather Service, Oct. 2007. 2 p

UNEP. 2010. United Nations Environment Program Vision 2010-13.pp.2

UNFCCC. (2005). Sixth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention; Addendum-Climate change impacts, adaptation measures and response strategies, UNFCCC, Montreal. 16p. http://unfccc.int/resource/docs/2005/sbi/eng/18a05.pdf

UNFCCC. (2007). Climate change: impacts, vulnerabilities and adaptation in developing countries. UNFCCC, Bonn, Germany. 64p.

Zobel, B. and Talbert, J. (1984). Applied forest tree improvement. John Wiley & Sons. 505p.

White, T.L, Adams, W.T. and Neale, D.B. (2007). Forest genetics. CAB international. 682p.

Mc Kinely C. R. and van Buijenen, J. P. (1998). Principles and techniques in tree breeding. In: Mandal A. K. and Gibson G. L. (eds.) Forest Genetics and Tree Breeding. CBS Publishers and Distributors. New Delhi pp. 1-15.

प्राकृतिक एवं ऐतिहासिक धरोहरो की भूमि: बुन्देलखण्ड

सौरभ दुबे एवं निकिता राय
कृषिवानिकी प्रभाग
उष्णकटिबन्धीय वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, भारत सरकार)
डाकघरः आर. एफ़. आर. सी., मन्डला रोड, जबलपुर (म. प्र.)

बुन्देलखण्ड क्षेत्र अपनी संस्कृतिक विरासत, इतिहास व शौर्य गाथाओं के लिये जितना प्रसिद्ध है, उतना ही यह क्षेत्र अपनी भौगोलिक व पर्यावरणीय विशेषताओ और वनो व वन्य प्राणियो की विविधता के लिये जाना जाता है। यह पठारीय क्षेत्र मध्यप्रदेश व उत्तरप्रदेश का सम्मिलत भूभाग है जिसके सीमांकन को लेकर अलग – अलग मत है। इसकी सीमाओं के निर्धारण के लिये विद्वानो ने पौरणिक, ऐतिहासिक साक्ष्यो, भाषायी व सांस्कृतिक समनताओ तथा भौगोलिक बनावटो का सहारा लिया है। इस क्षेत्र के अन्तर्गत मध्यप्रदेश के दतिया, सागर, दमोह, पन्ना, छतरपुर, टीकमगढ़ जिले तथा नरसिंहपुर, विदिशा, ग्वालियर, जबलपुर, अशोकनगर जिलो के कुछ भाग को सम्मिलत किया जाता है, वही उत्तरप्रदेश के झाँसी, ललितपुर, महोबा, हमीरपुर, बाँदा व चित्रकूट इस क्षेत्र में आते है।

बुन्देलखण्ड कि सीमाओ का विस्तार तथा संगठन महान चन्देलो तथा महाराजा छत्रसाल के शासन के दौरान अधिक हुआ है।

इत जमना उत नर्मदा, इत चम्बल उत टोंस।
छत्रसाल से लरन की, रही न काहू हौस॥

इसकी सीमाओ को लेकर लिखी गई यह पंक्ति

Source- www.bundelkhand.in

इसकी विशालता को भली भाँती दर्शाती है। मध्यप्रदेश के परिदृश्य में इसके हिस्से वाली बुन्देलखण्ड की धरा पर खजुराहो के भव्य मंदिर, ओरछा के महल व छतरियाँ इसकी शोभा बढ़ाते

है तथा साथ ही पन्ना राष्ट्रीय उद्यान तथा

नौरादेही, रानी दुर्गावती वन्य जीव अभ्यारण्य जैसे वन्य प्राणी आश्रय स्थल अपने आप में ही इसकी प्रकृतिक समृधि का प्रमाण देते है ।

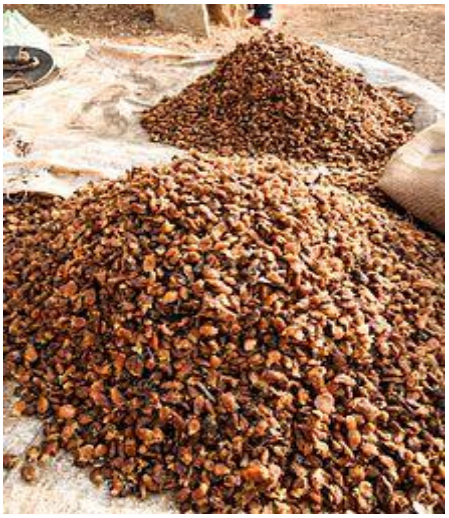
बुन्देलखण्ड अनेक छोटी बडी नदियो से भी समृद्ध है । प्रमुख नदियाँ बेतवा (बेत्रवती) और केन (कर्णावती) है, जो कि यमुना की सहायक नदियाँ है । सिंध, धसान, बाघिन, बीना, सोनार तथा इसकी सीमाओ पर टोंस आदि नदियाँ इस धरा को अपने जल से सींचती है । वर्षा पर निर्भर इनमें से ज्यादातर नदियाँ ग्रीष्मकाल में सूख जाती है। इस क्षेत्र को अपने वनो व वन्य प्राणियो की विविधता के लिये भी बखूबी तौर पर जाना जाता है ।

बुन्देलखण्ड क्षेत्र में उष्णकटिबंधीय शुष्क पर्णपाती प्रकार के वन पाये जाते है । यहाँ मिश्रित वन, झाडी वाले वन, कटीले वन, घास के मैदान तथा कही – कही पर अल्प मात्रा में बाँस के झुरमुट पाये जाते है । यहाँ के मिश्रित वनो में मुख्य तौर पर सागौन करधई मिश्रित वन पाये जाते है । सागर तथा दमोह और टीकमगढ़ के कुछ हिस्सो में ही अच्छी किस्म का सागौन पाया जाता है । अन्य वृक्ष की प्रजातियो में बीजा (*Pterocarpus marsupium*), तिनसा (*Ougeinia dalbcrgioides*), धवा (*Anogeissus latifolia*), बेल (*Aegle marmelos)*, खैर (*Acacia catechu*), पलास (*Butea monosperma*), तेन्दु (*Diospyros melanoxylon*), महुआ (*Mahuca Indica*) सेमल (*Bombax ceiba*), सलई (*Boswellia serrata*) आदि भी यहाँ पायी जाती है । यहाँ के मध्य भारतीय घास के इन मैदानो में दूब (*Cynodon dactylon*), लम्पा (*Heteropogon contortus*), गुन्हेर (*Themeda quadrivalvis*) तथा काँस (*Saccharum spontaneum*) आदि पायी जाती है। दतिया तथा आसपास के क्षेत्रो में कटीले वन पाये जाते है, जिसमे हिन्गोट (*Balanites roxburghii*), करील (*Capparis deciduas*), बेर (*Zizyphus mauritiana*), करोंदा (*Carissa carandas*), करधई (*Anogeissus pendula*), बबूल (*Acacia nilotica*) और रेउंझा (*Acacia leucophloea*), खेजडा (*Prosopis juliflora*) आदि प्रजातियाँ प्रमुख है ।

वृक्षो व वन्स्पतियो की कुछ महत्वपूर्ण व बहू उपयोगी प्रजातियाँ जीव जगत को भोजन के रुप में चारा, फल, फूल व आश्रय प्रदान करती है ।

महुआ (*Madhuca longifoila*)

महुआ इस क्षेत्र मे पाया जाने वाला बहुत ही महत्तवपूर्ण वृक्ष है । यह 15 मीटर से अधिक ऊँचाई तक बढ़ सकने वाला वृक्ष है। इसमे ग्रीष्मकाल मे फूल आते है जो की सूखे के मौसम में प्राणियो के लिये भोजन का महत्तवपूर्ण स्तोत्र बन जाता है ।



लंगूर, हिरण, जंगली सूअर व अन्य प्राणी इसके फूलो को खाते है। अतिरिक्त आय के लिये ग्रामीणो द्वारा इसके फूलो को एकत्र कर शराब बनायी जाती है या सूखे हुये फूलो को बाजार मे बेंच दिया जाता है ।

करधई (*Anogeissus pendula*)

यह एक सामान्य ऊँचाई वाला पर्णपाती वृक्ष है। इसकी छाल चिकनी तथा रंग धूसर रजत आभा लिये होता है ।

पत्तियो की सतह चिकनी होती हैं। इसमें मुख्यतः जुलाई से सितम्बर के महीनो में पीलापन लिये हुये हरे रंग के छोटे फूल आते हैं । सूखे स्थानो में यह पशुओ के लिये चारे का प्रमुख स्त्रोत हैं।

करील (*Capparis decidua*)

करील शाखाओ की अधिकता वाली झाडी या

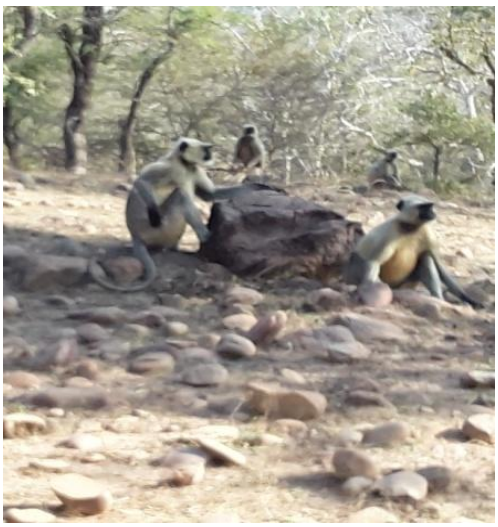
कभी – कभी छोटे वृक्ष के रुप मे पाया जाता है । यह एक सूखे के मौसम मे भी आसानी से जीवित रह सकने मे सक्षम होता है, नवम्बर से जनवरी के बीच मे इसमे लाल रंग के फूल आते हैं तथा का इसके बाद फल लगते है जो की कच्चे होने पर हरे तथा पकने पर गुलाबी – लाल रंग के हो जाते है। इसके फलो को विभिन्न प्रकार के पक्षी खाते हैं तथा स्थानीय लोगो भी इसके फलो को अचार या अन्य रूप मे खाने में उपयोग करते हैं ।

वन्य प्राणियो की यदि हम बात करे तो यहाँ के वनो मे अनेक प्रकार के जीव जन्तुओं की उपस्थिति पायी जाती है ।बाघ, तेन्दुआ, जंगली

बिल्लियो की कुछ किस्मे, जंगली कुत्ते, लकडबघ्घा, चीतल, नीलगाय, चौसिंघा, लंगूर, भालू, जंगली सुअर आदि, विभिन्न प्रकार के सरीसृप तथा पक्षियो की अनेक प्रजातियाँ जैसे मोर, शाहबुलबुल, जंगली मुर्गा, तोते, उल्लु, अनेक प्रकार के प्रवासी पक्षी तथा विलुप्ति की कगार पर खडे गिद्ध की विभिन्न किस्में (देशी गिद्ध, राजा गिद्ध, सफेद गिद्ध आदि) पायी जाती है।

हनुमान लंगूर (*Semnopithecus entellus*)

लंगूर यहाँ पायी जाने वाली वन्य जीवो की प्रजातियो में मुख्य है। इनका चेहरा काला व शरीर धूसर रंग का होता है । यह समूह में रहने वाले प्राणी है, इनके समूह में एक प्रमुख नर, कुछ मादाएं तथा छोटे बच्चे शामिल होते है। नर सपष्ट ऊप से मादाओ से बडे व भारी होते है।



ये वृक्षो तथा जमीन दोनो पर रहते व खुराक ढूढते है। इनकी खुराक में मुख्य रुप से फल, फूल, बीज, कोपले, छाल और जडे शामिल होती है । जंगल में ये शिकारी जानवरो के प्रति बहुत सजग रहते है तथा उन्हे देखने पर चेतावनी की आवाज निकालकर अपने साथियो व अन्य जानवरो को शिकारियो की जानकारी देते है, इसी कारण से लंगूरो को जंगल की आँख भी कहाँ जाता है तथा वनो में अक्सर ही चीतलो को इनके झुन्ड के पास ही चरते हुये देखा जा सकता है ।

नीलगाय (*Boselaphus tragocamelus*)

नीलगाय यहाँ पायी जाने प्रमुख हिरण प्रजातियो में से एक है । शारीरिक आकार के हिसाब से यह भारत में मिलने वाली सबसे बडी हिरण प्रजाती है ।

इनके नर और मादाओ के रंग में अंतर होता है। नरो के शरीर का रंग नीलापन लिये हुये गहरा धूसर होता है तथा मादाओ का रंग गहरा पीलापन लिये हुये नारंगी भूरा होता है। सामान्य तौर पर इनमे केवल नरो के ही सींग होते है और इनकी गर्दन के नीचे सफेद निशान होता है । इनकी खुराक में घास, झाडिया आदि होते है । नीलगाय जीवट वाला प्राणी है और यह सूखे के मौसम को भी आसानी से झेल सकता है ।

गिद्ध

बुन्देलखण्ड में गिध्दो की कुछ किस्मे जिनमें भारतीय गिद्ध (Gyps indicus), सफेद गिद्ध (Egyption Vulture), लाल सिर वाला गिद्ध (King Vulture) आदि पायी जाती है।

गिद्ध एक मुर्दाखोर पक्षी है जो की मृत पशुओ को खाता है। मवेशियो को दी जाने वाली दवा डायक्लोफिनँक के कारण सम्पूर्ण भारत में इनकी आबादी लगभग खत्म सी हो चुकी थी परंतु बुन्देलखण्ड के कुछ स्थान जैसे पन्ना राष्ट्रीय उद्यान तथा ओरछा अब भी इनकी बची हुई आबादी की शरण स्थल बने हुये है इन स्थानो में ये हमे देखने को मिल जाते है।

बुन्देलखण्ड में पडने वाला सूखा तथा कम बारिश इस क्षेत्र के जीव – जन्तुओ व वनस्पतियो पर गहरा प्रभाव डालते है। विगत वर्षो के सूखे के दौरान देखा गया कि कई क्षेत्रो के ग्रामीण अपना घर व मवेशियो को छोडकर अन्यत्र पलायन कर जाते है और उनके मवेशी आसपास के जंगलो में चले जाते है और वे वन्य पशुओ का बहुमूल्य चारा खा लेते है जिससे भोजन व पानी के लिये वन्य प्राणियो को संघर्ष करना पडता है। बहुमूल्य वन्य सम्पदाओ का अधिक दोहन, अवैध शिकार व ज़ंगलो कटाई जो की ईधन के लिये हो या किसी अन्य उपयोग के लिये, मवेशिओ के द्वारा अति चराई, आश्रय स्थल व आवास की कमी तथा सूखा आदि कारण यहाँ के वनस्पतियो व वन्य प्राणियो के लिये संकट उत्पन्न करते है।

References

Singh, S.K. (2005) Text Book of Wild Life Management. Lucknow, U.P.: International Book Distributing Co.pp 1-519.

Kanjilal, P.C.(1982) A forest flora for Pilibhit, Oudh, Gorakhpur and Bundelkhand. Delhi: Narendra Publishing House pp 1-427.

www.bundelkhadinfo.org

www.bundelkhand.in

Soil carbon sequestration

S. Suresh Ramanan
Department of Silviculture and Agroforestry,
College of Forestry, Kerala Agricultural University.
E-mail: sureshramanan01@gmail.com

Introduction

Worldwide soils accumulation over and above three times the amount of carbon as the atmosphere, and 4.5 times the quantity of carbon as the world's biota (Lal, 2004). Soil degradation, land use change, particularly to agricultural systems compounded with unscientific and unsustainable forest management have markedlyshrunk soil carbon stocks (Lal, 2004, Vagen et al., 2005). Managementof forests to make best use of the sequestrating atmospheric carbon into the terrestrial ecosystem is recurrentlyrecommended as the best *modus operandi* to reduce atmospheric CO_2 concentrations in the atmosphere. However, the way of carbon and amounts of carbon actually sequestered on short and long timescales are really complex. Apart form that the long-term implications of these management techniques on diverse soils and ecosystems, are generally in out of sortassumption (Baldock and Skjemstad, 2000; Six et al., 2002; Luztow et al., 2006).

SOM and carbon sequestration

In the face of this cavity in facts and information's, using forests as a prospective terrestrial carbon sink is being the top precedence for many globalestablishments. Even the Intergovernmental Panel on Climate Change (IPCC) is one such establishment, with a job to "provide the world with a comprehensive assessment of the current state of knowledge of climate change and its potential environmental and socioeconomic impacts." According to the report by the IPCC (2000), the forestry sector is accountable for 17% of greenhouse gas (GHG) emissions, making it the second major source of greenhouse gas emanations due to activities such as deforestation, forest degradation and other activities such as burning practices. Forests cover nearly a third of the earth's land surface, but this area is declining, instigating the IPCC to spend a substantial amount of energy and resources in encouragingscientific forest management for carbon sequestration. The IPCC plainly promotes afforestation, reforestation, and reduction of deforestation there by to increase global forest area; reduction of forest degradation and promoting silvicultural practices designed to intensify stand- and landscape-level C sequestration. Unambiguously, site preparation, tree improvement, fertilization, longer forest rotations, controllingof fire and forest conservation are reinvigorated. The IPCC confesses a lack of familiarity about the impacts of forest management on soil, and also states that there is lack of integration with climate impact studies with social issues which leads to sustainable development. To discuss these vital issues, we need to fuse present-day information's and data on multiple scales and plan interdisciplinary studies to illuminate the impact of silvicultural management on total ecosystem carbon storage, exclusively on the long term

scenario. In reaction to outcomes of the United Nations Framework Convention on Climate Change, the Kyoto Protocol was formed to set binding targets for industrialized countries to stabilize GHG emissions (UNFCCC 1998). Due to extensive involvement from countries globally, the Kyoto Protocol and its policy endorsements bear noteworthy weight for governments. One of the eight policy recommendations of the Kyoto Protocol is to encourage afforestation, reforestation, and sustainable forest management (article 2). It permitsto equate the carbon sequestered from this sort of forest management intervention to be used towards a country's GHG reduction obligation. The protocol acknowledges some technical and methodological issues in applying specific silvicultural interventionsintended to maximize terrestrial carbon storage to diverse ecosystems on long durations. In theory, these policy recommendations increase carbon input into soils, where it can be sequestered for long time. Afforestation, reforestation, and sustainable forest management do upsurge C uptake in biomass, and consequently should lead to an amplified organic inputs into the soil in the form of litter, woody debris, and roots. As detailed in the theoretical concept, the enhanced C inputs to soil are assumed to increase the short-term as well as the long-term soil carbon stocks. However the increase in net soil carbon sequestration ultimately depends upon the balance between the input and the loss. Generally the forest ecosystems, microbial respiration and soil erosion like disturbance are the sources of the carbon loss in soil ecosystem. Policy makers assume that carbon uptake and storage can be escalated through site and soil properties of that locality (Yanai et al., 2003). There is need to differentiate between short-term accumulation and long-term stabilization of soil organic matter (SOM). There are different contrivances controlling the temporary and long-standing fates of SOM, and if not given due consideration, the distinction between the two may not be palpable.

Conclusion

The term "stabilization" generally means to any process that thermodynamic or kinetically makes SOM to retain in the soil longer and "destabilization" mean any process which cuts the SOM retention time in the soil. For illustration, long-term steadiness of added organic inputs would lead to long-term C increases. On the other hand, the input may be lost to decay by microbes and respired back within hours or days to a few years into the atmosphere (i.e. Johnson et al., 2002) or removed from the soil matrix by any other means. This would evidently not therisein the SOM over time but also may even decrease SOM, as can be seen in priming effects. To discuss potential gains and losses of SOM in relation to forest management, an understanding of organic matter dynamics in the soil is important. While there is some debate of the importance of silvicultural intervention on SOM stabilization. However, without understanding how organic matter interacts with soil, it is impossible to accurately predict long-term consequences of any policy on carbon sequestration, so we need to begin with understanding SOM decompositionand stabilizationmechanisms of SOM on holistic approach.

References

Lal, R. (2004). Soil carbon sequestration impacts on global climate change and food

security. Science, 304 (5677), pp.1623-1627.

Baldock, J.A. and Skjemstad, J.O. (2000). Role of the soil matrix and minerals in protecting natural organic materials against biological attack. Organic Geochemistry, 31 (7), pp.697-710.

Vågen, T.G., Lal, R. and Singh, B.R. (2005). Soil carbon sequestration in sub-Saharan Africa: a review. Land Degradation & Development, 16 (1), pp.53-71.

Six, J., Conant, R.T., Paul, E.A. and Paustian, K. (2002). Stabilization mechanisms of soil organic matter: implications for C-saturation of soils. Plant and soil, 241 (2), pp.155-176.

Lützow, M.V., Kögel-Knabner, I., Ekschmitt, K., Matzner, E., Guggenberger, G., Marschner, B. and Flessa, H. (2006). Stabilization of organic matter in temperate soils: mechanisms and their relevance under different soil conditions–a review. European Journal of Soil Science, 57 (4), pp.426-445.

Yanai, R.D., Currie, W.S. and Goodale, C.L. (2003). Soil carbon dynamics after forest harvest: an ecosystem paradigm reconsidered. Ecosystems, 6 (3), pp.197-212.

Johnson, D.W., Knoepp, J.D., Swank, W.T., Shan, J., Morris, L.A., Van Lear, D.H. and Kapeluck, P.R. (2002). Effects of forest management on soil carbon: results of some long-term resampling studies. Environmental Pollution, 116, pp.S201-S208.

Mahul leaves collection as livelihood option of tribal people in Achanakmar-Amarkantak biosphere reserve

Neelu Singh, Rajesh Kumar Mishra and N. Roychoudhury
Tropical Forest Research Institute
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
Jabalpur – 482021, Madhya Pradesh, India

Bauhinia vahlii Wight & Arontt (Family-Leguminosae) is a gigantic, usually evergreen climber (Fig.1), commonly known as Mahul. It is also called as camel's foot climber as the leaves (Fig.2) are similar to a camel's foot print. It is the largest creeper in India, and can grow up to 10-30m long. Flowering and fruiting are observed only in matured climbers of 20 to 30 m height (Fig. 3) *B.vahlii* is an important species of economic *value* in the tribal belt of central region. The leaf is used by the grocery shops, eateries etc. as

Fig. 1: Newly recruited leaves in *B. vahlii*

plates, bowls and packing material (Fig.4). The plates made of Mahul leaves are used exclusively during the community feasts and rituals. The stem fibre is used for making ropes, basketry and wickerwork. The outer bark yields 17% tannin and 19% non-tannins. The root and bark have medicinal properties. Seeds of the plant are eaten both raw and fried.

Mahul leaves are available for collection around 9-10 months in a year, making it an almost year round livelihood option. The leaves are collected by local tribal people of Achanakmar-Amarkanatak biosphere reserve. The average collection per person per day is around 5 to 6 kilograms, which is sold in the market without additional

Fig. 2: Young leaves of *B. vahlii*

processing. The demand for Mahul Patta, both in India and abroad has been growing rapidly for quite some time. Recently, Self Help Group (SHG) comprise of tribal people in Achanakmar-Amarkantak

Fig. 3: Flowering in *B. vahlii*

biosphere reserve after collection of leaves going to Mahul leaves processing unit

Fig. 4: Plates prepared of *B. vahlii* leaves

established by BR authority, for better manufacturing of plates and bowls (Fig. 5). The marketing of products made of Mahul leaves are also doing by SHG.

Fig. 5: Mahul leaves processing unit at Shivtarai, Achanakmar-Amarkantak biosphere reserve.

Scientists of Lead Institute, Tropical Forest Research Institute, Jabalpur (MP), has standardized sustainable (non-destructive) harvesting practices of Mahul leaves in tribal belt of central India, including Achanakmar–Amarkantak biosphere reserve (Pandey and Singh, 2015). It has been concluded that harvesting intensities, 50-60% is found superior for getting quality as well as progressive recruitment of leaves in natural forest areas. It is suggested that harvesting should be restricted to twice (June and October) in a year without damaging the climbers.

References

Pandey, A.K. and Singh, N. (2015). Standardization of sustainable harvesting practices of Mahul Patta (*Bauhinia vahlii*). Project completion report submitted to Indian Council of Forestry Research & Education, Dehradun, 38 pp.

Occurrence of defoliator, *Dichromia sagitta* (Fabricius) (Lepidoptera: Noctuidae) on *Tylophora indica*

P.B. Meshram, Shashi Kiran Barve and Nahar Singh Mawai
Forest Entomology Division
Tropical Forest Research Institute
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
P.O. RFRC, Mandla Road, Jabalpur- 482021

Medicinal plants have been used as an exemplary source for centuries as an alternative remedy for treating human diseases because they contain different bioactive ingredients, which have great therapeutic value. Dumvel or Antamul, *Tylophora indica* (Burm. f.) Merrill syn. *T. asthmatica* (Wight) is medicinal perennial vine which is found in eastern, central and southern India, Sri Lanka, Thailand, Malaysia and Borneo. It is a small evergreen, climbing shrub. It is found in dry forest of sub-Himalayan tracts of North and East Bengal, Assam, Orissa, Konkan, Deccan, and plains of Tamil Nadu. Its botanical name is from the ancient Greek word tylos = knot and phoros = bearing. It is called Indian Ipecacuanha**,** as the roots are used as an effective substitute for Ipecac, which was used to cause vomiting after suspected poisoning. Its use to induce vomiting led to the inclusion of *Tylophora* in Bengal Pharmacopoeia of 1884. Leaves are expectorant and used to treat respiratory infections, bronchitis and whooping cough. Its root or leaf powder is used in diarrhea, dysentery and intermittent malarial fever (Anon., 1976, 2008; Singh *et al*., 1983).

To investigate the insect pest damaging this potential medicinal plant, the pest problem was informed from the staff of Non Wood Forest Produce Division, Tropical Forest Research Institute (TFRI), Jabalpur. Field surveys were conducted in Non-Wood Forest Produce (NWFP) Nursery, TFRI, Madhya Pradesh during April, 2017. During the course of study, it was observed that the herb to be severely infested by the insect pest and the larvae were feed voraciously on leaves (Fig. 1-2). About 80-90 per cent incidence was recorded. Larvae were collected from field and reared in laboratory up to adult stage which was later identified as *Dichromia sagitta* Fabricius (Noctuidae : Lepidoptera) from the collection of National Insect Repository, Forest Entomology Division, TFRI, Jabalpur (Acc. No. 277). The larvae are yellowish in colour with black bands on the body. The adult moths are medium sized with brown patches on the fore wings and yellow with terminal black marking on hind wings (Fig.4). The pupae were chocklet- brown in colour (Fig. 3) and the pupal period was recorded 7-8 days during the study period.

The seasonality, extent of damage and biology of *D. sagitta* on *T. indica* were studied by Gole and Das, 2011. Life cycle was completed in 41-46 days during January-February and 26-32 days during June-July. There were several overlapping generations in a year. A semilooper, *Dichromia orosia* Cramer (Lepidoptera: Noctuidae) was recorded as an important pest on *T. indica* (Joshi *et al.*, 1992; Devaiah *et al.*, 1983). A thorough review of literature has revealed that the genus *Hypena* has about 20 junior synonyms and *D. orosia* is a synonym for *Hypena*

sagitta. The occurrence of this insect pest was observed mainly during August-December in Karnataka state coinciding with the flowering of the plant (Gole and Das, 2011; Sridhar and Rani, 2010). This is the first report on the occurrence of *Dichromia sagitta* (Fab) from the potential medicinal plant *Tylophora indica* during summer season (in the month of April, 2017) in Madhya Pradesh.

1

2

3

Male

Female 4

Figs.: 1-2: Larvae of defoliator *Dichromia sagitta* feed on leaves of *Tylophora indica*; 3: Pupae of *D. sagitta*; 4 Adult Moth of *D. sagitta*

Acknowledgement

The authors are thankful to the NWFP Division, TFRI, Jabalpur for giving the information of the insect pest problem.

References

Anon. (1976). The Wealth of India S-W. CSIR New Delhi, 591 pp.

Anon. (2008). Agrotechniques of selected medicinal plants Vol. 1. National Medicinal Plant Board, Department of Ayush, Ministry of Health, Govt. of India.

Devaiah, M.C., Gouda, R.R., Kotikal, Y.K. and Yelshetty, S. (1983). A noctuid defoliator pest *Dichomia orosia* Cram (Noctuidae: Lepidoptera) of antamul a medicinal plant. Journal of Bombay natural History Society, 80 (3): 659.

Gole, N.S. and Das, B.K.(2011). Biology of *Dichromia sagitta* (Fab) Notuidae: Lepidoptera, a serious pest of Indian ipecac, *Tylophora indica*. The Journal of Plant Protection Sciences, 3 (2):14-19.

Joshi, K.C., Meshram, P. B., Sambat, S. Kiran, U. Humne, S and Kharkwal, G.N. (1992). Insect pests of some medicinal plants in Madhya Pradesh. Indian Journal of Forestry, 15 (1): 17-26.

Singh, U., Wadhwany, A.M. and Johri, B.M. (1983). Dictionary of Economic Plants in India, Indian Council of

Agricultural Research, New Delhi. Pp. 234-235.

Sridhar, V. and Jhansi Rani. B. (2010). Occurrence and biology of semilooper, *Hypena sagitta* (Fabricius) (= *Dichromia orosia* Cramer) (Lepidoptera: Noctuidae) on Indian ipecac, *Tylophora indica* (Burm. f) Merr. Pest Management in Horticultural Ecosystems, 16 (1): 78-79.

Know your biodiversity

Swaran Lata and Preeti Kaushal
Himalayan Forest Research Institute (HFRI)
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
Shimla (Himachal Pradesh)

Machlolophus xanthogenys Vigors

Machlolophus xanthogenys is endemic to India, Pakistan and Nepal. It is commonly known as Himalayan Black Lored Tit and *Parus xanthogenys* is its synonym. It is a passerine bird belongs to Order Passeriformes and Family Paridae. It is a common resident of Outer Himalayas to Eastern Nepal and breeds between 1500-2100 m, whereas in Nepal it reaches up to the heights of 2400 m, occasionally descending to 1200 m in winters. It is very characteristic bird of middle Dhauladhar range with yellow and black plumage. Bird is habituated around pine, Oak and deodar forest and also in subtropical evergreen bush jungle within a very narrow altitudinal range between 1500-2200 m.

The bird is approximately of 14 cm in size. Upper part is olive-green in color, male and female crest is black and ventral median stripe is black in color. A sprightly black and yellow crested tit having a band behind eye, which is black in colour, a few crest tipped with yellow. A long yellow supercilium joins the yellow nape-patch.Wings are spotted with yellow and black on shoulder with white longitudinal patches. Tertials are broadly tipped and edges are white. Tail of the bird is blackish slate in color with white outer edge and white tips. Sexes are practically alike.

These tits usually feed on small invertebrates, larvae, spiders, ants, cockroaches, vegetable matters, mulberries, raspberries etc. Similar to other tits, foraging is done in mixed parties in non-breeding seasons, but reported to be less gregarious than other tits. They are often seen solitary or in pairs. The voice of the birds is cheerful, sings with musical notes and loud. Song period is generally from January to September, chiefly in March- April.

Breeding season of Himalayan Black Lored Tit is from March to June. Nest is a pad of moss with a central cup lined with fur, usually in holes in trees from level up to about 6 m, occasionally between roof and ceiling of hill station bungalows. Eggs are usually 4-5 in number. Building, incubation and care of young ones are done by both sexes, although incubation period is undetermined.

This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion. The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion. For these reasons, the species is evaluated as Least Concern. Although population of Himalayan Black Lored Tit is abundant but due to population explosions, habitat degradations, these birds require attention before it's too late

and it will reach to the thresholds of vulnerability.

***Physochlaina praealta* (Decne.) Miers**

Physochlaina praealta is a valuable medicinal plant that grows in the high-altitude. It is distributed in temperate Himalaya from Kashmir to Bhutan and in Assam at altitude of 3300-4600 m. In Himachal Pradesh, it is found in Lahaul & Spiti, Kinnaur and Kullu district. It is Common on slopes, amongst stones and boulder. It belongs to order Solanales and family Solanaceae. It is commonly known as Tall Physochlaina. In Ladakh region plant is locally known as Sholar, Lang Thang and Bajar Bang. Physochlaina grandiflora and Scopolia praealta are its synonyms. Generic and specific epithet of the plant is derived from the Greek word '*physa*' means *'bladder'* and *chaina* means 'outer garment' referring to the inflated calyx.

It is an erect, glandular, nearly, smooth, leafy, robust, pubescent, perennial herb. Stems erect, 0.6-1.2 m long, branched above, glandular. Branches corymbosely upwards Leaves 5-15 cm long, stalked, wedge- shaped, ovate-oblong, entire, wavy margins, base cordate or cuneate, obtuse, pubescent on both sides; petioles 2-35 cm long, glandular pubescent. Flowers 2-7.5 cm long, greenish-yellow, funnel-shaped, pedicelled, in dense terminal, lax, compound, flat topped sticky velvety cluster.

Calyx lobes 5, 6-7 mm, bell-shaped, glandular pubescent, lanceolate, enlarging in fruit to 2.5 cm. Corolla 3 cm, 5, yellowish with purple vein, tubular, lobes 5, shallow, spreading, overlapping in the bud, enlarging in the fruit, spreading. Stamens 5, protruding, attached to the corolla tube. Ovary superior, of 2 fused carpels; style thread-like, equaling or slightly exceeding the corolla; stigma barely 2-lobed, protruding. Fruits (Capsules) 1.2 cm across, 2-celled, conspicuous, with tubular calyx, opening by a lid. Seeds 2 mm long, very small, net veined. Flowering and fruiting period is June-September.

Plant contains large amount of hyoscyamine, scopolamine and salts like Potassium nitrate, Potassium chloride and Potassium sulphate. Root contains hyoscyamine and sucrose. The leaves are poisonous and possess the belladonna like property of dilating the eye pupil and applied to cure boils. The leaves are used to reduce swellings and are applied to boils. The roots of the plant contain 0.64% alkaloids. The plant constitutes an excellent source of atropine. Seeds are used to expel round worms, also given as an emetic in bilious attack. In Lahaul, burnt seeds are smoked siphoned into tooth cavity through barley straw to provide instant relief for the aching tooth and plant is browed by cattle.

It is one of the most reputed plants of indigenous system of medicine, commercially exploited by local people for sale. It is one of the major sources of Tropane group of alkaloids used to treat peptic ulcers, prevent motion sickness, and as components of preanesthetic drugs. Like the other important medicinal plants

Physochlaina praealta is also facing extinction due to over-exploitation for medicinal use and other anthropogenic activities. Conservation status of *Phsochlaina praealta* is Vulnerable (IUCN, 2000) and the plant is extensively harvested for the herbal industry. It has wide scope in commercial cultivation because it is one of the rich sources of tropane alkaloids. Hence sustainable harvesting and development of suitable agro-technique for this reputed medicinal plant is needed for its conservation in natural habitat and to fulfil the herbal industry demand.

References

Ali, S. and Ripley, D. (1973). Handbook of the birds of India and Pakistan. Vol.9, Robins to Wagtails. Oxford University Press. pp.186-188.

Besten J.W.D. (2004). Birds of Kangra. Moonpeak Publishers. pp. 144.

Grewal, B. (2000). Birds of the Indian Subcontinent. Published by Local Colour Limited, Hongkong. pp.112.

Grimmet, R., Inskipp, C. and Inskipp, T. (1999). Pocket Guide to the Birds of the Indian Subcontinent, Oxford University Press. pp. 266.

Chauhan, N.S. (1999). Medicinal and aromatic plants of Himachal Pradesh. Indus Publishing Company, New Delhi, India. 632 pp.

Agrarwal, V. S. (2003). Directory of Indian Economic Plants. Bishen Singh Mahendra Pal Singh, Dehradun, India. 565 pp.

Ambasta, S.P. (1986). The useful plants of India. Publication and Information Directorate. CSIR, New Delhi. 918 pp.

www.flowersofindia.net

Tropical Forest Research Institute

Published by:

Tropical Forest Research Institute
(Indian Council of Forestry Research & Education)
(An autonomous council under Ministry of Environmnet, Forests and Climate Change)
P.O. RFRC, Mandla Road
Jabalpur – 482021 M.P. India
Phone: 91-761-2840484
Fax: 91-761-2840484
E-mail: vansangyan_tfri@icfre.org
Visit us at: http://tfri.icfre.org or http://tfri.icfre.gov.in

© Published by Tropical Forest Research Institute, Jabalpur, MP, India