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Biological Measures for Rehabilitation of the Mined-Out Area in Dantewada, Chhattisgarh, India

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Abstract - *Reclamation and Rehabilitation is the principal process used to mitigate the long-term impacts of mining on the environment. The main objective of the proposed R&R plan is to ensure the ecosystem biodiversity and habitat stability of the area impacted as less as possible in the long run for future sustainability. It has been aimed at topographic reconstruction with engineering and biological measures for erosion control and re-vegetation with adequate soil amendments including application of beneficial microbes (bio-fertilizers) such as mycorrihizal fungi, Plant Growth Promoting Rhizobactera (PGPR), etc., for stability and long term sustainability in the nutrient budgeting. Also, encouraging the native fauna to recolonize in areas re-vegetated after mining is the integrated aim of this restoration programme.*

***Key Words*: Reclamation, Rehabilitation, Fungi, Plant Growth Promoting Rhizobactera (PGPR), mining.**

1.INTRODUCTION

The eco-restoration and rehabilitation of open cast mined out area in heavy rain fall zone necessarily involves stabilization of slopes, soil and water conservation measures and afforestation with suitable species including grasses, shrubs and trees, mostly indigenous ones. Rehabilitation is sometimes termed as reclamation, because the damage to sites is so severe that soils have to be replaced. Reclamation is a process by which highly degraded lands are returned to productivity so as to restore biotic function and microbial productivity (1) and rehabilitation is an action to make restoration (2). Therefore, rehabilitation, reclamation and restoration are interrelated in development of vegetation in the degraded lands like mined out areas. Rehabilitation of degraded lands due to mining also involves reclamation of productive, economic and aesthetic values of the land. It is no doubt a challenging job and requires a thorough understanding of the ecological principles.

The main goal of restoration is to develop long-term sustainable ecosystem indigenous to the area where mining occurred. It results in natural regeneration and survival of plants and functioning of food webs in the degraded area. After rehabilitation of the mined out areas, it should be allowed for natural regeneration of grasses, herbs and other plant communities. Rehabilitated mined out areas themselves may change the vegetation in unpredictable ways, due to successional processes. The change of vegetation will be determined by a number of factors, notably site characteristics and climate. Moreover, once the nutrient cycling is re - established in the rehabilitated areas it will confirm the successful restoration of the degraded ecosystem. Many soil properties such as structure, water retention, nutrient availability and microbial activities are dependent on the organic matter. Plants take up nitrogen as ammonium nitrate from the soil and it is usually in the form of ammonia or ammonium but can be oxidized to nitrate by nitrifying bacteria. Significant levels of ammonium may accumulate in the deep anaerobic zones of degraded soil that result in high nitrification potential when exploited with nitrogen fixing bacteria and leguminous plant species which in turn result in improving soil fertility.

2. SPECIES SELECTION FOR AFFORESTATION

In a completely degraded area with low soil nutrient status, the colonization of plant species become very slow and primary succession will take place slowly for a long time span. Lichens, mosses, and small orchids capable of inhabiting rocks and a few grasses grow as primary colonizers. Depending on the extent of accumulation of organic debris, single species associations (Consociations) of grasses appear. The early grass colonizers gradually give way to typical grasslands.

In the elevation (500-1200 masl), similar to the mine site, the tree savanna enclosures comprised of mostly of moist deciduous tree species exist. Throughout the location of mine area, the mean annual rainfall is over 1445 mm, and the whole area can sustain Dry Deciduous to Moist Deciduous forest (which is true with the adjoining forests of the surrounding area). According to (3) , the forest types in this region are developed due to recurring fire and is considered as fire climax.

It is well known that areas receiving more than 1400 mm rainfall per annum, can expect the development of fire climax vegetation such as dry/moist deciduous forests (4) reported the colonization of moist deciduous species like Phyllanthus emblica, Careya arborea, Terminalia elliptica, etc. in moderate elevated areas (900-1400 masl).

The plant species suggested for eco-restoration have one or more reasons for its suitability. Hardy shrubs and deciduous tree species can survive in such adverse conditions. Species that naturally invade the disturbed areas such as Alstonia scholaris, Bridelia retusa, Trema orientalis, Macaranga peltata and easy regenerating species such as Xylea xylocarpa, Bombax ceiba, Careya arborea, Holarrhena antidysenterica are well suited for afforestation in similar areas with moist conditions. When these species establish in disturbed areas, nature itself takes care (if further disturbance is not caused). Seeds or propagules coming from inside or from adjacent forest areas through different agents establish and acclimatize in the environment.

The role of exotic or indigenous species in rehabilitation needs careful consideration. Careful selection of species is needed, as newly introduced exotics may also become pests in other situations. Exotic species are believed to have negative impact on site conditions, escape into original habitats and displace native species (5). Indigenous species are preferable than exotics because they are most likely to fit into a fully functional ecosystem and to be climatically adapted.

2.1 Afforestation Programmee

Afforestation programme in the mined areas has to be taken up to control landslides and soil erosion. Based on the survey and study, it is possible to recommend suitable plant species for the mined out area. The species has to be planted on the slopes, particularly trees, shrubs, herbs and grasses to stabilize the slope from soil erosion.

On broken up hill tops/bund tops, only grasses should be planted through seeds, nursery raised seedlings or slips. On slopes, for stabilization, rows of sturdy grasses like Cymbopogon nardus, Chrysopogan fulvus, Thysanolaena maxima and other grass slips are to be planted. Seeds and slips can be collected from surrounding areas without destroying the grass cover in such areas.

The following grass species are excellent soil binders, suggested for planting in the form of slips and seedlings (Table-1):

Table -1: Grass species suggested for planting in mined out area for stabilization

Sl. No.	Name of the species	Family	Habit
1.	*Arundo donax*	Poaceae	Shrub
2.	*Chrysopogon fulvus.*	Poaceae	Herb
3.	*Cymbopogon nardus*	Poaceae	Herb
4.	*Cymbopogon martini*	Poaceae	Herb
5.	*Eulalia trispicata*	Poaceae	Herb

Grasses have the capacity to bind soil particles with very high regenerative capacity and high viability of seeds. Other annual/perennial herbs also can be used for stabilization. They are also available naturally in the site. Crotalaria laburnifolia, C. retusa, Smithia conferta, Tephrosia purpurea and T. villosa are the other important leguminous plant species that can improve soil nitrogen status. These plant seeds can easily be collected from adjacent areas. Broadcasting of seeds during monsoon periods will give better results.

2.2 Plantation of trees and shrubs

Mixed plantation of trees and shrubs are recommended to be taken up along with the grass component on slopes of mined areas. Following local hardy species of trees and shrubs are suggested for planting (Table-2).

Table -2: Trees and shrubs recommended for planting on slopes of mined out areas

S. No.	Name of the species	Family	Habit
1.	*Albizia chinensis*	Mimosaceae	Tree
2.	*Bombax ceiba*	Bombacaceae	Tree
3.	*Bridelia retusa*	Euphorbiaceae	Tree
4.	*Buchanania lanzan*	Anacardiaceae	Tree
5.	*Clerodendru viscosum*	Verbenaceae	Small tree
6.	*Glycosmis pentaphylla*	Rutaceae	Shrub
7.	*Phoenix loureiroi*	Arecaceae	Shrub
8.	*Trema orientalis*	Ulmaceae	Small tree
9.	*Wendlandia tinctorea*	Rubiaceae	Small tree

2.3 Plantation of trees and shrubs along the slopes and stream bunds

This area is very fragile due to high velocity of running water. For mine drainage management, the engineering structures of erosion control should be implemented. These structures should be further strengthened by planting different trees and shrubs. The rainwater accumulating in the mine workings should be channeled to mine pit and pumped out only after settling the suspended matter. To protect the area

from erosion and to stabilize the slopes along the streams, the following trees and shrubs are to be planted (Table-3).

Table -3: Plants recommended for foot hills of the slopes and streams

S. No.	*Name of the species*	Family	Habit
1.	*Ardisia solanacea*	Myrsinaceae	Shrub
2.	*Caryota urens*	Arecaceae	Tree
3.	*Ficus auriculata*	Moraceae	Tree
4.	*Ficus racemosa*	Moraceae	Tree
5.	*Melastoma malabathricum*	Melastomaceae	Shrub

3. MANAGEMENT OF HAUL ROADS AND APPROACH ROADS

The haul roads and approach roads of this mine lease area are maintained very well with appropriate catch drains and slope stabilization vegetation all along. As the mine employed conveyor system for ore transportation, vehicular transportation and consequent pollution from dust is practically negligible, however, the mine haul roads within the lease should be maintained properly at regular intervals and regularly sprinkled with water to avoid dust during vehicular transportation. As an initiative to further greening, the area along the roads (approach/township/avenue) can be planted with suitable fast growing trees in three rows (with 2.5 m spacing) on either side. The species recommended for avenue plantation is provided in (Table 4).

Table -4: Tree species recommended for approach / township/avenue roads

S. No.	Plant species	Family	Hindi name
1	*Albizia lebbeck*	Mimosaceae	Kala siris
2	*Albizia procera*	Mimosaceae	Safedsiris
3	*Azadirachta indica*	Meliaceae	Neem
4	*Cassia fistula*	Caesalpiniaceae	Amaltas
5	*Dalbergia latifolia*	Fabaceae	Shisham

4. GREENBELT/SAFETY ZONE

The main objective of the greenbelt/safety zone is to provide a barrier between the sources of pollution and the surrounding areas. The greenbelt helps to capture the fugitive emission and to prevent the noise generated apart from improving the aesthetics. Development of greenbelt and other forms of greenery shall also prevent soil erosion and washing away of topsoil besides helping in stabilizing the functional ecosystem. As per the statutory guidelines, safety zone of 7.5 m width along the boundary within the mine lease area should be made as greenbelt. It is important to create a greenbelt with tall seedlings (>1 m height) of fast growing native species. The species listed in Table 5 may be selected for planting in 4 rows (2.5 x 2.5 m spacing) for greenbelt development.

Table -5: Tree species recommended for greenbelt development

S. No.	Botanical name	Family	Hindi name
1.	*Alangium salvfolium*	Alangiaceae	Akola/ Ankol
2.	*Albizia lebbeck*	Mimosaceae	Kala siris
3.	*Albizia procera*	Mimosaceae	Safedsiris
4.	*Azadiracht aindica*	Meliaceae	Neem
5.	*Cassia fistula*	Caesalpiniaceae	Amaltas
6.	*Dalbergia latifolia*	Fabaceae	Shisham

4.1 Total area afforestation at the conceptual stage

Afforestation is the main component of re-vegetation process to mitigate the negative impacts of mining on environment. Afforestation with native species components will facilitate restoration of the ecosystem diversity relatively similar to that of the pre-mining stage.

4.1.1 Multipurpose plant species for afforestation

Most suitable native vegetation components such as herbs, shrubs, trees and grass species having various utility like timber, medicinal, fodder, food, etc., recommended for considering afforestation are listed in Table 6.

Table -6: Multipurpose plant species recommended for afforestation of mine areas

S. No.	Plant species	Hindi name	Family	Uses
Tree				
1.	*Aegle marmelos*	Bael	Rutaceae	M, E, C
2.	*Alangium salvifolium*	Ankol/ Akola	Alangiaceae	M,T
3.	*Albizia lebbeck*	Kala siris	Mimosaceae	T
4.	*Albizia procera*	Safedsiris	Mimosaceae	T
5.	*Annona squamosa*	Seetaphal	Annonaceae	M,E,C
6.	*Anogeissus latifolia*	Dhawa/	Combretaceae	T
7.	*Azadirachta indica*	Neem	Meliaceae	M T
8.	*Cassia fistula*	Amaltas	Caesalpiniaceae	M
9.	*Chloroxylon swietenia*	Bhirra/ Bhivia	Flindersiaceae	M, T

Shrub				
10.	*Clerodendrum infortunatum*	Bhant	Verbenaceae	M
11.	*Helicteres isora*	Marur phalli	Sterculiaceae	M
12.	*Indigofera cassioides*	Saknya/ Kathi	Fabaceae	E
13.	*Phoenix loureirii*	-	Arecaceae	E, C
14.	*Vitex negundo*	Nirgundi	Verbenaceae	M
Herb and Grasses				
15.	*Aristida setacea*	Desi Jaddughas	Poaceae	C
16.	*Bothriochloa pertusa*	*Indian* Bluegrass	Poaceae	F
17.	*Cassia occidentalis*	Kasunda/ Bari kasondi	Caesalpiniaceae	M
18.	*Chrysopogon fulvus*	Dhalu/ dhaulu/ gurla/ zargha	Poaceae	F
19.	*Colocacia esculenta*	Arvi	Araceae	M, E
20.	*Crotalaria juncea*	Jhunjhunia/ masina/ San	Fabaceae	F
Bamboo				
21.	*Bambusa arundinacea*	Thorny Bamboo/ Bans	Poaceae	E, C
22.	*Dendrocalamus strictus*	Solid bamboo/ Bans	Poaceae	E, C
M=Medicinal; T=Timber; E=Edible; F=Fodder; C=Commercial				

5. BIODIVERSITY CONSERVATION PLAN

Biodiversity refers to various kinds of life forms with their habitats. Biodiversity is the basis of life on earth, important for the functioning of ecosystems and provides us with products and services. As the mining involves a lot of disruption to the physical environment, it interferes with various biological processes resulting in loss of biodiversity. It is, therefore, important to evaluate the magnitude and severity of impacts associated with mining and their implications for biodiversity conservation. Developmental projects in any eco-region must learn to respect the ecological integrity of the dependent organisms thriving in the area including the human beings and their habitats for long term sustainability.

5.1 Flora

Vegetation plays an important role in reclamation of the degraded lands. Rich floristic diversity is a desirable objective in itself and is likely to lead to high faunal diversity also. The present area lies within forest land which has typical floral elements of Moist Deciduous and Dry Deciduous forests. In certain places near the streams, purely evergreen species such as Cyathea gigantea, Phoebe paniculata, Eurya nitida, Olea paniculata, Ficus nervosa, Macaranga peltata and Neolamarckia cadamba and amphibious vegetation like species of ferns and sedges also could be observed. In order to achieve the objective of bringing back the disturbed vegetation in mined areas to pre-mining status, it is suggested in Biodiversity Conservation Plan to desist from planting exotics like Acacia auriculiformis, Acacia mangium, Cassia siamea, Casuarina equisetifolia, Grevillea robusta, Spathodea campanulata, Tecoma stans, etc. As the mine lease area has natural vegetation, efforts should be made to collect seeds, tubers and other planting materials and propagate the same in the nurseries. Seedlings and saplings of shrubs and trees from the undisturbed mineralized zones could be transplanted either in the areas proposed for afforestation or temporarily to the nursery for future planting.

5.2 Fauna

Following suggestions are made in this plan to improve the faunal population:

(a) Habitat protection

The diversity of animal species and their abundance is largely dependent on the availability of suitable habitats and vegetation cover on which they depend for their various biological needs. All the measures suggested herein may be followed to achieve protection of habitat for wildlife forms.

(b) Creation of Habitat for Avifauna

As birds act as seed dispersal agents as well as pollinators, efforts must be made to create environment for avifauna by planting suitable trees which provide habitat for them. Trees like Alangium salvifolium, Annona squamosa, Bombax ceiba, Cochlospermum religiosum, Erythrina suberosa, Ficus benghalensis, Ficus religiosa, Ficus racemosa, Maduca longifolia var. latifolia, Syzygium cumini, Ziziphus maurtiana, etc., may be planted to attract birds.

(c) Providing a corridor for the dwelling and movement of herpetofauna

Herpetofauna includes amphibians and reptiles and are well known environmental quality indicators because of their sensitivity to changes in the environment and specificity of the microhabitat they use. In the valleys within and outside the mine lease area, there are fore forest patches having both moist deciduous as well as evergreen characters, which are very good habitats for these kinds of organisms. Hence, it is suggested to create an environment for dwelling of native herpetofauna as well as a corridor to allow the movement of herpetofauna by planting suitable vegetation wherever disturbed between two patches of forests.

6. SOIL MANAGEMENT PLAN

The most practical way to increase the nitrogen capital of soil ecosystems is to establish nitrogen-fixing plants, usually legumes, which can quickly increase the nitrogen levels in the system. The easiest method is to broadcast large quantity of seeds of Horse gram (Macrotyloma uniflorum) and Hamata grass (Stylosanthes fruticosa) immediately after first showers.

The following measures in respect of soil management can be adopted in reclamation and rehabilitation of mined areas:

- As the beneficial microbes are present in the top soil, it must be removed and stacked separately as per the plan and be used for reclamation and rehabilitation of mined areas.
- Necessary precautionary measures should be taken to preserve the fertility and shelf life of the soil.
- The top soil containing beneficial micro flora must be used for raising plantation over different reclaimed areas such as dumps, backfilled areas, etc.

7. DISCUSSION & CONCLUSION

In order to ensure rehabilitation of the mine affected areas, regular monitoring of implementation of the proposed measures is very essential. Monitoring provides a method of measuring progress against an objective. In addition, site surveillance may be required to demonstrate that the mine site remains safe and poses no environmental risks. Regular monitoring also allows for a proactive response where the rehabilitation process is found to be lacking in the desired results. Monitoring also provides valuable reference data for authorities in subsequent decision-making and in refining environmental permitting procedures or land use planning. Monitoring a landscape's health over time in response to Environmental Management or regulatory drivers is important for land managers, ranging from individuals to governments, especially when the monitoring output has direct relevance for management decision-making. Monitoring may be seeking to look for evidence of landscape degradation or of rehabilitation progress and the procedure needs to have equal facility in dealing with these scenarios. This training would equip them to: Respond to environmental impacts, Develop plans to address impacts, To implement the plans and evaluate the results, and Report and record the results

In order to achieve these objectives, it is recommended to have suitable trainings in the form of refresher courses for the managers dealing with environmental issues.

REFERENCES

[1] Bradshaw, A.D. 1996. Underlying Principles of Restoration. Canadian Journal of Fisheries and Aquatic Science, 53 (Suppl. 1): 3-9.

[2] Brown, S. and Lugo, A. E. 1994. Rehabilitation of Tropical Lands- A Key to Sustaining Development. Restoration Ecology, 2, 97-111.

[3] Champion, H.G. and Seth, S.K. 1968. A Revised Survey of the Forest types of India. Govt. of India Press, Nasik.

[4] Lugo, A.E. 1997. The apparent paradox of reestablishing species richness on degraded lands with tree monocultures. Forestry Ecology and Management, 99, 9–19

[5] Seth, S.K. and Kaul, O.N. 1978. Tropical forest ecosystems of India: The Teak Forest. In: UNESCO and FAO. Tropical Forest Ecosystems. UNESCO-FAO, France.