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REVIEW ARTICLE

Green innovations : Next-gen silvicultural strategies for managing vegetative multiplication gardens

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Abstract

Silvicultural operations involve implementing specific techniques to achieve desired outcomes for a stand. Various techniques can be employed to enhance the growth and quality of timber stands. These methods encompass modifications to the canopy, such as encouraging natural regeneration, as well as practices like boundary marking, planting pattern, irrigation, tending and cultural operations. *Casuarina* trees are woody, evergreen trees with drooping equisetoid twigs. The leaves have a scale-like connate structure, the branchlets are needle-like cladodes, and the bark has a brown, rough, fibrous texture that exfoliates in longitudinal strips. Stomata are present in cladode structures, which are responsible for the process of photosynthesis. The ability of *Melia dubia* to thrive in dry conditions is really quite astonishing. Flowers are characterized by the presence of both male and female reproductive components, and they are arranged in clusters at the top of the stem, next to leaves that are smaller. In this study, we will build consistent techniques for fertigation in mother gardens, develop a fertilizer schedule for clonal hedge gardens, and establish a protocol for hydroponics rooted in natural settings. Planning, pruning, thinning, fertilizing, and harvesting are some of the actions that are included in the silviculture methodology. The density, structure, and composition of tree stands are the primary focuses of these treatments at this time. By dispersing forest resources in a spatial and temporal manner, a silvicultural system makes it possible to make accessible a wide range of forest resources. Green innovations in silviculture are designed to reduce the environmental impacts of forest management by adopting sustainable, eco-friendly practices that support both biodiversity and ecosystem health. Here's how they contribute to minimizing pesticide use and promoting biodiversity. The paper concludes with a brief overview of the main challenges likely to be faced with this integration and some strategies that may allow them to overcome these challenges. It is hoped this paper will provide a background for future case studies, and a catalyst for increasing integration between the several silvicultural strategies.

Keywords

clonal propagation; fertigation; hydroponic rooting; mother garden; sustainable silviculture

Introduction

The cultivation of forest crops is both an art and a science that is known as silviculture as well. From a more comprehensive point of view, silviculture covers not only the study of forest trees but also the actual application of those trees in the field (1). The subfield of forestry known as silviculture is concerned with the establishment, development, maintenance, and reproduction of stands of timber (2). A silvicultural system is a way of managing forests that entails harvesting, regenerating, and tending the crops that make up the forest (3). This is done in accordance with the principles of silviculture that have been developed. In the field of forestry, it is a method that incorporates rigorous planning in order to mold the growth of a forest crop over the course of time, so producing a distinct and desirable appearance (4). The process begins with the restoration of the land and the application of an appropriate strategy for the regeneration of the land (5). Additionally, it entails providing care for the new crop throughout its whole life cycle. A sequence of treatments that is carried out during the course of a stand's lifetime is included in a silvicultural system (6). The utilization of these treatments is intended to accomplish particular aims with regard to the structure of the stand, while simultaneously aligning with the more general objectives of integrated resource management (7). There are many different techniques and stages that are included in a silvicultural system. Some of these include harvesting, regeneration, and stand-tending (8). Every activity that takes place throughout the course of a rotation or cutting cycle is included in its scope. The configuration of the land surface has an effect on the nature of the vegetation because it influences elements such as the temperature and the patterns of the wind (9). The valleys in a hilly and attractive terrain are typically shaded in a way that is pleasant to the eye. The valley is subject to delayed morning sunlight and early afternoon darkness due to the proximity of the steep hills on both sides of the valley. Lower temperatures are experienced in the valleys during the winter months as a result of the shadow that is cast by the hills that are located nearby (10). In the summer, the valleys become exceedingly hot as the day progresses, despite the shade providing some comfort from the rising temperatures in the morning (11). This is because the heat that is emitted by the neighboring hills causes the valleys to become heated. Late into the night, this extreme heat continues. The valleys, which are located in close proximity to the hills, are subject to far more significant variations in temperature on a daily and annual basis in comparison to the hillside regions (12).

The purpose of this review paper is to standardize essential techniques in the administration of vegetative multiplication gardens, with a particular emphasis on species of *Casuarina* and *Melia dubia*. Through the establishment of a precise fertilizer schedule for the clonal hedge garden, the standardization of fertigation techniques for the mother garden in situ, and the formalization of a protocol for hydroponics rooting in situ conditions, it strives to improve the efficiency of agricultural practices. Within the context of these specialized garden settings, these aims highlight the intention to maximize the growth and sustainability of vegetation, thereby making a significant contribution to the field of silvicultural management.

Stages of silvicultural development method (SDM)

During the course of the SDM, which normally lasts for a period of fifty to sixty years (rotation), there are three to four intermediate cuts (thinning) that are performed throughout the rotation period (13). These cuts are performed in shorter cycles of ten years which may vary depending on the management program (Fig. 1). Clear-cutting is the first step in the process, which commences with regeneration therapy. The harvesting of the majority of the pine trees is made possible during this phase, even though only a small number of mature trees are left per hectare. This phase is extremely important. A significant contribution to the development of new plants is made by the trees that are still standing. The "liberation cut" is a new procedure that has been introduced after a decade has passed. The natural regeneration process is accelerated with the use of this therapy, which comprises performing intermediate cuts during the "rotation" time. The majority of the parent trees of the pines are cut down during this operation, and roughly six trees per hectare are left standing after the process is complete (14). This makes it possible for the young trees to flourish without having to compete with other plants for sunlight. In order to address the thinning of the area, a treatment is utilized after a decade has passed. The intermediate cuts that are a part of this procedure are particularly significant since they contribute to the regulation of the stand density. By doing so, trees that possess perfect characteristics for harvesting are given priority, while the remaining trees are removed (15). Species that are able to endure shade and a variety of wide leaf and coniferous species of varying ages have been included in the SDM that has been modified in certain locations of Mexico in order to accommodate mixed forest scenarios. The purpose of this modification is to make certain that silvicultural treatments are performed in a timely manner, which will ultimately result in the replacement of the original forest stands with new stands that are composed of trees that are consistent in age and have an optimal density (16).

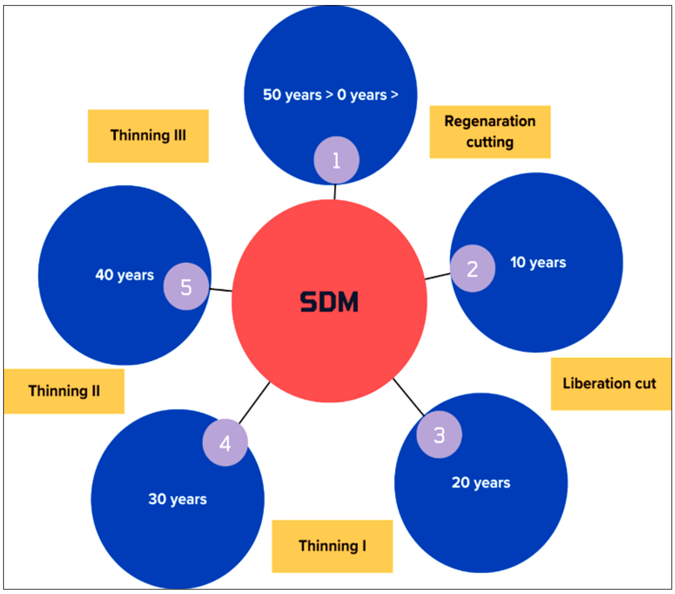

Fig. 1. Stages of SDM (Silvicultural development method).

Fertigation in mother garden

We are able to efficiently lower the concentration of immobile macronutrients and micronutrients by increasing the frequency of fertigation, which ultimately leads to a reduction in the amount of pollution that is released into the environment (16). Due to the fact that fertigation has the potential to cause nutrient leaching, it is essential to avoid applying an excessive amount of water when providing nutrients or when applying water after the application of nutrients (17). There is no danger of precipitation occurring when chelated traces of micronutrients such as iron, manganese, zinc, and copper are introduced to the irrigation system (18). Through effective management, it is possible to achieve a significant improvement in water consumption efficiency of between 25% and 40%. These alterations have a significant influence on the crop yield that is produced at the field level (19). It is possible for the cost and availability of fertilizers to have a significant impact on crop output, with nitrogenous fertilizers being particularly expensive and difficult to acquire. In the meantime, the levels of phosphate that are present in the soil can change on a micro-spatial scale. Nitrogen (N) is one of the most important nutrients affecting plant growth and is the most frequently applied fertilizer element. Therefore, all fertigation programs are based around the N concentration, and the levels of all the other nutrients are established relative to N. Therefore, it is essential for roots to grow continuously for them to be able to access areas of new soil that contain high quantities of phosphorus (P) (20). According to the findings of the research, nutrient P is notorious for its restricted mobility, and vitamin K cannot be said to be particularly mobile either. On the other hand, in terms of their mobility, the nutrients calcium and magnesium are somewhat in the middle (21). The presence of particular nutrients can make low-input agriculture more difficult to practice, whereas the availability of other nutrients can have an effect on crop productivity in soils that are alkaline or lime-based. Crop production is restricted in acid soil due to shortages in phosphorus (P), magnesium, calcium, and potassium (K), as well as proton toxicity caused by aluminium and manganese. As a consequence of this, the development of genotypes that have improved capacities for acquiring nutrients can result in increased yields in soil that has a low fertility level (22). There are a number of aspects that influence the efficiency with which nutrients are acquired in soil. These factors include root proliferation, the release of carriers that activate nutrients, symbiotic connections, the movement of water, and the dispersion of ions across the surface of the roots (20). It is vital to adjust the pH of the nutrient solution, check the electrical conductivity (EC), and ensure that there is an appropriate balance of anions and cations in order to achieve optimal crop nutrition through fertigation.

Nutrient-absorbing crops

Developing crop varieties with enhanced nutrient absorption, especially for phosphorus and potassium, can boost productivity in nutrient-deficient soils, reducing fertilizer reliance.

Stress-resilient crops

Research into plant hormones and natural growth stimulants can improve crop resilience against environmental stresses like temperature and humidity changes.

Biological protection

Promoting antagonistic fungi and bacteria as biological control agents can reduce chemical pesticide use, protecting crops while minimizing environmental harm.

Irrigation water quality

Improving irrigation water quality and managing pH levels of nutrient solutions are critical for optimal nutrient solubility and absorption in plants.

An examination of the physicochemical characteristics of the soil and the water quality is carried out to ascertain the EC of the solution. Agronomists all around the world are confronted with a number of issues, one of which is the requirement to lessen the detrimental impact that stress has on crops. This can be accomplished through the utilization of stimulants that are produced from either plants or animals, as well as through the utilization of bio-protection techniques that involve fungus and bacteria to improve the root system's ability to absorb nutrients. These tactics contribute to an increase in crop yield through their implementation (Fig. 2).

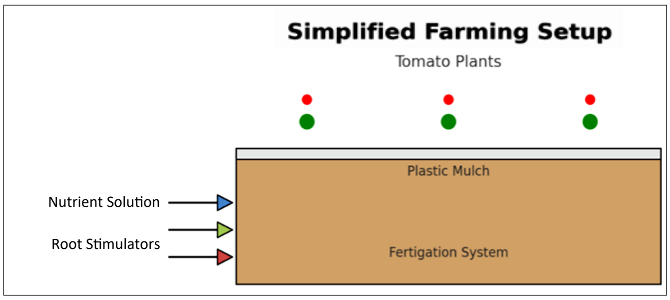

Fig. 2. Farming setup of fertigation system.

Clonal hedge garden

Effective and efficient fertiliser management is crucial for a clonal hedge garden to reach its maximum growth and development potential. To guarantee that the plants get the nutrients they need, a carefully planned programme usually involves applying multiple types of fertilisers at specific times of the year (23). Since this is the recommended application rate, each plant should get an application of one hundred grammes of balanced fertiliser in the early spring (24). An approach to doing this is to equally apply fertiliser to the base of every plant. Utilising a phosphorus-rich fertiliser is beneficial in the late spring. Research indicates each plant can benefit from a 50-gram application of this fertiliser mixed with the surrounding soil, which will promote the development of strong root systems (25) (Table 1).

The commercial cultivation of a wide variety of crops in greenhouses requires the utilization of hydroponics as an essential component (26). A fast-developing area of agriculture, hydroponics has the potential to bring about a revolution in the production of food in a sustainable manner in the years to come (27). Because of the

Table 1. Fertilizer schedule plan for a clonal hedge garden

Fertilizer Type	Method of Application	Time of Application	Application Rate	Additional Actions	References
Balanced N-P-K Fertilizer	Application around the base of each plant	Early Spring	100 g per plant	Watering after application	(46)
Phosphorus-Rich Fertilizer	Incorporation into the soil around the base of each plant	Late Spring	50 g per plant	Watering after application	(47)
Slow-Release Fertilizer	Incorporation into the soil around the base of each plant	Early Fall	100 g per plant	Mulching after application	(48)
Balanced N-P-K Fertilizer	Application around the base of each plant	Late Fall	75 g per plant	Watering after application	(49)

growing number of people throughout the world and the shrinking amount of land that can be used for agriculture as a result of urbanization, more and more people are looking at alternative methods of farming, such as hydroponics and farming without soil (28). Through the utilization of nutrient solutions, this cutting-edge method of cultivation eliminates the requirement for conventional soil by providing plants with nourishment in a water-based system (29). Even in areas with low soil quality and limited water supplies, hydroponics has a great deal of potential for providing sustenance for a sizeable section of the world's population and enabling developing countries to achieve their goal of providing food for their residents. In regions where there is a scarcity of space, the technology can potentially be exploited as a powerful source of food production (30). Adjusting the fertilization regime at different stages of plant development is crucial for optimizing growth and resilience in species like *Casuarina* and *M. dubia* during vegetative propagation in a clonal hedge garden. In the early spring, when the plants are actively growing, a balanced fertilizer containing N, P and K in equal proportions (e.g., 10-10-10) should be applied. This supports the initial surge in vegetative growth and root development. During the summer, when heat stress may be a concern, potassium-rich fertilizers (e.g., 15-10-30) can be introduced to enhance heat tolerance, improve water retention, and strengthen cell walls, which are critical for maintaining plant vigor under higher temperatures. Additionally, potassium helps in enhancing the overall drought resistance of the plant, especially for *Casuarina*, which is commonly grown in arid regions. In the autumn, as the plants transition into a more dormant phase, applying sulfur-containing fertilizers, such as ammonium sulfate, can help improve root quality by promoting the synthesis of proteins and enzymes that enhance root growth and increase nutrient uptake. This preparation ensures that the plants are better equipped for the colder months and can establish a strong root system for the following growing season. These tailored fertilization strategies, when combined with optimal watering and environmental conditions, help ensure sustained growth and long-term health of *Casuarina* and *M. dubia* in a clonal hedge system.

The use of different growing media in hydroponics allows for the provision of structural support to the roots of the plants, which helps to ensure that the plants are able to maintain their upright position and support their own weight (Fig. 3).

In the context of next-generation silvicultural strategies, managing vegetative multiplication gardens, such as clonal hedge gardens, requires a precise approach to nutrient management. For species like *Casuarina* and *M. dubia*, implementing a hydroponic protocol with a tailored fertilizer schedule can significantly enhance growth rates and propagation success. Hydroponic systems for *Casuarina* should focus on providing a balanced nutrient solution, maintaining an electrical conductivity (EC) level of 2.0–3.5 dS/m and pH around 5.5–6.5, as these species thrive in slightly acidic conditions. The fertilizer mix should contain macronutrients, including NPK, at a ratio of 3:1:2, supplemented with micronutrients like iron (Fe) and manganese (Mn) to promote robust root development and nutrient uptake. For *M. dubia*, a similar nutrient regimen can be applied, but with slightly higher potassium and calcium levels to support rapid vegetative growth and resistance to diseases. These practices, combined with efficient

Fig. 3. Hydroponic rooting system.

irrigation systems, allow for optimized growth conditions and enhance clonal propagation success in controlled environments

Solar fertigation is dependent on wireless sensor networks that are both inexpensive and very efficient in terms of energy consumption. The monitoring and transmission of data is something that these networks are able to do both locally and to software platforms that are hosted in the cloud. For the purpose of evaluating crop growth in real time and providing assistance to farmers in making informed decisions regarding the cultivation process (31), a photovoltaic power supply (34). This infrastructure for cloud computing allows for the management of these modules to be carried out in an automated fashion. In point of fact, with the assistance of modern technology, it is now feasible to effectively regulate and modify the fertigation process in accordance with the particular requirements of various crops and the stages of their development (35). An additional benefit is that a thorough record of operations may be kept, and vital data can be easily shared through a trustworthy tracking system that monitors the circumstances of the environment (Fig. 4).

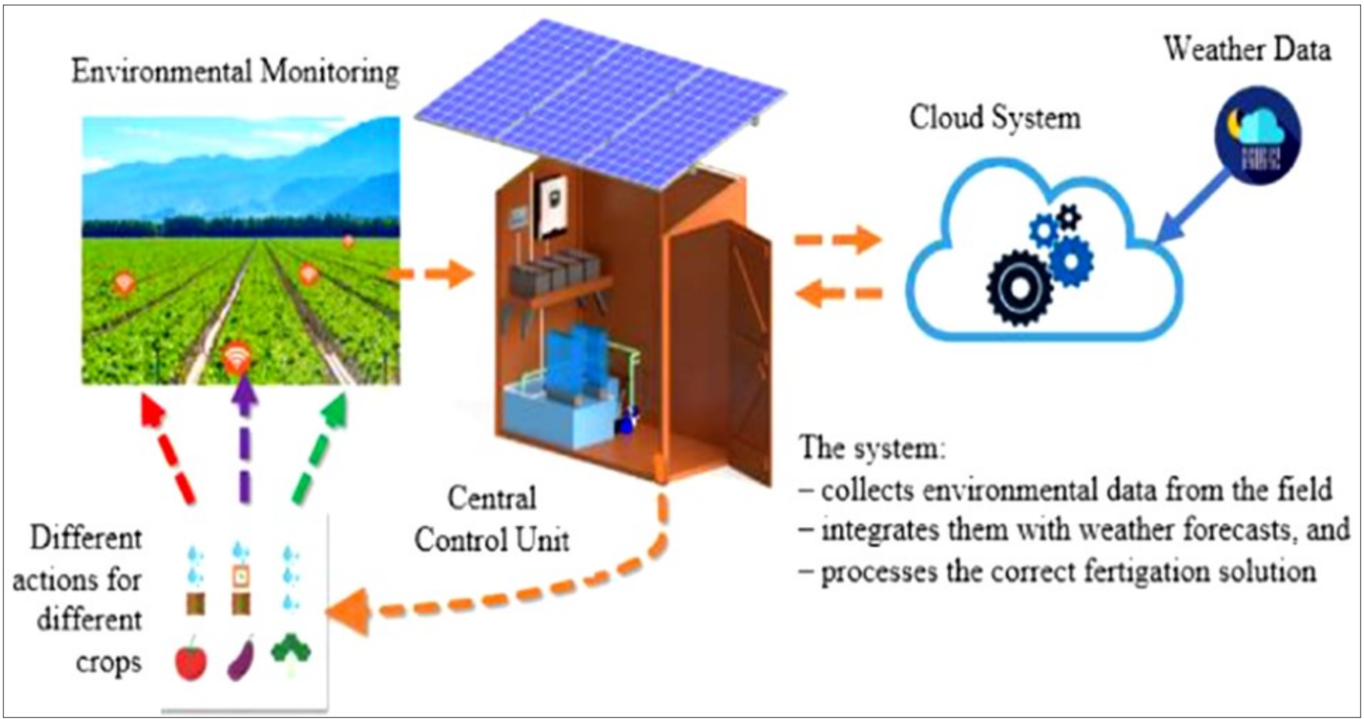

Fig. 4. Smart fertigation system (50).

the prototype recognized soil and environmental characteristics related to the crop. The incorporation of a wireless sensor network (WSN) that makes use of sophisticated information and communication technologies (ICTs) has the potential to considerably enhance the performance of an information system for the management of irrigation systems (32). The research utilized a wireless sensor network application for the control of irrigation systems. This application depended on radio frequency identification (RFID) and quick response (QR) codes.

The system that was investigated is a sophisticated fertigation system that determines the specific amount of water that crops require and collects data in both real time and historical time (33). An automated irrigating and fertilizing system that is tailored to the unique needs of plants and soil is utilized in order to maximize the efficiency with which water and fertilizer are utilized.

For the purpose of making informed decisions on the watering of crops, this approach has been developed. It takes into account a variety of elements, including the type of crop, the stage of growth, the weather conditions, the humidity, the temperature, as well as sensors for the soil and the plant. The fertigation system that is being suggested incorporates physical modules that are powered by

Species selection

The global demand for *M. dubia* and *Casuarina equisetifolia* wood has been increasing due to their wider applications and mainly due to the shorter rotation. The species produces approximately 41.5 cubic meters of wood per hectare annually, outperforming many alternatives. Its adaptability to agroforestry systems further boosts demand in countries like India, where agroforestry is vital for sustainable wood production. Between 2006 and 2011, India's wood imports increased from $1 billion to over $5 billion due to insufficient local timber resources. Globally, *C. equisetifolia* is also traded heavily in Southeast Asia and Africa for fuelwood and construction, while *M. dubia* plantations are expanding to reduce dependency on imports.

Casuarina species

In agricultural operations throughout the world, the salinization of land presents a serious difficulty. It is of the utmost importance to restore ecosystems that have been impacted by salinization in order to guarantee food security in semi-arid regions (36). The high costs that are associated with mechanical and chemical ways of rehabilitating salt-affected soils make it possible to study and harness the potential of biological systems that make use of salttolerant plant species (37). This is an alternative approach that can be considered. According to observations, certain species of *Casuarina* have an inherent capacity to withstand high quantities of salt (38). The introduction of arbuscular mycorrhizal fungus (AMF) and/or nitrogen-fixing bacteria (*Frankia*) to the plants, on the other hand, has been proven to be able to raise the level of tolerance that the plants have. *Casuarina* plantations have also been proposed as a means of fostering the expansion of plant diversity, which is another point of interest (Fig. 5). *Casuarina* is a versatile tree species with remarkable adaptability to a range of environmental conditions, including varied salinity levels, pH, humidity and drainage capacities. On saline soils, *Casuarina* can perform well, particularly species like *C. equisetifolia*, which exhibits salt tolerance due to its ability to exclude salt at the root level and accumulate compatible solutes. However, excessive salinity can reduce growth rates, impair nodulation with nitrogen-fixing *Frankia* bacteria, and lower biomass production. Soil pH also plays a critical role, as *Casuarina* thrives best in slightly acidic to neutral soils, but some species can adapt to mildly alkaline conditions. High humidity often enhances growth by improving water availability, while arid environments may reduce growth unless irrigation or other water-conservation measures are implemented. Adequate drainage is essential, as poor drainage can lead to waterlogging, root rot and stunted growth. Conversely, well-drained soils support healthy root development and robust growth. This adaptability makes *Casuarina* an excellent choice for afforestation, windbreaks and reclamation of marginal lands. However, careful management of environmental factors is necessary to maximize its growth potential (39). *C. equisetifolia* and *C. glauca* had been inoculated with *Frankia* and *Rhizophagus fasciculatus* prior to being planted in the field, and research was carried out on a plantation that included both of these species (Table 2).

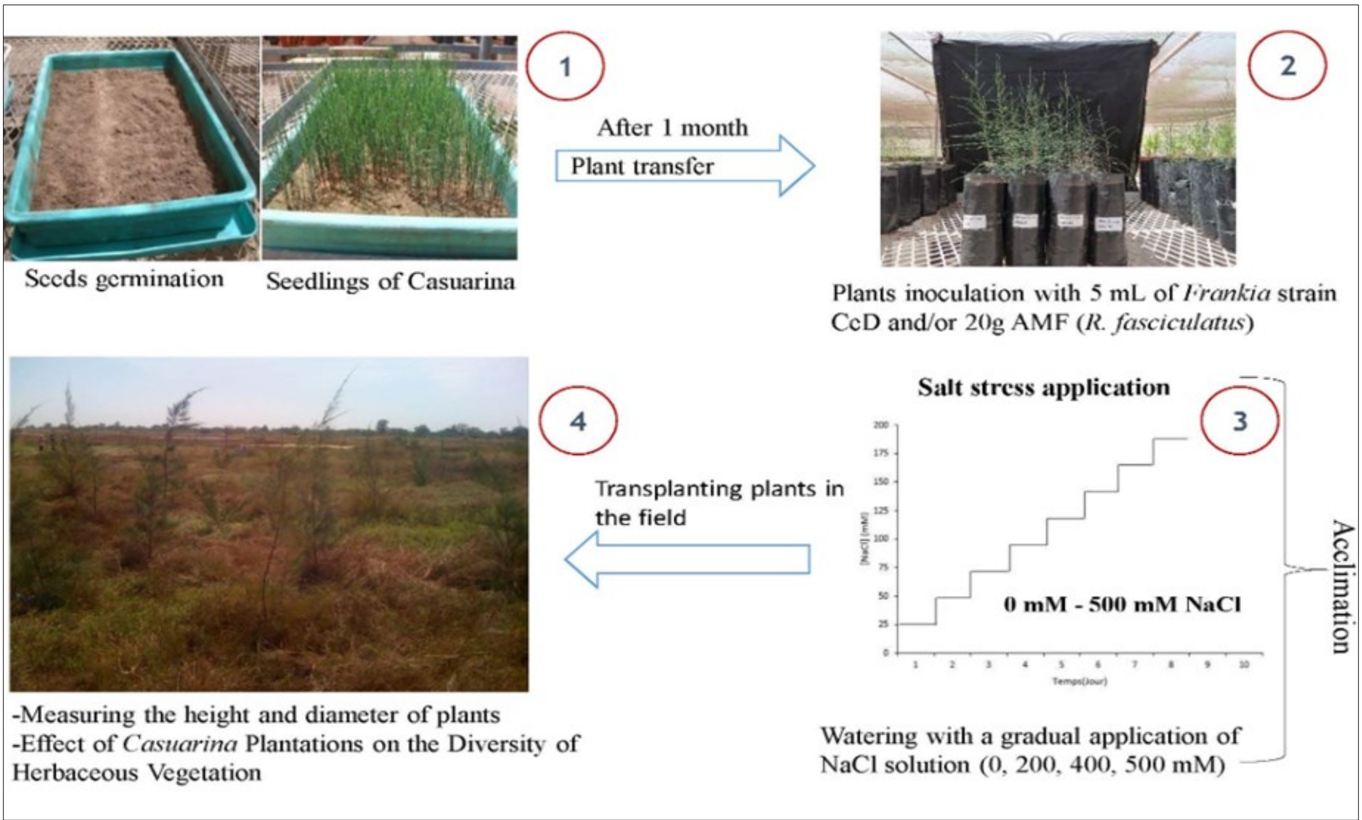

Fig. 5. Plantation of *Casuarina* effect on herbaceous vegetation diversity (38).

Table 2. Growth characteristics and management aspects of *Casuarina*

Aspect	Details
Growth Rate	Rapid early growth, with a potential annual height increase of 2–3 meters during early years. Annual yield incre-
Adaptability	Shows adaptability to poor soil quality and coastal areas. Extensive root systems aid in stabilizing soil and
Nitrogen Fixation	Capable of fixing atmospheric nitrogen, contributing to its nutrient requirements and growth.
Pruning	Regular and proper pruning promotes tree shaping, growth, and maintenance of optimal health.
Water Management	Requires adequate watering, especially during the initial growth period. Known to be drought-tolerant once
Pest and Disease Control	Vigilant monitoring and timely interventions are essential to prevent and manage pest and disease infestations.
Genetic Improvement	Continuous research on genetic diversity and selection of superior varieties through breeding programs is vital
Harvesting	Proper planning and management of activities are essential for sustainable utilization of *Casuarina* wood products.

Samples of vegetation were taken from 32 m^2 plots located both underneath and outside the *Casuarina* canopy.

The experimental area, which was 2500 m^2 in size, was divided into randomized blocks first. The results of the study indicate that the inoculation of *Frankia* and *R. fasciculatus* together has a beneficial effect on the growth and viability of both groups of organisms (38). A comparison of the sub-canopy habitat to the surrounding areas revealed that after four to five years, there was an increase in the number of species and the biomass of plants.

Melia dubia

The plantation species *Melia dubia* is highly prized for its adaptability to a wide range of soil and climate conditions, which has earned it widespread recognition as a highly sought-after target. A further factor that contributes to its appeal is the quick growth and straight boles that it exhibits (Fig. 6) (40). The regression model indicates that nine-year-old *M. dubia* stands on farmed woodlots have an average stand-level AGB of 93.8 mg ha^{-1} across a range of characteristics including management approaches, climate, and soil conditions.

According to the regression model, there is a consistent distribution of *M. dubia* plantations throughout nine age classes in a hypothetical landscape (Table 3). This is the prediction that (41) has made. These age classes vary from one to nine years old, and harvesting and re-

Fig. 6. *Melia dubia* woodlot (41).

Table 3. Growth patterns and key silvicultural practices associated with *Melia dubia*

Aspect	Details
Growth Patterns	*Melia dubia* is a fast-growing species with rapid early growth. It can reach heights of 20–25 meters within 7–8 years under favorable conditions. Adaptability to various soil types.
Spacing	Optimal spacing ranges for *M. dubia* plantations: 2m × 2m, 3m × 3m, or 4m × 4m. Proper spacing ensures maximum resource utilization and facilitates healthy growth and canopy development.
Soil Requirements	Thrives in well-drained soils with good organic content. It responds well to fertile soil conditions but can withstand moderate
Pruning	Regular pruning is essential for shaping the tree, managing canopy density, and promoting healthy growth. Prune dead or
Fertigation	Implementation of a fertigation schedule tailored to specific growth stages and soil conditions is crucial for providing neces-
Pest and Disease Control	Vigilant monitoring for pests and diseases like Powdery Mildew or Stem Borers is essential. Integrated pest management
Harvesting	Harvesting typically commences after 7–8 years when the tree reaches commercial maturity. Sustainable harvesting practices

planting are done immediately after harvesting. According to forecasts, the average amount of aboveground biomass (AGB) stock in this area is anticipated to be 44.1 mg ha^{-1} (42). Taking into account that the carbon content of AGB is around 50% (42), the average permanent aboveground carbon stock is calculated to be 22 mg ha^{-1} (Fig. 6). On the other hand, it was discovered that dry forests in South India had aboveground carbon reserves that ranged from 37 to 116 mg ha^{-1} (40, 43, 44). *M. dubia*, primarily valued for its fast-growing timber, holds significant potential for applications in medicine and cosmetics due to the bioactive compounds reported in the Melia genus. Studies on related species like *M. azedarach* have revealed the presence of limonoids, flavonoids, and triterpenoids with antibacterial, antifungal, anti-inflammatory, and antioxidant properties, which are highly sought after in the pharmaceutical and cosmetic industries (45). Emerging research suggests that *M. dubia* may also harbor similar compounds, though further investigation is needed to isolate, identify, and evaluate its bioactive constituents. Such studies could unlock its potential for developing herbal medicines, natural skincare products, and cosmeceuticals, thereby diversifying its applications and increasing its economic value. Exploring this avenue could make *M. dubia* a multipurpose species, appealing to markets beyond traditional forestry and agroforestry sectors, and aligning with the growing demand for plant-based and sustainable products in global industries

The quantification of carbon stocks can be helpful in assessing the life cycle of products manufactured by *M. dubia*, putting into action initiatives that offset carbon emissions, and implementing other strategies to reduce the effects of climate change.

Conclusion

The management of vegetative multiplication gardens is significantly impacted by silvicultural practices, as stated in the conclusion. Modifications to the canopy, tree harvesting, planting, thinning, and fertilization are some of the strategies that are included in these approaches. It is possible to achieve the required results for wood stands through the utilization of silvicultural systems, which also allows for the growth and quality of vegetation to be maintained. A standardization of procedures for fertigation in mother gardens, the development of a fertilizer schedule for clonal hedge gardens, and the design of a program for hydroponics rooted in natural settings are the primary foci of this work. They are identified as suitable possibilities for these silvicultural approaches because to their adaptability, growth qualities, and potential for increasing plant variety. *Casuarina* and *M. dubia* are the species that are highlighted as suitable options. It is absolutely necessary to use appropriate management procedures in order to successfully cultivate these species. These practices include pruning, water management, the control of pests and diseases, and genetic enhancement. In general, the application of silvicultural techniques has the potential to make a contribution to the management of vegetative multiplication gardens that is both efficient and more environmentally friendly.

Future direction

Hydroponics helps to increase the productivity and mass output when hydroponics is incorporated into silvicultural methods, especially when it comes to the growth of *Casuarina* and *M. dubia* with the nutrient based solution. Hydroponic systems maximize root development and nutrient uptake by standardizing methods like fertigation in mother gardens and creating exact fertilizer schedules for clonal hedge gardens. These techniques promote the sustainability, health and growth rates of vegetative multiplication gardens. It is a very useful for large-scale production for the quality planting material. Since hydroponics allows for consistent, high-quality propagation and allows plants to be rooted. Hydroponics guarantees more economical use of resources and helps to sustainably and environmentally meet the rising demand for lumber and other forest products.

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Authors' contributions

AB helped in choosing the review topic and its outline. BS, KH, TC participated in giving ideas related to the topic and drafted the manuscript. GS, SNK, RM, DS, MAN participated in sequence alignment and helped in overall correction of the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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