

PROCEEDING OF ONE DAY SPONSORED WORKSHOP

ON

“ Plantation Programmes in Industries & Allied Complexes ”

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RESPONSE OF PLANT SPECIES TO THE MINING SITES SITUATED
AT PALE AND SIRIGAO (GOA).

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OBJECTIVES :

1. Revegetation of the disturbed mining sites (Pale & Sirigao) with the involvement of student community.
2. Create an awareness in the student and non-student community (at Pale & Sirigao) about the ecological imbalance caused due to mining operations and suggest rectifying methods.
3. Protection and nurturing of threatened (endangered) plant species.

AREA OF WORK :

Location : Pale & Sirigao (Taluka: Bicholim, Goa).

DETAILS OF THE WORK :

A) Plan of work for the period under reference:

1. Survey of natural vegetation in and around Pale & Sirigao mines.
2. Physical and chemical analysis of the iron-ore rejects and tailings.
3. Selection of plant species on the basis of drought resistance and metal tolerance for the revegetation purpose.
4. Soil-ameliorations: Different combinations of iron-ore reject with natural soil and also with sea-weeds (Sargassum sp.). Ipomoea biloba as a pioneer species for stabilization of iron-ore waste. Enumeration of micro-organisms of different dumps and tailings. Selection of best non-symbiotic nitrogen fixing bacteria.
5. Raising seedlings in the nursery with different soil combinations or/and sea-weeds.
6. Transplanting and monitoring.
7. Multiplication of adaptive species - plants suitable

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for growing on nutrient deficient soil and metal tolerance.

8. Protection to the Threatened species in the nursery.

B) Methodology followed:

1. For survey of the vegetation:
 - a. Taxonomy by conventional methods.
 - b. Ecology by qualitative and quantitative methods.
2. Physical and chemical analysis of the iron-ore rejects and tailings:
 - a. By conventional procedures.
3. Nursery experiments:
 - a. With different soil combinations.
 - b. With sea-weeds.
 - c. With earthworms.
 - d. With micro-organisms.
4. Response studies in the nursery and in the field:
 - a. Selection, multiplication, transplantation and monitoring.

C) Achievements during the period:

1. Survey of natural vegetation in and around project site shows that it is a semi-deciduous and potentially evergreen forest. The most dominant tree forms are - Terminalia arjuna, Terminalia paniculata, Syzygium cumini, Alstonia scholaris, Sterculia urens, Mallotus albus, Garcinia indica, Strychnos nux-vomica. Among the shrubs the most dominant ones are Memecylon wightii, Calycopteris floribunda, Clerodendrum viscosum, Holarrhena antidysenterica, Ervatamia heyneana, Woodfordia fruticosa. Among the herbs, the most dominant ones are Naregamia alata, Chromolaena odorata, Hemidesmus indicus, Ichnocarpus frutescens, etc.
2. During the survey, the following threatened plant species have been located. Now most of these species are protected in the nursery. The species are: Angiopteris evecta, Gnetum ula, Drosera indica, Hippocratea indica, Rauvolfia serpentina, Rauvolfia tetraphylla, Acampe praemorsa, Aerides masculosum, Dendrobium ovatum, Habenaria marginata, Rhynchostylis

retusa, Nervilia aragoana.

3. In the first year (1987), sixty thousand seedlings, in the second year (1988), eighty thousand seedlings and in the third year (1989) one lakh, twelve thousand seedlings of different species were raised in the nursery for the plantation purpose. Out of this, thirty six thousand seedlings of different species were planted on the iron-ore rejects (dump) and on tailing site of Pale and Sirigao during monsoon in the year 1987; forty thousand seedlings in the year 1988 and eighty six thousand seedlings were planted in the year 1989. In addition to this, a large number of seedlings were supplied to other mining sites for plantation purpose.
4. Soil analysis of the reject and tailings clearly indicates that iron (Fe), Aluminium (Al_2O_3), Manganese (Mn), and silica contents were more compared to the garden soil.
5. Azotobacter chroococum was found to be the most effective for Cassia tora plant. Glomus fasciculatum is most effective for Leucaena leucocephala along with the native Rhizobium strain. Azotobacter chroococum and G. fasciculatum was helpful in nutrient cycling. Ipomoea biloba found to be most suitable plant for stabilizing dumps and tailings. This plant did not show any visual toxic symptoms. Chemical analysis of this plant showed accumulation of Fe and Mn. Proteins, Carbohydrates and chlorophylls were depressed. Ameliorating the iron-ore waste with 30% FYM greatly enhanced the plant growth. Incorporation of earthworms in the iron-ore mine reject improved physical characteristics of the soil (reject), availability of nutrients, plant growth and nodulation..
6. Plants such as Acacia auriculiformis, A. nilotica, Azadirachta indica, Parkia biglandulosa, Tamarindus

indica, Terminalia bellerica, Garcinia indica, Pithecell-obium dulce, Syzygium cumini, Agave americana, Pennisetum hohenackeri, Bauhinia purpurea, Alstonia scholaris are showing growth response among the planted species. These plants are high in their survival percentage even under stress conditions.

7. Plants such as Arundinella pygmaea, Manisuris goensis, Eragrostis uniolooides, Cynodon dactylon, Alysicarpus vaginalis, Crotalaria triquetra, Rungia pectinata appear to be toxic tolerant.
8. Seeds of drought resistant and metal tolerant plant species have been dispatched to Comalco, North Queensland, W. Australia and University of Negav, Beer Sheva, Israel, in exchange for seeds from their countries.

D) Results of academic importance:

1. One Sr. Research Fellow and one Research Assistant have submitted their thesis for the Degree of Ph.D. and M.Sc. (by research) respectively under the guidance of Dr. S.G.Torne. They will receive their degree from Goa University.
2. Graduate and under-graduate students are being trained in mineral nutrition (plants) and to show how plants grow under stress conditions.
3. In order to create awareness in the student community, two N.S.S. camps, each of ten days duration (4.11.86 to 14.11.86 and 17.10.88 to 26.10.88) were conducted. at Pale mines area.
4. Audio-visual film (1/2" VHS film) has been prepared showing the impact of mining on environment and the efforts made for its effective restoration. This film was shown to the students of different colleges.
5. Delegates from India and abroad who attended the

FIMI (Federation of Indian Mineral Industries, New Delhi) conference held at Goa (3rd & 4th, Feb.'89) visited the project site on 5th Feb.'89. Prominent delegates from abroad were Prof. A.D.Bradshaw, Prof. M.J.Chadwick, Mr. Larry Brown, Mr. Neil Kemp, Mr. Watkin and others. Participants of Project monitoring workshop for Western Ghats held at Goa University (16.2.89-18.2.89) visited the project site (Pale mines) on 18th Feb.'89.

6. Prof. M.J.Chadwick and Dr. Nick Michael of Beijer Institute, University of York, UK have proposed some collaborative research into land reclamation at an iron ore mine in Goa in association with our research fellows.
7. The students of graduate and under-graduate classes were taken to forest area in and around Pale mines on a number of Botanical excursions to foster better understanding in conservation of the threatened plant species.

E) Results of practical importance and action points for field application:

1. Disturbed natural productive soil was improved. Soil fertility was increased by giving fertilizer treatment to the seedlings on the dumps. Moreover, humas content and moisture retention capacity also increased.
2. Annuals like grass (Pennisetum sp., Arundinella sp. etc.), Sesbania, Atylosia, Leucaena, Gliricidia were grown on dumps and as a result soil erosion was checked to a great extent.
3. Open-cast mining results in serious soil-dust generation. Dust is carried far and wide places affecting the atmosphere and health of the local population. This was checked by planting trees in large numbers not only on the dumps and tailings but also all along the approach road to the

Chowgule's staff quarters and other residential areas.

4. Mining directly affects the natural vegetation since most of the mines are located in the forest. Destruction of forest land results in irregular exploitation of the vegetation. Structure of plant community (plant societies) is disturbed. Attempts were made to replace those plant societies along with the tree species in this vegetation programme. This was to bring uniformity in the vegetation pattern in the Western Ghats.
5. Matured seedlings raised in bigger bags (1meter x 50cms) get established quickly on the dumps and at tailings than the seedlings obtained from smaller bags (20cms x 15cms).
6. Seedlings raised from low nutrition deficiency soils are being tested on mining rejects in other countries such as Israel and Western Australia and their seedlings (mainly legumes) are being tested in our mining areas.
