

# Restoring Forest Cover on Degraded Land: Three Dimensional Plantations

It has been the custom in forestry to carry out plantations on level stretches of land. Plantations have generally been laid in a 2 dimensional grid to produce homogeneous cropping, particularly for the exploitation of timber. This follows the "normal" human inclination for order.

This conventional order may not always apply in all situations. For example, plantations in barren scrub or wasteland have a very different purpose, to reclaim land that is fast degrading, losing its forest cover, and finally its topsoil. Are conventional plantations the optimal way for reclaiming forest land? We propose an unconventional method for reviving forest cover that does not require the capital and labor intensive input needed for conventional plantations or social forestry. The method is based, instead, on exploiting specific natural conditions.

Our observations pertain to areas which initially are/or have become degraded to barren scrub. These areas have low precipitation. The ambient conditions being such that there is a relatively dry climate and a hot summer followed by some rain. The areas should have a geology of compacted deposits. This is often the case in some of the more degraded areas.

In such areas when minor quarrying or digging of the underground rock is carried out, crags and cracks are created in the subterranean rock. If the area has a nucleus of tree species to provide the seed and is then left to the elements, seeds become trapped in the crags and substantial natural regeneration can occur. In contrast, on flat stretches of land natural regeneration seldom occurs. Thus, only when the smooth surface is dug and "fractured" does regeneration occur. Hence the title, "Three Dimensional Plantations".

To understand this one must look at the interplay of climate, topography and geology.

The climate we are discussing is relatively dry with an annual rainfall of less than 500–600 mm. The conditions are semiarid with scattered brush. The semiarid conditions produce a hot low pressure ambient atmosphere, particularly in the summer months, leading to strong winds, which scatter and blow away the natural seed on the ground.

The topography of the land is emphasized in this brief observation. Normal flat or undulating landscape does not act as a barrier to the mobility of dust or seeds. However, when minor quarrying for stone is carried the surface becomes fractal and we get a craggy landscape. In these areas,



Natural growth of Sheesham (*Dalbergia sissoo*), around a rocky spur in a shallow quarry on the southern ridge of the Arravalli hills, Delhi, India. Photo: V. Soni.

particularly when there are loose semi-porous rock deposits, the seeds can easily lodge in the crags and are protected from winds.

One may expect that seed may safely reside in depressions or indentations. But Bernoulli's principle suggests that this is not the case. An indentation has the effect of widening the cross section for the surface flow of air. Since this flow can be assumed to be steady, this implies that velocities should be lower where the crosssection is wide. Bernoulli's principle indicates that the pressure must be larger at the indentations. Fluid moves from higher to lower pressure and will therefore lead to deposited seed being removed from the indentation.

The geology of the area is clearly important. In case the land has no rock like deposits like quartzite, sandstone and/or limestone, digging will simply produce indentations without crags. The seeds, in this situation, will often be too mobile, due to Bernoulli pressures, to lodge and germinate.

Usually, the hot dry summer is followed by some rain. The summer seed which has lodged in the crags or the crannies thus receives vital water. This water also collects in the crags. Germination can then follow.

An explicit example where forest cover has occurred naturally under the above conditions, is the Arravalli hills around Delhi. The Arravallis are one of the oldest and lowest mountain ranges in India and run from Mt. Abu in southwestern Rajasthan to Delhi. These are rather low hills layered with quartzite and covered by semiarid vegetation. The climate is dry with hot summers and an annual rainfall of less than 60 cm. In areas where minor quarrying has occurred and then suspended and where there has been a small

nucleus of species like sheesham (*Dalbergia sissoo*) and neem (*Azadirachta indica*), natural regeneration has occurred within a span of 5 years. In contrast, on the stretches that are naturally contoured no natural regeneration occurs, only a growth of keekar (*Prosopis*) and babul (*Acacia nelotica*) and rootstock. Extensive evidence of such regrowth is seen in the Arravalli areas that have been quarried and abandoned.

The area of wasteland in the developing world is increasing due to population pressure and rapid development. In India, 'wastelands' are now of the order of 30%. This exceeds the forest area, which is about 20%, and only half of this has good forest cover, the rest being degraded. Environmental sustainability depends on reclaiming this degraded land.

Degraded land or wasteland areas located on compacted deposits can be restored by shallow quarrying, i.e. by digging down to a depth of roughly 6 m with lateral ridges of the order of 3–5 m. Regeneration will occur automatically if there is a host nucleus of trees nearby. Otherwise, seeds could be simply distributed by the air at the beginning of the rainy season. At this time, water is available and collects in the crags and crannies where the seed germinates.

In cases where the local geology is less rocky and craggy, this scheme may not be effective and quarrying will have to be supported by a bed of gravel to provide the aquifer and an overlay of rock to provide the crags.

This proposal for wasteland reclamation suggests that quarrying is not always environmentally unsound. Once regeneration is established it still needs to be protected from cattle. Craggy landscapes are inhospitable, and hazardous for cattle, and even if some protection is still needed, this is a small price for the gains that can be achieved.

I thank my parents for creating my interest in forests. I thank members of the CPQLW for their fellowship, in particular Deshdeep Sahdev, Kuldip Nayyar, Prabeen Singh and Priya Sen.

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