DEVELOPMENT OF TREE PLANTATION THROUGH MIYAWAKI METHOD AT SABARMATI RIVERFRONT DEVELOPMENT CORPORATION LIMITED - A RESEARCH

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ABSTRACT
The current paper deals with the progressive and sustainable approaches of development of tree plantation through Miyawaki method at Sabarmati Riverfront Development CorporationLimited. Miyawaki forests are one approach that has recently received a lot of attention. The Miyawaki method of reforestation, named after Japanese botanist and plant ecologist Akira Miyawaki, is a method of ecological engineering that advocates the growth of forests even in small areas by first treating the top layer of soil and then planting the local species that can thrive on their own. Ahmedabad’s municipal corporation, which has Kobe, Japan as a sister city, is experimenting with this and hopes to develop such green spaces not only on land but also now on completely flowing Sabarmati River. ‘We chose this fast-growing urban forestry method, as it has reported 15% faster growth rate per year compared to the other reforestation methods,’ said Dr. Asif Memon, General Manager (Parks and Garden), and Sabarmati Riverfront Development, who is overseeing the reforestation initiatives. Moreover, for maintenance, all that a Miyawaki forest requires is good water supply and weeding for two years. Thereafter, it will be self-sustaining, need no external support. The current study gathers the strategic objectives for developing tree plantations using the Miyawaki method, as well as the benefits to nature and other ecosystems.

Keywords: Tree Plantation, Miyawaki Method, Sabarmati Riverfront Development Corporation Limited (SRFDCL), Ahmedabad.

INTRODUCTION
The removal of existing green cover in cities to make way for construction and other projects has been a major casualty of India’s rapid urbanization. With people demanding that a good quality of life include not only conserving, but also adding to the city’s green cover, Ahmedabad, like other cities, is experimenting with ways to create small green areas in an ever-expanding concrete urban landscape. Planting greater bushes enables to hold wholesome soils and humidity tiers within side the air across the world. It starts while timbers adjust the water cycle. Trees take in air and transpire it lower back into the atmosphere, successfully filtering and controlling the ranges of humidity anywhere they are. In the past 5-6 decades, many scientists have gained new insights in the theories and several practical actions of restoring and rebuilding natural ecosystems (Jordan et al., 1981; Falk et al., 2006; Clewell and Aronson 2007).

Restoration of ecological functions, expansion of individual habitats, and enhancement of biodiversity are all examples of natural restoration (State John and Madsen, 2004). Restoration can also be defined as “a deliberate activity that initiates or accelerates the recovery of an ecosystem in terms of its health, dignity, and sustainability” at the ecological level (Aronsonet al., 2002). Plant populations that have been degraded are notoriously
difficult, if not impossible, to rebuild (Van Diggelen and Marrs, 2003). Forest recovery is a long term process, and the results are often unsatisfactory, as shown by more than 200 years of reforestation practice. Plantations of various species are now possible, but the transition from a simple plantation to a forest population capable of evolving and sustaining itself according to natural successional patterns is still a rare occurrence (for Italy, cf. Bellarosa et al., 1996). The mere presence of vegetation regeneration, on the other hand, should be ignored. It is critical to regain natural vegetation using a mixture of different native species that adhere to the habitat's potential pattern, as well as to attempt to restore the region's entire unique ecosystem (Miyawaki, 1992)

We don't have the patience to wait several hundred years for forest restoration to be completed; because we live in a world where urbanization and industrialization are rapidly evolving, so developing an alternative reforestation technique can be beneficial in future (Miyawaki, 1999). The “native forests by native trees” method, which is based on vegetation-ecological theories, is a reliable forest restoration method (Miyawaki et al., 1993; Miyawaki 1993a, b, 1998b, 1996; Padilla and Pugnaire, 2006; Miyawaki and Golley 1993). Prof. Akira Miyawaki suggested it, and it was the first to be implemented in Japan. This strategy allows for the restoration of native green habitats, natural biocoenosis, multilayer forests as well as the quick formation of well-developed ecosystems, due to the simultaneous employment of intermediate and late successional species in plantations. Miyawaki is Japanese word and first introduced by Japanese botanists' call "AKIRA MIYAWAKI" Internationally renowned botanist working at the institute of environment science and technology of the YOKOHAMA NATIONAL UNIVERSITY (YNU) (Miyawaki 1975, 1981).

This method can be used to grow an urban forest. The plantation density has increased by 30 times, and the growth rate has increased by 10 times. And it becomes maintenance-free within a time interval of 3 years, which is the smallest forest. This method used to grow an urban forest, within a short span of 20 -30 years, while natural forests grow in 200 to 300 years. Using the Miyawaki method, diverse plant species are planted close together so that the plants only absorb sunlight from the top and develop upwards rather than sideways, resulting in a plantation that is 30 times denser, grows 10 times faster, and is maintenance free after three years. The minimum size of the forest should be 4 by 3 meters; it should receive sunlight for at least 8 hours each day.

This approach is slowly gaining attraction in India. It is an effective way to increase green cover, especially in congested areas such as barren land, parks and hospitals. In urban areas where land and space are limited, this approach is a viable choice. Mini forests using the Miyawaki method in backyards are not feasible in highly urbanized Indian cities such as Ahmedabad, Delhi, Mumbai, Chennai, and Bengaluru since these cities are heavily populated and very few people have backyards in their homes. Mini forests, on the other hand, can be grown on government or community property. Allowing for optimal land optimization can be extremely satisfying.

### MIYAWAKI INFORMATION OF THE SABARMATI RIVERFRONT

There is a total of seven Miyawakis on the riverfront in Ahmedabad, each with its own unique field, tree, place, and watering system. They are all well maintained. SRFDCL currently has approximately 33,000 sq m (8.1 acres) of land, on which 1,04,400 trees have been planted, which is a significant figure. Taking care of such a large number of plants is difficult. The table-1 shows all Miyavaki areas, addresses, no. of variety, location everything.

| No. | Addition Of miyawaki's | No. of trees | No. of variety | Area in sq. m. (ac.) | Date of plantation (appx.) | Tree per sq. m. (approx.) | Location | Location coordinates |
|-----|------------------------|--------------|----------------|---------------------|----------------------------|--------------------------|-----------|----------------------|
| 1   | Between Gandhi bridge to | 350 0        | 19             | 200 0 (0.4 9)       | 04/20 19                   | 2                        | https://maps.app.goo.gl/gjxZvuabBUuScdZ57 | 23°02’1 N   | 72°34’1 6.3°E        |

https://iabcd.org.in/
(TABLE NO-1 shows the number of Miyawakis, number of trees, varieties, area covered and locations)

Around 40 different indigenous tree species, including Drumstick, Mahuda, Jamun, Aamla, Mulberry, Kanjo, Kaju, Flame of the Forest, Sesam, Shami, Neem, Ramfal, Cordia species have been planted along with exotic varieties such as Cassia species, Peltophorum, Gulmohar, Spathodea, Largestonia, Saptaparni, Chinibadam, and Rain tree. The exotic species selected are ones that have been flourishing for a long time in Ahmedabad. Figure-1 below shows all the Miyawaki locations on the Sabarmati Riverfront. Figure-1 indicates the location of Miyawakis on the map.
DEVELOPMENT OF MIYAWAKI

STEP-1: DETERMINING THE TEXTURE OF SOIL AND QUALITY OF BIOMASS:
The land along the Sabarmati River was almost barren; it was very difficult to grow vegetation in all the coastal lands as it was bad that is why vegetation cannot grow there. That’s why one meter of soil from above was extracted with JCB which was not at all fertile soil. Sabarmati river front have total seven Miyawaki plantations and is shown in figure-1 at different locations.

![Removing unfertile soil](image)

![Land with productive soil](image)

(All Miyawakis were developed with the same process with soil preparation after removing unproductive soil and replacing it with the fertile soil to 70% soil and 30% rice husk, farm yard and coco peat. After preparation of this soil, fill it in the hole of one meter through JCB and then the space is ground levelled. Soil texture helps in estimating the water storing capacity, root perforation potential, water infiltration capacity, edibility and nutrient retention ability. Further, check the soil texture whether it is loamy, sandy or clayey.)

![Fill the Fertile Soil](image)

![Leveled Ground](image)

Additives in soil

**Perforator** substances aid in the improvement of perforation and the rapid development of roots. We can do this by using dry and spongy biomass found in nature. Wheat husk, rice husk, groundnut shells and corn husk can be used in grain mills and in animal food storage.
(Rice husk)

**Water retainer**: Comparing to the herbal water retention ability, water retainer helps soil maintain extra moisture and water. A stalk of dry sugarcane or coco peat can be used as natural materials. Another better way is to soak the cloth in water for at least few minutes before removing and squeezing it. This cloth can be used as a water retainer after the water oozes out on squeezing.

**Manure**: For nourishment, organic fertilizer is needed. Depending on the environment and availability, different products may be used, such as cow manure, goat manure, or vermi compost. Manure is a nutrient-releasing plant fertilizer that releases nutrients gradually.

(Trolley of coco peat)

Direct sunlight dries out the soil, making it difficult for young saplings to meet their requirements.
This is important especially during the first 6-8 months, when the flowers are still in the development phase. Mulch can be used to prevent water evaporation. Wheat straw, barley stalk, rice straw or corn stalk can also be used in this process.

**Step-2 Getting the Area Ready:**

**Site inspection:** To assess the project’s viability and scope, go to the site. Take photos of the site and confirm that fencing, preservation workers, and going for walks with water and sunshine are all accessible. Debris and weeds must be removed since they deplete the soil’s nutrients and obstruct the flow of materials and citizens. As a result, they must be cleaned manually or with the aid of a machine. Ensure that the weeds that have been pulled are properly eliminated from the site to avoid their re-occurrence.

![Manually Weed Cleaning](image1.png)

**Making strategy to build roads to designated areas:** First, remove weeds, large stones, and boulders. The course can be made up of any material, but tractors and trucks must be able to use it.

![Inside glimpse of Miyawaki](image2.png)

**Step-3 Choose the Right Tree Species for Plantation:**

Make a plant list of all native species that are more visible in the respective temperature and atmosphere of your area. Then further categorize them into deciduous, evergreen and perennial plants.
Before choosing a native tree, make a choice keeping in mind the atmosphere and weather of the place because the atmosphere and temperature of all the places are different, it will be difficult for the plants to survive, so we should try planting more plants. Make a record of all native organisms of your area. Determine the form (deciduous, evergreen or perennial), benefits, and top layer. Check the nursery for native species saplings, height (ideal height is 60 to 80 Cm) and age. This will account for 40-50 % of the forest’s tree diversity.

Small and big trees should be planted according to their perimeter as shown in the given figure-2, So that all the trees get enough sunlight and grow upwards in the direction of sunlight. Miyawaki also has a rule that growing trees in a bunch gives less sunlight to the lower side so that its stem remains thin but also increases in height so in a short time the small forest is ready.

**Step-4 Design the Forest:**
Create a 4 layered plantation where shrubs grow up to 6 feet from the first layer, small trees grow up to 25 feet from the second layer, large trees grow up to 40 feet from the third layer and canopy trees grow from the fourth layer. Arrange the dense plantation with native plants such that they grow into different layers. All the species of plants should be arranged in a staggered manner so as to avoid nearby plantation of same species.

**Step-5 Fence around for protection:**
Those grown trees are also needed to be protected. Because if there is no fence around, any pet (like cow, dog, bull and humans) will come inside. And if it gets inside, it will cause a lot of damage to the vegetation. The first few months require extra care as the trees are small. Therefore, it is necessary to fence around to pay more attention to all this.
Step 6 Tree plantation:

Materials to be mixed: Fertilizer, water retainer, and perforator should be mixed together without any clumps in the exact ratio that was calculated at the onset for each mound.

✓ Choosing trees for the plantation: Arrange plants on mound to create a perfect, multi-layered forest. In each square meter, try grouping plants that grow in different layers—shrub, sub tree, tree, and canopy. Avoid planting two trees of the same species next to each other, and avoid following a trend while planting the trees. Maintain a 60-centimeter gap between two saplings. The aim is to create a dense plantation of native tree species in a random pattern.

✓ Plantation: To plant the tree, use a trowel to dig a small pit on the ground, discard the root bag from the plant, and carefully position the plant in the pit. Outside, the soil is leveled gently around the plant stem such that it is not pressed or completely packed.

Step 7 Supporting the plants with the help of sticks:

Saplings require support during their first few months to avoid drooping or bending. Insert sticks into the soil near the plant’s roots without destroying them. Use 1 m bamboo sticks for plants shorter than 1 m. For taller plants, slightly thick 2-2.5 m long bamboo sticks are used. Use thin jute cords, tie the sticks to the plant stems. At least one alternative plant may need support sticks.
Step-8 Watering plan:
The layout of water pipeline system can be constructed by an architect depending on the area's daily water requirement, with bore wells, overhead water tanks, and electric motor pumping directly from the river. There are seven Miyawaki among which one Miyawaki is supplied with water directly from the river by a single electric motor and one have bore-well so water is sprinkled with the help of sprinkler. In the other five Miyawaki, water is given from the water tanker two to three times in a week.

Step-9 Maintaining and supervising the plantation
✓ The forest should be given water at least one or two day in the first year.
✓ There should be no weeds for the first one year.
✓ Pesticides and inorganic fertilizer should not be used in first few months of plantation.
✓ Monitor the forest after every one month to observe the growth of all the plants.
✓ Not to cut or prune the forest.
RESULT

During the study, a total of 50 plants belonging to 24 families, 38 genera were documented from the study area (Table 2). Plantation from Miyawaki method grows very well. The tree can reach a height of 2 to 3 meters in around three years and after 3 years, the sunlight in the lower part also stops coming in. The photo below shows the length of the trees that grow in two years.

![Final view of Miyavaki after following all the steps](https://iabcd.org.in/)

| NO. | LOCAL NAME | SCIENTIFIC NAME | FAMILY | HABIT | HOW TO GROW       |
|-----|------------|-----------------|--------|-------|------------------|
| 1   | Aambali    | Tamarindus indica | Fabaceae | Tree  | Seed             |
| 2   | Sonmohar   | Peltophorumpterocarpum | Fabaceae | Tree  | Seed             |
| 3   | Kher       | Senegalia catechu | Legumes | Medium Tree | Seed or cutting |
| 4   | Saragvo    | Moringa oleifera | Moringaceae | Tree | seed or cuttings |
| 5   | Kanji      | Holoptela integrifolia | Ulmaceae | Tree  | Seed or stem cutting |
| 6   | Kanjo      | Pongamia pinnata | Legumes | Tree  | Seed             |
| 7   | Shirish    | Albizia lebbeck | Legumes | Tree  | Seed             |
| 8   | Jamfal     | Psidium guajava | Myrtaceae | Tree  | seed, air layering, grafting, cuttings or T.S culture |
| No. | Common Name     | Scientific Name               | Family     | Type       |
|-----|----------------|-------------------------------|------------|------------|
| 9   | Paras pipal    | Thespesia populnea            | Malvaceae  | Tree, seed, root cuttings or air-layering |
| 10  | Rain tree      | Samanea saman                 | Leguminosae| Tree, seed, stem and root cutting         |
| 11  | Gulmohar       | Delonix regia                 | Fabaceae   | Seed       |
| 12  | Khakhra        | Buteamonomosperma             | Fabaceae   | Seed       |
| 13  | Setur          | Morus alba L                  | Moraceae   | Seed, seed, mmediu m-sized, or cuttings, or gratings |
| 14  | Spataparni     | Alstoniascholaris             | Dogbanes   | Seed       |
| 15  | Kachnar        | Bauhinia Variegata            | Legumes    | Seed or cutting |
| 16  | Jambu          | Syzygiumsamarangense          | Myrtaceae  | Tree, Cutting |
| 17  | Pink poui      | Tabebuia rosea                | Bignoniaceae| Tree, Seed |
| 18  | Mahudo         | Madhuca longifolia            | Sapotaceae | Tree, Seed |
| 19  | Gondi          | Cordia sinensis               | Ctendenactyliae | Tree, Seed |
| 20  | Baka Limbdo    | Melia azedarach               | Meliaceae  | Tree, Seed |
| 21  | Neem           | Azadiracta indica             | Meliaceae  | Seed, root shoot & cutting |
| 22  | Mango          | Mangifera Indica              | Anacardiaceae| Tree, Seed |
| 23  | Gundo          | Cordia dichotoma              | Boraginaceae| Tree, Seed |
| 24  | Kailashpati    | Couroupitaguaianensis        | Lecythidaceae| Tree, Seed |
| 25  | Aritha         | Sapindus Mukorossi            | Sapindae   | Deciduous Tree, Seed |
| 26  | Arduso         | Ailanthus excelsRoxb          | Simaroubaceae| Tree, Seed |
| 27  | Badam          | Terminalia catappa            | Rosaceae   | Tree, Seed |
| 28  | Tilak tulsi    | Ocimumtenuiflorum             | Lamiaeae   | Shrub, Seed |
| 29  | Kadi Mendi     | Lawsonianaermis               | Lythraceae | Tree, Seed |
| 30  | Sharu          | Casuarina equisetifolia       | Casuarinaceae| Tree, Seed |
| 31  | Piplo          | Ficus religiosa               | Moraceae   | Tree, Seed |
| 32  | Borsalli       | Mimosopselengi                | Sapotaceae | Tree, Seed |
| 33  | Jambu          | Syzygiumsamarangense          | Myrtaceae  | Tree, Cutting |
| 34  | Sisam          | Dalbergia sissoo              | Fabaceae   | Tree, Root Suckers, Seed |
| 35  | Nilgiri        | Eucalyptus                    | Myrtaceae  | Tree, Seed |
| 36  | Mahogany       | Swietenia mahagoni            | Meliaceae  | Tree, Seed |
| 37  | Baval          | Vachellianiliotica            | Fabaceae   | Tree, Seed |
| 38  | Paras Jambu    | Syzygiumsamarangense          | Myrtaceae  | Tree, Cuttings And Layered |
| 39  | Vad            | Ficus Benghalensis            | Moraceae   | Large tree, Seed |
| 40  | Pilkhan        | Ficus Virens                  | Moraceae   | Large tree, Seed |
| 41  | Sevan          | Gmelina Arborea               | Lamiaceae  | Tree, Seed |

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CONCLUSION

Miyawaki is a good way to plant trees. This allows a lot of trees to be grown in less space with less hard work, after two to three years the maintenance is done at zero. This method can be used to grow a large number of trees which has brought many benefits to humans and the environment. Trees reduce noise in cities, prevent temperatures from rising, purify the air and a good place to live and eat for small animals and birds. It is suggested that Miyawaki should be in all the big cities where there is less land to plant trees and more pollution in states like Delhi, Noida, Kanpur, Gurugram etc. In such cities, more trees can be grown in less land just like in Miyawaki method. However, having such a small forest near the city is a matter of pride and destiny for people of that city.

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