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**Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve**



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**From the Editor's desk**

*Urban parks play a crucial role in mitigating climate change through the carbon sequestration potential of trees. These green spaces act as vital carbon sinks, absorbing atmospheric carbon dioxide and storing it in their biomass and soils. The extent of carbon sequestration varies depending on factors such as tree species, age, size, and management practices. Mature trees with dense canopies tend to sequester more carbon than younger or smaller trees, while species with higher growth rates and larger leaf surfaces typically exhibit greater carbon uptake rates. Maximizing the carbon sequestration potential of urban parks involves strategic tree planting, species selection based on local climate conditions, and proper maintenance practices. By recognizing the importance of trees in urban parks for carbon sequestration and investing in green infrastructure, cities can mitigate carbon emissions, improve air quality, and enhance the overall well-being of urban residents.*

*In line with the above this issue of Van Sangyan contains an article on Carbon sequestration potential of trees in urban parks. There are also useful articles viz. Green house - A high tech nursery environment, Monocarpny - An event of mass flowering, Morus alba for sustainable livestock production in India, नीम : प्रकृति का अनमोल उपहार, Navigating the future: The role of technology in precision forestry, Quercus semecarpifolia - A fascinating tree in western Himalayas, Sea turtle conservation through beach management and hatchery programmes, Overview of versatility and rigorous quality of Tara gum tree, and कसई: एक बहुउपयोगी एवं बहुआयामी वृक्ष प्रजाति.*

*Looking forward to meet you all through forthcoming issues*

**Dr. Naseer Mohammad**

Chief Editor



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## Carbon sequestration potential of trees in urban parks

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### Introduction

The concentration of greenhouse gases (GHGs) in the atmosphere, particularly carbon dioxide (CO<sub>2</sub>), plays a significant role in climate change and global warming is the most abundant anthropogenic GHG and is responsible for approximately half of the greenhouse effect that contributes to global warming (Reddy *et al.*, 2010). Carbon dioxide is constantly being released from burning fossil fuels, plants, and animal respiration. The rise of greenhouse gasses, especially anthropogenic emissions of CO<sub>2</sub>, is the main cause of global climate change. (Wang Y, 2019) (Xiaojing Zhao, 2022). In 2021, global CO<sub>2</sub> emissions from energy consumption and industrial processes rebounded to reach an amount of 36.3 gigatonnes (G), the highest ever annual level (IEA, 2022). According to the World Economic Forum (WEF), without stronger action, global capacity to mitigate and adapt to climate change will be diminished, eventually leading to a “hot house” world scenario. CO<sub>2</sub> is a major contributor to global warming. Thus, increasing CO<sub>2</sub> emission is one of the major environmental concerns and it has been well addressed in Kyoto protocol (Hangarge, 2012). It has direct effect on carbon sequestration, more than 116 million tons of CO<sub>2</sub> per year is sequestered contributing to reduce atmospheric carbon.

(SKS Jasmin, 2011) (Hangarge, 2012). In light of global efforts to combat climate change, there is growing interest in the carbon sequestration potential of trees. Tree plantations are being considered as a means of mitigating atmospheric CO<sub>2</sub> levels and addressing climate change (Kraenzel *et al.*, 2003). Terrestrial ecosystems play a crucial role in the global carbon cycle, influencing atmospheric CO<sub>2</sub> levels. They can act as carbon sinks by absorbing carbon during vegetation growth and as carbon sources through deforestation or forest degradation (Schulze, 2006). Tropical forests, in particular, are of significant interest due to their high potential for plant productivity, as well as the high levels of deforestation and forest degradation occurring in these regions. Carbon sequestration in tropical forests offers a positive approach to carbon mitigation. There are three forestry actions that can increase carbon fixation compared to the baseline: expanding forestland, extending rotation periods, and increasing management intensity (Haile *et al.*, 2008). The greatest potential for carbon sequestration through trees lies in subtropical and tropical regions. Trees also impact air temperature in urban environments while enhancing its visual appeal. Trees, through their growth process, serve as a reservoir for atmospheric carbon. Consequently,



cultivating trees in urban areas has the potential to contribute to the reduction of CO<sub>2</sub> concentration in the atmosphere by sequestering it in the form of biomass (Baes *et al.*, 1977). It is important to document the biomass and carbon content of each species and native vegetation component, rather than focusing solely on total aboveground biomass and carbon storage (Lamlom and Savidge, 2003). However, most studies have not sufficiently examined the different parts of trees, shrubs, and herbs, and have primarily focused on total aboveground biomass and carbon storage.

Urban parks are defined as delineated open space areas, mostly dominated by vegetation and water, and generally reserved for public use. Urban parks are mostly larger, but can also have the shape of smaller ‘pocket parks. Urban trees can sequester CO<sub>2</sub> through photosynthesis, and store carbon as biomass in plants and soil. Urban parks in the city may slightly decrease concentrations of atmospheric CO<sub>2</sub> locally, especially when they are away from strong emitting sources (Fares, S., Conte, A, 2020). Trees in cities (i.e., urban forests) currently store carbon, which can be released back into the atmosphere after the tree dies, and sequester carbon as they grow. Urban trees also influence air temperatures and building energy use, altering carbon emissions from a variety of urban sources.

Thus, urban trees have an impact on the local climate, carbon cycles, energy consumption, and climate change.

With the growing expanse of urban areas trees inside these areas have the ability to store and sequester significant amounts of carbon on an annual basis. Understanding the national carbon effect can help to prepare annual inventories of GHG emissions and sinks. The United Nations New Urban Agenda acknowledged the importance of urban greenspace in fostering social integration, economic progress, and environmental improvement and presented a series of implementation strategies for improving its social, economic, and ecological qualities in a sustainable manner (Ramirez-Rubio *et al.*, 2019). Individual urban trees can be worth up to £450,000 (\$600,000), and these services are worth around \$1 million km<sup>2</sup> per year (Endreny *et al.*, 2017).

**Estimation of carbon sequestration potential of trees**

There are generally two methods to estimate carbon sequestration in plant biomass:

- Direct method- that involves cutting of the trees
- Indirect method that is calculated through the above ground biomass and below ground biomass method without cutting the trees (Sahu 2020).

S No	Parameter	Method
1	Diameter at Breast Height	1.37m from the base with Tape
2	Height	Ravi Multimeter
3	Volume	Basal area x Height x Form factor (Pressler’s formula, 1865)



4	Stem Biomass	Volume x average wood density (Smith, 1954)
5	Above Ground Biomass (t/ha)	Stem Biomass (t/ha) × BEF (Biomass Expansion Factor) (IPCC, 2006)
6	Below Ground Biomass	Above Ground Biomass × 0.26 (Eggleston <i>et al.</i> , 2006)
7	Total Biomass	Above Ground Biomass + Below Ground Biomass
8	Total Carbon Sequestration	Total Biomass × 0.47 (IPCC, 2006)

### Recent studies on carbon sequestration from urban parks

Vijayalakshmi and Dnyanesh (2021) estimated the Carbon sequestration potential of trees in urban green spaces of Pune city over 66 gardens covering 317.25 acres in duration of 3 years. They estimated total carbon sequestration was 7, 27, 291.785 tonne of CO<sub>2</sub> is worth of Indian Rs. 1606733011.422/-. It will help in Climate mitigation and reducing the carbon footprints of Pune city.

Sahu *et al.*, (2020) studied Carbon sequestration potential of trees in an urban area in Sambalpur town in Eastern India. They suggested the trees with more girth at breast height and height of trees plays a profound role in carbon sequestration potential. Species such as *Ficus benghalensis* (3355.065 kg C/tree/year) and *Ficus religiosa* (1645.335 kg C/tree/year) showed higher carbon sequestration while, *Ziziphus jujuba* (36.178 kg C/tree/year) and *Bombax ceiba* (44.410 kg C/tree/year) showed lower carbon sequestration potential.

Tak and Kakde (2020) examined carbon sequestration potential of dominant trees in urban areas of Thane city. The average standing stock of organic carbon in 238 trees in Thane city is 0.561t C/year. It is

observed that, *Azardirachta indica* (3,289.8 kg C/tree) is the best carbon-absorbing agent in the area.

Tripathi, M., & Joshi, H. (2015) conducted carbon stock estimation studies in 36 urban parks (combined area 4.48 ha) from East Delhi area. Total standing biomass of 2688 trees came out to be 510.96 Tons and total carbon stored was 255.49 Tons. *F. bengalensis* dominated the list having 105 trees and sequestered 24.62 Tons of carbon in its standing biomass followed by *A. indica* (23.49 T) and *Bombax ceiba* (21.59 T) and least carbon (3.63 T) was sequestered by *Cordia dichotoma*.

Sai Abhipsa Dash *et al.*, (2022) conducted carbon stock estimation studies in public parks of Bhubaneswar, Odisha and found that the carbon stock is ranging from 13.48 Mg in an area of 0.22 ha in SV Park, to 479.49 Mg in an area of 8.91 ha in BP Park. On average, we estimated the biomass per ha to be 32.85 Mg.

Devi (2017) studies on carbon sequestration potential of trees in 35 urban parks of Jammu and Kashmir state showed that trees in these parks stored 39112.50 t (1089.18 t / ha) of carbon. Rajinder Park stores a maximum of 31585.98 t of carbon followed by Gole Market Park which stores 1703.15 t of carbon. Species-wise



maximum value of carbon was found for *Ficus bengalensis* (15349.08) followed by *Eucalyptus sp.* (1703.157 t).

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## Green house - A high tech nursery environment

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### Abstract

Greenhouses offer a controlled environment that facilitates year-round crop production, enhancing sustainability and reducing reliance on transportation and pesticides. The meticulous regulation of environmental factors within greenhouses empowers growers to optimize crop quality and yield. Technologies such as automated controls, sensors, actuators, and simulation tools play key roles in maintaining ideal conditions, while renewable energy sources and advanced materials contribute to energy efficiency. Research focuses on areas like illumination control, microclimate regulation, and the development of IoT-based monitoring for improved crop cultivation. Through the integration of various technologies and control measures, intelligent greenhouses stand as a promising solution for sustainable and efficient agriculture.

**Keywords:** Greenhouse. Controlled Environment, Automation, IoT Monitoring and Simulation Tools.

### Introduction

Greenhouses are frames of inflated structure covered with a transparent material in which crops are grown under controlled environment conditions. This controlled environment enables the growth of crops in regions and seasons that would otherwise hinder their development,

thereby extending the growing seasons of seasonal crops. This proximity to consumption areas reduces transportation distances, conserves water and land resources, and decreases the reliance on pesticides. It is a highly effective technology that continually enhances the productivity, profitability, and sustainability of agricultural systems, ensuring a year-round production of high-quality produce.

The term "controlled environment" in greenhouses refers to the meticulous regulation of essential environmental factors within the greenhouse to align with the specific growth requirements of the crops. This empowers growers to improve crop quality and increase yield. The critical environmental parameters governing greenhouse operations include solar radiation, air temperature, relative humidity (RH), and carbon dioxide (CO<sub>2</sub>) levels. These factors profoundly impact crop production and, at the same time, influence greenhouse energy consumption, which can represent up to 40 percent of the total production costs.

### Creation of controlled environment in greenhouse

Greenhouses use computer technology and control hardware like sensors, controllers, and actuators to maintain precise environmental conditions. This setup allows for continuous monitoring and

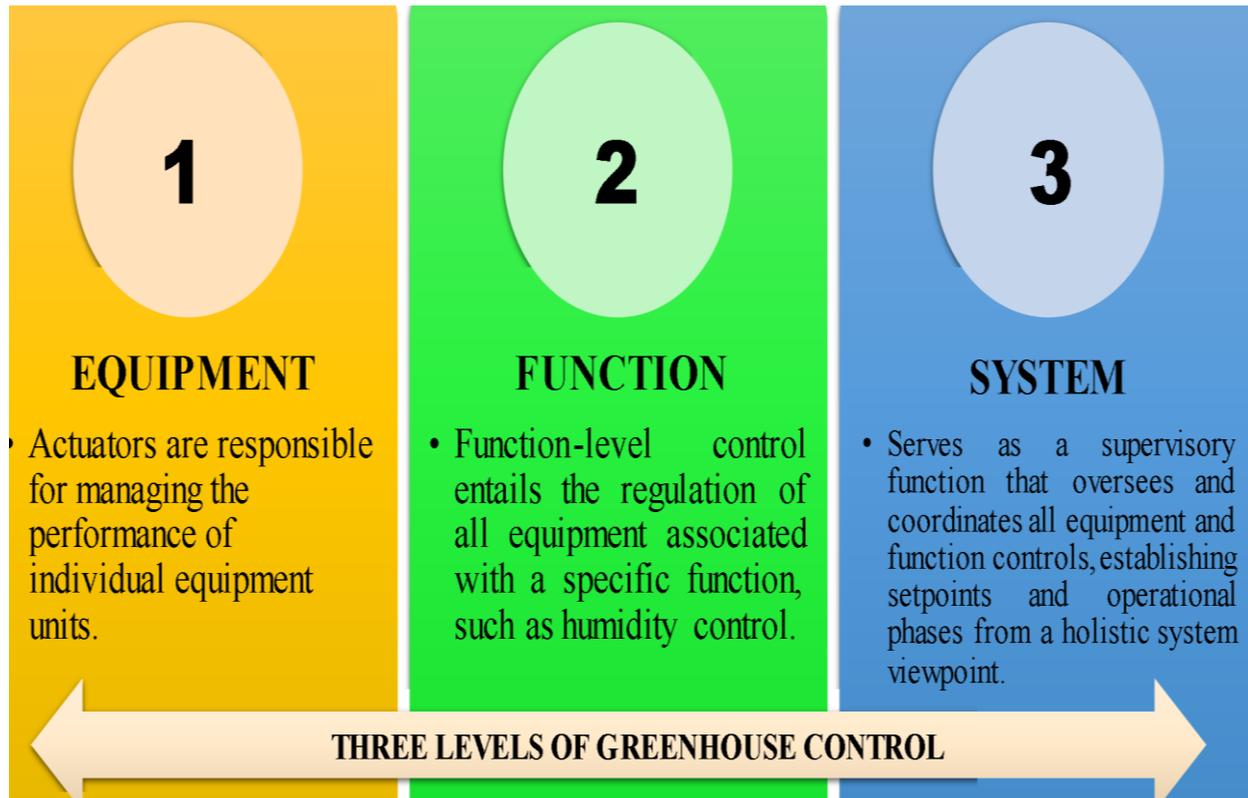


adjustment of factors such as temperature, humidity, solar radiation, and CO<sub>2</sub> levels, as well as equipment coordination. The control system includes a network of sensors, controllers, and actuators that assess parameters like temperature, RH,

**Three levels of greenhouse control**

Equipment, Function and System — defined by the National Greenhouse Manufacturers Association

CO<sub>2</sub> concentration, and air flowrate. Sensors are placed inside and outside the greenhouse at various positions, including plant level and control component inlets and outlets.



**Illumination control in greenhouse**

Greenhouse lighting systems, with automated controls, can adapt to external conditions by activating extra lighting when needed. Recent research effectively tackled the task of optimizing light intensity in greenhouses using a parallel particle swarm optimization (PSO) algorithm. The primary objective was to identify the best positions and quantities of LED lights for activation, aligning with the plant's light requirements, and thereby reducing energy consumption.

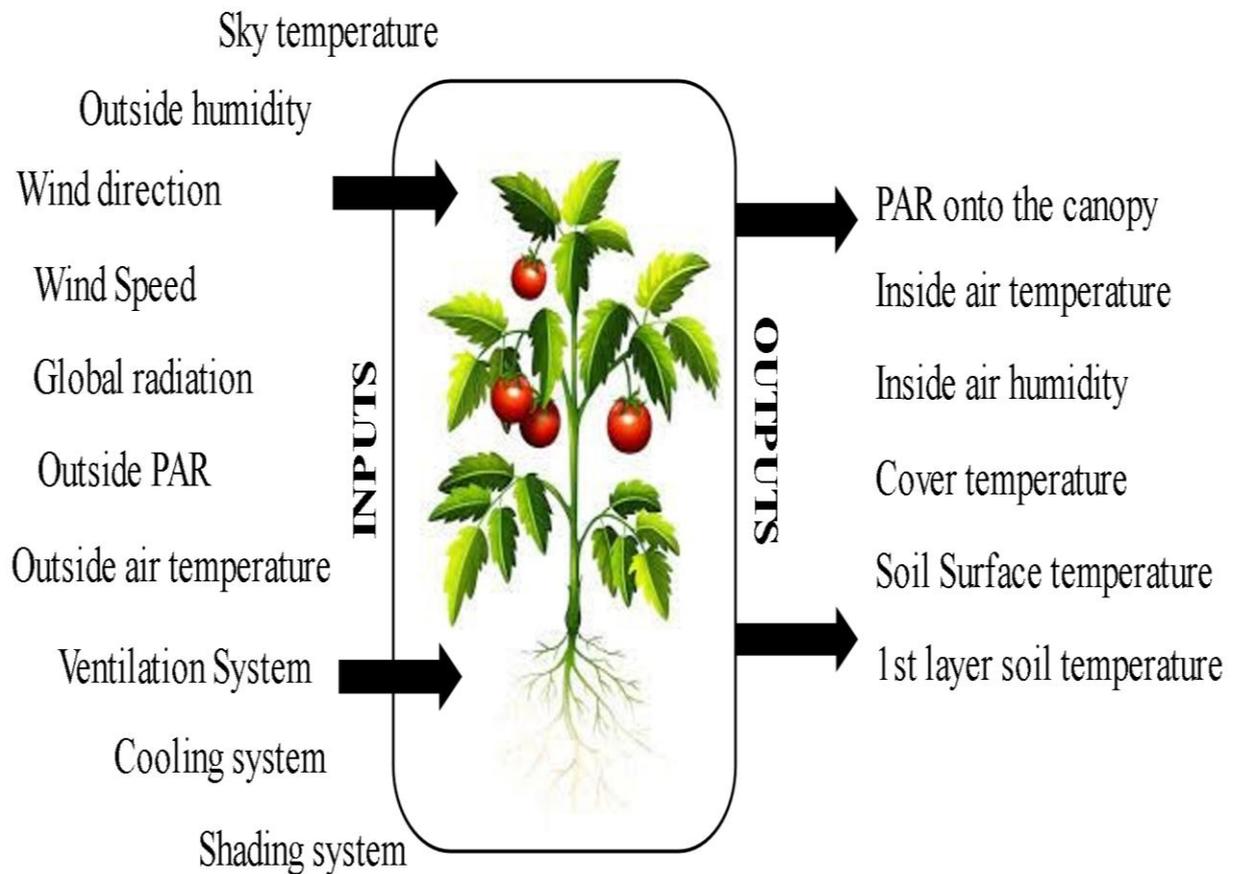
**Microclimate and temperature control in greenhouse**

The control components are mainly the cooling, heating, and ventilation systems, as well as the shading and fogging systems. Evaporative cooling, such as misting, reduces plant moisture loss and leaf transpiration by lowering temperature through evaporation. Misting is divided into low-pressure and high-pressure systems, known as fog-cooling. In fog-cooling, high-pressure water passes through small nozzles, typically less than 10 µm in size. A fan disperses these tiny



water droplets into the greenhouse air, decreasing temperature through evaporation. These systems are commonly used for seed germination and propagation

in greenhouses. However, they can lead to increased humidity that fosters bacterial diseases like algae and botrytis.



**Fig: Inputs and outputs in a greenhouse environment**

Temperature control in a greenhouse affects humidity levels, and excessive illumination without CO<sub>2</sub> enrichment can be counterproductive. It's crucial to consider these components together for a harmonious operation of the chosen systems.

**Renewable energy technologies in greenhouses**

In greenhouse crop production, energy expenses, typically ranking second only to labor costs are a significant overhead. A critical sustainable development objective in the industry is to reduce greenhouse

energy consumption while increasing yields. Greenhouse locations often offer favorable conditions for harnessing renewable energy technologies. Given their exposure to natural elements like sun, wind, and earth, greenhouses can effectively leverage solar energy (utilizing photovoltaics and solar thermal panels), wind energy (via wind turbines and windmills), and geothermal energy (using geothermal heat pumps).

**Advanced covering materials**

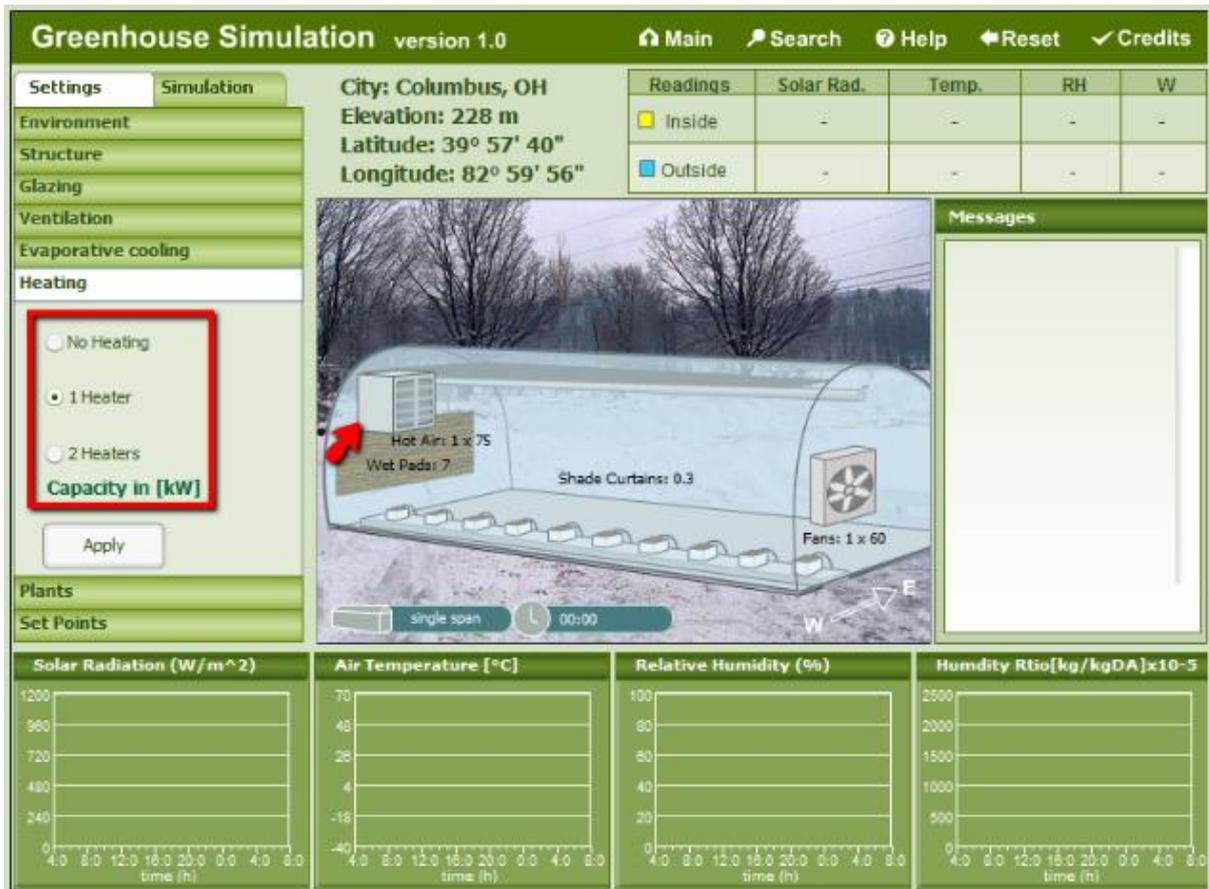
The materials used to cover greenhouses greatly influence the indoor conditions.



Studying and developing alternative materials capable of regulating radiation and thermal gains in the greenhouse is crucial. Implementing such materials can significantly enhance farming conditions while lowering the energy requirements for heating, cooling, and ventilation.

**Advanced simulation tools**

Simulation tools, used for evaluating the energy performance of constructed spaces and emulating thermal conditions in greenhouses, play a vital role in energy assessments. Fitz-Rodríguez *et al.*, introduced an interactive, dynamic simulator for greenhouse environments.



In general, an intelligent greenhouse integrates all these parameters like renewable energy technologies, advanced covering materials passive techniques to minimize the energy consumption, energy storage equipment as well as advanced monitoring and simulation tools of its performance.

**IoT-based monitoring**

Conventional data monitoring methods in greenhouses often face challenges such as limited sharing, labor-intensive processes, low spatiotemporal resolution, absence of

centralized data, and organizational shortcomings in overseeing greenhouse environmental aspects. IoT presents a valuable prospect, not only for greenhouse environmental monitoring but also as a means for non-destructively quantifying the physiological factors of cultivated plants, which can be shared within a network of greenhouse producers.

**Conclusion**

Greenhouses offer an innovative solution to enhance crop production and reduce the environmental impact of agriculture. They



enable year-round, controlled growth, ultimately benefiting both the industry and the environment. Key elements of effective greenhouse management include precise control systems, intelligent lighting, microclimate regulation, and the integration of renewable energy technologies. Furthermore, advanced materials, simulation tools, and IoT-based monitoring contribute to sustainable practices and increased productivity in modern greenhouse agriculture. This holistic approach represents a promising path toward a more sustainable and efficient future for greenhouse farming.

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## Monocarpy – An event of mass flowering

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Mass flowering is an enchanting phenomenon that occurs across the world. It exemplifies semelparity, a phenomenon in which an organism, whether it be a plant or an animal, reproduces just once before perishing. Within the plant realm, this phenomenon is also referred to as monocarpy, representing a distinctive flowering behaviour where a plant species blooms and yields seeds only once in its lifespan, subsequently ceasing to exist. These plants are commonly referred to as annual or periodical plants. In order to prepare for a mass seeding event, these plants undergo an extended vegetative phase, enabling them to accumulate ample resources to produce abundant quantities of alluring seeds.

Mass flowering and a similar process known as masting predominantly observed in trees that shed acorns or nuts, are believed to have evolved as Défense mechanisms against seed predation. The abundance of seeds during these events can satiate predators, ensuring that a significant number of seeds can germinate and contribute to the next generation. Another hypothesis suggests that mass flowering increases cross-pollination, making the species more alluring and noticeable to pollinators. Lastly, mass flowering may aid certain species in out-competing other plants in the area, enabling the establishment of numerous

seedlings and asserting dominance in the landscape.

The population dynamics of these plants heavily rely on environmental cues that trigger flowering, ultimately leading to the demise of reproductive individuals and creating what can be described as a "graveyard" of plants. There are two plausible explanations for this phenomenon. Firstly, the immense energy required for seed production puts significant stress on the plant, leading to a drastic reduction in its lifespan. Secondly, the death of the mother plant creates favourable conditions for the survival of its seedlings by providing access to sunlight, water, and nutrients, thus creating optimal conditions for their growth and development.

### Kinds of monocarpy

There are three kinds of monocarpy

- Annuals and biennials, which are monocarpic by definition
- Unbranched perennials (such as Ensete, Corypha and Spathelia) which are monocarpic by morphology
- Branched perennials (such as bamboos, Strobil0anthes and other Acanthaceae) which are monocarpic by adaptation.

The presence of autonomic calendars controlling flowering is clear only in the last group; they may occur in the



morphological monocarps but there is yet no reason to postulate them.

Mass flowering is observed not only in *Strobilanthes* but also in plants belonging to nearly 20 different families. However, most of these species are non-periodical, meaning that the interval between two mass flowering events is irregular and not predictable. Monocot plant families that include monocarpic species encompass Agavaceae, Araceae, Arecaceae, Bromeliaceae, Musaceae, and Poaceae. On the other hand, dicot plant families that include monocarpic species consist of Acanthaceae, Apocynaceae, Asteraceae, and Fabaceae. Additionally, two other genera of mass flowering plants are *Cerberiopsis* (in the Apocynaceae family) and *Tachigali* (in the Fabaceae family), with the latter being commonly known as the 'suicide tree'.

#### **Monocarpic in strobilanthes**

The *Strobilanthes* genus comprises 145 species in India, with 72 of them being endemic to the Eastern Himalayas and the Western Ghats. These species exhibit long flowering intervals and are categorized as plietesials. Among them, *Strobilanthes kunthiana*, also known as neelakurinji, has gained significant attention for its well-documented and predictable flowering interval, which is exploited for tourism purposes in certain parts of the Western Ghats. The neelakurinji flowers from late August to October, with its peak bloom occurring in mid-September. This relatively short flowering window is evolutionarily effective.

To adapt to their unique flowering patterns, *Strobilanthes* species have developed specific plant-pollinator

interactions. Observations by early scientists revealed that the same small animals and birds that fed on the seeds of neelakurinji also fed on the seeds of mass-flowering bamboo in the Western Ghats. Additionally, honeybees (*Apis* sp.) were observed as the primary pollinators of neelakurinji during its flowering period. In 2019, studies discovered the presence of tiny spiders living inside the tubular corolla of neelakurinji. These spiders wait inside the flowers, preying on the pollinators that enter the nectar tube. As the spiders move within the flowers, pollen adheres to their bodies, facilitating pollen transfer between flowers and enabling self-pollination. The existence of these pseudo pollinators, such as the spiders, was a novel finding in research, highlighting the need for further studies to understand their contribution to the reproduction of *Strobilanthes* and the intricate evolutionary relationships between these plants and other species in their ecosystem.

#### **Bamboo**

Bamboo has gained global attention due to its unique life history. It is a perennial flowering plant that exhibits distinct characteristics in its flowering behaviour. These include:

- **Long Vegetative Phase:** Bamboo species typically have an extended vegetative phase, during which they grow and spread through their underground rhizome system. This phase can last for decades or even up to a century.
- **Strong Asexual Reproductive Capability:** Bamboo possesses remarkable asexual reproductive abilities. A single clone of bamboo has the potential to populate an



entire bamboo forest, thanks to its ability to produce new shoots from its extensive rhizome network.

However, the flowering behaviour of bamboo can have negative consequences for those who rely on bamboo resources. Most bamboo species only flower once in their entire life cycle. The flowering period varies among different species, with some flowering as frequently as every three years, while others may have intervals as long as 150 years.

The mass synchronous flowering of bamboo can be particularly challenging for people who depend on bamboo for their livelihoods. This phenomenon can disrupt the availability of bamboo resources and potentially lead to famine, especially among self-sufficient farmers who rely on bamboo as a vital source of income and sustenance.

Bamboo species which exhibit mass flowering are *Acidosasa purpurea*, *Ampelocalamus patellaris*, *A. scandens*, *A. stoloniformis*, *Bambusa arnhemica*, *B. bambos*, *Cephalostachyum chinense*, *Ce. latifolium*, *Ce. pingbianense*, *Chimonobambusa pachystachys*, *Ch. quadrangularis*, *Ch. rigidula*, *Ch. szechuanensis*, *Ch. tumidissinoda*, *Ch. utilis*, *Chimonocalamus dumosus*, *Chusquea abietifolia*, *Ch. quila*, *Ch. ramosissima*, *Dendrocalamus longispathus*, *Fargesia denudata*, *F. fungosa*, *F. murielae*, *F. nitida*, *F. obliqua*, *F. qinlingensis*, *F. robusta*, *F. scabrida*, *F. spathacea*, *Gaoligong shaniamegalothyrsa*, *Gigantochloa albociliata*, *G. nigrociliata*, *Guaduatrinii*, *Indocalamus tessellatus*, *I. wilsoni*, *I. angustata*, *Melocalamus compactiflorus*, *M. scandens*, *Otatearamirezii*, *Phyllostachy*

*atrovaginata*, *Ph. edulis*, *Ph. fimbriiligula*, *Ph. glabrata*, *Ph. glauca* f. *Yunzhu*, *Ph. glauca*, *Ph. heteroclada* f. *solide*, *Ph. meyeri*, *Ph. nigra* var. *henonis*, *Ph. propinqua*, *Ph. rutila*, *Ph. sulphurea* var. *viridis*, *Ph. vivax*, *Pleioblastus amarus*, *Pl. argenteostriatus*, *Pl. linearis*, *Pl. maculatus*, *Pl. pygmaeus*, *Pseudosasa japonica*, *Sarocalamus faberi*, *Sasa kurilensis*, *S. palmata*, *S. senanensis*, *S. veitchii* var. *hirsuta*, *Sasaellakogasensis* 'Aureostriatus', *Sasamorphanica*, *Schizostachyum dumetorum*, *Sch. pergracile*, *Shibataeachinensis*, *Sinobambusatootsik*, *Yushaniaconfu* (Zheng et al., 2020).

### Dipterocarpus

The Dipterocarpaceae family comprises 16 genera and nearly 600 species, primarily found in South and Southeast Asia, where they dominate approximately 85% of forested land (Appanah & Turnbull 1998). Dipterocarps are known for their supra-annual mass-flowering events, which occur at irregular intervals of 2–10 years and often involve multiple dipterocarp and related species (Ashton et al., 1988). Initially, it was believed that mass flowering was exclusive to dipterocarps. In dense forests, many dipterocarp species exhibit exceptionally heavy flowering. Wood (1956) discovered that more than two-thirds of the approximately 200 dipterocarp species in North Borneo flowered and fruited during a single intense event. Medway (1972) observed 13 dipterocarp species from 1960 to 1969 and found that 62% and 77% of the species, respectively, flowered during two mass flowering events over the observation period. Burgess (1972) and Cockburn (1975) observed that nearly 50% of mature



dipterocarp individuals flowered during favourable flowering years. Appanah (1985) noted that over 70% of the dipterocarp species (out of 27 species) in a particular forest reserve flowered during a mass flowering event (Appanah 1993).

While masting species in a seasonal tropical regions benefit from predator satiation and successful pollination, there is evidence to suggest that flowering induction in dipterocarps evolved in seasonal tropics characterized by recurring dry seasons.

### Conclusion

Mass flowering is a captivating phenomenon observed in various plant species. It is an example of semelparity or monocarpy, where plants reproduce only once before dying. Mass flowering serves as an evolutionary defence against seed predation, increases cross-pollination, and helps certain species outcompete others. The population dynamics of monocarpic plants depend on environmental cues, and the death of reproductive individuals creates optimal conditions for seedling survival. Monocarpy is observed in different plant families, including monocots and dicots. Strobilanthes and bamboo are notable examples of monocarpic plants. The family Dipterocarpaceae exhibits supra-annual mass-flowering events

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## *Morus alba* for sustainable livestock production in India

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*Mulberry* (*Morus* spp.) a member of the Moraceae family, holds significant economic value due to its extensive geographic and altitudinal range. It thrives across various continents and climatic zones, from tropical to arid, semi-arid, and temperate regions. This adaptability allows for its cultivation in diverse forms, and its various parts, particularly the leaves and fruits, serve multiple purposes. Globally, there are 150 reported species of *Mulberry*, with 68 of them recognized for their economic importance. Among these, *Morus alba*, native to the lower Himalayan region of India, stands out as a crucial species. It is a fast-growing deciduous tree, typically reaching heights of 10 to 35 meters, and holds a well-established reputation as one of India's economically significant species. *M. alba* can be found both in the wild and under cultivation across India, thriving in tropical, sub-tropical, and temperate zones, making it a versatile and invaluable resource.

### **Distribution and ecology**

*M. alba*, commonly known as the white mulberry, displays a broad distribution across various climate zones in Asia, Africa, Europe, North East America, and South West America (Kafkas et al., 2008). In India, the mulberry tree thrives in tropical, sub-tropical, and temperate regions and is extensively cultivated in states such as Himachal Pradesh, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar,

Orissa, Assam, Manipur, Andhra Pradesh, Karnataka, and Chennai, among others (Srivastava et al., 2008). In the wild, particularly in the Himalayan region, *M. alba* can be found growing sporadically within forests and communal lands. It often coexists with other tree species, including *Bauhinia variegata*, *Celtis australis*, *Ficus auriculata*, *Toona ciliata*, and *Grewia optiva*. Altitudinally, this tree species is reported to range from the foothills to 1500 meters above mean sea level (amsl) in the Himalayas (Sharma et al., 2021). In hilly areas, *M. alba* predominantly grows near stream beds or slopes, taking advantage of the sufficient moisture available in these locations (Sharma et al., 2021). The prevailing climate conditions in its habitat are characterized by a mean annual temperature spanning from 0 to 43°C and a mean annual rainfall ranging from 1000 to 2500 mm. The soil composition varies from sandy loam to clayey loam, with a pH level typically falling between 6.0 and 7.5. These ecological attributes showcase the adaptability and widespread occurrence of *M. alba* across diverse regions and ecological conditions.

### **Botanical description**

*M. alba* is a rapidly growing medium-sized tree that can reach heights of up to 35 meters and has a cylindrical, relatively small trunk with bark ranging from greyish to greyish-brown. Its canopy is moderately



dense, and its leaves are green, petiolated, and highly variable in shape. They can be ovate, broadly ovate, or narrowly ovate, and they come in simple forms. These leaves exhibit a range of characteristics, from being unlobed to bi-, tri-, tetra-, and penta-lobed, featuring toothed (dentate), scalloped (crenate), or finely scalloped (crenulate) margins with a network of veins (reticulate venation) (Collet, 1980; Kirtikar and Basu, 1984). The inflorescence of *M. alba* is axillary and pendulous (hanging down). The flowers are typically bisexual, although occasionally they can be unisexual, and they are arranged on different branches of the same plant. These flowers are greenish in color and relatively inconspicuous. They consist of four petals arranged in an overlapping (imbricate) fashion, and male flowers have four stamens, while female flowers feature a unilocular or bilocular ovary with a single ovule. The style of the female flower is bipartite. The fruit of *M. alba* is a syncarp, which can be white, pinkish-white, purple, or black, and it can grow up to 5 cm in length. It contains numerous drupes enclosed in a fleshy perianth (Collet, 1980; Kirtikar and Basu, 1984). Flowering of *M. alba* typically occurs during the months of March and April, and the fruits ripen in April to May (Collet, 1980; Kirtikar and Basu, 1984).

#### Utilization

*M. alba* is a versatile and valuable species with a wide range of uses, both ecologically and economically:

#### Sericulture

The leaves of *M. alba* are primarily cultivated for use in sericulture, the process of rearing silkworms (*Bombyx mori*) to produce high-quality mori silk.

This is a significant economic activity, with the leaves serving as the primary food source for silkworms (Datta, et al. 200).

#### Fuel wood

The branches and stems of *M. alba* are utilized as a source of fuelwood. They have a high calorific value, ranging from 4370 to 4770 kcal/kg, making them a valuable energy resource (Collet, 1980; Kirtikar and Basu, 1984).

#### Wood and pulp

The wood of *M. alba* yields pulp of good quality and strength, suitable for producing white writing and printing paper. Additionally, the bark of the tree produces fiber that is used in the textile industry (Luna, 2005).

#### Construction and furniture

The medium-density wood (670-850 kg/cubic m) of *M. alba*, featuring white or pale yellow sapwood and brown hardwood, is employed in building houses, constructing beams, making flooring, agricultural implements, and producing lightweight furniture (Luna, 2005). It has earned international recognition for use in crafting sports equipment such as hockey sticks, tennis and badminton rackets, and cricket bats (Luna, 2005).

#### Edible fruits

The fruits of *M. alba* are edible and contain anthocyanins, which confer antioxidant, radiation-protective, vasoprotective, anti-inflammatory, and hepato-protective properties (Vijayan et al., 2011). They are commercially used to make various products, including jam, jelly, sharbats, tea, and wine.

#### Medicinal properties

Different parts of the tree, including the bark, roots, and stem, have been found to possess purgative, anthelmintic, and



astringent properties (Vijayan et al., 2011). The leaves of *M. alba* are of medicinal value, exhibiting various health benefits such as anti-diabetic, antioxidant, hypoglycemic, anti-obesity, anti-inflammatory, and anticancer activities (Ma et al., 2022). Moreover, these leaves are edible and used as vegetables in Himalayan households.

#### **Livestock feed**

*M. alba* leaves are also used as fodder for livestock during lean periods, enhancing milk yield and quality.

#### **Propagation technology**

*M. alba* can be propagated by seeds or cuttings (softwood or hardwood) or by grafting. However, easiest way to propagate *M. alba* is using stem cuttings. Hardwood cuttings of white mulberry *M. alba* L. from at least one year old branches from mature trees should be collected during February month. Cuttings should be kept up to 15-20 cm long, 3-5 cm in diameter with 3-4 buds and a clean 45 degree cut should be given with a sharp knife without bark split. Basal end of the cuttings should be treated with 2000 ppm IBA for 30 seconds and should be planted inside growing media having sandy soil and farm yard manure (FYM) in the ratio of 1:1 in poly bags (Singh et al., 2014). Regular watering, weeding and intercultural operations should be carried out for proper growth and rooting of the cuttings. Once the cuttings are four-six month old they can be planted in the field during monsoon season at proper spacing.

#### **Fodder quality traits**

*M. alba* leaves are known for their excellent fodder quality, making them a valuable resource for both large and small ruminants. They offer several benefits in

terms of nutrition and livestock productivity:

#### **Nutrient-rich fodder**

*M. alba* leaves are rich in nutrients, containing a significant amount of crude protein (15–35%), as well as essential macro and micro nutrients, vitamins, and bioactive compounds. This nutritional richness makes them highly suitable for animal consumption.

#### **High dry matter digestibility**

*M. alba* leaves have a high dry matter digestibility, ranging from 75% to 85%. This means that animals can efficiently process and utilize the nutrients from these leaves.

#### **Palatability and metabolizable energy**

*M. alba* leaves are palatable to livestock and provide a high metabolizable energy content, ranging from 1130 to 2240 kcal/kg. This makes them a preferred food source for animals.

#### **Cost-effective fodder**

*M. alba* leaves are particularly valuable during lean periods when other feed sources may be scarce. They can help reduce feeding costs and provide essential nutrition to livestock.

#### **Milk yield and quality**

Supplementation of dairy animals with *M. alba* leaves has been shown to enhance milk yield and improve the quality of milk, including its protein and fat content. This is beneficial for dairy farmers seeking to increase productivity (Datta et al. 2002; Venkatesh et al. 2015).

#### **Versatile feed forms**

*M. alba* leaves can be easily converted into various feed forms, such as hay, silage, and leaf meal. These forms can be stored for future use, ensuring a stable and nutritious food supply for livestock.



### Rumen health and microbiota

The supplementation of animal diets with 5–10% *M. alba* silage has been reported to improve rumen microbiota and fermentation. This enhances the production of fiber-digesting, propionic acid-synthesizing, and milk fat-enhancing microorganisms. These improvements lead to an increase in milk yield in dairy animals (Li et al., 2022).

Thus, *M. alba* leaves are a valuable and versatile source of fodder for livestock, offering a wide range of nutritional benefits. They not only improve animal health and productivity but also provide a cost-effective solution, especially during periods of feed scarcity. Additionally, their versatility in feed preparation and storage adds to their significance in livestock production.

**Table 1. Fodder quality traits of *Morus alba* leaves**

Traits	Content (Dry Matter Basis)
Dry matter	24-32%
Total ash	9-10%
Crude protein	15-35%
Neutral detergent fiber	28-30%
Acid detergent fiber	17-18%
Crude Fiber	13.11%
Calcium	20171.1 ppm
Potassium	16018.7 ppm
Phosphorus	2144.1 ppm
Copper	17.4 µg/g
Iron	58.7 ppm
Manganese	4.22 µg/g
Gross energy	17.60 MJ/kg
Metabolizable energy	1130–2240 kcal/kg
<b>References: Al-Kirshi (2013)</b>	



a. Fruits of *Morus alba*b. *Morus alba* Treec & d Leaves of *Morus alba*

**Following characteristics make it potential source of nutritious green fodder:**

- Presence of large and highly palatable leaves during summer season.
- Low cellulose and lignin content in leaves.
- High dry matter digestibility in comparison to other fodder trees.
- High leaf biomass production potential.
- High mineral and crude protein content (Table 1)

Leaves of *M. alba* can be mixed with the dry fodder for supplying nutritional feed to

livestock. Moreover, *M. alba* leaf supplementation to dairy animals has been proved to enhance milk yield and quality (protein, fat content) (Datta et al. 2002; Venkatesh et al. 2015) thus can be utilized for enhancing livestock productivity. Moreover, mulberry leaves can be easily converted into hay, silage; leaf meal etc. thereby can also be stored for feeding the livestock. Feed supplementation with 5–10% of *M. alba* silage have been reported to improve rumen micro-biota, fermentation, and enhance the production of fiber-digesting, propionic acid synthesizing and milk fat enhancing microorganisms leading to the



improvement in milk yield in dairy animals (Li et al., 2022).

Despite being a potential species for ensuring fodder security and enhance livestock productivity, *M. alba* has not been utilized for the same in the country and limited attention to mulberry has been given by livestock and fodder researchers. *M. alba* due to huge variation in leaf yield as well as nutritive traits and being able to grow at under a wider range of soil and environmental conditions indicates the huge scope for utilizing mulberry for identifying suitable germplasm for all the agro-climatic zones of the country.

Thus, under the current scenario when country is facing shortage of quality fodder as well as low livestock productivity, promoting *M. alba* cultivation can act as a potential affordable source of quality fodder for livestock guaranteeing access to protein and nutritionally rich fodder for livestock.

#### **Way forward to utilize this tree for sustaining livestock production in India**

This species should be promoted for cultivation on farm bunds to sustain green fodder supply.

- Agricultural border land areas should be planted with this species along with other fodder tree species to sustain quality fodder supply round the year.
- Plantation of this tree species should be promoted on Grazing lands.
- Appropriate lopping cycle and intensity should be identified to utilize this tree efficiently without hampering its regeneration.

- Twigs, leaves of *M. alba* can be collected before leaf fall to conserve as tree hay.
- *M. alba* leaves can be converted to tree leaf silage.
- Its leaves can be made into leaf meal by sun drying their leaves to 20-30% moisture content followed by grinding. After grinding the powder is pressed using hydraulic press to make blocks. These leaf meal blocks can be stored for long time and are full of nutrients and sufficient to meet requirement of nutrients during lean period.

#### **Conclusion**

*M. alba* is an important multipurpose tree species of India with high fodder value. As our country is facing shortage of quality green fodder especially during lean period therefore promoting this tree for supplying quality green fodder should be focused on to sustain livestock in production in India.

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## नीम : प्रकृति का अनमोल उपहार

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### परिचय

नीम से हम सभी परिचित है, यह भारत में प्रायः सभी जगह पाया जाता है | इसका वैज्ञानिक नाम "अजाडिरेक्टा इंडिका " है जो की मेलियेसी प्रजाति से है।

ओषधीय गुण होने के कारण इसके पत्तियों, बीजों, फलों आदि का उपयोग पारंपरिक चिकित्सा में सदियों से होता आ रहा है | भारत के ग्रामीण क्षेत्रों में इसे "गाँव का दवाखाना " नाम की संज्ञा दी गयी है।

कृषि उपज बढ़ाने के लिए नीम के पत्तियों का खाद, कीटनाशक के रूप में पत्तियों का घोल एवं आनज भंडार में इसके पत्तियों का उपयोग सदियों से होता आ रहा है।

### उपयुक्त जलवायु एवं रोपण विधि

यह वृक्ष उष्णकटिबंधीय एवं उपोष्णकटिबंधीय जलवायु में आसानी से उग सकता है | यह 0-50°C तापमान आसानी से सहन कर सकता है, उच्च ताप सहनशक्ति के कारण इसे पश्चिमी राजस्थान जैसे कम वर्षा एवं बंजर भूमि में भी आसानी से उगाया जा सकता है।

अच्छी किस्म के बीजों को लगभग 10 मीटर लंबी, 1 मीटर चौड़ी तथा 15-20 सेमी ऊंची क्यारियां बना कर 15 से 20 सेमी. की गहराई में बो दिया जाता है , लगभग 1 महीने बाद इन पौधों को पॉलिथिन के थेलियों में स्थानतारित

कर दिया जाता है या बीजों को सीधे पॉलिथिन के थेलियों में बोया जा सकता है जिसमें उपजाऊ मिट्टी, जैविक खाद, और बालू की अनुपात 1:1:1 होनी चाहिए।

जब ये पौधे 4 से 6 महीने के हो जाए तो मानसून के समय में लगभग 5 x 5 मीटर की दूरी पर 30 x 30 x 30 सेमी. के गड्डों में प्रत्यारोपित कर देना चाहिए तथा मौसम अनुकूल समय पर सिंचाई करनी चाहिए तथा एक बात का विशेष ध्यान रखना चाहिए की इन गड्डों में जल जमाव न हो पाएं।

### नीम के खेती में समस्याएं

वैसे तो नीम बंजर भूमि में भी उग सकता है एवं उच्च तापमान सहन कर सकता है , इसके उत्पादों की भी बाजारों में मांग है , फिर भी यह किसानों के बीच लोकप्रिय नहीं हो पा रहा है इसके निम्न कारण है :-

- प्रचार की कमी
- अच्छे बीजों की सामान्य लोगों तक पहुँच न होना
- प्रशिक्षण की कमी
- स्थानीय मंडियों में नीम के कच्चे उत्पाद का खरीददार न होना
- नीम के उत्पाद कुछ वर्षों बाद प्राप्त होना , इस दौरान सरकार से कुछ आर्थिक सहायता न प्राप्त होना





नर्सरी में नीम के पौधे



नीम का पेड़

### नीम क्यों जरूरी है ?

- नीम; शुष्क, अर्द्ध शुष्क, बंजर भूमि में आसानी से उग सकता है इससे इन क्षेत्रों में होने वाले मृदा अवघटन

और मरुस्थलीकरण को नीम के पौधे लगा कर रोका जा सकता है।

- राष्ट्रीय पर्यावरण इंजीनियरिंग अनुसंधान संस्थान द्वारा नई दिल्ली के कुछ जगहों पर किए गए अध्ययन



से ये पता चल की दूसरे पेड़ों के मुकाबले नीम में प्रदूषण सहने और अवशोषित करने की क्षमता ज्यादा होती है, अतः शहरों में हरित पट्टी का विकास नीम के पेड़ों द्वारा किया जा सकता है।

- पिछले कुछ दशकों से रासायनिक उर्वरकों का उपयोग अनियंत्रित ढंग से किया गया, जिससे मृदा एवं पर्यावरण की गुणवत्ता में ह्रास हुआ है, नीम के जैविक खाद के उपयोग से ये रोका जा सकता है।
- पिछले कुछ वर्षों में नीम से संबंधित उत्पादों की बाजार में मांग बढ़ने के कारण नीम के कच्चे मालों को मंडी में अच्छी कीमत मिल रही है इससे किसानों को आय का एक वैकल्पिक स्रोत मिल रहा है।

### नीम रसायन

नीम को कार्बनिक पदार्थों का भंडार कहा जाए तो कोई अतिशयोक्ति नहीं होगी ! इसके पत्तियों, फलों, फूलों आदि में विभिन्न प्रकार के रासायनिक पदार्थ पाया जाता है जो इसको कृषि एवं औषधि में उपयोग योग्य बनाता है।

विभिन्न शोधों से प्राप्त जानकारी के अनुसार इसके पत्तियों में निम्न रासायनिक पदार्थ पाया जाता है।

टेबल 1 – नीम के पत्तियों में उपस्थित यौगिकों के

विवरण

महत्वपूर्ण यौगिक	उपलब्धता (प्रतिशत/100g)
कार्बोहाइड्रेट	47.46 - 51.2
कूड प्रोटीन	14.01 – 18.82

कूड फाइबर	11.20 – 23.80
वसा	
आमीनो एसिड (mg/100g)	73.3
ग्लूटामिक एसिड टैरोसिन (Tyrosine)	31.5
असपार्टिक एसिड	15.5
अलानीन (Alanine)	6.4
खनिज (Minerals) mg/100g	3.4
कैल्सीअम (Ca)	510.0
लोहा (Fe)	0.13 – 0.24
फास्फरस (P)	
नींब ऑलिड (Nimbolide)	-
नीम बीनेन (Nimbinene)	-
नींब इंडिऑल (Nimbandiol)	-

### नीम से प्राप्त उत्पाद

एक स्वास्थ्य एवं परिपक्व नीम वृक्ष से सालाना औसतन 30 – 50 कि.ग्रा. निंबोला (फल), 350 कि.ग्रा. पत्तियां एवं लकड़ियाँ प्राप्त की जा सकती है।

30 कि. ग्रा. फल से औसतन 6 कि.ग्रा. नीम का तेल और 24 कि.ग्रा. खली ( नीम केक ) प्राप्त किया जा सकता है।

5 \* 5 मीटर पर नीम लगाने पर प्रति हेक्टेयर औसतन 400 वृक्ष लगाए जा सकते हैं, जिससे 6-7 वर्षों बाद फलों और पत्तियों को बेच कर औसतन 5 – 8 लाख रुपया कमाया जा सकता है।





नीम का खली

नीम का फल

नीम का पत्तियां

## नीम का औषधीय गुण

हमारे पूर्वज सदियों पहले से ही नीम के औषधीय गुण से परिचित थे, इसलिए वे नीम को "गाँव का दवाखाना" नाम की संज्ञा दिया | आयुर्वेद चिकित्सा में नीम का एक महत्वपूर्ण स्थान है , नीम के औषधीय गुण पर अनेकों शोध पत्रिका प्रकाशित हो चुका है और अभी भी गहन शोध जारी है।

नीम के कुछ औषधीय गुण निम्न हैं:-

- नीम के कोमल पत्तियां चबा कर खाने से रक्त शोधन होता है।
- नीम के पत्तियों को पानी में उबाल कर नहाने से चर्म रोग नहीं होता है।
- नीम के पत्तियों का लेप बालों में लगाने से बाल स्वास्थ्य रहते हैं।
- नीम के दातुन से दांत साफ करने पर दांत साफ और स्वास्थ्य रहता है।

## नीम का कृषि में उपयोग

नीम के पत्तियों, फलों, बीजों में किटाणु रोधी एवं जीवाणु रोधी गुण होने के साथ - साथ इनमें प्रचुर मात्रा में खनिज एवं पोषक तत्व मौजूद होता है , जो की एक पौधे के विकास के लिए आवश्यक होता है।

पिछले कुछ दशकों से रासायनिक कीटनाशकों एवं उर्वरकों के अत्यधिक इस्तेमाल से उपजाऊ भूमि का तेजी से निम्नकरण हो रहा है , इसलिए किसान जैविक खाद की और अग्रसर हो रहे हैं | पिछले कुछ वर्षों में नीम आधारित कीटनाशकों

और उर्वरकों का बाजार में मांग बहुत तेजी से बढ़ा है।

नीम का उपयोग कृषि में निम्न है :-

- सामान्य यूरिया के मुकाबले नीम लेपित यूरिया में नाइट्रोजन की मात्रा अधिक होती है और यह जल एवं भूमि को प्रदूषित नहीं करता है इसलिए उर्वरक के रूप में नीम लेपित यूरिया उत्तम माना जाता है।
- नीम का खली (बीज से तेल निकालने के बाद बचा अवशिष्ट ) में अनेकों खनिज तत्व पाया जाता है , इसका इस्तेमाल पोधा रोपण के समय खाद के रूप में किया जाता है।
- नीम का तेल भी कीटनाशक के रूप में उपयोग किया जाता है।
- नीम का पत्तियों का जैविक खाद पौधों के लिए उत्तम माना जाता है क्योंकि पत्तियों में कार्बोहाइड्रेट , प्रोटीन, फाइबर, खनिज तत्व पाया जाता है जो की पौधे के विकास के लिए आवश्यक होता है।
- पत्तियों को पानी में भीग कर या पिसकर उस पानी को कीटनाशक के रूप में फसल में छिड़काव किया जाता है।

## नीम- भूत, वर्तमान और भविष्य

सदियों से नीम का उपयोग घरेलू स्तर पर छोटे - मोटे बीमारियों का इलाज एवं कृषि में



कीटनाशक के रूप में होता था , लोग इसके व्यापक गुण से अपरिचित थे | जैसे-जैसे तकनीक का विकास हुआ नीम पर शोध पत्रों की बाढ़ आ गई और इसका उपयोग घरेलू स्तर से व्यावसायिक स्तर पर होने लगा | आज बाजार में नीम आधारित बहुत से प्रभावकारी औषधि एवं कीट नाशक, खाद उपलब्ध है।

भारत सरकार के लिए नीम आधारित परियोजनाएँ “आम के आम गुठली के दाम ” साबित हुआ है , इससे किसानों को आय के वैकल्पिक स्रोत मिल रहा है , साथ ही में वृक्ष रोपण से पर्यावरण भी स्वच्छ हो रहा है। नीम को बढ़ावा देने के उद्देश्य से भारत सरकार 2015 से 100% नीम लेपित यूरिया उपलब्ध कराने का निश्चय लिया है इससे ना केवल नीम के खेती को बढ़ावा मिलेगा बल्कि वनीकरण के लक्ष्य को भी प्राप्त करेगा |

### निष्कर्ष

नीम एक बहुपयोगी वृक्ष है , इसका उपयोग कृषि के साथ-साथ औषधि , शृंगार प्रसाधन आदि में किया जाता है | यह बंजर एवं पथरीली भूमि में उग सकता है अतः इससे भूमि निम्नीकरण को आसानी से रोका जा सकता है | कम लागत में किसानों को अच्छी आमदनी का एक वैकल्पिक स्रोत प्रदान कर सकता है |

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## Navigating the future: The role of technology in precision forestry

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### Abstract

The principle of “precision forestry” is that it uses modern tools and technology to get as much real information as it is possible to improve decision making process and to ensure current goals of forest management. The best known and most frequently used tools of modern technology are remote sensing, navigation systems and geographic information systems. New trends are decision support systems and tools for tree identification and tools for wood material testing and measurement. There is a large interest of the forestry sector in these technologies because as the primary source of data “precision forestry” provides more accurate (realistic) information than currently used sources. Aim of this article is to clarify and inform the professional, but also the general public with the precision forestry, its definition and its tools.

**Keywords:** Forest Management; Technology; modern tools; decision making

### Introduction

Precision forestry is a term adapted from the agricultural sciences, where for some years ‘precision agriculture’ has been used to describe the application of modern electronics, computers and sensors to

agriculture and its related disciplines. The term ‘precision forestry’, coined relatively recently, refers to the use of high-tech sensors and analytical tools to support site-specific forest management (McRoberts et al., 2010). Precision forestry furthers this tradition through the development and application of technologies that provide detail on our forests, and the environments they inhabit, along with mechanisms to store and analyse the newly available data to create relevant information and knowledge.

There are a multitude of definitions and applications of the term, but a useful summary comes from the opening remarks to the inaugural Symposium on Precision Forestry (2001) by Professor B. Bruce Bare of the University of Washington:

The goal of precision forestry is to deploy high resolution data to support site-specific tactical and operational decision-making. This allows for highly repeatable measurements, actions and processes to grow and harvest trees, as well as to protect and enhance riparian zones, wildlife habitat, aesthetics, and other environmental resources.

### Key aspects of precision forestry

Precision forestry is an advanced approach to forest management that utilizes technology, data analytics, and automation



to optimize various aspects of forestry operations. The goal is to enhance efficiency, sustainability, and productivity in the management of forest resources. Here are some key aspects of precision forestry:

#### **Remote sensing and monitoring**

- Discuss the use of satellite imagery, drones, and other remote sensing technologies to gather detailed information about the forest, including tree health, density, and overall condition.
- Explore how real-time monitoring helps in detecting disturbances such as pests, diseases, or illegal logging.

#### **Data analytics and decision support systems**

- Explain how big data analytics and decision support systems are employed to process and analyze vast amounts of information collected from the forest.
- Discuss how these systems help in making informed decisions related to harvesting, replanting, and overall forest management.

#### **Forest inventory and growth modeling**

- Discuss how precision forestry utilizes advanced inventory methods, including laser scanning and LiDAR (Light Detection and Ranging), to accurately assess the composition and structure of the forest.
- Explore growth modeling techniques that use collected data to predict future forest development.

#### **Precision silviculture**

- Explore the concept of precision silviculture, which involves tailoring forest management practices to specific site conditions and individual trees.
- Discuss how precision silviculture aims to optimize the growth and yield of forests while minimizing environmental impact.

#### **Instruments and technologies used in precision forestry**

##### **Light detection and ranging (Lidar)**

Lidar is a laser-based surveying technology used in many industries and fields of research. Sensors measure the distance between emitted and reflected pulses of laser light, to create a 3-D image (“point cloud”) of the object scanned. The sensors can be mounted on aircraft or ground based. In forestry, they are increasingly used to produce terrain or water-flow models and derive estimates of standing wood inventory (such as trees per hectare, tree heights, and trunk diameters). The potential applications for lidar are many and powerful. For example, more precise knowledge of terrain, water flows, and forest inventory can help optimize road construction, with roads placed to minimize cost and environmental impact and built in the best sequence to match harvest plans. The benefits can be far beyond initial expectations.

##### **Unmanned aerial vehicles (uavs)**

UAVs are increasingly used in forestry for surveillance and mapping. They can also be fitted with lidar or thermal cameras to collect forest-inventory data, detect outbreaks of pests and diseases, and give early warning of forest fires. There are even early attempts to utilize UAVs in remote or difficult terrain for simple

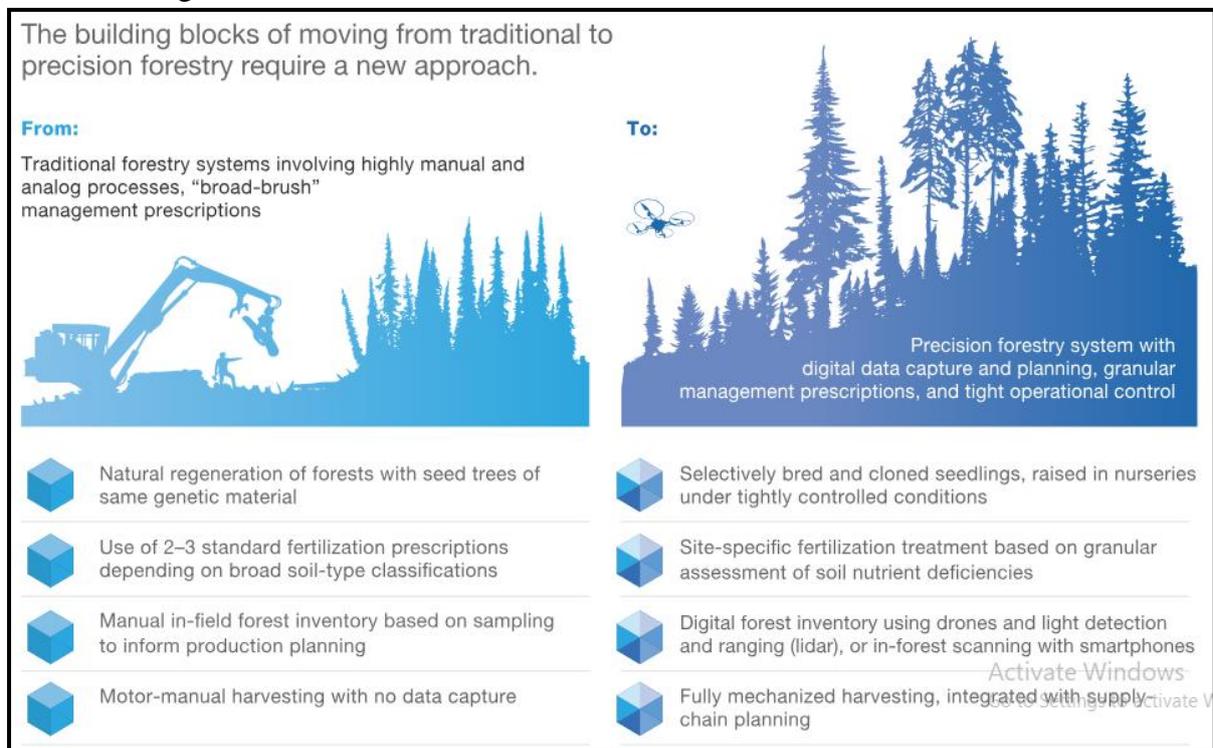


forestry operations, such as planting seeds, spraying for weeds, pests, and diseases, and fertilizing young seedlings. As with lidar, the potential applications for UAVs are many, as they are both tried and tested, and the underlying UAV technology continues to evolve.

**Individual tree analysis (ITA)**

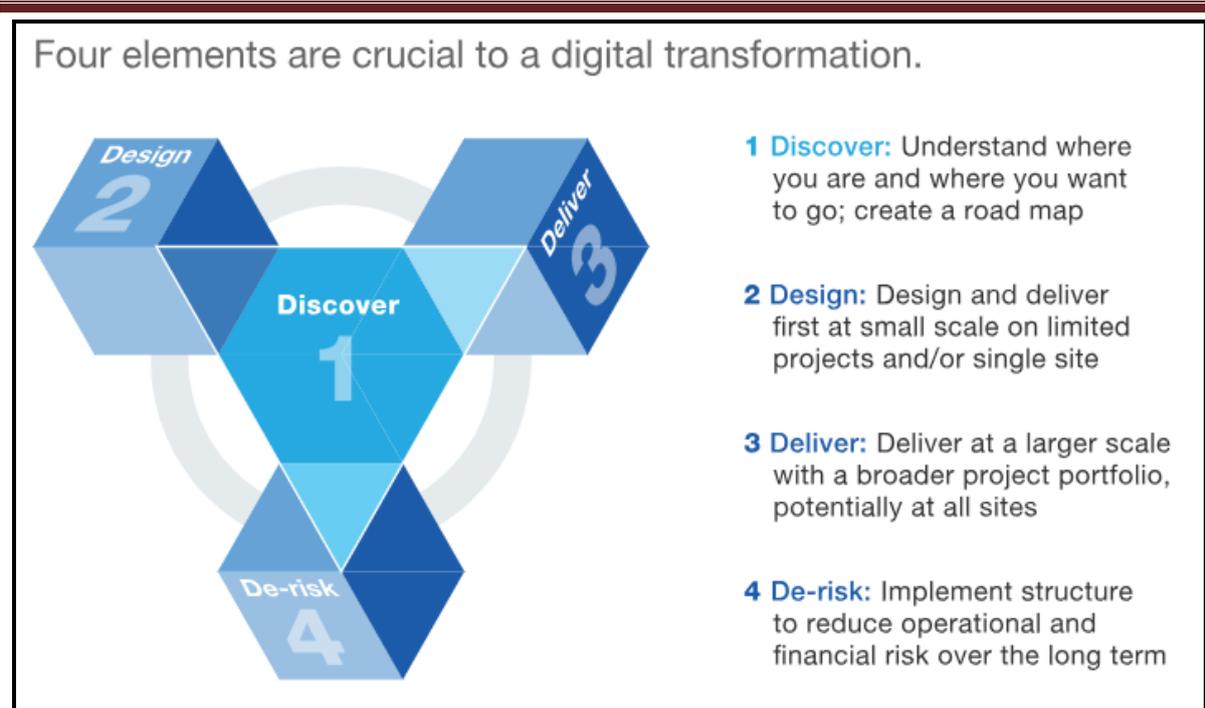
Research into ITA is an exciting and rapidly changing area with considerable potential to provide detail on tree dimensions. The techniques generally rely on identifying and delineating the crowns of individual trees in the ALS point cloud and extracting tree-level metrics. These

metrics can be used to measure tree traits directly, or to build empirical models that can be used to estimate variables of interest based on aspects of canopy size or shape. Although somewhat challenged by GPS inaccuracies under a closed canopy and the requirement for denser point clouds, the implications of ITA for precision forestry are profound. As well as possibly opening the door for individual tree inventory practices, ITA also has the potential to provide a means of characterizing the growth and performance of every tree in a subject forest.



**Figure 1:** Building blocks from traditional to precision forestry





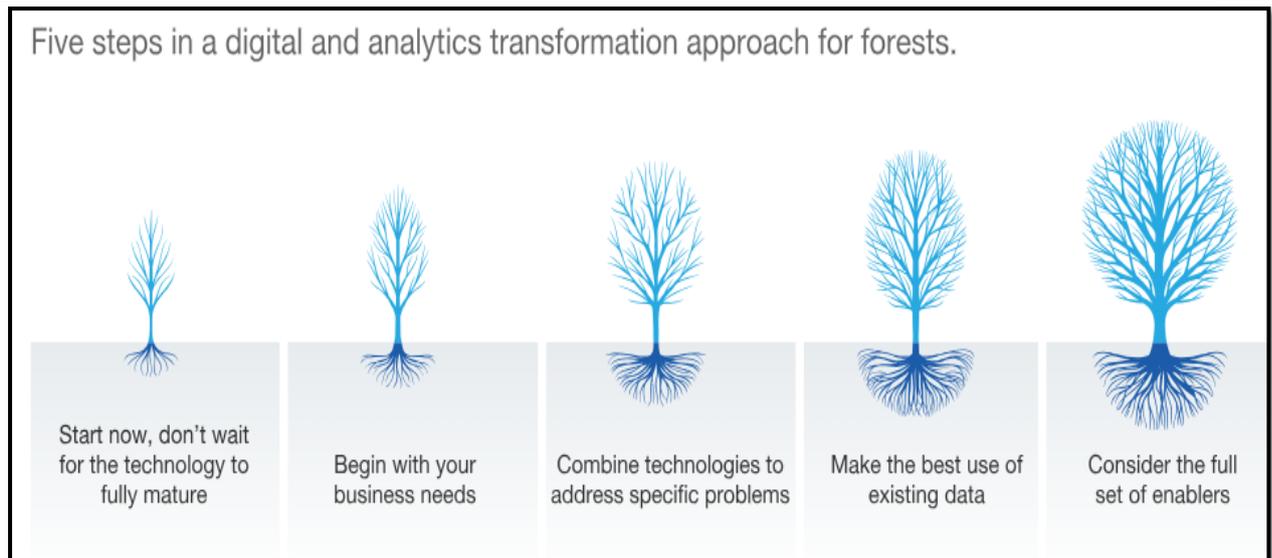
**Figure 2:** Four Elements to digital transformation

### Five steps in precision forestry

From our experience to date, we can offer five practical pointers to ensure that a company is well aligned at the start of its precision forestry digital transformation:

- Start now, don't wait for the technology to fully mature. For instance, use manual reading of UAV images while algorithms are being built, because this helps narrow down the exact problems to solve, and the requirements for doing so.
- Begin with your business needs. Many precision forestry technologies are used for data collection, which is only the starting point and should be followed by analytics, and only then decision making.
- Combine technologies to address specific problems. The new technologies are most powerful when used in combination, for instance, for forest re-establishment: UAVs to collect stocking data, analysis to identify low stocking hot spots, and decision making to prioritize areas to replant.
- Make the best of use of existing data. This, if cleaned and integrated into one unified data set, may be enough in itself to run predictive analytics and drive improved decision making.
- Consider the full set of enablers. Don't look at just the new technologies—consider the IT backbone, business processes, capabilities, and organizational setup as well.





**Figure 3:** Five Steps in precision forestry

### Conclusion

Precision forestry emerges as a transformative force in sustainable forest management, seamlessly blending advanced technologies with ecological stewardship. By harnessing the power of remote sensing, data analytics, and automation, precision forestry optimizes operational efficiency, enhances environmental sustainability and fosters economic viability. Despite challenges such as implementation costs and societal impacts, the precision forestry paradigm

offers unprecedented opportunities for informed decision-making, resource conservation, and the coexistence of human needs with ecological balance. As we navigate this dynamic landscape, the collaborative efforts of technology developers, forestry professionals, and communities will be pivotal in shaping a future where precision forestry not only meets the demands of the present but also safeguards the health and resilience of our forests for generations to come.



## *Quercus semecarpifolia* – A fascinating tree in western Himalayas

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### Introduction

The intriguing tree species *Quercus* (oak) belongs to the Fagaceae family. The Indian Himalayan lands are home to almost 35 species of *Quercus* which can thrive well at altitudes ranging from 1000 – 3600 m. Oaks thrive in a range of habitats, including temperate deciduous forest, evergreen forests, savannahs and subtropical woodlands (Tantray *et al.*, 2017). *Quercus* is a gregarious tree species and its few species also create the climax vegetation at high altitudes. The most common oak species in the Western Himalayas are *Quercus glauca* (Phaliyant), *Q. leucotrichophora* (Banj), *Q. floribunda* (Moru), *Q. semecarpifolia* (Kharsu) and *Q. ilex* (Holm oak). These oak species are found at various altitudes and have physical characteristics that distinguish them from one another.

*Quercus semecarpifolia* Smith, often known as Kharsu oak or Brown oak, is a high-altitude oak species found in the Western Himalayas. It is evergreen in nature and can be found in elevations ranging from 8000 – 12000 ft (Troup,

1921). Being a gregarious tree species, it forms usually pure stands of forests (Shrestha, 2003). *Q. semecarpifolia* is a major tree species in upper temperate and subalpine forests of the Himalayas forming climax vegetation at high altitudes. It is an economically and ecologically significant multipurpose tree species (Singh *et al.*, 2021). It provides fuelwood, fodder, agricultural implements, tannin and is also used in tasar sericulture (Singh *et al.* 1997).

*Q. semecarpifolia* is the most favored forest for luxuriant growth of ground flora, habitat for animals and multipurpose usage by the local people due to the maintenance of microclimate and ideal habitats with a rich source of natural resources. It is crucial to environmental balance at both the local and regional levels in a climax community as it also help in mitigating climate change by sequestering atmospheric carbon. Thus, it becomes imperative enough to know about the various morphological and nutritive dimensions of this species.



**Distribution and Habitat: (Troup, 1921)**

<b>Altitudinal range</b>	8000 to 12000 ft.
<b>Soil</b>	It can be found both on poor rocky soils, where it is typically stunted, and on deep, rich, moist soil in more or less sheltered locations.
<b>Precipitation</b>	Occurs in the regions that receive heavy snowfall and moderate rainfall.
<b>Aspect</b>	Occurs on all aspects and slopes

**Morphology and Phenology: (Troup, 1921)**

<b>Height</b>	80 – 90 ft
<b>Girth</b>	Upto 7 ft or more
<b>Leaves</b>	2-4 inches long leaves are elliptic or oblong in shape and are coriaceous, glabrous and spinous in young trees but often whole on mature trees and dark green in color from above and brown tomentose on lower surface.
<b>Bark</b>	Cracked in rectangular scales and is rough and dark grey in color.
<b>Male Catkin</b>	Catkins are 2-5 inches long appears on the new shoots as dense drooping clusters
<b>Female flower</b>	The female spikes is almost 0.8 inches long and comes with 3-12 small sessile flowers and are axillary at the upper portion of the new shoot.
<b>Acorn growth</b>	Acorn growth is minimal or nonexistent during the first season. The second season, however, sees the successful rapid growth of acorns of various sizes that are green and dark brown in hue. Acorn ripening typically takes 15 months, starting from the time of blossoming. The acorn ripens between June and August, and germination happens as soon as the fruit falls.

**Silvicultural features: (Troup, 1921)**

<b>Light requirement</b>	Light demander species
<b>Root system</b>	Gigantic root system
<b>Wind resistance</b>	Wind firm in nature
<b>Coppicing power</b>	Coppicing and pollarding ability of this species is remarkably well
<b>Damage by snow</b>	Quite susceptible to the damage by the drifting/sliding snow





**Causal associates**

<b>Causal associates</b>	Its casual associates among conifers are <i>Picea simithiana</i> , <i>Taxus baccata</i> , <i>Pinus wallichiana</i> and <i>Abies pindrow</i> and the broad-leaf associates are <i>Prunus pardus</i> , <i>Betula utilis</i> , <i>Acer caesium</i> , <i>Pyrus lanata</i> , <i>Juglans regia</i> and <i>Rhododendron arboreum</i> . In the <i>Q. semecarpifolia</i> forest, shrubs including <i>Rosa</i> , <i>Rubus</i> , <i>Viburnum</i> , <i>Lonicera</i> , <i>Rhododendron</i> , <i>Myrsine</i> , <i>Berberis</i> , <i>Daphne</i> and dwarf bamboo are also known to be associated with this tree.
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**Nutritive value (on % Dry matter basis)**

Parameters	Content	Reference
Dry matter	53.40 %	Anandan and Dey, 1998
Organic matter	95.20 %	Anandan and Dey, 1998
Crude fibre	26.70 %	Anandan and Dey, 1998
Crude protein	8.38 to 9.22%	Singh Todaria, 2012
Ether extracts	3.8 %	Singh <i>et al.</i> , 1998
Total ash	4.80 %	Singh <i>et al.</i> , 1996
Acid insoluble ash	0.07 %	Paswan <i>et al.</i> , 2008
Neutral detergent fibre	53.90 %	Raju <i>et al.</i> , 2018



Acid detergent fibre	50.20 %	Raju <i>et al.</i> , 2018
Calcium	1.6 %	Singh <i>et al.</i> , 1998
Phosphorus	0.23 %	Sahoo <i>et al.</i> , 2016

### Uses

- It makes good firewood and excellent charcoal as the calorific value of its sapwood is almost 4,879 kcal and of heartwood 4,815 kcal/kg of dry wood and is thus extensively used by the local inhabitants during the winter period.
- It also acts as a source of food for wild animals as bears that are particularly fond of its acorns.
- Its utilization as a fodder tree is very frequent, as it is extensively lopped in the hills of Himachal Pradesh and Uttarakhand for livestock feeding, especially, during the winter season as there is scarcity of the other fodder resources during the winter season.
- Its wood is generally used only locally for building door frames, beds stands, ploughs, mule saddles and as a substitute for imported oak for kegs in distilleries.
- It is also one of the essential yielder of tannins almost contains up to 23.65% of tannin its bark and branches.
- Its utilization in making the handles of the agricultural implements is also reported.

### Threats to *Q. semecarpifolia*

- Excessive lopping for fodder, charcoal production and fuelwood

causes immense damage to its forests (Shrestha *et al.*, 2013).

- Large scale felling of trees in its forests for human settlements and increasing the cultivation area for carrying out agriculture activities.
- Overgrazing or uncontrolled grazing in its forests leads to the destruction of its seedlings, thereby reducing its regeneration.
- Alteration of the understory growth due to biomass collection adversely affects its regeneration potential.
- Invasion by the alien species and obnoxious weeds like *Eupatorium odoratum* leads to the destruction of the native species like seedlings of *Q. semecarpifolia*.

### Conclusion

*Q. semecarpifolia* is one of the important multipurpose oak species in Western Himalayas. It not only provide numerous tangible benefits such as fuelwood, fodder, timber, tanning material and food for animals, but, also provides different regulating services as amelioration of microclimate, enhancement of soil fertility, water cycle regulation, carbon sequestration and support the biodiversity. However, its forests are being deteriorated by factors such as excessive lopping for fodder, overgrazing, high rate of forest litter removal and invasion by obnoxious weeds. Thus, by considering the multipurpose nature of *Q. semecarpifolia*, it needs to be protected by adopting conservational measures like regular



checks on its felling by the officials of forest department and imposing strict penalty for such offences. Collective efforts from the nomadic communities and local people to protect its regeneration from the domestic and wild animal populations is required and setting up of protected areas like national parks and wildlife sanctuaries in habitat or highly distributed areas of *Q. semecarpifolia* can be done. Thus, by making the local population aware regarding the multiple uses of *Q. semecarpifolia*, we can conserve this fascinating tree of Western Himalaya.

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## Sea turtle conservation through beach management and hatchery programmes

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Sea turtles have remarkable lifestyles, which makes them fascinating to both professional biologists and wildlife enthusiast. They are air breathing vertebrates like birds and mammals but have returned to a near complete life in the water. Most sea turtles undertake long distance migrations, as hatchlings and juveniles during a long pelagic phase in the open ocean, and as adults between their feeding and breeding grounds. Sea turtles do not have parental care. The female turtle deposits the eggs on the beach and leaves the rest to nature. Nature worked pretty well for millions of years, but human related threats such as harvest of adults and eggs, incidental catch in fisheries, erosion, sand mining, beach armouring, lighting and predation by feral animals has had severe negative impacts on most turtle populations. Thus, it is important to consider the following components for the success of conservation programme to safeguard the populations of sea turtles:

### Population size and trends

It is important to accurately determine whether populations are increasing or decreasing or stable. Hence, even if the main focus of a programme is conservation education, it is essential to keep records of details like the number of

nests laid on a particular beach each season.

### Assessment of habitat

The nesting habitat should be assessed periodically to evaluate threats such as sand mining, beach armouring and lighting.

### Sources of mortality

These will essentially determine the main actions to be taken towards conservation.

### Research and data management

Basic research often provides useful insights into the biology of a species, which can have important implications for conservation. Data should be collected systematically on nesting season, abundance (number of nests/ beach/ season), adult mortality, clutch sizes and on hatching success in-situ and in the hatchery.

### Public awareness and education

Public support is required for successful conservation, and hence education and awareness must form a central part of conservation programmes.

### Involving local communities

It has become increasingly clear that successful conservation programmes need to involve local communities i.e., the people who are most directly in contact with the animals in question.

### Setting up a hatchery

### Location of the hatchery



The best location for a hatchery is at a site that is similar as possible to the habitat of the nesting site of the turtles. If the beach is sufficiently long, several hatcheries should be established. Hatcheries also need to be located close to the nesting beach to minimize trauma during transportation of eggs. The hatchery should be enclosed by chain link fence or wire mesh.

### Collection and transport

Sea turtles are very sensitive and may return to the sea without nesting if they are disturbed while stranding or excavating. During this period, workers should be very careful not to disturb the turtle with lights or movement. Ideally, eggs should be collected, transported and placed in the hatchery within 2 hours after egg deposition. Eggs collected within 8 – 10 hours generally have a good chance of survival, if handled carefully.

### Nest construction

The nest should be constructed in the shape of the natural nest i.e., with a narrow

neck and a flask shaped bottom. The eggs should be buried at the same depth as the natural nest, which can vary depending on the species of turtle and then covered first with moist and then dry sand on the very top. Some hatcheries use mesh enclosures for each nest to restrain hatchlings after they emerge to facilitate data collection and release. However, hatchlings should be released immediately after they emerge from the nest, or else they may die due to extended periods of exposure to sunlight.

### Hatchlings release

Hatchery personnel should anticipate hatching for each nest. Expected dates of hatchling emergence can be estimated from date of collection, and can also be predicted by the “caving in” of sand surface above the nest when hatching begins. Hatchlings should be released into the sea immediately after emergence, but at different times of the night and at different points to prevent the creation of feeding stations for bigger fishes.



**Olive Riddley Sea turtle hatchlings release activity at the Besant Nagar beach, Chennai**  
(Pic courtesy: The New Indian Express, E – Paper)



**Beach management programme**

Hatcheries are obviously not an ideal solution to the conservation of sea turtles since they involve substantial manipulation of natural events. They require considerable manpower and hatching success of nests may be much reduced. An alternative is to suggest that one should simply remove all the people and associated predators, but this may be neither ethical nor possible. Alternative methods of beach management or in – situ protection include a variety of measures.

**Beach patrols and disguising nets**

The very presence of monitoring and surveillance personnel or even just researchers are often enough to deter egg collectors. All five species of sea turtles found in Indian waters are classified in Schedule I of the Wildlife Protection Act, 1972. Offenders can be sentenced to imprisonment for maximum of seven years. Egg collectors can be deterred by removing the evidence of nesting by wiping out the track and smoothing over the nesting site.

**Predator control**

Sometimes, the best way to deal with predators is to eliminate them. However, this is an option to be excised only with domestic feral, introduced species because elimination of native predators can negatively impact the coastal ecosystem. The placement of mesh or caging surrounding each individual nest is possible on beaches where the main threat

is from predators such as dogs and pigs. The mesh should be buried deep enough to protect the egg from burrowing by predators.

**Conclusion**

Hatchery and Beach management programmes are playing a crucial role in maintaining the population of sea turtles in balance by reducing the threats to the eggs and hatchlings. Along with conservation, it offers excellent opportunities for education and awareness. They allow wildlife enthusiasts and students to participate in and contribute to conservation programmes, and help in giving them exposure to key conservation issues and to learn the basics and ethics of wildlife conservation.

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## Overview of versatility and rigorous quality of Tara gum tree

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### Abstract

Over the past few decades, there has been a notable surge in research efforts dedicated to the exploration of naturally occurring polymers owing to their advantageous physicochemical properties. Among these polymers, polysaccharides have emerged as focal points in investigations related to drug delivery and biomedical applications. Tara gum, a specific polysaccharide, has garnered significant attention in nutraceutical, pharmaceutical, and biomedical fields. Its versatile applications span from safeguarding bioactives against environmental degradation to packaging food materials and contributing to controlled-release drug delivery systems. Notably, Tara gum has undergone various derivatizations, broadening its potential applications. Modified forms of the gum have found utility in diverse biomedical contexts, such as the development of superabsorbent polymers. These polymers, in turn, have practical applications in areas like diaper manufacturing, gardening, and agriculture, particularly in arid regions. Despite the substantial progress made in this realm, comprehensive summarizations of these advancements remain conspicuously absent in the existing literature. This article seeks to fill this void by providing a succinct overview of Tara gum. It aims to encapsulate key aspects,

including the source of the gum, structural interpretations, and rheological analyses. Additionally, the article strives to offer an in-depth exploration of existing literature, with a specific emphasis on elucidating the diverse applications of Tara gum and its modified forms within the pharmaceutical and biomedical domains. Through this comprehensive synthesis of information, the article endeavors to contribute to a better understanding of the potential and versatility of Tara gum in cutting-edge scientific and industrial applications.

**Keywords:** Poinciana spinosa MOL, Caesalpinia pectinata and Polysaccharide.

### Introduction

Tara gum is obtained through the grinding of the endosperm of the seeds of *Caesalpinia spinosa*, a plant belonging to the Leguminosae family. Primarily composed of high molecular weight polysaccharides, Tara gum predominantly consists of galactomannans. The main component of Tara gum is a linear chain composed of (1,4)-beta-D mannopyranose units, with alpha-D-galacto-pyranose units attached through (1,6) linkages. Notably, the mannose to galactose ratio in Tara gum is 3:1. This ratio distinguishes Tara gum from other similar gums, such as carob bean gum (4:1) and guar gum (2:1).

Tara gum is often characterized further in terms of viscosity and loss on drying, providing additional specifications for its



commercial use. This detailed chemical and structural information forms the foundation for understanding the unique properties and applications of Tara gum in

various industries, including nutraceuticals, pharmaceuticals, and biomedical fields.



It's interesting to note that Coyote Brand Tara Gum is derived from *Caesalpinia spinosa*, a member of the Leguminosae family. This plant species is the source of Tara gum, and it is primarily cultivated in Peru. The production of Tara gum typically occurs from April through December, suggesting a seasonal aspect to its harvesting and processing.

### Characteristics

#### Solubility

Tara gum is soluble in water, meaning that it can dissolve in water to form a homogeneous solution. This solubility in water makes it a versatile ingredient for various applications, especially in food and pharmaceutical industries where water-based formulations are common. On the other hand, Tara gum is insoluble in ethanol, indicating that it does not dissolve in ethanol or alcohol. This property may have implications for certain applications where ethanol-based solutions are involved, as Tara gum may not exhibit the same level of compatibility or solubility.

#### Gel test

Evidence showing that the sample forms a gel when tiny volumes of sodium borate are added to its aqueous solution indicates that the sample probably possesses gelation capabilities. Sodium borate, also known as borax, is a common cross-linking agent for certain types of polysaccharides, including galactomannans like Tara gum.

#### Viscosity

The provided procedure outlines the preparation and testing of a solution using the sample, likely Tara gum. Let's break down the steps:

1. Transfer 2 g of the sample into a 400-ml beaker:
2. Measure 2 grams of the sample and place it in a 400-ml beaker.
3. Moisten the sample with about 4 ml of isopropanol:
4. Add approximately 4 ml of isopropanol to the sample in the beaker, ensuring thorough moistening.



5. Add 200 ml of water with vigorous stirring:
6. While stirring vigorously, add 200 ml of water to the beaker containing the moistened sample. Continue stirring until the gum is completely and uniformly dispersed.
7. Observe the formation of an opalescent, moderately viscous solution:
8. The resulting solution should be opalescent (having a milky or cloudy appearance) and moderately viscous. It's noted that this solution is less viscous than a guar gum solution but more viscous than a carob bean gum solution when prepared and tested similarly.
9. Transfer 100 ml of this solution into another 400-ml beaker:
10. Take 100 ml of the prepared solution and transfer it to a different 400-ml beaker.
11. Heat the mixture in a boiling water-bath for about 10 minutes:
12. Place the second beaker containing the 100 ml solution in a boiling water-bath and heat the mixture for approximately 10 minutes.
13. Cool the solution to room temperature:
14. Allow the heated solution to cool down to room temperature. Observe a marked increase in viscosity.

After cooling, observe that the solution shows a significant increase in viscosity compared to its initial state. This viscosity

change indicates a potential gelling or thickening property, which is a characteristic feature of certain gums, including Tara gum.

#### **Purity**

##### **Loss on drying**

Not more than 15%

##### **Ash**

Not more than 1.5%

##### **Acid insoluble matter**

Not more than 2%

##### **Protein**

Not more than 3.5%. Proceed as directed under Nitrogen Determination (Kjeldahl method). The percentage of nitrogen determined multiplied by 5.7 gives the percentage of protein in the sample.

##### **Starch**

Not detectable To a 1 in 10 solution of the sample, add a few drops of iodine TS. No blue colour is produced.

##### **Lead**

Not more than 2 mg/kg Determine using an atomic absorption technique appropriate to the specified level.

##### **Functions of properties**

The unique properties of Tara Gum position it as a versatile hydrocolloid with distinctive characteristics. Some key features include:

##### **Bridging cold soluble guar and cold insoluble locust bean gum**

Tara Gum exhibits a unique position between cold-soluble, highly galactose-substituted guar gum and cold-insoluble, lower galactose-substituted locust bean gum. This positioning suggests a balance of solubility and galactose substitution that makes it distinct in its application.

##### **Associative or synergistic effects**

Tara Gum demonstrates associative or synergistic effects, similar to locust bean



gum. This means that it can enhance viscosity and gelation when used in combination with certain other hydrocolloids, such as Kappa and Iota Carrageenans and Xanthan Gum. This feature expands its applicability in various formulations.

#### **Viscosity and gelation similar to locust bean gum**

Tara Gum solutions share similarities with locust bean gum solutions in terms of high viscosity and a short texture. This indicates its potential as a thickening and gelling agent in various food applications.

#### **Texture enhancement in frozen desserts**

In frozen desserts, Tara Gum contributes to a fat-like texture, smooth eating properties, and provides excellent heat shock protection. These attributes make it valuable in the formulation of frozen treats.

#### **Potential in mixtures with xanthan gum**

The combination of Tara Gum and Xanthan Gum in mixtures is noted for providing excellent long-term suspensions. This suggests potential applications in products like salad dressings, sauces, and similar formulations where suspension stability is crucial.

In summary, Tara Gum stands out for its unique positioning between guar and locust bean gum, its associative effects with other hydrocolloids, and its specific contributions to texture, smoothness, and stability in various food applications, especially in frozen desserts and suspensions. This makes it a valuable ingredient for creating desirable attributes in a range of food products.

#### **Food applications**

Tara Gum is highlighted for its benefits in non-fat and low-fat food products, such as

frozen desserts, cultured dairy products, condiments, baked goods, and salad dressings.

#### **Versatility in applications**

Tara Gum is suitable for a wide range of non-fat and low-fat food applications, making it a versatile ingredient in the food processing industry.

#### **Cold-solubility**

Similar to guar, Tara Gum is cold-soluble, and it achieves maximum viscosity in water, milk, and other low-solid systems within a short period, typically several minutes.

#### **Synergistic effects**

Tara Gum works synergistically with other hydrocolloids like Kappa Carrageenan and Xanthan Gum. This synergy enhances gel strength and reduces the susceptibility of gels to syneresis (the release of liquid).

#### **Cold-water solubility and viscosity**

Tara Gum provides cold-water solubility and viscosity at 25°C, contributing to its usability in various food processing conditions.

#### **Heat shock protection**

Unlike Locust Bean Gum, Tara Gum offers outstanding heat shock protection. This property is essential in preventing undesirable changes in texture and structure due to temperature fluctuations during processing and storage.

#### **Buttery mouthfeel**

Tara Gum imparts a rich buttery mouthfeel to food products, enhancing their sensory appeal.

#### **Lower usage levels**

Tara Gum requires usage levels that are 20 to 25 percent less than Locust Bean Gum. This can result in cost savings for food processors.

#### **Resistance to breakdown**



Tara Gum resists breakdown during high shear conditions, maintaining its functionality and structure in demanding processing environments.

#### **Improved texture in frozen desserts**

In comparison to Locust Bean Gum, Tara Gum provides a better texture in frozen desserts without causing gumminess. This makes it a preferable choice for achieving desired frozen dessert characteristics.

Overall, Tara Gum appears to be a valuable ingredient for food processors, offering a range of functional benefits across different food applications.

#### **Conclusion**

Tara Gum stands as a naturally occurring hydrocolloid polysaccharide with a distinctive high molecular weight. Its molecular structure is intricately woven with galactan and mannan units, connected through glycosidic linkages, akin to the composition of guar and locust bean gum. The United States Food and Drug Administration (FDA) have conferred upon Tara Gum the Generally Recognized as Safe (GRAS) status, attesting to its safety for consumption. In accordance with the specifications detailed in the Food Chemicals Codex, Tara Gum fully complies and aligns with regulatory standards, ensuring its secure utilization in food applications. The endorsement extends to the Federal Register,

elucidating the permissible uses in the realm of food. Furthermore, Tara Gum meets the criteria set forth by the United States Pharmacopeia, allowing its incorporation not only in food but also in pharmaceutical applications, underscoring its versatility and compliance with rigorous quality standards.

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## कसई: एक बहुउपयोगी एवं बहुआयामी वृक्ष प्रजाति

मनोज पूसाम, प्रमोद कुमार, फातिमा शिरीन, रमा सोनी एवं सुषमा मरावी

आनुवांशिकी एवं वृक्ष सुधार प्रभाग

भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद -उष्णकटिबंधीय वन अनुसंधान संस्थान  
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कसई का वानस्पतिक नाम *Bridelia retusa* है, जो कि Phyllanthaceae, परिवार से संबंधित है, आमतौर पर भारत में इसे खाजा या कसई के रूप में जाना जाता है, यह भारत के गर्म भागों में पाया जाने वाला एक उष्णकटिबंधीय छोटा वृक्ष है। इसे मराठी में आसन, हिंदी में काजी, अंग्रेजी में स्पिन्स किनो ट्री कहा जाता है, यह जंगलों, नदी के किनारे एवं चट्टानी स्थानों में पाए जाते हैं। यह महाराष्ट्र, कर्नाटक, केरल, और तमिलनाडु में बहुतायत में पाया जाता है। दक्षिण भारत में 2000 मीटर तक मध्य और मध्य-पूर्व भारत में 600 मीटर तक, 1000 मीटर तक हिमालय के क्षेत्रों में और 1000 मीटर तक उत्तर पूर्व भारत में पाया जाता है। यह मुख्यतः बांग्लादेश, नेपाल, श्रीलंका, दक्षिणी चीन, इंडोचाइना और सुमात्रा आदि देशों में भी पाया जाता है। अंडमान और निकोबार द्वीप समूह को छोड़कर पूरे भारत वर्ष में पाया जाता है। इसकी छाल का रंग ग्रेडिश ब्राउन होता है। जो नये वृक्ष होते हैं, उनमें नुकीले धार-दार काँटे लगे होते हैं। यह मध्यम सूखा प्रतिरोधी वृक्ष है। और सूखी उथली मिट्टी पर जीवित रहने में भी सक्षम है। कसई की शाखाएं

स्पाइक्स के रूप में दिखने वाली होती है, अंडाशय और द्विप नियमित रूप से त्रिकोणीय होते हैं। तना 15-20 सेमी व्यास के चमकदार या छोटी बालों, सीधे, कठोर शंकु के आकार के काँटों से युक्त होते हैं।

कसई एक ऐसा वृक्ष है, जो जंगलों और खुली भूमि में प्रायः पाया जाता है। है। रेतीली दोमट मिट्टी, ग्रेनाईट या बेसाल्ट व्युत्पन्न रेतीली मिट्टी और चूना पत्थर के साथ यह सूखे सदाबहार या पर्णपाती जंगलों से 50 से 600 मी की ऊंचाई पर एवं कभी-कभी 1400 मी की ऊंचाई तक भी पाया जाता है।

### पत्तियाँ

कसई की पत्तियाँ कठोर समांनातर पार्श्व नसों के साथ कठोर और युवा तनों की छाल पर मजबूत रीढ़ की तरह होती है। यह एक सूखा हार्डी प्रजाति है। लीफ-ब्लेड, अंडाकार तिरछा होता है।

### पुष्प

क्रीमी-सफेद रंग के टर्मिनल स्पाइन पेनकिल में जो 6-16 सेमी लम्बे होते हैं। एवं भूरे बालों वाले होते हैं। मई-अगस्त में कसई के पुष्प फॉलिकल्स में व्यवस्थित रहते हैं।





कसई का वृक्ष



कसई का फल

**फल**

कसई के फल ग्लोबोज, मांसल मीठे एवं मटर के आकर के होते हैं। बैगनी- काला तथा एक कठोर बड़े हुए गोमेद के रूप में रहता है। फल अंडाकार 5-10 मिमी व्यास के तथा

बिलोबेड-2 बी वाले होते हैं। पहले फल हरे फिर बाद में बीज बहुत छोटे और हरे-हरे झुर्रीदार हो जाते हैं। इनके फल प्रसार का समय जुलाई-सितम्बर है।



कसई का फल



### बीजों का संग्रहण

संग्रहण का सबसे अच्छा समय नवंबर-दिसंबर के मध्य हैं, कसई के बीजों में 4-5% moisture content, होता है। इसलिए इसे रूढिवादी (Recalcitrant) माना जा सकता है। बीजों को 15°C तापमान पर भंडारण एक वर्ष के लिए किया जा सकता है।



### कसई के बीजों का प्राकृतिक अंकुरण

कसई के बीजों का प्राकृतिक रूप से बीजांकुरण हो जाता है। क्योंकि जब इन फलों को पक्षी खाते हैं। बर्ड ड्रॉपिंग जब जमीन में गिर जाते हैं तो इनका प्राकृतिक रूप से बीजांकुरण हो जाता है।

### बीजांकुरण

कसई के बीजों के अंकुरण के लिए तापमान 35°C सबसे अच्छा होता है। तथा कसई के बीजों का (अंकुरण) प्रकाश एवं अँधेरे में भी हो जाता है। इसके अंकुरण के लिए तापमान की सीमा 30-40°C है। बुवाई की गहराई 1सेमी होनी चाहिए। अंकुरितों की ऊंचाई 15सेमी तक पहुंचने के लिए एक वर्ष का समय लगता है। इन पौधों को छाया में रखने पर लाभ होता है। बीज को बोने से पहले बीज के गूदे को निकालना चाहिए तथा 24 घंटे के लिए ठंडे पानी में भिगोना चाहिए।

### पानी में भिगोना





बीजों की बुवाई



बीजों की बुवाई





कसई के बीजों से अंकुरित पौधे

### औषधीय गुण

कसई के पत्तों और छाल के अर्क का उपयोग कान के दर्द के लिए किया जाता है। यह पेट दर्द के निवारण में भी प्रभावकारी है। भारत में तमिलनाडु के तिरुनेलवेली जिले में पलियान जनजाति की महिलाएं मेनोरेजिया को ठीक करने के लिए कसई की छाल का अर्क उपयोग करती हैं। पौधा तीखा, कड़वा, गर्म होता है। यह लंबोगो और हेमरेजिया में उपयोगी है। मूत्र के अवक्षेप को हटाने के लिए कसई की छाल लाभकारी होती है। गठिया रोग के उपचार में इसका उपयोग किया जाता है। जंगलो में उपस्थित आदिवासी समुदाय औषधीय रूप में इसका उपयोग किया जाता है। जैसे फल, औषधि उद्देश्य के लिए पत्तियों और छाल का अर्क उपयोग किया जाता है। कसई के छाल का उपयोग एंटीवायरल, के रूप में किया जाता है। छाल में टैनिन की मात्रा 16-40% पाई जाती है।

### कसई फल के मुख्य पोषक तत्व

मुख्यतः कसई के छाल में टैनिन होता है, तथा ट्राईपटिन कीटोन की उपस्थिति भी रहती है। जो फल पक जाते हैं, उनके गूदे में बीटा साइटो-स्टेरॉल और गैलिक तथा एलाजिक एसिड पाया जाता है।

कसई के वृक्ष में सामुदायिक मकड़ी का जीवन चक्र



सामाजिक मकड़ी (स्टेगोडाइफस सारासिनोरम) *Stegodyphus sarasinorum*, Family-Eresidae का जाला कसई के वृक्ष में पाया जाता है, जो कि कई बड़े गुच्छों के जाले होते हैं। जिसमें 150-200 के लगभग मकड़ियों का समूह रहता है। जो अपने सामुदाय के साथ रहते हैं। तथा अपने भोजन के लिए सामूहिक रूप से विभिन्न प्रकार के कीट-पतंगों, कीड़ों आदि का शिकार करते हैं। तथा अपना जीवन चक्र पूरा करते हैं।



सामाजिक मकड़ी का जाला





कसई वृक्ष के फलों को खाने वाले पक्षी  
लाल वेनटेड बुलबुल, हरा कबूतर, पीले पैरों  
वाला हरा कबूतर, हंसता हुआ कबूतर, रॉक  
कबूतर इंडियन गोल्डन ओरिओल, ग्रे हॉर्न बिल,

गुलाब की अंगूठी वाला तोता, ग्रेटर कोकोकल,  
कोयल, जंगल मैना, बैंक मैना, सामान्य मैना,  
मादा कोएल, भारतीय ओरिओल, नीले गले  
वाला बैरबेट, इसके फल को खाते हैं।

### कसई वृक्ष के फलों को खाने वाले पक्षी

Sr. No.	Common Name	Scientific Name	Family
1.	Yellow-footed green pigeon	<i>Treron phoenicoptera</i>	Columbidae
2.	Indian Golden Oriole	<i>Oriolus o. kundoo</i>	Oriolidae
3.	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae
4.	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	Bucerotidae
5.	Bank myna	<i>Acridotheres ginginianus</i>	Sturnidae
6.	Laughing dove	<i>Stigmatopelia senegalensis</i>	Columbidae
7.	Rock Pigeon	<i>Columba livia</i>	Columbidae
8.	Rose-ringed parakeet	<i>Psittacula krameri</i>	Psittacidae
9.	Common Myna	<i>Acridotheres tristis</i>	Sturnidae
10.	Indian oriole	<i>Oriolus kundoo</i>	Oriolidae
11.	Rufus Tree pie	<i>Dendrocitta vagabunda</i>	Corvidae
12.	Brahmin starling	<i>Sturnia pagodarum</i>	Sturnidae

### भविष्य में उपयोगिता के पहलू

गावों में घर के चौखट बनाने में भी इस लकड़ी का उपयोग किया जाता है, इसके आलावा कसई की लकड़ी का उपयोग खेती में उपयोग होने वाले

औजार बनाने के लिए किया जाता है। कसई की पत्तियों और छाल के अर्क को संग्रहित किया जा सकता है। छाल का उपयोग टैनिन के लिए किया जा सकता है। गठिया में जिन्जेली तेल के साथ एक अस्तर के रूप में भी इसका उपयोग किया



जाता है, तथा पका फल खाने योग्य होता है। पत्तियों का उपयोग पशुओं के चारे के लिए किया जाता है। इसकी छाल और जड़ कसैले होते हैं और रोगाणुरोधी होते हैं। वृक्ष का दोहन को दवा, भोजन और अच्छी गुणवत्ता की लकड़ी के स्रोत के रूप में स्थानीय जंगलों से किया जा रहा है।

### निष्कर्ष

मानव जीवन के लिए वैसे तो सभी वृक्ष प्रजाति महत्वपूर्ण होते हैं, उनमें से कुछ वृक्ष जीवन के लिए बहुत महत्वपूर्ण होते हैं जैसे कसई का वृक्ष हमारे जीवन में महत्वपूर्ण योगदान देता है। ब्रिडेलिया रेडुसा के संपूर्ण भागों को पारंपरिक रूप से उपचार के लिए इस्तेमाल किया जाता है। गठिया, मधुमेह, दस्त, पेचिश, मूत्रावरोध को दूर करने और छालों जैसी कई बीमारियों में किया जाता है। जनजातीय लोगों द्वारा गर्भनिरोधक के रूप में एवं बाँझपन को निवारण करने के लिए पौधे का उपयोग किया जाता है।





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