ANNUAL REPORT (2020-21)
BEST PRACTICES UNDER SUSTAINABLE DEVEMENT FRAMEWORK

Manganese Group of Mines,
(Joda West, Bamebari & Tiringpahar)
Tata Steel Ltd.
Dist. Keonjhar (Odisha)

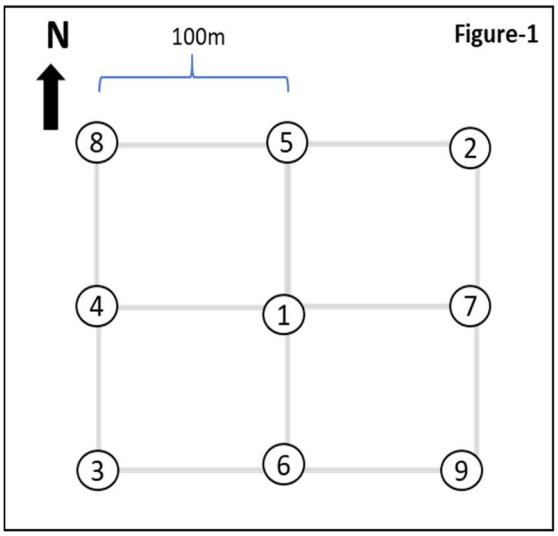
EXPLORATION -

Optimizing combination of exploratory Reverse Circulation and Core drilling for resource proving under detail exploration for manganese ore - A Tata Steel Perspective

Tata Steel Limited since long has been carrying out exploration and mining of manganese ore in the granted leaseholds around Joda, Khondbond, Malda, Joribar and Bamebari, located within the famous Bonai-Keonjhar iron-manganese belt of Odisha. Manganese ore in the area is mainly associated with shale, phyllites and cherts of banded iron formation (BIF). Iron ore deposits in this belt at many cases are exposed on surface as outcrops while majority of manganese mineralization is concealed within the shale, phyllites and occur as pods and pockets. Such mineralization characteristics of manganese ore offer challenge for exploration agencies and mining lease holders to plan and execute exploration, locate manganese ore bodies and then prove resource by delineating shape, size and grades of ore bodies.

Detail exploration (G1 level as per UNFC) for manganese deposits in this part of India require close spaced drilling with section spacing at 50m intervals while along the sections, boreholes are spaced at 50m or closer to that. The general approach is to drill first borehole at the most potential location where there are surface indications, prove subsurface mineralization and then spread-out to trace extension of the mineralized zone. This require huge expenditure and time in exploratory drilling and at many cases, return from a very detail exploration campaign with close spaced drilling proves to be negative. It is therefore, very much essential to develop concepts on mineralization pattern, litho-structural controls of manganese mineralization in the target area and then plan and execute site specific exploration proposal.

At Tata Steel Limited, potential manganese mineralized zones are identified based on detailed surface geological mapping, structural data analysis and interpretations, then by proving concepts with few test boreholes. After that in stages, detail exploratory drilling program is executed for delineating geometry and grades of manganese ore bodies. At Tata Steel, both reverse circulation (RC) and core drilling methods are used in combination. RC drilling is a fast method of subsurface data collection, allow quick data generation at lower costs, while core drilling allows to collect subsurface samples as solid cores, with precise data on depth, thickness of ore mineralization and provide samples which is devoid of any possible contamination. Core samples allow to carryout sample grading to identify relative proportion of high, medium, low grade ore and subgrade in the mineralized zone, thus provide valuable information in evaluating economics



(1) RC drilling plan

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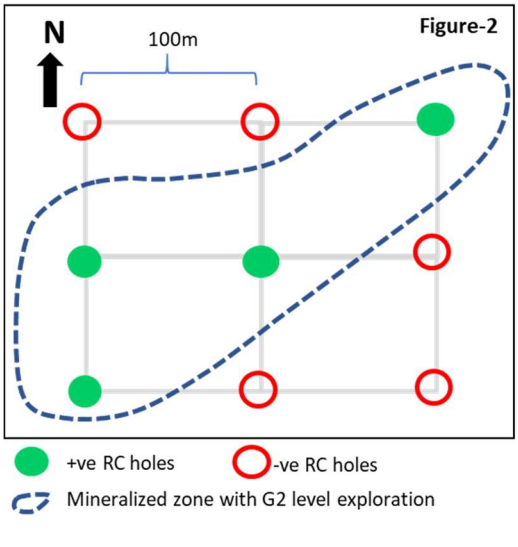
of any manganese ore deposit. Combination of RC and core drilling has proved to be helpful to acquire required subsurface information in establishing resource and grade of manganese ore with desired level of confidence.



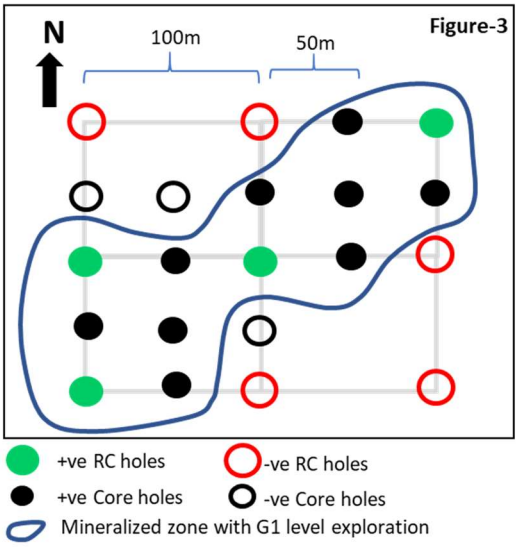
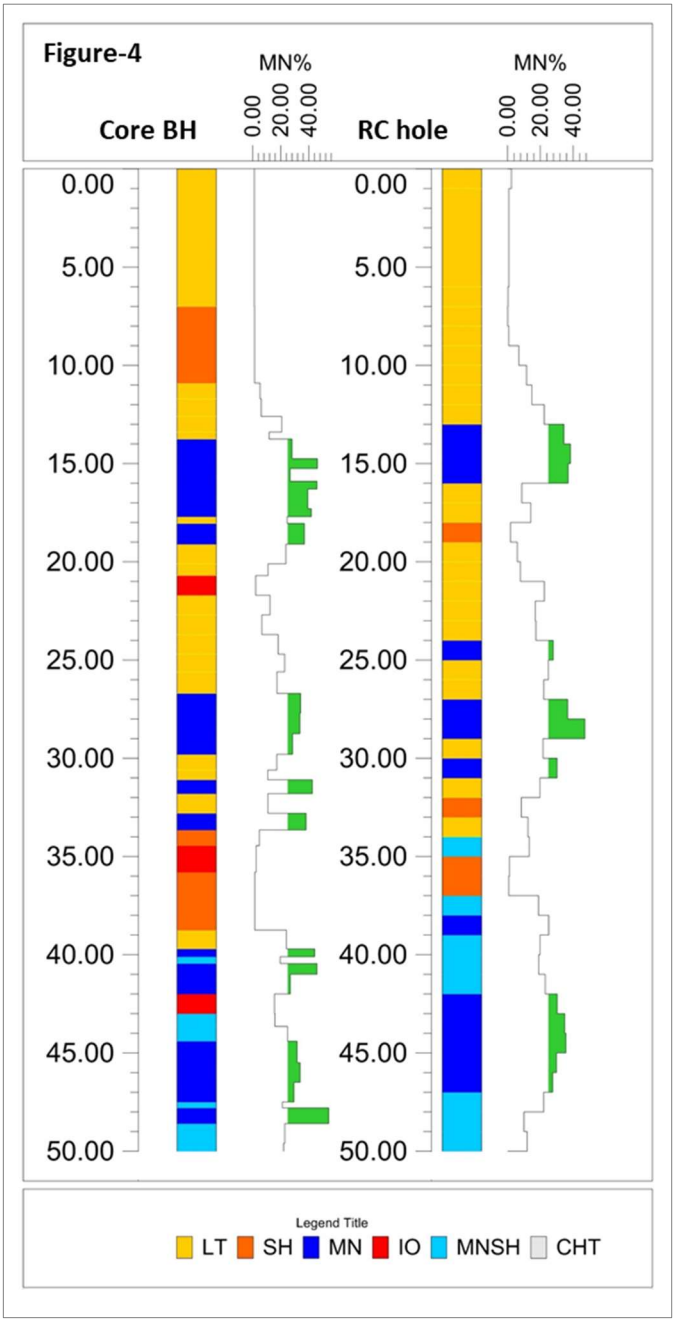


Figure-1 demonstrate borehole plan of G2 level exploration for manganese ore which is witnessed to occur as stratabound deposits of irregular habit. Initially, boreholes are planned at grid intersections spaced at 100m apart. Reverse circulation (RC) drilling is deployed in the order of most promising to least promising drill point based on developed concept on manganese ore mineralization in the area (demonstrated in Figure-1 as 1 to 9) and accordingly drilling is performed at each drill locations. During drilling, RC chip samples are collected at 1.0m intervals ensuring more than 80% mass recovery by weight. Detail logging of the chip samples are carried out at drill site and samples are reduced using riffler to collect representative samples for visual investigation and chemical analysis. Based on RC chip logging and chemical analysis results, on plan, boundary of mineralized zone is demarcated around the positive holes (Figure-2), having manganese ore mineralization (Mn >10%) for the explored block. In the next stage of detail exploration at G1 level, core drilling is performed within the mineralized zone at 50m hole spacing. Based on the observed mineralization in the core boreholes, the mineralized zone in the explored area is refined and finalized (Figure-3). It could be seen from Figure-2 that out of the 8 RC holed drilled, 4 holes turned to be positive with respect to manganese mineralization at 50% strike rate whereas, in Figure-3, 9 core boreholes were turned to be positive out of the 12 drilled boreholes at 75% strike rate.

This method of borehole planning and execution with initial RC holes in the mineralized area and then followed by core drilling allow to ensure higher strike-rate during core drilling. This strategy of exploration has helped Tata Steel Limited to optimize core drilling requirement, reduce exploration cost, while acquiring required subsurface information for precisely delineating manganese ore bodies during G2 and G1 level exploration. Applicability of RC drilling and hence gathered sub-surface data and chemical analysis information is also validated by means of drilling of twin boreholes, one RC and one Core borehole, located within 2m radius of each other. The comparative study indicates that both RC and core drilling is very much comparable for delineation of

lithology and manganese mineralization along the boreholes (Figure-4). Drilling and logging of RC chips for manganese ore exploration require trained eyes and considerable field exposure of exploration geologists which geologists of Tata Steel Limited has mastered over the years in order to delineate manganese mineralized zone with high confidence level.



TRAFFIC MANAGEMENT –

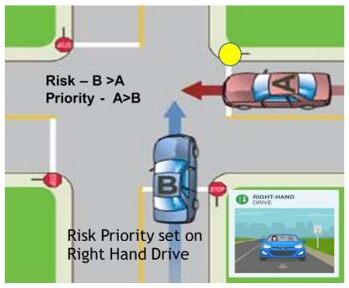
Smart Management In Land-vehicle Equipment (SMILE)

These systems utilize sensors, cameras, cellular routers and automation to monitor and automatically direct traffic and reduce congestion. The right technology solution can be scaled to any size and painlessly upgraded at any time. Simultaneously, these technology solutions prepare Smart Cities for coming technology evolutions, including Connected Vehicle and the full deployment of high band network connectivity.

Presently this system is being installed at Bamebari Iron & Mn. Mine. Subsequent to trial results and fixing of issues, the same will be deployed at Joda West & Tiringpahar Iron & Mn. Mine.

The present lay out is indicated in Figure – 5

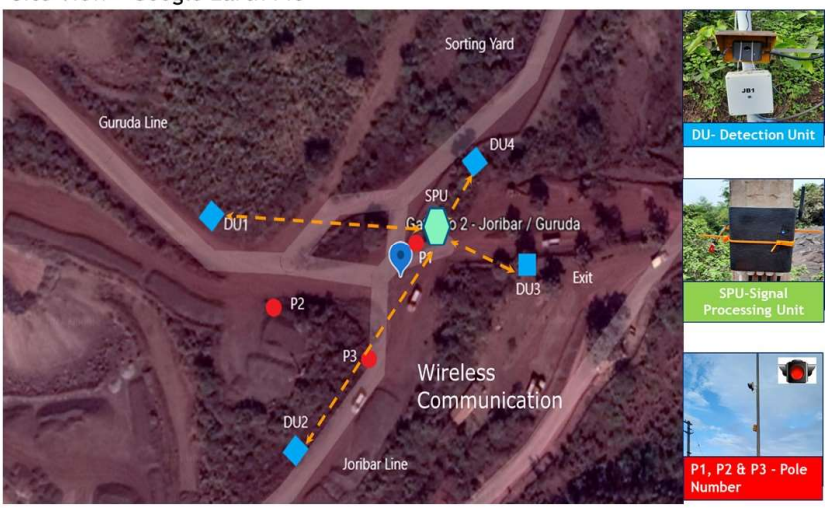
Line of Fire Concept



Risk Priority Path Customization

1. Man > Machine
2. Machine > Man
3. Loaded Dumper > Unloaded
4. LMV > HEMM
5. Line of Fire

Site View - Google Earth Pic



(Figure – 5)

Potential Benefits -

- Reduced Man Machine Interface during movement through the road.
- Priority based risk mitigation based upon customized path prioritization.
- Availability of data storage option for data analytics and further system improvement. (Like capturing of near misses, vehicle density during peak hours (time frame analysis)).
- Data extraction through mobile app – Under improvement.

SOIL AMENDMENT BEFORE PLANTATION-

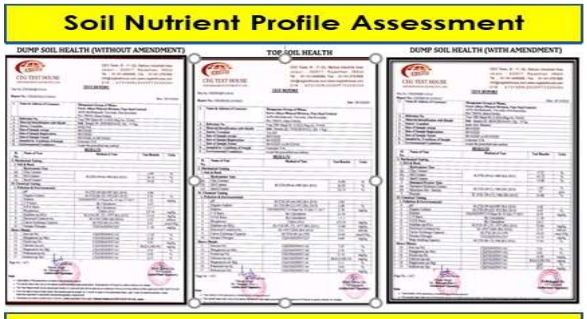
Objective- Soil amendments aims to improve soil quality in terms of its structure and biochemical function. To offset the adverse impact of mining over the soil quality, a number of soil amendments such as biochar, Panchagavy based solvents substrate, hydro mulches and compost have been used.

How We Do It- There are two basic types of soil amendments have been used to improve soil fertility and stabilize site conditions: Organic amendments: It is the composition of organic moieties derived from biomass such as dry leaves, rice husks, Panchagavya, tender coconut water, food waste, compost, wood chips, biochar, animal manure, geotextile, and sewage manure or STP sludge.

These substances are extremely rich in organic matter and macro- and microelements that increase the fertility of soils by ameliorating microclimatic conditions and may also provide substrates for microbial growth such as NCOF based Trichoderma bacterial inoculum.
Inorganic or mineral amendments: These amendments are generally contained minerals associated with soil fertility. Gypsum is commonly used to decrease soil pH by bonding high sodium salts and lime or limestone to decrease the soil pH.

To improve soil fertility in terms of primary nutrients (N,P,K) application of DAP, Nitrogenous fertilisers and Urea is practiced apart from application of Humic substrates and Neem Coated fertiliser cakes and Bone Meal for calcium enrichment.

Construction of Contour trenches to fill with dry leaves based mulches and creation of lock and Key arrangements for improving soil moisture are the core key activities that promotes faster soil remediation.



DEVELOPMENT OF CENTRALISED NURSERY -

APPROACH TOWARDS SUSTAINABILITY- To strengthen the biodiversity management plan and afforestation measures, establishment of a Nursey becomes inevitable to support the field projects aiming improvement in biodiversity.

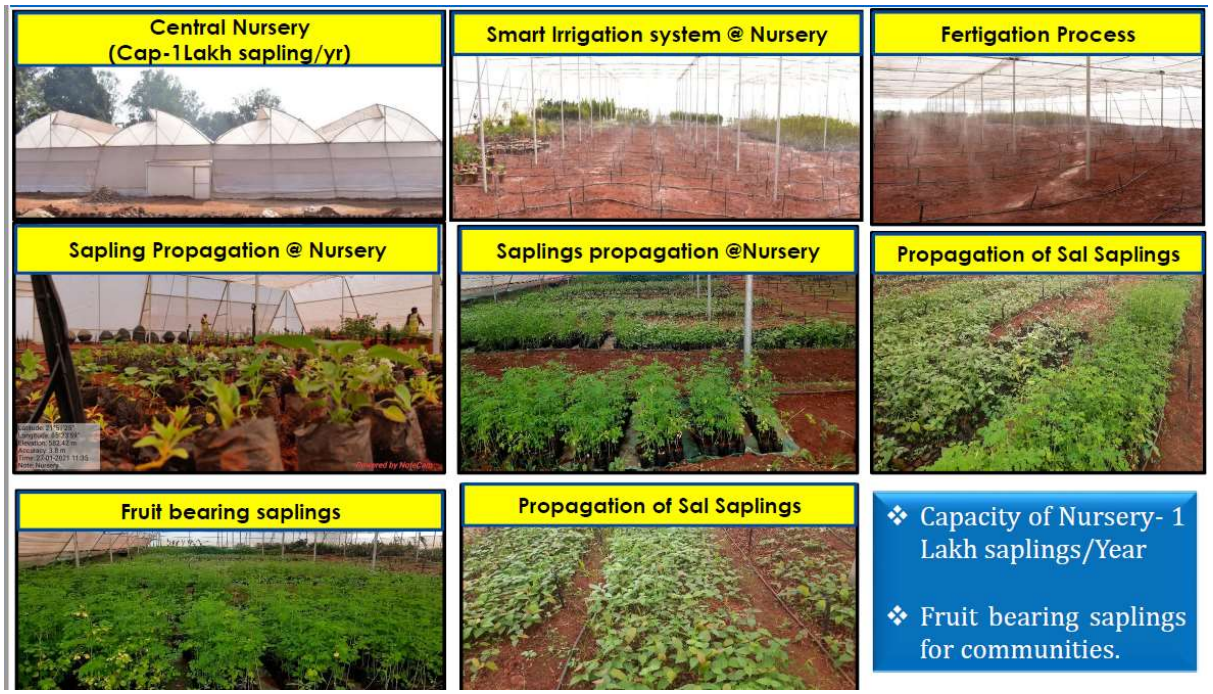
The company has established one such centralised Nursery at Bichhakundi Vegetable garden over 2000 sq-mtr area, fitted with all the smart irrigation features to take care of automatic irrigation requirement. This project is currently catering to needs of all the three leases under the Manganese Group of Mines.

Objective- The primary objective of the Nursery was to develop mine's capacity in terms of propagation of native varieties of forestry plants.
A naturally ventilated Poly- house over 2000sq-mtr area with a propagation capacity of 1Lakh saplings per year will cater the peripheral requirement in terms of supporting the local communities in developing agroforestry-based farming.

Advantages- Propagate around 1Lakhs saplings preferably from the local forestry varieties of 20-25 species as per their dominance in the controlled forest area. Quality of saplings and delivery in time is ensured at the site itself. This has prevented our dependency upon the external agencies where at times suitable species of our demand could not be made available.

Damages to the saplings during transportation due to exposure shock on account of climatic variation from the place of germination till our sites is also prevented. The project has a RoI value 2.5times the project cost over a span of 3 years.

Successful germination of saplings even native varieties (Sal Saplings) from the seeds collected in the nearby forest areas was also made possible because of the Nursery. Smart Irrigation features with 700Nos of Micro sprinklers: 700Nos and 410 nos of foggers
Suffice to the irrogation requirement and maintaining adequate moisture level within the poly house.



MIYAWAKI PLANTATION -

Principles Implemented

This Method of Plantation is inspired from the research work of Dr. Akira Miyawaki, a Japanese botanist who advocated the urgent need to restore the prevailing indigenous forest. Out of his research work based on temperate forests of Japan he realised that, in ecology, potential natural vegetation (PNV), also known as Kuchler potential vegetation, is the vegetation that would be expected given environmental constraints (climate, geomorphology, geology) without human intervention or a hazard event.

This principle of Potential Natural Vegetation (PNV) is widely used in modern conservation and renaturation projects to predict the most adapted species for a definite ecotype. Native species being considered having optimum ecological resilience for their native environment, and the best potential to enhance biodiversity. This principle of PNV when refined was termed as "Miyawaki method" to restore native forests from seeds of native trees on very degraded soils which were deforested and without humus

Process Adopted: Promotion of competition between plants, principle of natural selection, and plant associations is ensured maintaining a substratum preferably with mulch of rice straw or husks or other organic mulches and seeds collected from native forest areas and germinated at local nursery and plantation in random to semirandom spacing fashion.

How We Do It:

1. **Preparation of soil -** A blend of perforators, water retainers, organic and natural fertilizers, manure and microorganisms should be added to the existing soil. Perforator materials like biomass, rice husk, wheat husk, corn husk or chipped groundnut shells facilitate the plant roots to cultivate speedily. 3-4 Kgs of Rice Straw is spread over one sq-mtr.
2. **Soil Amendment**- Water retainers like coco peat or sugarcane stalk permit the soil to hold more moisture and water in comparison to the soil's natural water retention proportions. Organic fertilizers like manure or vermicompost nourish the soil. We adhere to addition of Organic solvent called as "Panchagavya" made out of five ingredients such as Cow Urine, Ghee, Jaggery, ripen banana, tender coconut water, etc.
3. **Collection of Seeds** from native forest – This is the most crucial step that ensure principles of natural selection based on Survival for Existence Theory. The local seeds collected is expected to have best adaptable ecological resilience. Seeds collected from the forest needs to be germinated at a local nursery.
4. **Method of Plantation** – The site is levelled well and dressed properly to ensure proper drainage around the soil layers. Plantation to be ensured by using selected young saplings (native varieties) of 15-24 inches height maintain a density of around 4-5 saplings per sq-mtr but with a semi random to random spacing fashion.
5. **Monitoring-** Tie the plants to support sticks with a jute string so that they do not crook and curve in the former months of plantation. Water the forest once a day and keep the forest devoid of weeds for the first 2 years. Do not use any chemicals like pesticides or inorganic fertilizers. Monitor the forest every 2 months to check the growth of all the plants and do not cut or prune the forest. Monitoring becomes appreciable if the saplings taken out for plantation are tagged properly with name of species and height of saplings, etc.

Effect of Miyawaki Method of Plantation-

Miyawaki Plot May 2020

Miyawaki Plot in December-2020

Miyawaki Plot in March'2021

Miyawaki Plot in Aug'2021

VETIVER PLANTATION -

Principles Implemented –

The Vetiver System (VS) is a system of soil and water conservation whose main component is the use of the vetiver plant in hedgerows. Vetiver grass, Chrysopogon zizanioides function aids in reducing damages from water flush in rainy season, increasing soil humidity in arid season, acting as nursing crop for forestation and soil and water conservation in economic crops plantation.

Chrysopogon zizanioides, is the main component to all Vetiver System bioengineering and conservation applications. It can be used in the tropics and semi-tropics, and areas that have a Mediterranean climate where there are hot summers, and winters are temperate.

How We Do It-

The Vetiver grass planting period and suitable styles should be considered for each problems target area. If the soil has been appropriately improved and humidity adjusted, the Vetiver grass will rapidly grow and become permanent compact fencing within short period of time.

The dense culms above the soil surface will aid in soil sediment and organic matters filtration which are washed away by inundation, results in decreasing the movement of those matters, when there are sediment and the degradation takes place, the soil above the Vetiver grass fence will increase in fertility.

Vetiver is planted as a hedgerow across a slope of overburden dumps and other such locations maximum soil erosion potential.

Its massive, finely structured root system can grow fast - in some applications, rooting depth can reach 10–12 ft (3–4 m) in the first year. This deep root system makes the vetiver plant drought-tolerant and difficult to dislodge by strong current.

Technique-

The basic technique of soil stabilization using vetiver consists of one or more hedgerows planted on the contour. Nursery plants or slips (clumps) of about 3 tillers each, are typically planted 4-6 inches (10 – 15 cm) apart on the contour to create, when mature, a barrier of stiff grass that acts as a buffer and spreader of down slope water flow, and a filter to sediment. The development of strong plants and a deep root system requires full sun. Partial shading stunts its growth, and significant shading can eliminate it in the long term by reducing its ability to compete with more shade-tolerant species.

Multiple hedgerows may be required for a secure slope stabilization, in which case the separation between rows depends on the slope, soil condition and composition, and the severity of the problem. Typical distances range between three and six feet. Some published guidelines recommend a distance between rows of about 5.7 ft. (1.7 m) for a 30° slope, and about 3 ft. (1 m) for a 45° slope.

Advantages of Vertiber System-

- Low maintenance cost with minimal space requirement.
- If suitable crop is selected then exhibit little or no competition with associated crop.
- Thick fibrous roots act as a very good soil binder and forms a dense vegetative barrier that slows and spreads rainfall runoff. Combined with a deep and strong root system, a wide range of pH tolerance (from about pH 3 to pH 11), a high tolerance to most heavy

metals, an ability to remove from soil and water large quantities of nitrates, phosphates and farm chemicals, the vetiver plant can be used for soil and water conservation, engineered construction site stabilization, pollution control (constructed wetlands), and other uses where soil and water come together.

- Hedges of vetiver do not channel runoff, as do engineered systems. They allow surface runoff to percolate slowly through the hedge. Because of this advantage the system does not necessarily require additional layouts of design for structure such as drainage waterways
- It can be used in the tropics and semi-tropics, and areas that have a Mediterranean climate where there are hot summers, and winters are temperate.
- It can be planted along an average contour and still functions well. This makes it possible to reach much wider areas and allows a great deal of latitude in where and how they wish to incorporate the hedgerow.
- The vetiver hedgerows can perform their function while occupying a narrow strip of less than 50cm width per hedgerow and with the hedgerow kept pruned down below the level of the crop. This allows the introduction of hedgerow systems into the field with the minimum possible change in current farming practices.
- The young leaves of the grass are palatable, and the hedges can be pruned at short intervals to provide cut-carry fodder. The fodder value of the young leaves falls between that of the Napier grass and fresh maize stove.

Effect of Vertiber System-
Slope Stabilization of OB Dump using Vertiber System

SOLAR PLANT FOR ENERGY SUSTAINABILITY-

Background- Solar power in India is a fast-developing industry as part of the renewable energy in India. The country's solar installed capacity was 44.3 GW as of 31 August 2021.

The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule. In 2015 the target was raised to 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022, targeting an investment of US$100 billion.

Our Project- A small solar park has been developed aiming reduction of the carbon foot print of our mining operation at a degraded land over 1 Acre area within the Eco-Restoration Park at Bichhakundi Vegetable Garden. The solar power plant established at the site is made of 430nos of modules with a potential of 130KW-h of power generation.

Since the date of commissioning, we have generated around 30000KW-h of electricity. The power plant is connected to the local grid of the state and the company realises benefits in terms of energy billing.

ECO-RESTORATION PROJECT -

Objective- To develop a facility showcasing integration of socio-economic projects at its mining sites which will offset the adverse foot print in long term. One such project is Eco-restoration project which is under progress at Joda West Iron & Mn. Mine.

Special Features of Eco-Restoration Park-

- An area of 3.89Ha within the mine lease area is being converted into an Eco restoration park accommodating a centralised nursery over 2000 sq-mtr, a Herbal Garden with 25-20 keystone medicinal species, a pisciculture over 2400sq-mtr area with harvesting volume of around 24000cu.m and a Water Treatment Plant with 400KLD capacity for providing safe drinking water to the local community.

Special Features:

- ❖ Solar Power Plant-130KW
- ❖ Water Treatment Plant-400KLD
- ❖ Pisciculture cum Rainwater Harvest Pond-24000cu.m
- ❖ Nursery-1Lakhs propagation capacity

******* End of Report*******