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Tree Transplantation - A Great Initiative for A Greener Development

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Abstract

Tree transplantation is becoming an increasingly important tool in conservation, helping to reduce environmental damage caused by deforestation and urban expansion. The process involves key biological, mechanical, and logistical steps, including planning, root preparation, safe transport and post-care management till successful establishment. When executed properly, tree transplantation can save valuable time, preserve biodiversity, enhance urban green spaces and deliver immediate environmental benefits such as carbon sequestration and temperature regulation. However, the practice also presents challenges, including high costs, technical complexity, and variable success rates depending on tree species and site conditions. Real-world examples demonstrate that successful transplantation is achievable with appropriate planning, specialized tools and coordinated efforts across disciplines. Emphasizing the importance of standardized guidelines and stronger policy support, tree transplantation can become a valuable component of sustainable urban development strategies.

1. Introduction

Forest trees play a crucial role in supporting both the environment and human existence. They generate oxygen, absorb carbon dioxide and contribute to climate stability by influencing rainfall and lowering temperatures. The roots of trees help prevent soil erosion and aid in purifying and conserving freshwater, making them essential to the water cycle. Additionally, forests support rich biodiversity, offering habitat and nourishment to countless species of plants and animals. While cutting down trees is needed to provide wood for construction, paper and various other uses, it can also have serious negative effects on ecosystems and the environment. When logging and similar activities are done on a large scale, they

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Tree Transplantation - A Great Initiative for A Greener Development

can cause deforestation turning once-forested land into areas with little to no vegetation. Since trees produce enormous amount of oxygen and absorb greenhouse gases, removing trees may contribute to global warming. Additionally, tree loss can destroy the natural habitats of many animal species, disrupting entire ecosystems and threatening biodiversity. Mature trees also play a significant role in mitigating urban heat islands by reducing local temperatures by up to 5°C through shade and evapotranspiration (Pataki et al., 2021), and they improve air quality by filtering pollutants and sequestering carbon dioxide, with larger trees offering more substantial benefits due to their extensive canopies and biomass (Nowak and Crane, 2002). Economically, they provide essential services such as stormwater management, contributing approximately \$3 billion annually in the U.S. alone (Anonymous, 2023). Therefore, to minimize the damaging effects of tree cutting or deforestation, one of the most effective solutions identified is “tree transplantation or tree translocation.

An old technique called tree transplanting has been used to preserve some trees that are in danger of being cut down, removed, or damaged because for a number of reasons. Trees that are endangered and regarded significant because of their species type, rarity of occurrence, endangered status, size, age, location, religious significance, medicinal value, emotional worth, aesthetic value, etc., may be considered for transplantation. It cannot be carried out on a wide scale. This method is site-specific and can be used on a local scale.

2. Scientific Approach to Tree Transplantation

The sequential steps involved in tree translocation starting from initial assessment and planning, followed by site preparation, root pruning, excavation, lifting and transportation and concluding with transplantation and post-care at the receptor site are depicted in Figure 1, which illustrates the process through a detailed flowchart.

2.1. Season of transplanting

The best months for transplanting of big trees are November and December. Since it is impractical to maintain recently transplanted large trees stable during the rainy season *viz.*, from June-September and it is not advised to do this work during that time. Trees that are moved during the growing season, when shoot growth is at its fastest, are typically ineffective and eventually die.

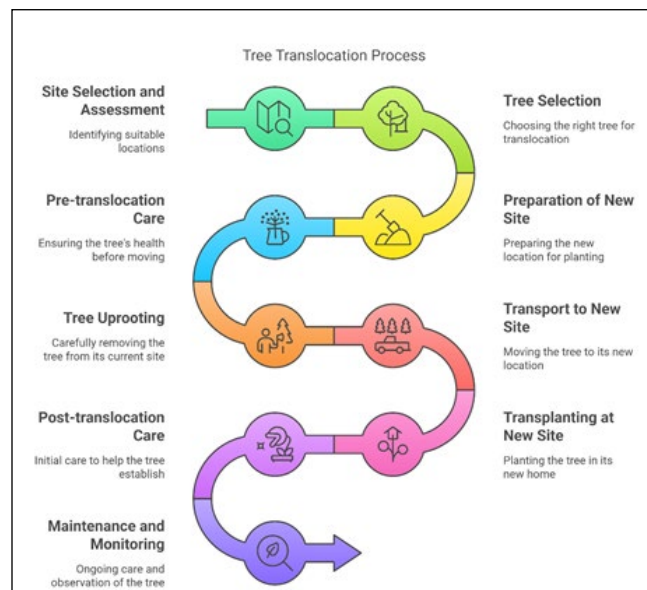


Figure 1: Steps involved in tree translocation

2.2. Treatment to the tree - before translocation

A tree should only be taken into consideration if it is good and promising. One can use standard tools like a larger tree spade or a nursery spade. At least five to seven days before the tree is actually removed, the pre-treatment should be started. A medium bucket JCB must be used to dig a trench one meter deep around the tree trunk, 1.5 to 2.0 meters away, and watering has to be limited to the trench. Depending on local convenience, the shape might be either spherical or rectangular. This will prepare the roots for mild exposure and displacement and aid in softening the soil. When transplanting larger trees, it's important to lift them with sufficiently large root balls to include as many roots as possible (Figure 2), which helps promote quicker re-growth and faster establishment. Using root growth enhancers can also support recovery. If any roots are exposed or damaged during the process, antibacterial or antifungal sprays or solutions can be applied to prevent infection. Depending on the tree species and site conditions, crown or root pruning may be carried out. However, it's essential to ensure minimum harm to the tree.

2.3. Pruning

While transplanting, any stems that are diseased, damaged, or infested with insects should be properly removed or trimmed. In some cases, root pruning is necessary prior to transplantation. Further pruning might also be needed to adjust the leaf area in proportion to the

Tree Transplantation - A Great Initiative for A Greener Development

reduced root system, ensuring better balance and survival of the tree. Before transplantation, the leaves should be trimmed. Trees should only be lifted and securely packed for relocation once new leaves begin to appear. After root cutting, the emergence of fresh root growth must be confirmed. Transplantation should proceed only after this new growth is observed, ensuring that the roots remain healthy and free from rot during the entire process.



Figure 2: Treatment to the tree (root balls) - before translocation; (Source: Menon, 2017)

2.4. Treatments in transplanting site (Receptor site)

The new planting site should be chosen to closely match or replicate the conditions of the original location. Additionally, preparations and necessary treatments at the receptor site should begin at least 5 to 7 days before the actual transplantation takes place. The depth and firmness of the root ball decide a planting pit's size. In general terms, the planting pit width should be at least 1.5 times the root ball's diameter in accordance with international standards. To support healthy root development, the transplanted tree should be placed in a well-treated, nutrient-rich, and disease-free soil pit that provides at least two feet of extra space around the root ball. To ensure efficient water percolation, planting pits should have drainage and it should be watered every day. It may

be filled with slurry or solutions containing antifungal, antibacterial, anti-termite, or dung. After three days, the planting pit should be filled up to 1.0 meter from the bottom using a mix of high-quality organic manure, vermicompost or farmyard manure (FYM), along with either mother soil or good quality local soil, which helps create a familiar and supportive root environment. Regular watering should be continued until the day of transplantation, ensuring the soil stays moist but well-drained to avoid waterlogging. The receptor site should be treated with specific antifungal, antibacterial, and anti-termite solutions (Table 1), along with root hormones and organic amendments like vermicompost, to create a disease-free and nutrient-rich environment conducive to healthy tree establishment.

Table 1: Treatment at the receptor/transplanting site

Treatment Type	Chemical Used	Application Rate	Quantity per tree (Litres)
Anti-termite	Chlorpyrifos 20% EC	4 ml per 3 litres of water follow at all places	8
Antibacterial	Bactinash 200	17 g per 3 litres of water	2
Antifungal	Carbendazim (Bavis-tin)	2 g per 3 litres of water	15
Root hormone	Indole-3-butyric acid (IBA)	20 ppm solution	20
Organic amendment	Vermicompost	15–25 kg per planting pit	--

(Source: Kshirsagar et al., 2018)

2.5. Tree lifting for transplanting

The tree should be sufficiently cushioned at the trunk with gunny sacks on the day of transplantation so that the crane can hold and raise it from the top. To allow the tree to lodge or hang onto the long vehicle, it should also be tied at the trunk with ropes of a suitable length. To lift the ball of earth with a large quantity of unbroken roots, the soil must be further loosened with a JCB. Wet gunny bags should be used right away to cover the roots and the soil ball once the tree has been removed from the ground.

2.6. Tree transportation

To maintain a firm grip and posture while traveling, the tree should be fastened to the vehicle at appropriate points after it has been loaded. To protect the root ball

Tree Transplantation - A Great Initiative for A Greener Development

and soil from sun exposure and drying out, they should be kept continuously covered with damp gunny bags and regularly watered to maintain moisture. To allow for smooth movement, the tree branches can be tied without breaking. The vehicle should travel at a speed that doesn't hurt the tree in any way.

2.7. *Temporary nursery for uplifted tree recovery*

In certain situations, when the new planting site is located far from the original site, when tree species have weak root systems, or during harsh weather conditions like droughts or heavy rains, trees are temporarily placed in a transit nursery. This allows them time to recover. During this period, they must receive proper irrigation and nutrients to promote healthy root development and stability. Once the trees are ready, they can be relocated to their final site.

2.8. *Tree transplanting*

The tree should be positioned upright in the planting pit, avoiding any tilting, and ideally aligned in the same direction as it was at the original site. Before completing the backfilling process, any gunny bags, cloths, or support materials used to wrap the root ball should be removed from the hole. If any branches were damaged during transportation, they should be carefully pruned. Once the tree is placed in the pit, it should occupy about one meter in depth, leaving another meter of space above the base of the trunk (collar). The pit should then be filled with a combination of mother soil and stored high-quality soil, reaching approximately one meter above ground level (Figure 3). Watering should continue until the soil is well compacted. This setup ensures that the tree is surrounded by one meter of mother soil below the roots, one meter of soil above the roots, and an additional one meter of good soil above ground level-providing proper support,

balance and stability for the transplanted tree.

2.9. *Post care management*

Proper post-transplant care is essential to ensure the survival, successful establishment, and long-term health of newly transplanted trees and shrubs. This phase involves several coordinated practices aimed at reducing transplant shock, promoting root establishment, and enhancing stress tolerance. Ideally, post-care maintenance should continue for at least 3 to 5 years or until the plant is fully established. The following practices should be done after tree transplanting for better establishment.

i. *Watering*

- Adequate and timely watering is critical for the establishment of transplanted trees
- Apply 20-25 litres of water once a week directly to the root ball.
- The irrigation frequency should be adjusted based on soil texture and prevailing weather conditions.
- Check soil moisture at a depth of 4–8 inches to determine the need for irrigation.
- During periods of intense heat or drought, foliar water sprays may provide temporary relief.
- Avoid waterlogging, as excessive moisture can cause root rot and reduce oxygen availability to the roots.
- The application of fertilizers and nutritional supplements may support faster establishment (Appleton and French, 1995).

ii. *Mulching*

- Mulching offers multiple benefits that support soil health and plant establishment
- Apply a 2–3 inch layer of organic mulch in a circular ring around the plant, ideally covering a 6-foot diameter.
- Keep mulch at least 4 inches away from the trunk to prevent rot and pest infestation.
- Mulch conserves soil moisture, regulates temperature extremes, adds organic matter, and suppresses weed growth.

iii. *Soil enrichment and nutrient management*

Effective nutrient management is crucial for the successful establishment and growth of transplanted trees. In many cases, fertilizer application is unnecessary unless a specific nutrient deficiency is confirmed. During the initial establishment period, nutrients released gradually through the decomposition of mulch and organic matter



Figure 3: Tree transplanting at receptor site and well-established tree after tree transplanting; (Source: Menon, 2017)

Tree Transplantation - A Great Initiative for A Greener Development

incorporated into the soil are often sufficient to support healthy development. It is important not to mix fertilizers or manure directly with the backfill soil, as this can cause root damage. If fertilization is deemed necessary within the first few years, a fully soluble, balanced fertilizer should be applied to ensure safe and effective nutrient delivery.

Additional guidelines for fertilization include:

- Tailor nutrient application to the tree's developmental stage to maximize effectiveness.
- Avoid nitrogen application in late summer, unless deficiency symptoms are evident, to prevent late-season growth that is vulnerable to winter injury.
- Apply phosphorus (P) and potassium (K) in the fall to encourage strong root development and improve the tree's ability to withstand winter conditions.
- The use of root growth stimulants can further support early establishment and enhance tree vigor (Harris and Bassuk, 1993).
- By following these best practices, soil enrichment and fertilization efforts can significantly improve transplant success and long-term tree health.

iv. Pruning

- Minimal pruning is recommended at the time of transplanting
- Most nursery stock is already pruned to remove structural defects such as co-dominant leaders, crossing, or poorly oriented branches.
- Additional pruning immediately before or after transplanting is generally unnecessary unless to remove damaged limbs.

v. Staking

- Tree stability should be evaluated before deciding to stake
- Generally, staking is not recommended, as free movement of the crown encourages stronger trunk development.
- If the tree is unstable due to wind or poor root anchorage, use soft, wide ties such as nylon webbing or padded straps to secure it to stakes.

3. Benefits of Tree Transplantation

Tree transplantation offers numerous ecological, social, and economic advantages. These include reducing the urban heat island effect, conserving mature trees,

enhancing biodiversity, promoting environmental sustainability and fostering community involvement (Figure 4).

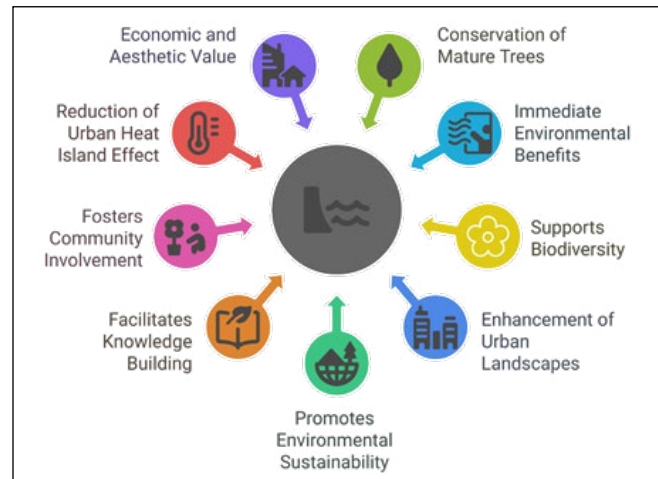


Figure 4: Benefits of tree transplantation

4. Constraints of Large Tree Transplantation

Transplanting trees presents a range of constraints that must be carefully addressed to ensure success. Mechanically, the process involves significant challenges in digging, lifting, and transporting trees without causing damage, requiring specialized machinery and engineering solutions tailored to the size and weight of the tree. Additionally, transportation of large trees requires coordination with regulatory authorities to secure permits and ensure clearance of overhead utility lines, such as power cables and telephone wires. Physiologically, large trees face issues such as reduced root regeneration capacity, sensitivity to the timing of transplantation, and varying responses depending on the tree's life cycle stage, all of which influence the likelihood of successful establishment (Kozlowski and Davies, 1975). Proper water balance is critical for the survival of transplanted trees, as improper irrigation can lead to water stress or root decay, with Kozlowski and Davies (1975) emphasizing the importance of managing water balance for transplant success.

Additionally, larger trees generally have higher evapotranspiration rates, which require careful irrigation management, as demonstrated by Devitt et al. (1995), who noted that plant size is crucial in measuring evapotranspiration in arid region trees. Moreover, large trees tend to experience longer transplant shock

Tree Transplantation - A Great Initiative for A Greener Development

compared to smaller trees, leading to slower recovery and increased vulnerability to environmental stress, as noted by Lauderdale et al. (1995). The complexities of large tree transplantation are further compounded by the limited understanding of the biological and environmental factors that influence success, especially for large specimens (Newman, 1975). Furthermore, a successful transplantation process requires collaboration among various disciplines, including agricultural and civil engineering, urban forestry, horticulture, plant pathology, entomology, and agricultural economics, to assess feasibility and cost-effectiveness. Finally, as the industry shifts toward producing large trees for transplantation, research into nursery production practices becomes crucial for improving success rates and ensuring long-term tree health.

5. Success Stories for Tree Transplantation in India

In 2017, the National Highways Authority of India (NHAI) undertook a tree transplantation initiative as part of the infrastructure project for constructing a flyover at the NH-16 and NH-65 junction at Benz Circle in Vijayawada, Andhra Pradesh (A.P.). This effort was carried out in collaboration with the A.P. Greening and Beautification Corporation, based in Vijayawada. The state reported successful outcomes in a few projects, with transplanted trees surviving for up to five years. The transplantation cost was approximately ₹ 13,000 per tree, resulting in a total expenditure of ₹ 35,36,000 for relocating 272 trees. Every tree that has survived is growing a lot of branches and leaves.

In 2017–18, VE Commercial Vehicle Ltd. carried out a tree transplantation project at Gorewada Zoo in Nagpur, Maharashtra. Trees with trunk diameters ranging from 20 to 45 cm and a maximum age of 30 years were relocated within a distance of 1 to 3 km. The cost of transplanting each tree was around ₹ 6,000, with a total of ₹ 28,74,000 spent on the relocation of 479 trees.

In 2017, several tree species including *Terminalia arjuna* (arjun), *Ficus virens* (pilkhan), *Dalbergia sissoo* (shisham), *Albizzia lebbek* (sirir), *Populus deltoides* (poplar), Kokat, *Syzygium cumini* (jamun), *Aegle marmelos* (bael), and *Tectona grandis* (teak) were uprooted and replanted at the Indian Institute of Management (IIM) in Kashipur, Uttarakhand, within the SIDCUL area. The transplanted trees had trunk diameters ranging from 0 to 90 cm. The

transplantation was carried out manually, at a cost of ₹ 23,500 per tree, with a total of ₹ 30,08,000 spent to relocate 128 trees. The state reported a 100% survival rate for all 11 species after three years of transplantation.

Since 2017–18, the Research Wing of the State Forest Department, Tamil Nadu has undertaken tree translocation efforts along NH-45 (Perungalathur–Vandalur–Irumbuliyur Highway) and the Walajabad–Sunguvarchatram–Kelecheri Road. Out of the 17 species that were relocated, eight species including *Millettia pinnata*, *Lannea coromandelica*, *Morinda tinctoria*, *Peltophorum pterocarpum*, *Phoenix*, *Ficus religiosa*, *Albizzia lebbek*, and *Spathodea campanulata* achieved a 100% survival rate.

The Forest Ecology and Climate Change Division of the Arid Forest Research Institute in Jodhpur, Rajasthan conducted an experimental study in 2012 to assess the effects of transplanting larger trees on their survival, growth, and cost-effectiveness. The research aimed to replace dead trees during a thinning operation in an agroforestry plantation of *Hardwickia binata* and *Colophospermum mopane*, originally established in 1994. According to a 2015 report, the survival rate was 100% for *Hardwickia binata* and 66% for *Colophospermum mopane*. The three-year study concluded that careful handling during digging, transportation, and planting—especially ensuring the root ball is the right size—can significantly reduce transplant shock. The estimated annual cost for transplanting each plant was ₹ 1,150.

6. Conclusion

Tree transplantation has emerged as a vital strategy for balancing urban development with environmental conservation. This technique preserves biodiversity, enhances air quality, mitigates urban heat islands and maintains aesthetic and ecological values besides sustainable growth. However, challenges like the complexity of transplanting mature trees, the need for specialized equipment, and resource-intensive post-transplant care can limit its widespread use. Despite these constraints, successful cases show that with proper planning and expertise, trees can be relocated successfully.

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