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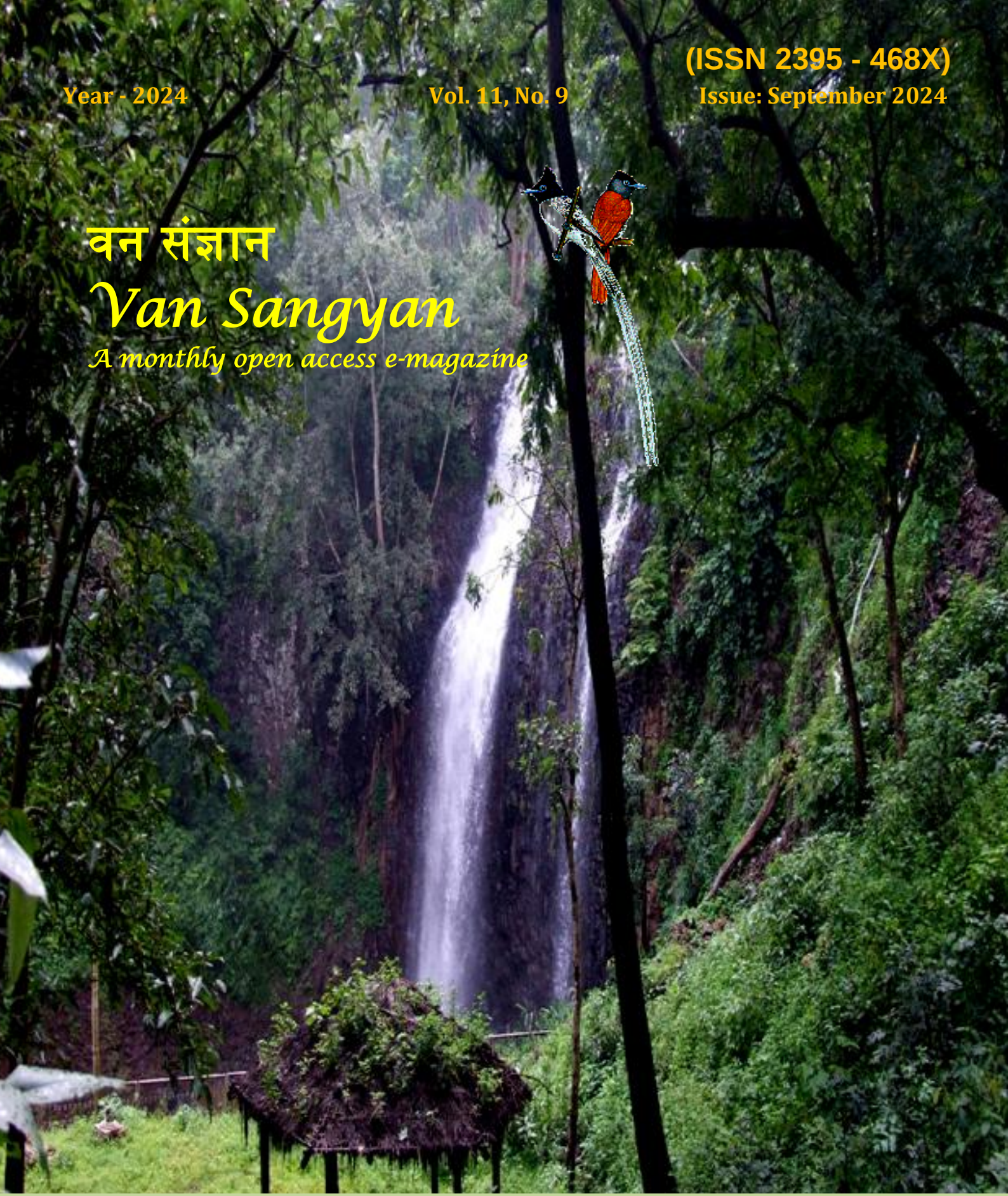

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Van Sangyan

Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

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The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number. TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve

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From the Editor's desk

Die-back disease of Neem (Azadirachta indica) has emerging as a significant concern for the forestry in India. This disease causes progressive death of twigs, branches, shoots, and roots, starting from the tips, and impacts neem trees of all sizes and ages, leading to nearly complete loss of fruit productivity in severely affected trees. As Neem trees are integral to rural economies and sustainable agriculture, it is crucial to implement effective management strategies, including monitoring, early detection, and the promotion of disease-resistant varieties, to safeguard this invaluable resource and ensure the resilience of forest ecosystems across India.

In line with the above this issue of Van Sangyan contains an article on Die-back disease of Neem: An emerging issue in forest industry. There are also useful articles viz. Solar Drying: Advancements and challenges in solar wood drying technology in India, चमत्कारिक वृक्ष मोरिंगा फसल की उन्नत खेती , Nanolignin: Synthesis methods and applications in polymer composites, Harnessing excellence: Delving into the thermal properties of oil in wood modification for enhanced performance, Phyllanthus indofischeri Bennet – A wild edible fruit with multifarious uses, Ecological significance of Rhododendron arboreum: Regeneration problems, utilization, and response to climate change, Harnessing forests for climate change mitigation, Arial Unicode MS, वृक्ष प्रजातियों से चारा उत्पादन, संरक्षण एवं आजीविका के संभावित स्रोत and *साल्विया हिस्पैनिका (चिया) नया 'सुपरफूड'.*

Looking forward to meet you all through forthcoming issues.

Dr. Naseer Mohammad

Chief Editor

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Die-back disease of Neem: An emerging issue in forest industry

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Introduction

Neem (*Azadirachta indica*) is commonly known as 'Indian Lilac', and it is one of the most versatile, multipurpose trees of the tropics. Neem is native of the Indian subcontinent and it occurs naturally in Shivalik hills, dry forests of Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra up to an altitude of 700 m (Roxburg. 1874). South Asian and sub-Saharan regions constitute the main areas of distribution. Today neem trees are found in nearly 80 countries worldwide.Its importance at global context has been enlightened by The US National Academy of Science by publishing a report entitled "Neem: A tree for solving global problems" in 1992 (NAS,1992). It is cultivated and frequently naturalized throughout the drier regions of tropical and sub-tropical India. Neem, renowned for its anti-viral, anti-bacterial and anti-inflammatory properties, is under a virulent fungal attack and the disease is spreading rapidly. Almost every part of neem *i.e.*, leaf, bark, seed, flower etc. used for making beneficial products.Neem has been shown to exhibit insect control activities against as many as 250 insect species (Anonymous 1993). More than 150 compounds have been isolated from different parts of this enigmatic tree. Neem has potential to use against plant pathogenic fungi and in the treatment of many human pathogenic fungi. The ingredients are known to have vital effects on as much as 350 species of agricultural pests. But it does not exempt the neem trees from being attacked by pests and diseases. It has become a familiar sight in Maharashtra and also in some other states over the last few years that twigs and leaves of neem trees dry up. The dieback disease was first reported in the country during the 1990s near Dehradun in Uttarakhand. The dieback is a fungal disease but the neem trees are sometimes hit by insect infestation and the combination of both increases its impact. Though neem trees are strong enough to combat the damage caused by the disease, measures to control its spread can be undertaken at community level for better results.

What is die-back of neem?

Die-back of neem is serious disease caused by fungus *Phomopsis azadirachtae.*The occurrence of die-back of neem was first reported from new forests of Dehra Dun, North India (Sateesh *et al.*, 1997)It is said to be complex of pest (Tea mosquito bug) and multiple pathogen attack (*Phomopsis* and *Colletorichum* spp.) but major one is *Phomopsis azadirachtae.* The *Phomopsis azadirachtae* is a fungal pathogen responsible for causing die back disease in neem belonging to the genus *Phomopsis.* The species was first identified and described by Sateesh *et al.* in 1997.*P. azadirachtae*, the incitant of die-back on neem is a deuteromycetes fungus and seed-borne in nature.

Morphological characteristics of *P. azadirachtae*

Mycelium immersed, branched, septate, profuse, colourless, becomes pale brown later. Conidiomatais pycnidial, solitary or aggregate, half-immersed, pale brown to dark brown or black, ampulliform or sub-globose, unilocular, thick-walled, uniform throughout with the endogenous basal swelling cone with lumina of bigger cells, outer layers melanised, 300-500 µm high, up to 900 µm, wide in sections, ostiole single, unilocular, circular, papillate (Girish *et al.*, 2008).Conidiophores simple or branched, short or elongate, septate, filiform, hyaline, line the inner layer of locule, 12-20 × 1.6-2.0 µm, subulate or filiform, integrated or discrete, channel and collarette minute, hyaline, periclinal thickenings of variable thickness, 5-8 × 1.6-3 µm, The pathogen produces two types of spores i.e.Alpha(α)conidia are hyaline, fusiform, straight, 2-4 guttulate, smooth, aseptate, 4.8-11 × 1.6-3.2 µm, germinate readily, Beta(β) conidia are hyaline, filiform, eguttulate, aseptate, 16-25.6 × 1.6-2.0 µm germination unknown (Girish *et al.*, 2008).

Die back disease symptoms

- The disease symptoms include twig blight, inflorescence blight and fruit rot.
- The disease is more pronounced during August to December, though can be observed throughout year.
- Appearance of symptoms starts with the on-set of rainy seasons and becomes progressively severe in later part of the rainy season and early winter season.
- The terminal branches are mainly affected. The disease results in the progressive death of the tree, year after year (Girish *et al.*, 2008).

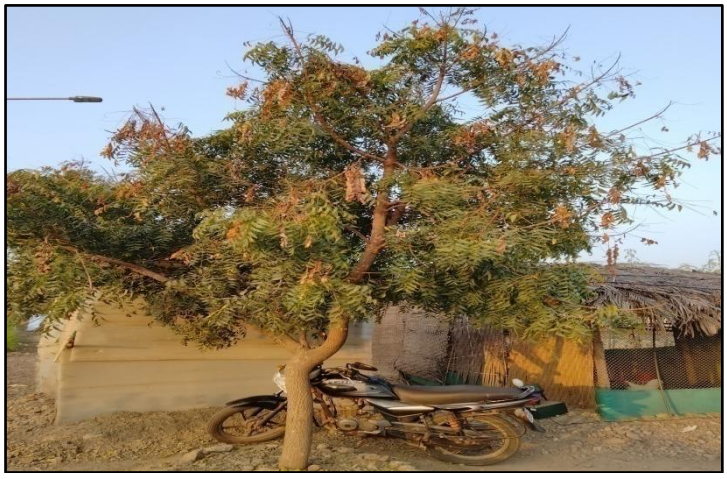

Fig: Die-back disease of neem at Malegaon, Pune (PC: Dr. Sangram Chavan)

- Twig blight is the major symptom of die back disease, also results in inflorescence blight and fruit rot resulting in almost 100 % fruit yield loss.
- Disease has been noticed in neem trees irrespective of age, size and height.Disease spreads through conidia that are disseminated by rain droplets and insects.

Integrated disease management of die-back of neem disease

Implementation of integrated disease and pest management (IDPM) programs which combine cultural, chemical, and biological approaches are highly recommended to control dieback of neem.

Cultural Control

- The pruning *i.e.*, removal of old dead twigs and branches is very important for the control of diseases. Previously infected dead shoots should be removed early in the spring before new growth begins to lessen the number of infective spores (tnau, agritech portal).
- To manage dieback disease, traditional horticultural practices have been applied to confront the fungal attack.
- In general, avoidance of wounding of trees can limit disease incidence (Alemu, 2014).
- Infected parts should be pruned from 7-10 cm below the infection site, removed, and burnt (Asrey *et al*., 2013).
- Attempts to arrest early infections have been made by treating with copper oxychloride or pasting with cow dung on pruned ends.

Biological control

- *B. subtilis* and *P. aeruginosa* were highly effective in suppressing the growth of the pathogen.

Chemical control

- Bavistin is effective, which completely suppresses mycelial growth, sporulation and conidial germination at 0.3 ppm.
- Treatment of neem seeds with bavistin resulted in the death of the seed-borne pathogen.
- Carbendazim (bavistin) at 0.25 ppm controlled the growth of the pathogen completely. (Girish *et al.*, 2008).

Future perspectives

- Geographical demarcation of pathogens inciting die back disease of neem is necessary.
- Identification of particular genes associated with host pathogen interaction.
- Management of neem seedlings at nursery stage to maintain the vigor of tree.
- Interdisciplinary approach is necessary to study the mechanism of die back of neem in detail.
- Public awareness and area wide approach to manage both pest and pathogen causing of die back of neem.
- Use of advanced technologies to survey the actual incidence e.g., Hyperspectral Remote sensing.
- Co-operative approach among state forest and agriculture department.

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Solar Drying: Advancements and challenges in solar wood drying technology in India

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Introduction

Wood, a very important biological material, primarily consists of cellulose, hemicellulose, lignin, and secondary metabolites in the form of extractives. In its green state, wood retains moisture, providing an ideal environment for microbial growth and decay. Various organisms such as insects, fungi, termites, and bacteria feed on moist wood, leading to degradation. Additionally, moisture-induced shrinkage and swelling can cause significant damage to wood structures and furniture. To enhance wood's longevity and usability, it must undergo drying to reach specific moisture levels. Throughout history, humans have employed various drying methods to remove moisture from wood, aiming to mitigate the risks of biodegradation. Traditionally, techniques like air drying and kiln drying have been used, supplemented by modern approaches such as vacuum drying, dielectric heating, and hybrid systems combining multiple methods. Controlled drying, also known as wood seasoning, and ensures defect-free dried wood suitable for various applications. Therefore, understanding proper drying techniques is essential for prolonging wood lifespan and optimizing resource utilization.

India, being a developing country with a large population, has a significant demand for raw materials, including wood. Wood serves as a crucial natural resource, widely acknowledged for its utility (Leiker and Adamska, 2004). While water is essential for tree life, it must be removed before utilizing wood as timber. Once a tree is felled, it loses its natural resistance against decay and insect attacks, termed natural durability (Scheffer and Morrell, 1998). Drying wood is the initial step towards enhancing its performance in various aspects such as dimensional stability, finishing, weight reduction for transportation, preservation, and mechanical properties improvement (Oloyede and Groombridge, 2000). The process of reducing water content in wood before utilization is termed wood drying (Oyebamiji et al., 2015). Wood is obtained from natural forests or trees outside forests in diverse shapes and sizes, dictating the drying technique employed (Simpson, 1983). The art of wood drying dates back to ancient civilizations, with around 300-400 commercially utilized wood species requiring specific drying methods (Simpson, 1983). In the contemporary context, drying techniques should prioritize enhancing wood drying quality while being energy-efficient (Lianbai,

2007). Human efforts to dry wood have evolved, encompassing a range of methods from conventional to advanced drying techniques (Hansson and Antti, 2003; Sharma et al., 2022).

Water in wood exists primarily in two forms: free water and bound water (Stamm, 1967; Simpson, 1983). Additionally, water may be present in vapour form within cell lamina, although at typical humidity and temperature levels, this vapour content is negligible (Sharma and Kumar, 2023). Free water resides in cell lumens, while bound water is chemically bound within cell walls (Perre and Keey, 2014).

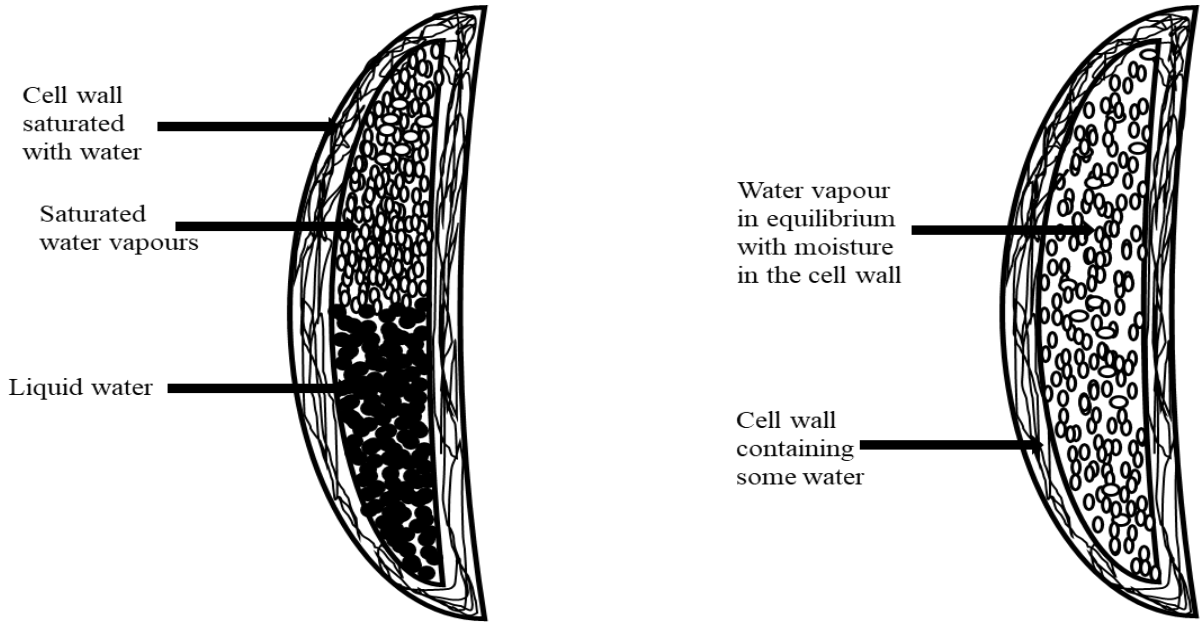

Fig.1: (A) Water in the cell of green wood; (B) Water in cell of dry wood

Fig. 1 illustrates the distribution of water within green and dry wood cells. The Fiber Saturation Point (FSP) is a crucial concept in wood drying, marking the point at which there is no free water present, and cell walls are saturated solely with bound water. Above the FSP, water removal is relatively easy and requires less energy since the water is not chemically bound. Conversely, below the FSP, only bound water within cell walls exists, necessitating higher energy input to break these bonds and release the water from the wood. In addition to the FSP, Equilibrium Moisture Content (EMC) significantly influences wood drying properties. EMC represents the moisture content at which there is no exchange of water or moisture with the surrounding environment (Oyebamiji et al., 2015). Efficient wood utilization necessitates the removal of this moisture content. Water travels within wood through diffusion or along moisture gradients (Nelson, 1986). Various techniques have been developed to remove water from wood, evolving from ancient times to modernity in response to societal needs.

Solar kiln

Solar timber drying kilns merely apply the principles used in greenhouse to the drying of timber where heat is trapped inside a

structure glazed with a material that is transparent to short wave radiation (light) and non-transparent to longer wave radiation (heat) and which at the same time reduces heat loss by conduction and convection. There are several types of solar kilns, but they all generally rely on some type of solar collector to provide the heat energy that evaporates the water in the lumber (Belessiotis and Delyannis, 2011). Unlike solar heating for an office or home, in lumber drying it's not possible to reduce the heat requirement to the point where solar heating can be competitive. When you've got a certain amount of water to remove from a certain amount of wood, you need a certain amount of total heat to do it, and that heat requirement can't be changed. Drying times in a solar kiln are dependent upon the weather, and thus unpredictable (Ekechukwu and Norton, 1999). In hot climates, they can degrade lumber due to excessive drying. In colder climates, they are unreliable and slow. Solar kilns often use electric–powered fans to circulate air through the lumber, but the cost of running these fans is high—and because of the long drying times, you've got to run the fans for a long time, making solar drying quite expensive. The electricity for running the fans in a solar kiln is usually more than would be used running a DH kiln, as the drying time is longer.

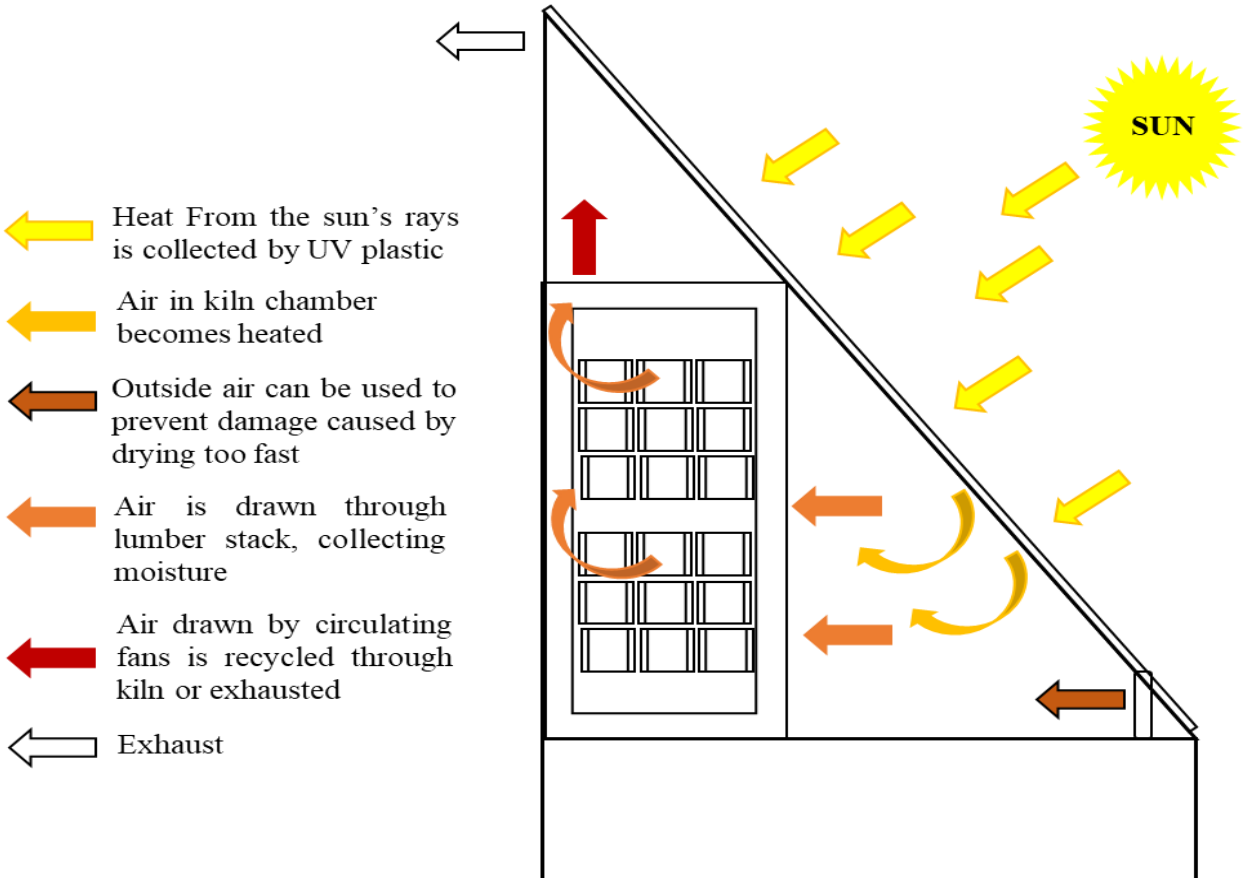

Fig.2: The Drying process of solar kilns

Advantages of Solar Kiln

Environmental friendliness

Solar kilns utilize renewable solar energy, reducing reliance on fossil fuels and minimizing carbon emissions, thereby contributing to environmental sustainability.

Cost-effectiveness

Solar energy is free and abundant, leading to reduced operating costs over the long term compared to conventional kilns powered by electricity or fossil fuels.

Energy efficiency

Solar kilns can achieve high levels of energy efficiency, especially in sunny regions, by harnessing natural sunlight to dry wood effectively.

Reduced drying time

With proper design and operation, solar kilns can achieve comparable or even faster drying times than conventional kilns, leading to increased productivity and throughput.

Improved wood quality

Solar kilns can provide more uniform drying conditions, resulting in better wood quality with fewer defects such as warping, checking, and degradation.

Versatility

Solar kilns can be designed and scaled to meet various drying needs, from small-scale operations for hobbyists to large commercial facilities, making them suitable for a wide range of applications.

Independence from the grid

Solar kilns operate off-grid, making them ideal for remote locations or areas with unreliable electricity supply, providing greater independence and flexibility to wood processing operations.

Status of solar drying of timber in India

In India, solar drying of agricultural products is relatively common, but its application in timber drying remains limited. Challenges such as:

Lack of continuous operation

It operates intermittently and does not run continuously for 24 hours; drying does not occur during nighttime, resulting in longer overall drying times.

Lack of awareness

Many timber producers and processors are unaware of the benefits and feasibility of solar drying.

Technical expertise

Adequate training and technical knowledge are essential for designing, operating, and maintaining solar drying systems.

Infrastructure

The lack of suitable infrastructure, including drying chambers and equipment, impedes the adoption of solar drying technologies.

Future research directions for improving solar wood drying efficiency include

Minimizing heat losses from the kiln

Addressing transmission losses from the kiln due to convection, conduction, and radiation is crucial. Strategies such as effective sealing of joints, multiple glass glazing layers, low emissivity coatings, and using inert gases like Argon can help reduce these losses.

Optimizing kiln design

Conducting studies to estimate the actual heat demand for wood drying in commercial-size kilns can help optimize the sizes and areas of the roof and south wall of double-inclination kilns, maximizing solar flux in winter months.

Enhancing thermal conductivity of Phase Change Materials (PCMs)

Improving the low thermal conductivity of PCMs can resolve issues related to their melting and solidification processes.

Implementing nano-coatings on thermal collectors

Exploring nano-coatings to increase the absorptivity of collectors and enhance

efficiency can be a promising avenue for research.

Developing automatic, self-sufficient solar drying systems

Integrating solar drying systems with thermal storage and computer programming can create commercially viable and energy-efficient solutions.

Conducting pilot-level studies

Undertaking pilot studies with commercial-scale kilns can provide valuable insights for practical implementation.

Exploring high storage density materials

Researching materials with high storage density can improve the economic feasibility and commercial acceptance of solar drying systems.

Utilizing crossers/stickers as PCM containers

Investigating the use of crossers, commonly used in wood stacking, as containers for thermal storage can enhance the efficiency of solar wood drying systems.

Conclusion

The solar drying of timber presents a promising avenue for addressing the challenges of traditional drying methods while leveraging renewable energy sources. Despite its potential advantages such as environmental friendliness, cost-effectiveness, and improved wood quality, the widespread adoption of solar drying in India faces hurdles related to operational continuity, awareness, technical expertise, and infrastructure. However, future research directions outlined, including minimizing heat losses, optimizing kiln design, enhancing thermal conductivity of Phase Change Materials (PCMs), and developing automatic systems, offer promising solutions to enhance the efficiency and viability of solar wood drying. By addressing these challenges and embracing innovative approaches, the solar drying of timber can emerge as a sustainable and efficient method to meet the growing demand for wood products while minimizing environmental impact and maximizing resource utilization.

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चमत्कारिक वृक्ष मोरिंगा फसल की उन्नत खेती

रविन्द्र कुमार ढाका, सोम दत्त शर्मा, नवजोत सिंह कलेर एवं नरेश ठाकुर

हॉर्टिकल्चर एवं फॉरेस्टरी महाविद्यालय
डॉ यशवंत सिंह परमार हॉर्टिकल्चर एवं फॉरेस्टरी विश्वविद्यालय, नौनी
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परिचय

मोरिंगा को हिमाचल व पंजाब में संजना और सौंजना कहते है । हिन्दी में सहजन के नाम से एवं अंग्रेजी में मोरिंगा के नाम से जाना जाता है। भारत के किसानों के लिए यह एक बहुवार्षिक सब्जी व पत्तियां उपज देनेवाला बहुउपयोगी पौधा है। गाँव देहात में सहजन बिना किसी विशेष देखभाल के किसान अपने घरों के आसपास एक-दो पेड़ लगाकर रखते हैं, जिसके फल का उपयोग, वे साल में एक बार जाड़े के दिनों में सब्जी के रूप में करते हैं। दक्षिण भारतीय लोग सहजन के फूल, फल, पत्ती का उपयोग अपने विभिन्न प्रकार के व्यंजनों में साल भर करते हैं। सहजन के बीज से तेल भी निकाला जाता है। पौधे के सभी भागों का उपयोग विभिन्न कार्यों में किया जाता है। बीज को उबालकर सुखाने और फिर पाउडर बनाकर विदेशों में निर्यात भी किया जाता है। सहजन में औषधीय गुण प्रचुर मात्रा में होते है। आयुर्वेद में सहजन से तीन सौ ज्यादा रोगों का उपचार के बारे में बताया गया है।

सहजन में पोषक तत्वों जैसे- प्रोटीन, ऑयरन, बीटा कैरोटीन, अमीनो एसिड, कैल्शियम, पोटेशियम, मैग्नीशियम, विटीमिन ए, सी और बी, एंटीऑक्सीडेंट, एंटीबैक्टीरियल जैसे गुण पाए जाते हैं। वहीं इसकी पत्तियां भी काफी फायदेमंद होती है। सहजन की पत्तियों में संतरे और नींबू की तुलना में 6 गुना से अधिक विटामिन-सी होता है। इसके साथ ही दूध में 4 गुना अधिक कैल्शियम, गाजर की तुलना में 4 गुना अधिक विटामिन ए, केले की तुलना में 3 गुना अधिक पोटेशियम एवं दही की तुलना में तीन गुना अधिक प्रोटीन पाया जाता है। इसलिए, सहजन को सुपरफूड पौधा, मैजिक पौधा, मिरेकल पौधा, ईश्वर प्रदत्त पौधा आदि नामों से सुसजित किया हैं।

सहजन और सौंजना भारतीय मूल का मोरिन्गासी परिवार का सदस्य है। इसका वनस्पतिक नाम मोरिंगा ओलीफेरा है। सामान्यतया यह एक बहुवार्षिक, कमजोर तना और छोटी-छोटी पत्तियों वाला लगभग दस मीटर उंचाई वाला पौधा है। यह कमजोर जमीन पर भी बिना सिंचाई के साल भर हरा-भरा और तेजी से बढने वाला पौधा है। हाल के दिनों में सहजन का साल में दो बार फलने वाला वार्षिक किस्में तैयार की गयी है, जो न सिर्फ उत्पादन ज्यादा देती है, बल्कि यह प्रोटीन, लवण, लोहा, विटामिन-बी, और विटामिन-सी से भरपूर मात्रा में प्रदान करती है। हिमाचल परदेश के हमीरपुर, बिलासपुर एवं ऊना जिलों के किसानों के लिए उनकी फसल प्रणाली का एक आर्थिक महत्व का उपयुक्त फसल है। हाल ही में, बमसन विकास खंड, हमीरपुर में पहली बार मोरिंगा के 3 ,000 के करीब पौधे मुख्यमंत्री योजना तहत लगाए गए हैं। हॉर्टिकल्चर एण्ड फॉरिस्ट्री कॉलेज, नेरी, हमीरपुर में, इसी गत वर्ष से रिसर्च कार्य शुरू किया गया है । इस प्रकार, मोरिंगा एक आर्थिक महत्व का चमत्कारिक फसली पौधा हैं।

चित्र 1 : मोरिंगा की वैज्ञानिक खेती

जलवायु

सामान्यतया 25-30° के औसत तापमान पर सहजन के पौधा का हरा-भरा व काफी फैलने वाला विकास होता है। यह ठंढ को भी सहता है। यह विभिन्न पारिस्थितिक अवस्थाओं में उगने वाला एक बहुउपयोगी पौधा है।

मिट्टी

सौंजना की खेती सभी प्रकार की मिट्टियों में की जा सकती है। यहाँ तक कि बेकार, बंजर और कम उर्वरा भूमि में भी इसकी खेती की जा सकती है।

सहजन की उन्नत किस्में

सौंजना का साल में दो बार फल देने वाले किस्मों में पी.के.एम.1, पी.के.एम.2, कोयेंबटूर 1,कोयेंबटूर 2, ओडिसा 1, रोहित 1एवं भाग्य प्रमुख किस्मेहैं। इसका पौधा 4-6 मीटर उंचा होता है तथा 90-100 दिनों में इसमें फूल आता है। जरूरत के अनुसार विभिन्न अवस्थाओं में फल की तुड़ाई करते रहते हैं। पौधे लगाने के लगभग 170-180 दिनों में फल लगकर तुड़ाई के लिए तैयार हो जाता है। साल में एक पौधा 200-400 फलीया लगभग 40-50 किलोग्राम फलीया देता है जिसकी लम्बाई 65-70 सेंमी. तथा मोटीई 6.3 सेंमी. होती है। यह फलीया काफी गूदेदार होती है तथा पकाने के बाद इसका 70 प्रतिशत भाग खाने योग्य होता है। इसके पौध से 2-10 वर्षों तक पेड़ी फसल के साथ अंतर फसलों को लिया जा सकता है। प्रत्येक वर्ष फसल से फलीया लेने के बाद पौधे को जमीन से एक मीटर उँचाई छोड़कर काटना आवश्यक होता है।

खेत की तैयारी

सौंजना के पौध की रोपनी में गड्ढा बनाकर किया जाता है। खेत को अच्छी तरह खरपतवार से साफ़-सफाई का 2.5 x 2.5 मीटर की दूरी पर 45 x 45 x 45 सेंमी. आकार का गड्ढा बनाते हैं। गड्ढे के उपरी मिट्टी के साथ 10 किलोग्राम सड़ा हुआ गोबर का खाद मिलाकर गड्ढे को भर देते हैं। इससे खेत, पौध के रोपनी हेतु तैयार हो जाता है। साजन की पत्तों की खेती के लिए 1 हेक्टेयरमें 10 किलो बीज की आवश्यकता होती है। पत्तों की खेती में बीज को कम दूरी पर लगाया जाता है, पौधों से पौधों की दूरी 1 मीटर होती है और लाइन से दूसरी लाइन की दूरी 1 मीटर होती है, इस प्रकार

से 1 हेक्टेयरमें लगभग 10,000 पौधे लगाए जा सकते हैं।

प्रबर्द्धन

सौंजना में बीज और शाखा के टुकड़ों दोनों से ही प्रबर्द्धन होता है। अच्छी फलन और साल में दो बार फलन के लिए बीज से प्रबर्द्धन करना अच्छा होता है। एक हेक्टेयर में खेती करने के लिए 1 किलोग्राम बीज पर्याप्त होता है। बीज को सीधे तैयार गड्ढों में या फिर नर्सरी में, पॉलीथीन बैग में तैयार कर गड्ढों में लगाया जा सकता है। पॉलीथीन बैग का पौधा, 1महीना में खेत में लगाने योग्य हो जाता है।

शस्य प्रबंधन

एक महीने के तैयार पौध को, पहले से तैयार किए गये गड्ढों में माह वर्षा ऋतु अर्थात जुलाई-सितम्बर माह में रोपनी कर दें। पौधा जब लगभग 1 मी. का हो जाये तो पौध के ऊपरी भाग कट कर दें, इससे पौधे में बगल से शाखाओं को निकलने में आसानी होती हैं। सहजन पर किए गए शोध से यह पाया गया कि मात्र 15 किलोग्राम गोबर की खाद प्रति गड्ढा तथा एजोसपिरिलम और पी.एस.बी. (5 किलोग्राम/हेक्टेयर) के प्रयोग से सहजन की जैविक खेती की जा सकती है।

सिंचाई

अच्छे उत्पादन के लिए सिंचाई करना लाभदायक होता है। गड्ढों में बीज से अगर प्रबर्द्धन किया गया है तो बीज के अंकुरण और अच्छी तरह से स्थापन होने तक नमी का बना रहना आवश्यक होता है। फूल लगने के समय खेत ज्यादा सूखा या ज्यादा गीला नहीं रखना चाहिए, दोनों ही अवस्था में फूल के झड़ने की समस्या होती है।

पौधा संरक्षण

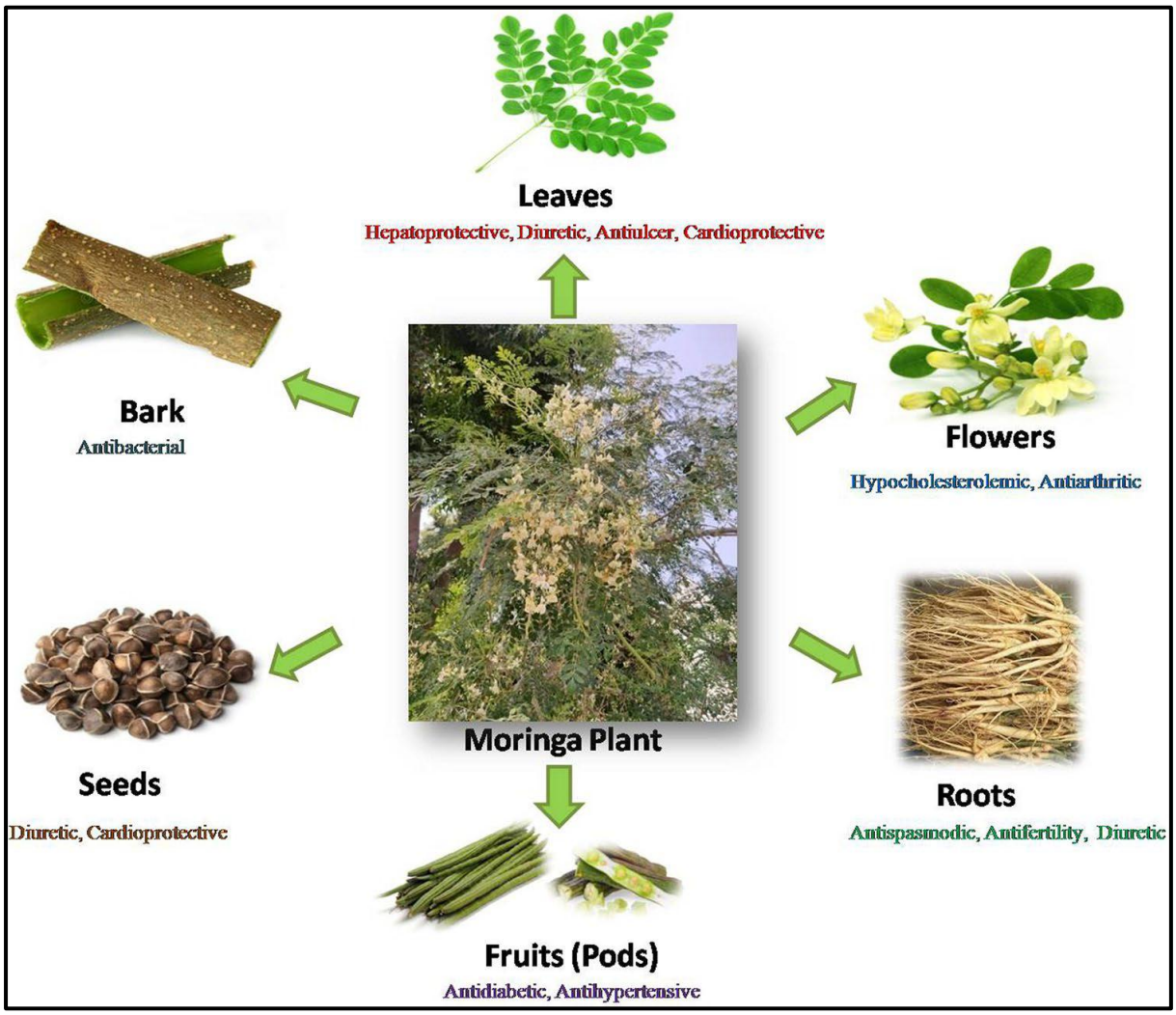
सौंजना पर सबसे ज्यादा आक्रमण भुआपिल्लू नामक कीट से होता है, इसे अगर नियंत्रित नहीं किया जाय तो यह सम्पूर्ण पौधे की पत्तियों को खा जाता है तथा आसपास में भी फ़ैल जाता है। इसके नियंत्रण के लिए सरल और देशज उपाय यह है कि कीट के नवजात अवस्था में नीम की खली का घोल बनाकर अगर इसके ऊपर डाल दिया जाये तो सभी कीट मर जाते हैं। वयस्क अवस्था में जब यह सम्पूर्ण पौधों पर फ़ैल जाता है तो एकमात्र दवा डाइक्लोरोवास (नूभान) 0.5 मिली. एक लीटर पानी में घोलकर पौधों पर छिड़काव करने से तत्काल लाभ मिलता है। सहजन के दूसरे कीट में, कभी-कभी फल फलीयों पर फल मक्खी का आक्रमण होता है। इस कीट के नियंत्रण हेतु भी डाइक्लोरोवास (नूभान) 0.5 मिली. दवा एक लीटर पानी में घोलकर छिड़काव करने पर कीट का नियंत्रण होता है।

फल की तुड़ाई एवं उपज

साल में दो बार फल देनेवाले सहजन की किस्मों की तुड़ाई सामान्यता फरवरी-मार्च और सितम्बर-अक्टूबर में होती है। प्रत्येक पौधे से लगभग 200-400 (40-50 किलोग्राम) फलीया सालभर में प्राप्त हो जाती है। सहजन की तुड़ाई बाजार और मात्रा के अनुसार 1-2 माह तक चलती है। सहजन की पत्तों की खेती में तीन 3 महीने के अंतराल से पत्तों की कटाई छँटाई होती है। इस प्रकार से सहजन की 1 साल में चार बार कटाई ले सकते है। सहजन की डालियोंको काटने के बाद उसमें से छोटी डालियाँ अलग करनी है और उन छोटी डालियों को पानी से धोना है। पानी से धोने के बाद इन पत्तियों को छांव में या शेडनेट के नीचे सुखाने के लिए डालना है। आमतौर पर सहजन की पत्तियां अच्छे प्रकाश में, 3 से 4 दिन में सूख जाती है। 8-10 क्विंटल सुखी पत्तियां की उपज प्रति हेक्टेयर होती है। फलीयों की कीमत 60-80 रुपये प्रति किलोग्राम होती है, वही सूखी पत्तियों की कीमत भी 60-80 रुपये प्रति किलोग्राम होती है। जबकि सूखे पाउडर की कीमत 100-150 रुपये प्रति किलोग्राम होती है।

सहजन का गुण एवं उपयोग

सहजन एक बहुउपयोगी पौधा है। पौधे के सभी भागों का प्रयोग भोजन, दवा औद्योगिक कार्यों आदि में किया जाता है। सहजन में प्रचुर मात्रा में पोषक तत्व व विटामिन पाये जाते है। सहजन का फूल, फल और पत्तियों का भोजन के रूप में व्यवहार होता है। सहजन का छाल, पत्ती, बीज, गोंद, जड़ आदि से आयुर्वेदिक दवा तैयार किया जाता है, जो लगभग 300 प्रकार के बीमारियों के इलाज में काम आता है।



चित्र 2 : मोरिंगा के विभिन्न भाग एवं उनके उपयोग

निष्कर्ष

सहजन बिना किसी विशेष देखभाल एवं शून्य लागत पर आमदनी देनी वाली फसल है। किसान भाई अपने घरों के आस-पास अनुपयोगी जमीन पर सहजन के कुछ पौधे लगाकर जहां उन्हें घर के खाने के लिए सब्जी उपलब्ध हो सकेंगी वहीं इसे बेचकर आर्थिक सम्पन्नता भी हासिल कर सकते हैं। इसके औषधीय व औद्योगिक गुणों पर ध्यान रखते हुए किसानों के बीच में एक स्थाई दीर्घकालीन आमदनी हेतु सोच विकसित करके अधिक मुनाफा कमाया जा सकता है।

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Nanolignin: Synthesis methods and applications in polymer composites

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Introduction

Trees are the largest and the oldest living organisms on earth, producing a complex lignocellulosic biomaterial known as wood. Wood is the very first source of energy for mankind and continues to be the most important single source of renewable energy along with its application in the development of structural components for high-rise buildings It is one of the most abundant and versatile natural materials having a unique and complex chemical structure that primarily comprises 38 – 51% cellulose, 17 – 38% hemicellulose, 21 – 31% lignin and 2 – 3.5% other extractives and has been observed to depend on various factors such as species, age, location, climatic conditions, longitudinal and radial location in the tree(Jiang *et al.*, 2018).Lignin, the second most abundant biomaterial besides cellulose, is a highly complex and aromatic biomaterial that plays an important role in plants by providing mechanical support and translocating minerals and water. It is extensively branched and composed of a variety of functional groups such as hydroxyl (-OH), methoxy (CH_3-O-), carbonyl (-C=O), carboxyl (-COOH) and benzene (C_6H_6).

However, apart from its abundant natural availability a large quantity of lignin, around 50 million tonnes per year is being produced by the paper and pulp industries but only 2% of it is extracted and effectively used in various value-added products. The majority of lignin has been discarded or burned for heat and electricity generation. Nowadays, nanotechnology is pivotal in the fields of medicine, agriculture, energy, food processing, chemistry, cosmetics, electronics and environmental clean-up due to the exceptional surface-area-to-volume ratio and high surface energies of nanoparticles, which make them more advantageous than bulk macro materials (Liu *et al.*, 2020). Converting unordered and complicated lignin into ordered and uniform nanoparticles has attracted wide attention for their controlled structures and size, enhanced polymercompatibility and improved antioxidant activity.

Synthesis methods of Lignin and Lignin Nanoparticles (LNPs)

Lignin

The process of extracting lignin from lignocellulosic biomass involvesbreaking down lignin graduallyby using fragments with alteredfunctional groups enabling its solubility (Lisý*et al.*, 2022).different solvents resulting in smaller There are

currently four main processesmentioned belowin Table 1.

Nanolignin

Nanomaterials are unique possessing high reactivity because of their increased surface area compared to their macromolecules. Similarly, macro-lignin particles can be converted into nano size.Several studies have reported methods of nanosizing lignin including (1) Physical methods and (2) Chemical methods

Table 1. Summary of methods for extracting lignin

S. No.	Delignification	Summary	References
1	Sulphite process	Lignosulphonate, Hydrolytic process, NaOH and Na_2SO_3, Temperature: 120–180ºC, High molecularweight product	Kienbergeret *al.*, 2021
2	Kraft process	Kraft lignin, Hydrolytic process, NaOH and Na_2S, Temperature 150–180 ºC, Medium molecularweight product	Hubbeet *al.*, 2019
3	Organosolv	Organosolv lignin, Hydrothermal process, Organic solvent, Temperature 90–210 ºC, Low molecularweight product	Kienbergeret *al.*, 2021
4	Soda process	Soda lignin, Hydrolytic alkaliprocess, NaOH, Temperature 90–150 ºC, Low molecularweight product	Lisýet *al.*, 2022

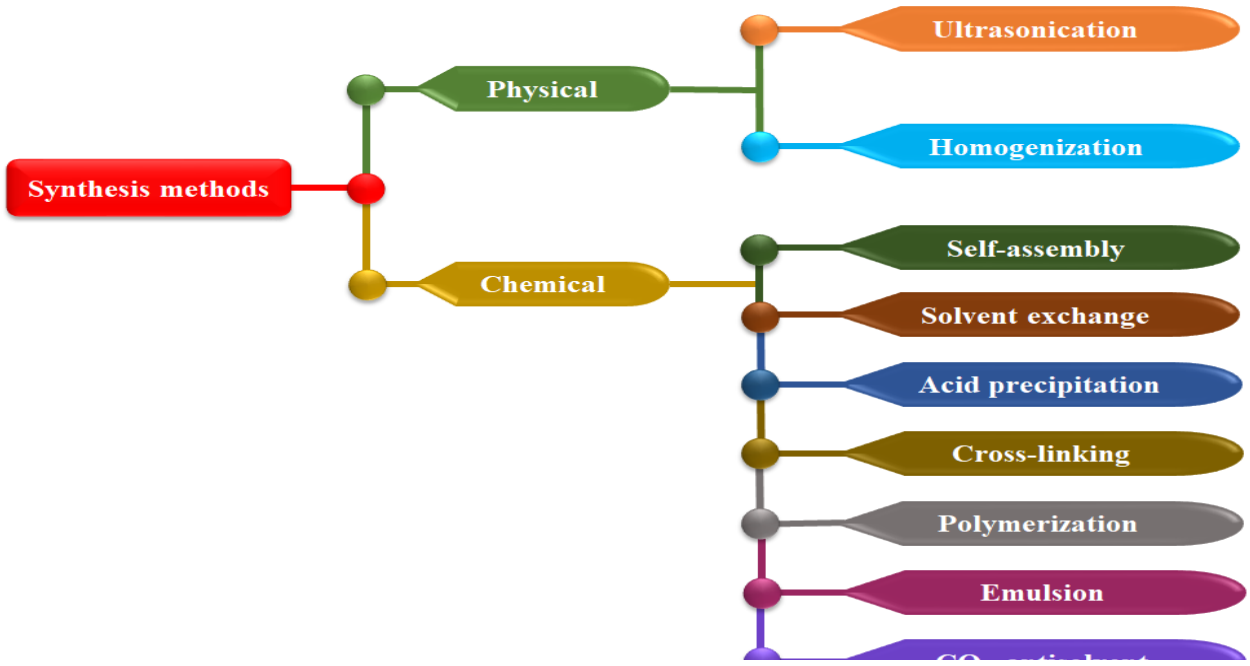

Fig. 1: Schematic representation of nanolignin synthesis methods (Behera *et al.*, 2023)

Physical methods

Several researchers have preferred physical methods to synthesise LNPs either by ultrasonication or homogenization. These methods are simple as theyreduce particle size through mechanical separation or by using high-frequency sound waves.

Ultrasonication

The ultrasonication technique uses high-frequency sound waves to create mechanical vibrations, which can break down lignin into nanoparticles

Homogenization

Homogenization involves subjecting lignin to high shear forces, which break down larger particles into smaller ones.

Chemical methods

The chemical method is utilized to convert lignin into nanoligninin which, spherical LNPs are obtained due to the interaction of chemicals with lignin particles.

Self-assembly

It involves the spontaneous organization of lignin molecules into nanoparticles without external forces.

Solvent exchange

In this, the lignin nanoparticles are created when an anti-solvent is added to the lignin solution because the anti-solvent reduces the lignin's solubility.

Acid/Flash Precipitation

It involves inducing the precipitation of nanoparticles by changing the solvent conditions, such as pH or temperature.

Emulsion polymerization

It is a technique utilized to produce polymer nanoparticles by dispersing monomers in an aqueous phase containing a surfactant and a water-immiscible organic phase, often with the aid of an initiator.

CO_2antisolvent method

It involves dissolving the raw lignin in a variety of non-aqueous solvents, including tetrahydrofuran, dimethyl sulfoxide, ethanol and acetone.

Table 2. A comparative profile of different methods to LNPs

S. No.	Source of lignin	Method	Size (nm)	Shape
1	Wheat straw, Sarkanda grass	Ultrasonication	10–50	Spherical
2	Soda Lignin	Homogenization	<100	Non-spherical
3	Kraft Lignin	Solvent shifting	38	Spherical
4	Soda Lignin	Self-assembly	67	Spherical
5	Alkali lignin	Solvent shifting	13	Spherical
6	Organosolvlignin	Acid precipitation	100-463	Irregular

Synthesis of modified lignin nanoparticles for their incorporation in composites

The peculiar chemical nature leading to strong hydrogen bonding between the molecules is the main reason for the difficulty of dispersion and size reduction of lignin nanoparticles. So, several methods have been adopted to improve the reactivity and surface properties of LNPs with chemical modification (Parvathy *et al.*, 2021).

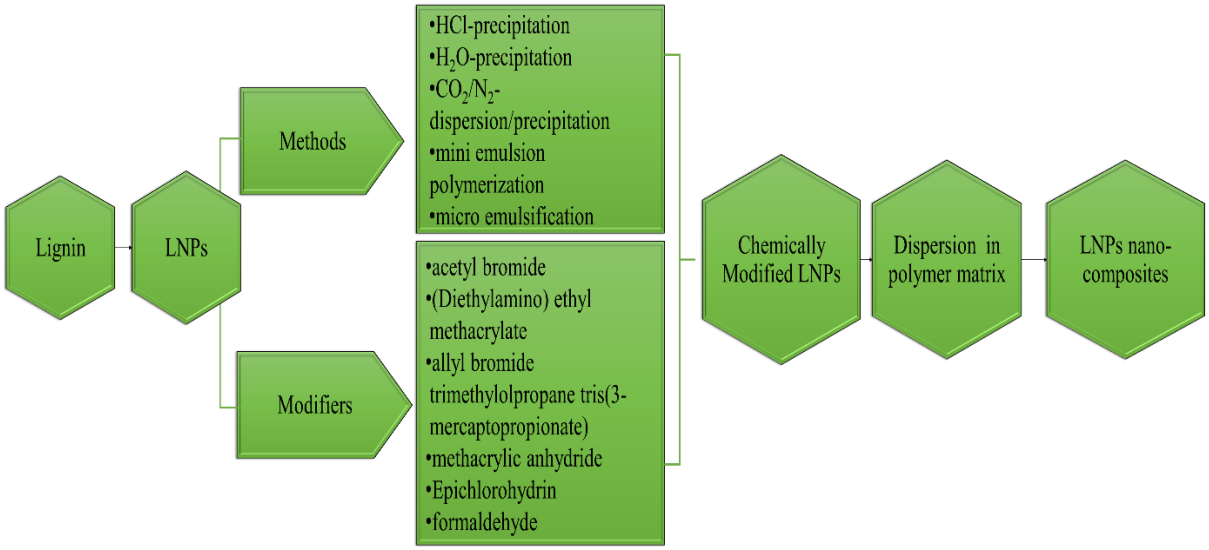

Fig. 2. Methods and modifiers for synthesis of modified LNPs for preparation of LNP polymer composites.

materials characterized by an ultrafine phase dimension ranging from 1 to 1000 nanometers. Nanolignin composites are nanocomposites and nanohybrids that involve lignin being utilized as a component after converting it into nanoform along with polymeric or metal matrix. Lignin is a biopolymer that has been used in the synthesis of andBaican, 2023).Due to its affordability, renewable nature, and widespread availability, lignin proves to be a viable additive for polymer matrices such as rubber, polyvinyl alcohol (PVA), polylactic acid (PLA), polymethyl methacrylate (PMMA), polyethylene (PE)and epoxy(Parvathy*et al.*,2021).The nano transformation of lignin yields nano

entities with higher reactivity compared to their bulk counterparts, whose inclusion in composites endows them with enhanced mechanical properties and bioactivities.The development of lignin-based nanocomposites opens a new eco-friendly option for bio-composites by surpassing hazardous and expensive chemicals.

Recently, biobased fillers like LNPs have attracted much research due to their lightweight, biodegradable and large-scale availability, along with their ability to provide improved thermal stability and mechanical with significantly less hazardous to the environment.

Table 3. Mechanical properties and degradation temperature of nanolignin composites

Polymer	Composition and Content	Tensile strength (MPa)	Young modulus (E)	Degradation Temperature TGA (Tmax °C)	References
PLA	PLA	44.3	1955.8	346.5	Yang*et al*., 2015
	PLA+1wt.% LNP	48.7	2153.2	351.1	
Bio-PTT	PTT	51.49	2058	427	Gupta *et al*., 2014
	PTT+1.5wt.% LNP	59.16	2227	447	
	PTT+1.5wt.% LNP + 7 VGCF	61.74	2309	542	
Natural Rubber	Pure	25.24	2.00	370.0	Jiang *et al*., 2018
	7wt.% LNP	29.24	2.95	386.5	

*PLA-polylactic acid, LNP-Lignin Nanoparticles, PTT- Poly (trimethylene terephthalate),VGCF - vapor-grown carbon fibers.

Applications of nanolignin composites

Nanolignin composites can be modelled and fabricated to have excellent properties such as biodegradability, non-toxicity, environmental resistance, excellent thermal stabilityand biocompatibility. For instance, they can be used as antioxidants, thermal/light stabilizers and reinforced materials. They also have great potential as chelating agents, antimicrobial agents, UV protectors, nanofillers, adsorbents, catalysts, supercapacitors, drug and gene carriers and emulsion stabilizers (Behera *et al.*, 2023). Recently researchers have reported the increased adsorption efficiency of lignin-based hydrogels and their subsequent applications in water purification. The ability of these hydrogels to remove pollutants can be enhanced if lignin nanoparticles can be translated into hydrogel nanocomposites.

Conclusion and future perspective

With the growing demand for renewable materials such as lignin-based biomaterials in value-added applications, LNPs and composites continue to confront various challenges due to their complicated structure, which must be addressed. Most of the methods used during the synthesis of lignin used expensive and environmentally hazardous chemicals that need to be substituted with inexpensive

and environmentally friendly solvents such as water and ethanol. Preparation and applications of nano lignin-based polymer composites is still a nascent stage that needs to be explored further for improved performance keeping in mind the sustainability aspect. Further research to bring the fabrication of LNPs toa commercial scale and rapid synthesis of LNP composites with greener methods can open a new vista in the research of lignin nanocomposites.

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Harnessing excellence: Delving into the thermal properties of oil in wood modification for enhanced performance

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Introduction

Wood is an extremely versatile material with several applications in industries ranging from construction and furniture to creative efforts and even aeronautical engineering. However, despite its widespread use and natural capabilities, wood has some limits that require modification to improve performance. These limitations include sensitivity to biodeterioration and fluctuations in dimensional stability, especially under changing environmental circumstances. The effects of thermal alteration are considerable, improving the wood's endurance, dimensional stability, and mechanical strength.Thermal modification strengthens wood's chemical composition, making it more resistant to moisture, insects, decay, and other forms of deterioration. This not only extends the life of wood products, but also broadens their applications, particularly in outdoor and high-moisture conditions that standard untreated wood may struggle to withstand.

Need of oil - Thermal modification of wood

The early 1990s saw a surge in environmental concern, with a need to limit the use of persistent hazardous chemicals and a shift to ecofriendly green procedures that may be utilized indefinitely. One such technology is oil-based wood modification. OHT is one of the technique for modifying wood without using toxic chemicals is heat treatment, which can increase the material's dimensional stability, water resistance, and biological endurance during the oil heat treatment procedure, wood is heated in vegetable oil (such as sunflower, rapeseed, or linseed oil) which render high durability at a tolerable strength decrease, wood is heated in a closed process vessel at temperatures between 180 and 220°C while being submerged in hot oil. Under the brand name Menz Holz OHT, the procedure was created in Germany (Jirouš-Rajković*et al*., 2019). The enhancement of heat treatment using vegetable oils is the result of study into thermal treatment of wood (Sidorova 2008).

Oil-based thermal modification of wood is a specialized procedure that enhances wood qualities by combining heat and specific types of oils. Unlike typical thermal modification methods, which expose wood to heat in the absence of oxygen, oil-based thermal modification includes impregnating the wood with oil before thermal treatment.

The procedure usually begins with the selection of appropriate oils, which can be vegetable oils, mineral oils, or other bio-based oils. These oils perform several functions in the alteration process. For starters, they operate as heat transmission carriers, ensuring that the wood is heated evenly. Second, the oils permeate the

wood structure, lubricating it and allowing heat to diffuse into its core.

Finally, the oils react chemically with the wood components during the heating process, altering the wood's characteristics. Furthermore, thermal modification improves dimensional stability and lowers the possibility of warping, shrinking, and swelling, guaranteeing that wood products retain their shape and integrity over time. This is especially important in construction and architectural applications, where precision and durability are critical. To overcome these limitations and realize the full potential of wood, a variety of modification techniques have been devised, with thermal modification emerging as a promising option. Thermal modification involves heating wood to temperatures above 180°C in an oxygen-deprived atmosphere. This process causes chemical modifications in the wood cell wall components, altering their molecular structure. In essence, thermal modification is a sustainable and effective method of increasing the value of wood that adheres to the principles of environmental conservation and resource efficiency. By using heat to modify the qualities of wood, we can open up new possibilities and ensure that this renewable natural material continues to play an important part in a variety of sectors for future generations. One of the primary benefits of oil-based thermal modification is its capacity to give long-term protection for the wood. The impregnated oils serve as preservatives, inhibiting the growth of fungus and other bacteria that cause degradation. Furthermore, the treated wood has reduced hygroscopicity, which means it is less likely to expand and shrink in response to humidity fluctuations.

Advantages and disadvantages of Oil-thermal treatment of wood

Overall, oil-based thermal modification provides a sustainable and environmentally benign method for improving the performance and lifespan of wood components. By harnessing the synergistic effects of heat and oil treatment, this procedure allows for the creation of wood products with improved qualities, boosting their potential applications in building, furniture manufacturing, and other industries. Over the past two decades, the development of alternative wood modification technologies has received significant encouragement due to environmental and health concerns around the impregnation of wood with specific chemicals, Heat treatment is one of them (Dubey *et al*., 2016). Wood thermal treatments are advantageous and ecofriendly methods can enhance some wood attributes such as dimension stability, durability, and colour (Bazyar 2012). It has been proven that substantial changes in both physical and mechanical characteristics occurred in a thermally modified wood, resulting in a reduction in wood-related problems such as swelling owing to increasing moisture content (Cheng *et al*., 2014).As in thermal treatment there is a significant reduction in the quantity of bound water in the wood cell wall (Cai *et al*., 2021; Obataya *et al*., 2002).

On the contrary, it has also been analysed that thermal modification of wood results in considerable strength loss and deprived mechanical properties due to the alteration in the anatomical structures of wood also,

Wood usually darkens after a heat treatment, which is frequently attributed to the development of coloured breakdown products from hemicelluloses and extractive chemicals (Sundqvist *et al*., 2002). Heat-treated wood has various drawbacks in addition to enhanced stability, decreased hygroscopicity, and dimensional changes, such as loss of toughness, decreased tensile and bending strengths, unstable colour when exposed to the elements, and the emergence of surface cracks (Živković *et al*., 2008).The duration of thermal treatment determines the degree of swelling and EMCi.e.with increase in the temperature, EMC and Anti Shrinkage Efficiency (ASE) decrease (Bak *et al*., 2012). Hence it is formulated that a decrease in EMC leads in better dimension stability of wood. By using oil treatment methods uniformity in colour can be achieved by those species which are solely treated by thermal modification.

Conclusion

Oil-based thermal modification of wood presents a sustainable approach to enhancing wood properties by combining heat and specific oils. This technique improves dimensional stability, durability, and resistance to decay. While it may cause strength loss and color alteration, its benefits outweigh limitations, making it valuable for diverse industries. Over the past two decades, alternative wood modification technologies have gained momentum due to environmental concerns, further highlighting the significance of oil-based thermal treatment. By harnessing the synergistic effects of heat and oil, this method not only extends the lifespan of wood products but also broadens their potential applications, aligning with eco-friendly practices.

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Phyllanthus indofischeri Bennet – A wild edible fruit with multifarious uses

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Introduction

Non-timber forest products (NTFP) such as seeds, fruits, roots, flowers are important source of income and livelihood for Indigenous people living in and around forests. (Panayotou et al., 1992 and Ganesan R. 2003).The extraction and use of non-timber forest products (NTFPs) have had historical and current importance in cultures of indigenous people and in local economics. With increase in market demand, NTFPs today have been playing a role in large-scale commercial income generation and employment in many parts of the world (Sinha and Bawa2002). Due to lack of knowledge on their distribution or overexploitation or population status, may lead to the species vulnerable to extinction. (Ganesan R. 2003). *Phyllanthus indofischeri* Bennet is a species endemic to peninsular India and globally vulnerable (Thyagarajan, 1998; Kiemer, 2003 and Chattopadhyay, 2006). Due to commercial importance of these fruits and preferred marble green color with less dark spots due to fungal attack make these *Phyllanthus indofischeri* more vulnerable. C.E.C. Fischer in 1906 first collected *Phyllanthus indofischeri* from North Coimbatore and described as *Emblicafischeri* Gamble (Ganesan, 2003). Following the rules of nomenclature, *Emblicafischeri* should have been renamed as *Phyllanthus fischeri* pax. But already existed for an African Species of Phyllanthus.Therefore, the Indian species was renamed as *Phyllanthus indofischeri* Bennet (Ganesan, 2003). It has different common names depending on the region Perunelli (Tamil), Chittiusiri (Telugu).

Origin and distribution

It is found in hilly areas in high altitudes above 350m. Limited to peninsular India, Karnataka, Tamilnadu and velugonda hills of Nellore district of Andhra Pradesh and it is endemic to Deccan Plateau of certain drier forest areas of Southern India found in scrub forests. (Gamble 1925).

Description

Deciduous tree which grows up to height of 5-12 m. Bark is smooth in younger trees, fissured with square or rectangular flakes in older trees, grey, terete branches, glabrous, tubercled with persistent scars of previous year branchlets, branchlets are pale brown 3-5 per tubercle, acropetal, deciduous, subtended by minute scales, scales puberulous, 1.5-2.2 mm long, floriferous part of branchlets are thick with prominent floral and bract scars restricted to lower portion of branchlets thick with prominent floral and bract scars restricted to lower portion of branchlets, young branchlets are 5-9 cm long and with floriferous portion is up to 3.5 cm long. Stipules are brown, pinkish triangular and minute, and scaly 1-1.5 mm long, acuminate, fimbricate to laciniate along

margin. Leaves are alternate, distichous, obtuse rounded or subcordate at base less than 50 per branchlet, elliptic or ablong. Leaf blades 2.8 X 0.5-1.3 cm, sub-sessile, entire, acute, coriaceous, glabrous, glaucous beneath, or retuse at apex. Lateral nerves 5-7 pairs, looping along margin, prominent beneath obscure above. Flowers fascicled, in leaf less portion branchlets, acuminate at apex, bracts triangular, laciniate to fimbricate along margins. Pedicles filiform, 2-3 mm long, sub-fleshyperianth lobes 6, oblong to obovate, imbricate, papery,1.5-2mmlong,obtuse at apex, laciniate along margins, glabrous, with a globose gland at base, pale green. Disc fleshy, enclosing three-fourth of ovary, 6-angled, irregularly lobed. Ovary globoid, styler arms 3, each 6-8 mm long, slender, flat, bifid at apex curved, glabrous beneath. Stamens 3, yellow, filaments united into a column,1-2 mm long, vertically dehiscing anthers 1-2

(https://envis.frlht.org/)

mm long. Pedicillate male flowers, many restricted to lower portion of floriferous branchlets. Sessile female flowers usually 1-3, surrounded by numerous male flowers, protogynous, restricted to upper portion of floriferous branchlets. Fruits drupaceous, fleshy 2.5-4 cm, globose, across, pale green, seeds 6, grey (Ganesan 2003; Rao 2011). Fruits and seeds have been used in pickles, herbal medicines, cosmetics, jams as well as dyeing and tanning. Seed extracts used in hair oils and medicines (Sinhaand Bawa, 2002).

Propagation

Among various Conservation methods, *in-vitro* propagation is generally followed or enhance the biomass and conserve the germ plasm especially when population members are low in wild (Anitha, 2014) and also to maintain plant genetic resources. In-vitro propagation methods are essential they are becoming increasingly important for rare and endangered plant species (Sudha *et al.*, 1998). Anitha 2014 in her study reported the effective procedure for *in-vitro* conservation of *Phyllanthus indofischeri* through embryo culture. Embryos from mature seeds were used as explants. Although germination was achieved on MS medium containing various Plant growth regulators, maximum response was observed on MS medium with added BAP 2.0 mg/l+IBA2.5mg/land GA_3 0.1mg/l and observed plantlets formation.

Marketing

According to fruit harvesters, the marble green color with less dark spots due to fungal attack makes the fruits more valuable. Preferred colour of this fruit can make it more exploited and vulnerable. Also, the market demand for Indian goose berry fruits is forcing collectors to harvest *phyllanthus indofischeri*.

Fruit collectors, tempt by money, cut the threes the major branches to maximize collection and also during a religious festival called ‘Utthanadwadasi’ held at end of monsoon season, huge number of people in Karnataka and Andhra Pradesh worship the fruiting branches along with tulsi (*Ocimum sanctum*) believing that this

fruiting branches will bring prosperity to their families. On this day of festival large loads of lopped branches of *Phyllanthus indofischeri* with young fruits are sold in local market. Due to high increase in demand, it has been cultivated on large scale. It has been introduced in cultivation as a horticultural variety under name 'Krishna' in Tamilnadu and 'Champakad large' in Kerala. In addition, Horticultural varieties with good traits have been released for large-scale farming to meet the demand from the international market. However, large quantities of fruits of *Phyllanthus indofischeri* are still harvested from wild in different parts of India (Ganesan, 2003).

Conservation

Phyllanthus indofischeri Bennet. is a vulnerable medicinal plant and listed in IUCN (The International Union for Conservation of Nature).It is facing threat from habitat loss and also from excessive fruit collection that impedes its regeneration. Scrub and dry deciduous forests in peninsular India have been extensively cleared for agriculture in the past. Present the rest of other patches of these forests are under threat due to forest fire, grazing conversion to monoculture plantations, encroachment and unsustainable collection of NTFPs (Non-timber forest products) and fuel wood (Rawat 1997; Ganesan, 2003)

Conclusion

The above-mentioned facts reveal that the species have a good economic potential. Since *phyllanthus indofischeri* is a significant NTFP species with distribution in a few pockets of forests of Deccan plateau in Southern India, indiscriminate collection can lead this species to rapid extinction. Bringing awareness to NTFP collectors about its vulnerability to extinction and restricted distribution might encourage them to pot non-destructive collection practices. Efforts have begun in this direction by Forest department by involving indigenous people and local NGO (Non-governmental organization) (Bawa, 1999). These agencies are trying to reduce the level of damage of tree while harvesting and to improve the regeneration of *Phyllanthus indofischeri.*

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Ecological significance of *Rhododendron arboreum*: Regeneration problems, utilization and response to climate change

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Nauni, Solan, Himachal Pradesh-173230

General description and distribution

The term 'Rhododendron' finds its roots in the Greek words 'Rhodo', meaning rose, and 'dendron', meaning tree. Rhododendron, a vast genus of woody plants within the Ericaceae family, boasts a remarkable diversity. These plants range from low-lying creepers measuring just a few centimetres in height to towering trees reaching up to 30 meters. They exhibit both evergreen and deciduous characteristics. In their natural habitats, the Himalayas and South East Asia emerge as hotspots for rhododendron diversity. Globally, there are approximately 1024 species of rhododendron, with India hosting 87 species, 12 subspecies, and 8 varieties. Notably, 20 of these species are unique to the Indian Himalayan Region. Rhododendrons thrive in mountainous regions with temperate climates, often favouring elevations between 1500 to 4000 meters characterized by high rainfall, humidity, rich organic matter, and acidic soils. They often coexist with mosses, which aid in moisture retention. In India, they are indigenous to the Himalayas, North Eastern regions, and the southern Western Ghats. In the northwestern Himalayas, particularly Himachal Pradesh and Jammu and Kashmir hosts four notable species of rhododendron: *Rhododendron arboreum* (known as burans), *Rhododendron campanulatum* (Kashmiri Patta), *Rhododendron anthopogon* (Talispatra), and *Rhododendron lepidotum* (Kashmiri Patta) whereas, six rhododendrton species are present in Uttarakhand.

Table 1: The distribution of rhododendron species across different Indian states (Bhattacharaya and Sanjappa 2008)

Name of State	Number of Species Reported
Arunachal Pradesh	67
Sikkim	36
West Bengal	19
Nagaland	7
Uttarakhand	6
Manipur	5
Himachal Pradesh and Jammu & Kashmir	4
Mizoram and Meghalaya	2
Tamil Nadu and Kerala	1

Rhododendron arboreum stands out as one of the most widely distributed and recognized species across the Indian subcontinent and beyond.It is an evergreen tree and can grow up to 14 metres in height and 2.4 metres in circumference. Bark that is soft, rough, and reddish-brown exfoliates in thin flakes. The flowering and fruiting seasons are March through April and June through September respectively. This species is also known as Burans, Bras, Buras, or Barah-ke-phool in local dialects, serves as the state tree of Uttarakhand and the state flower of Nagaland.

Habitat and Ecological importance of *R. arboreum*

*R. arboretum*is an important associate species of Himalayan forests ecosystems, which can be generally found between 1500 and 4000 metres above mean sea level. As per the Champion and Seth forest classification, *R. arboreum*is mainly found under forest types of 9/C1b – Himalayan Chir Pine Forest, 12/C1a – Ban Oak Forest, 12/C1b – Moru Oak Forest, 12/C1c – Moist Deodar Forest and 12/C1e – Moist Temperate Deciduous Forest. At low elevation, it mixes with Chir pine and broadleaf species, while in low to mid hills it remains under canopy species in *Quercusleucotrichophora* and *Quercus floribunda* forest. At high elevation it remains either as under canopy species in *Quercussemecarpifolia* forest or dominates as canopy species in some location near timberline (Gaira et al. 2014).

Rhododendrons perform a number of vital roles in the forest since they are regarded as key indicators of a healthy forest ecosystem, which sustains a variety of species. They help to maintain fragile ecosystem in the transition zone between sub alpine to alpine. It has also been observed that *Rhododendron spp*. preserve moisture in hilly regions while sustaining transpiration rates and humidity in places with minimal rainfall at higher elevations. Additionally, they maintain the slope of mountains, regulate wind speed, and help to manage soil erosion. *Rhododendron arboreum* plays a crucial role in various aspects of ecosystems and human welfare. Studies have highlighted the plant's significance in biodiversity, especially in mountainous regions (Jump et al., 2012).The plant's distribution patterns and regeneration status in different forest ecosystems have been studied, shedding light on its role in forest dynamics and regeneration processes (Giri&Katzensteiner, 2015; Paul et al., 2018).

Regeneration problems

Rhododendron species face hurdles in seed viability and germination. Dormancy issues, minute seed size and low seed viability often hinder successful germination. Habitat fragmentation caused by human activities isolates rhododendron populations, reducing genetic diversity and disrupting pollination. Anthropogenic factors such as deforestation, urbanization, and unsustainable logging threaten rhododendron habitats, with over 300 species facing extinction risks due to such activities. Climate sensitivity poses another challenge, as variations in temperature and rainfall patterns affect flowering and seed production. Studies predict shifts in flowering phenology and distribution due to climate change, with rhododendrons likely to move to higher elevations to adapt. Furthermore, presence

of thick humus layer, drought like condition and competition from invasive species limits resources for rhododendron regeneration, while overharvesting for ornamental, medicinal, and fuel purposes further threatens their survival. Unsustainable extraction of rhododendron plants for firewood exacerbates the pressure on their populations, especially in rural areas where fuel-wood is essential for daily needs.

Propagation Techniques

Propagation of *R. arboreum* presents a formidable challenge, yielding few satisfactory outcomes. Natural proliferation occurs swiftly in newly exposed terrain, such as landslides and crevices of barren rocks, where ample moisture exists; however, arid locales hinder natural reproduction as seedlings swiftly succumb to drought.

However, the artificial regeneration through seeds involves pre-sowing immersion of seeds in gibberellic acid solution followed by sowing in the month of March or April in containers filled with moistened fine sand or powdered brick, left uncovered and sheltered from precipitation and excessive sunlight. Subsequent transplantation, if warranted by size, occurs in the second season, followed by nursery maintenance until suitable for outdoor planting. The recommended substrate, as proposed by Pathak et al. (2021), comprises equal parts soil, sand, and cow dung, with a targeted pH of approximately 6.2, ensuring optimal germination outcomes. Stem cuttings presents an alternative method for *R. arboreum* propagation. Stem cuttings of size 0.5–1 cm in diameter and 10 cm in length, ensuring they are healthy and freedom from diseases or pests are mostly preferred. Application of growth-promoting hormones such as IAA (Indole-3-acetic acid) and NAA (1-Naphthaleneacetic acid) at specified concentrations i.e. 1000 ppm and 2500 ppm (Ahmad et al. 2020 and Ahmad and Puni, 2010) has been considered optimum for stimulating root development. Regular monitoring for rooting and growth signals is essential, coupled with adjustments to environmental parameters to optimize rooting and overall plant vigor. Maintenance of adequate moisture levels, avoiding water logging, as moisture is integral to successful root initiation.

Response to Climate change

Rhododendron species are sensitive to climatic variations. Changes in temperature, rainfall patterns, and extreme weather events influence their flowering, pollination, and seed production, affecting their regeneration success. In recent studies, it is predicted that rhododendron arboreum is likely to move towards higher elevation in Himachal Pradesh and Uttarakhand to cope with climate change due to global warming. Study conducted by Gaira et al (2014) generates evidences of changes in flowering phenology of Rhododendron arboreum in Indian central Himalaya. Real-time field observations (2009-2011) showed peak flowering during early February to mid-March. Analysis on long-term temperature data revealed significant increase in seasonal (winter and post-monsoon) and annual mean maximum temperature which predicted 88-97 days early flowering over the last 100 years. Furthermore, long-term temperature data from real-time field observations and herbarium records

depicted annual mean maximum temperature responsible for shifts in flowering dates of the target species. Furthermore, research has emphasized the impact of climate change on Rhododendron species, stressing the need for conservation strategies to safeguard them in the face of changing environmental conditions (Kumar, 2012).

Utilization

The phytochemical composition of *Rhododendron arboreum* includes flavonoids, alkaloids, terpenoids, and glycosides which substantiates its traditional applications and highlights its pharmacological potential (Ahmad et al. 2022). Additionally, Rhododendron arboreum is recognized in traditional medicine for its anti-ulcer and wound healing capabilities (Agarwal & Rajput, 2023). These plants are also noted for their compounds that alleviate headaches and reduce blood pressure. Traditionally, the flowers have been used in the treatment of several ailments, and the extracted juice is both nutrient-rich and culturally valued refreshment.

Economically, rhododendrons provide multifaceted opportunities for local communities. They are a source of income through the sale of flowers and value-added products such as juice, jam, wine, and squash, thereby supporting livelihoods and bolstering rural economies. However, it is important to exercise caution in the consumption of certain plant parts, such as the leaves and rhododendron honey, due to their potential toxic effects. In regions like Uttarakhand and Himachal Pradesh, the commercial exploitation of rhododendrons is emerging, with small-scale enterprises increasingly producing popular items like squash, which are marketed both locally and in urban centers. Studies have shown that a significant number of households in these areas participate in the harvesting and trading of rhododendron flowers, generating considerable income during the flowering season.

Future research thrust

Utilizing *R. arboreum* for livelihoods requires balancing conservation efforts, as its wide-ranging use for fodder, fuelwood, and agricultural tools increases anthropogenic pressure. Thus, conservation via domestication and sustainable harvesting is imperative. Addressing the scarcity of germination data for rhododendrons, research can focus on developing nurseries and promoting local conservation efforts to mitigate slow vegetative propagation and poor seed germination rates. Sustainable harvesting practices, such as leaving 60% of flowers on trees to mature into seeds, should be encouraged. Non-destructive harvesting methods and community involvement can be promoted through awareness and capacity-building programs.

Restoration and conservation efforts for rhododendrons not only benefit biodiversity but also address ecological concerns. Establishing sanctuaries and utilizing ex-situ conservation methods, like tissue culture, can aid in their preservation. Educating local communities about rhododendron significance and facilitating simple propagation methods like seed germination and air layering can enhance conservation efforts and promote economic opportunities. Research on genetic variability highlights the need for in-situ conservation measures and exploring ex-situ methods such as tissue

culture to preserve genetic diversity. Promoting *R. arboreum* as a horticultural crop and providing training on quality control and value addition can enhance its commercial potential while sustaining local livelihoods.

Conclusion

Rhododendron arboreum plays a pivotal role in its native ecosystems, but it faces significant challenges related to regeneration, utilization, and climate change. The difficulties in natural regeneration may be exacerbated by overexploitation and habitat degradation, necessitating sustainable management practices to preserve these keystone species. Whereas, the sound success by artificial mean through seed as well as vegetative mean is still awaited. Furthermore, the utilization of *Rhododendron arboreum* provides substantial economic benefits to local communities and it must be balanced with conservation efforts to ensure the long-term viability of populations. The response of *Rhododendron arboreum* to climate change remains a critical area of study, as shifts in climate parameters could alter its distribution and phenology, impacting not only the species itself but also the broader ecological networks it supports. Addressing these challenges through comprehensive research and adaptive management strategies is essential for the conservation and sustainable use of *Rhododendron arboreum* in the face of environmental changes.

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Harnessing forests for climate change mitigation

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Introduction

Climate change is assumed as a certainty and described it as the biggest challenge humanity has ever faced. It is widely acknowledged that anthropogenic greenhouse gas emissions are the main reason that is accelerating the process (Lionel *et al.*, 2020). Finding ways to lessen the effects of climate change is therefore crucial, primarily because their severe effects have already been felt, frequently manifested in the occurrence of exceptionally violent weather events. Undoubtedly, forests are one of the most effective and easiest ways to act as carbon sinks. With their ability to support around a billion people and serve as habitats for the majority of the planet's species, forests are essential ecosystems. Healthy forests play a crucial role in absorbing billions of metric tonnes of CO_2 annually.

The ability of forests to absorb carbon from the atmosphere through the process of photosynthesis is the primary mechanism underlying their role in mitigating the effects of climate change. Compared to other terrestrial ecosystems, forests have a definite advantage in their capacity to absorb significant amounts of carbon. Thus, woods may offer a way to lessen the effects of climate change, a problem that continues to affect the world. Every year, trees absorb approximately 2.6 billion tons of carbon dioxide, or one-third of the CO_2 emitted by burning fossil fuels (*IUCN*, 2021). Forest preservation and restoration are critical to meeting global climate targets. As a result, forests constitute an achievable solution since they can efficiently contribute to CO_2 capture and sequestration over a variety of time periods. Better management of existing forests would improve forest growth and help mitigate climate change by increasing the forest carbon (C) stock, by storing carbon in forest products, and by generating wood-based materials substituting fossil carbon based materials or other CO_2-emission-intensive materials (Pekka *et al.*, 2022).

Forests - Carbon relation

Forests are able to create their own carbon cycle because trees and plants in general absorb CO_2 from the atmosphere and use it to produce organic matter, water, and solar energy through photosynthesis. It is the process that allows the use of biomass energy to be considered carbon neutral, as it is considered that the carbon emitted is only that which the plant has absorbed and stored during its lifetime. Trees and forests are already one of the most effective carbon capture methods (Kumar *et al.*, 2023). According to the US Forest

Service, America's woods store around 800 million tons of carbon each year, accounting for approximately 12% of total US emissions (U.S Forest Carbon Data, 2023). Forests sequester or store carbon mostly in trees and soil.

Forests as carbon sink

When trees carry out photosynthesis, they remove carbon dioxide from the air, bind it to sugar, and release oxygen. Trees use sugar to form wood, branches, and roots. Wood is an incredible carbon sink because it is mostly made of carbon (about 50%), it lasts for years as a standing tree, and takes years to break down after the tree dies. While trees mainly store carbon, they do release some carbon, such as when their leaves decompose, or their roots burn sugar to capture nutrients and water. Young woods feature a lot of trees and are great at collecting carbon. Middle-aged trees grow slowly compared to new trees, but they sequester and store more carbon.

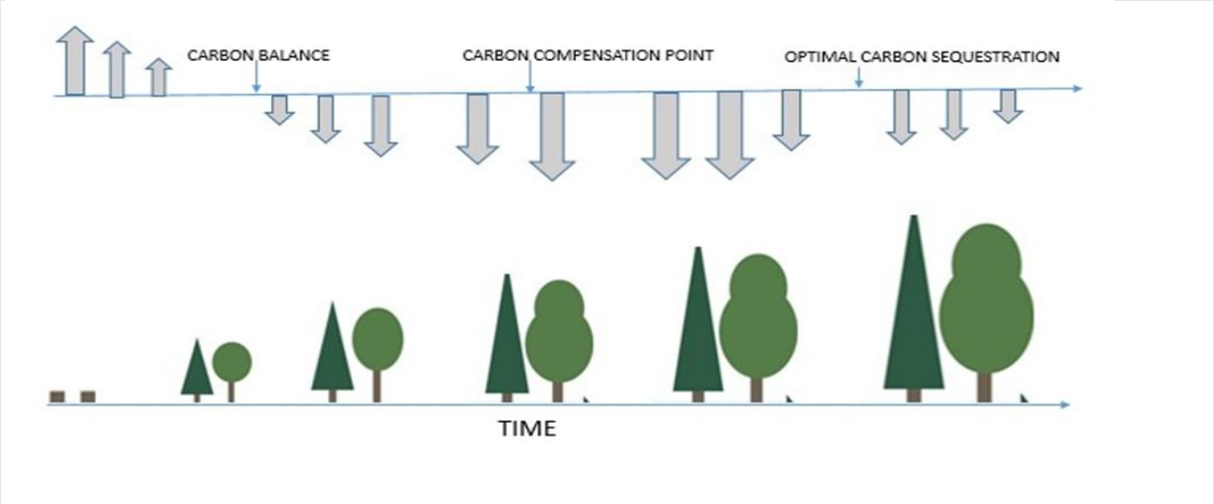

Fig. 1 Variation of carbon absorption with tree age

Soil

Forest soils contain plant roots, leaf litter, and other dissolved organic material. The quantity of carbon retained in forest soils varies, and how much carbon soil can sequester is determined by several local characteristics such as geology, soil type, and plant. Clay soils can bind a considerable quantity of carbon, whereas sandy soils cannot. Soils with more organic material (pieces of wood, rotting leaves, or dead organisms) can store more carbon because organic material readily binds loose carbon molecules and is stored as carbon.

Forests: a mitigating factor

Forests are excellent examples of natural recovery and adaptation, making them one of the most successful nature-based remedies. Their resilience, doesn't shield them from anthropogenic stressors, including land-use change, deforestation, agricultural intensification, and urbanisation. Healthy forests are effective carbon sinks, which means they absorb and store CO_2. According to estimates, forests absorbed twice as much carbon as they emitted between 2001 and 2019, averaging 7.6 billion metric tons of CO2 per year (*UNDP*, 2023). Therefore, forests provide a crucial capacity to remove greenhouse gases from the atmosphere and help us avoid the worst impacts of the

climate crisis. According to the Intergovernmental Panel on Climate Change (IPCC), the agriculture, forestry, and other land use (AFOLU) sector can contribute up to 30% of the GHG emissions reductions required to keep global warming below 2°C at a reasonable cost. For the AFOLU industry, forests provide numerous high-impact mitigation opportunities (Verma *et al*., 2023).

Forest management based on carbon sequestration capacity

Carbon conservation model

The model shows an interaction that contributes to a forest management trend in which carbon concentration is conserved in the forest. In theory, this model does not contribute to reducing atmospheric carbon, nor does it contribute to increasing it. With the concern of carbon content, this model is considered neutral.

Carbon Storage Model

The model is the representation of the forest management for carbon storage. The goal of this model is to increase the amount of carbon in the forest plants and soil, as well as the surface or carbon content of biomass in natural and planted forests, through increased storage in durable wood products. To improve carbon storage in vegetation and soil, it is vital to protect secondary forests and other degraded forests. Reforestation of uncovered land, as well as the promotion of natural or artificial regeneration of secondary forests, and increasing forest covers on agricultural land or pastures, all contribute to enhancing sequestration. (*Nelson et al.*, 2008)

Ways to increase carbon sink capacity of forest

- Converting additional forestland to plantations might significantly boost carbon sequestration.
- Additional potential management interventions include delaying timber harvests, planting trees rather than relying on natural regeneration, thinning to enhance forest growth, combating forest fires and other disturbances, and fertilizing.
- Preventing deforestation and restoring natural ecosystems by reforestation.
- Plantation of trees with good carbon sequestering capacity. eg., Teak, Poplar, Silver maple etc.
- Agroforestry has enormous potential to contribute to India's forestry NDC target, hence it should be pushed (Singh *et al.*, 2023).

Initiatives through plans, programs and policies

National action plan on climate change

The NAPCC identifies methods that enhance development objectives while also providing co-benefits to effectively address climate change. Action Plan on Climate Change (NAPCC) coordination, State Action Plan on Climate Change (SAPCC), National Institute on Climate Change Studies & Actions, National Carbonaceous Aerosols Program (NCAP), Long Term Ecological Observations (LTEO), International negotiations and capacity building. The NAPCC is comprised of eight "National Missions". They aim to increase understanding of climate change, adaptation and mitigation, energy efficiency, and natural resource conservation. The eight missions are:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change
- Climate change mitigation involves reducing or preventing human-caused greenhouse gas emissions. Everyone may contribute to climate change mitigation, from individuals who adopt sustainable behaviors and advocate for change to government implementing rules, provide incentives, and facilitate investment. Through regulation of policies and programs, climate change can be decreased to some extent by implementing strict actions for prohibiting activities that produce greenhouse gases. They offer opportunities to improve resilience and contribute to sustainable development.

Table 1: Programs and policies to mitigate climate change

PROGRAMS / POLICIES	FEATURES
National Afforestation Program (2002)	Aims to accelerate the on-going process of developing forest protection, management and development functions to decentralized institutions.
Green India Mission (2014)	• Increasing carbon sinks in sustainably managed forests and other ecosystems. • Enhancing resilience of vulnerable species/ecosystems to changing climate. • Enabling adaptation of forest-dependent communities to climatic variability
National REDD+ Policy (2014)	Intended to provide incentives to local forest communities to protect forests (carbon sinks).
National Forest Policy (2018)	The ministry of environment, forest and climate change has framed a new draft which proposes climate change mitigation through sustainable forest management.

Climate change: a challenge for India

Over the past few years (2000-2022), global greenhouse gas emissions have exceeded relatively. During the period of 2000-2008, carbon emission went to be increased with low percentage. After 2010, there went a sudden increase due to excess number of pollution that boosted through

various modernized technologies and anthropogenic activities. Carbon emission kept on increasing up to pre-pandemic period to 50.2%. In 2020, the COVID-19 pandemic caused a 4.8% drop in emissions and suddenly it rebounded by 4.7% in 2021 (*Ian Tiseo*, 2023). Till now, there is regularity in increase of greenhouse emissions.

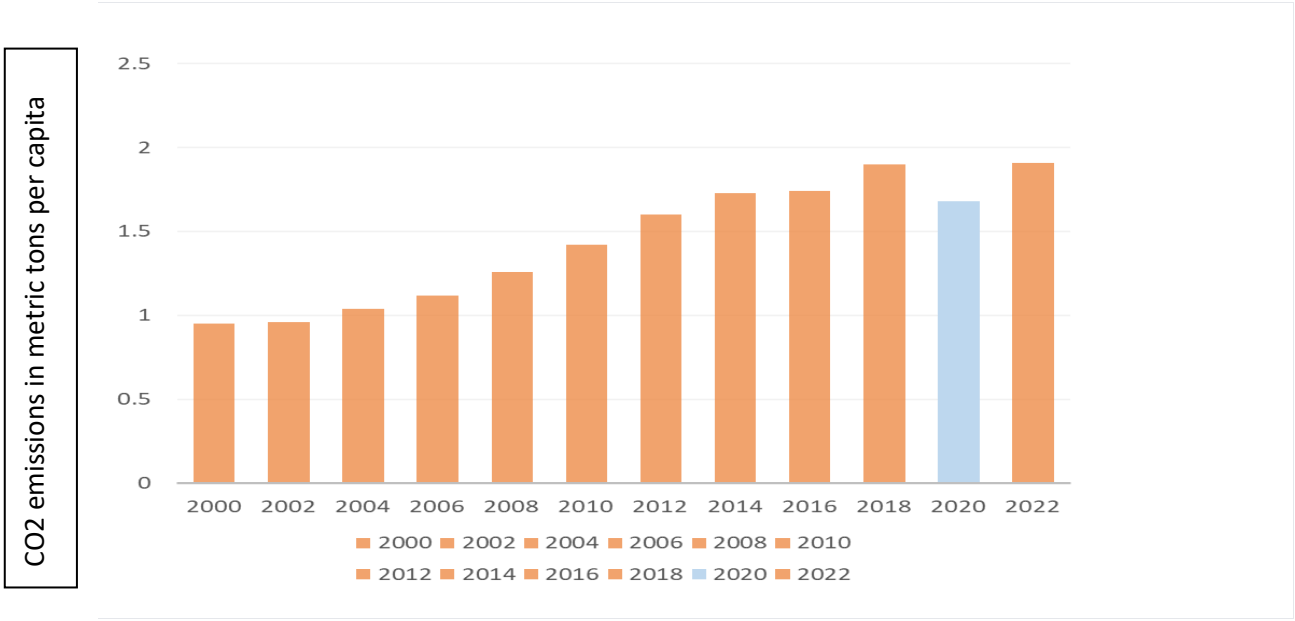

Fig 2. Rate of carbon emissions from year 2000-2022

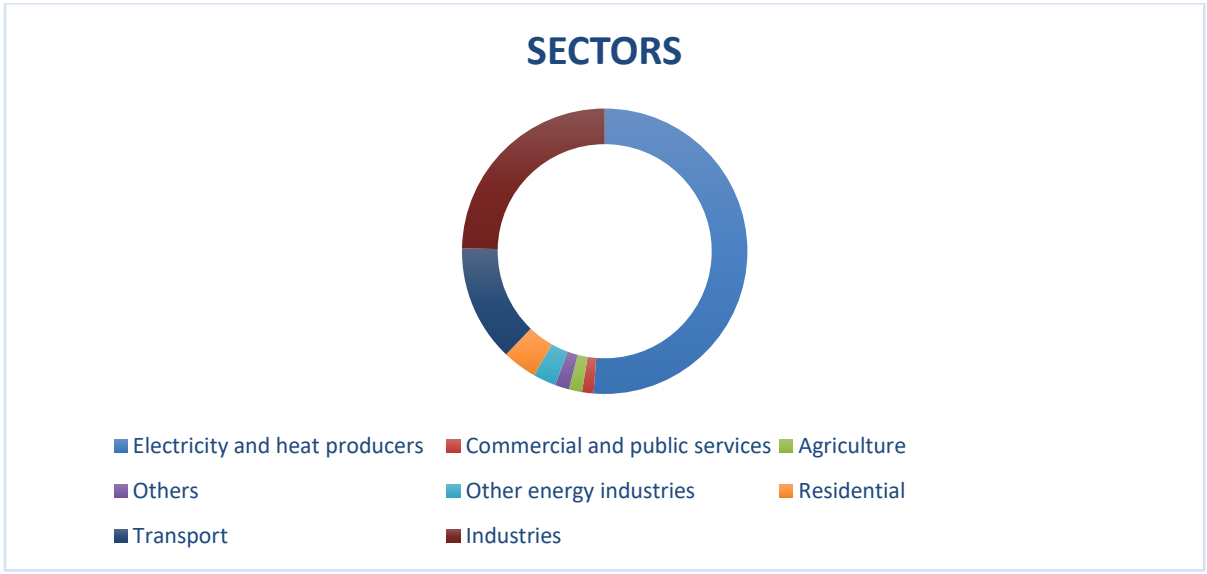

Fig. 2: Sector wise carbon emission

Conclusion

When trees are destroyed, usually due to deforestation for agriculture or urbanization, the stored carbon is released back into the atmosphere, leading to climate change. Thus, conservation and sustainable forest management are critical. The larger the green cover of the forest and healthier the trees are, the better is its capacity to sequester carbon. They are under threat due to deforestation and degradation. Forest preservation and

restoration are crucial for achieving the world's climate goals. A pragmatic and far-sighted approach is necessary. Coal, a major role in India's energy industry, must be regulated, and a transition to green energy is required to help India meet its renewable energy conversion objective. Forests that serve as carbon sinks require long-term management through collaboration between local people and the government. Financial, political, and policy leadership are at the heart of all recommendations for a successful climate change policy in India. Regional, state, national, and global involvements are the most effective ways for India to attain its climate resilience goals and long-term sustainable growth.

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वृक्ष प्रजातियों से चारा उत्पादन, संरक्षण एवं आजीविका के संभावित स्रोत

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परिचय

भारत की अर्थव्यवस्था मुख्यतः कृषि पर निर्भर करती है, जिसमेंपशुधन पालन एक महत्वपूर्ण भूमिका निभाता है। वैश्वीकरण के कारण दुनिया भर में दूध और अन्य डेयरी उत्पादों की मांग बढ़रही है। वन और गाँव की सामान्य भूमि जो परंपरागत रूप से इस व्यवसाय को बनाए रखने का मुख्य आधार रही है, वह बढ़ते जैविक दबाव से तथा प्रबंधन पर पर्याप्त ध्यान न देने के कारण पहले ही खराब हो चुकी है। गुणवत्तापूर्ण चारे और प्रशिक्षित श्रमिको की कमी के कारण डेयरी उत्पादों की आपूर्ति तथा उत्पादन कृषकों के समक्ष एक चुनौती है। चारे की मांग और आपूर्ति के बीच अंतर को कम करने के लिए बेहतर तकनीकों के साथ उच्च उत्पादकता के वृक्ष उत्पादित चारे का उपयोग कर सकते हैं। चारे के लिए अनुकूल वृक्ष प्रजातियों की व्यापक उपलब्धता से ग्रामीण जीवन और पशुपालन में व्यापक उन्नति देखने को मिलेगी, इस प्रकार के चारों को खाने के उपरांत मवेशियों के द्वारा उत्पन्न किये गए अपशिष्ट एक उत्कृष्ट जैव उर्वरक का उत्तम विकल्प बन सकते हैं। यह घरेलू स्तर पर गुणवत्तापूर्ण चारा उत्पादन और रोजगार सृजन को बढ़ावा देनेके लिए लाभप्रद है, वर्तमान में बढ़ती जनसंख्या तथा डेयरी उत्पादों की खपत के कारण पशुपालन के क्षेत्र में बढ़ोत्तरी देखने को मिली है, जिससे चारे की बढ़ती मांग को पूरा करने के लिए कृषक वृक्ष उत्पादित चारे का उपयोग कर अधिक लाभ कमा सकते हैं। मिश्रित खेती तथा पशुपालन, ग्रामीण जीवन का अभिन्न अंग हैं। भारतीय अर्थव्यवस्था में कृषि और पशुधन क्षेत्र अभी भी 52 प्रतिशत कार्यबल को रोजगार प्रदान करता है, यदि पशुपालन के साथ-साथ कृषक वृक्ष उत्पादित चारों को भी अपनाते हैं, तो दो वर्षों में इस प्रकार के रोजगार सृजन का स्तर 52 प्रतिशत से बढ़कर 75 प्रतिशत तक हो सकता है। वृक्ष उत्पादित चारे हमारी अतिरिक्त मांग को पूरा करने के साथ ही कृषि योग्य भूमि हेतु अतिरिक्त जैव उर्वरक की मांग को भी पूरा करते हैं, चारा उत्पादन में इस पद्धति की भागीदारी बहुत महत्वपूर्ण है। भारत में दुनिया का 15 प्रतिशत पशुधन है, जो देश के सकल घरेलू उत्पाद में लगभग 8.5 – 9.0 प्रतिशत का योगदान करता है। यह देश के विभिन्न हिस्सों में फैले लाखों परिवारों को भोजन तथा कृषि के लिए खाद प्रदान करने के साथ-साथ सूखे के समय कृषि पर निर्भरता को कम करता है। पशुपालन नीतियों के कारण बढ़ती पशुओं की आबादी देश में पहले से ही चारे से सम्बंधित संसाधनों पर और दबाव डाल रही है, चारे की इसी समस्या को दूर करने के लिये पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, भारत सरकार द्वारा कैम्पा परियोजना के अंतर्गत अखिल भारतीय समन्वित अनुसंधान परियोजना “जंगल में सतत चराई को कम करने के लिए चारे की उपलब्धता और गुणवत्ता में वृद्धि ”प्रयागराज के भा0 वा0 अ0 शि0 प0 –पारिस्थितिक पुनर्स्थापन केन्द्र द्वारा

चलायी जा रही है। इस परियोजना का उद्देश्य वनों में सतत चराई की समस्या पर काबू पाने के लिए प्रतिमान विकसित करना तथा वनों और सामुदायिक भूमि में चारे के वृक्ष और उच्च पोषक मूल्य वाली घास के सतत उत्पादन की विधियाँ विकसित कर उनका प्रसार करना है। चारे के लिए पत्ते प्रति 6 माह पर एकत्रित करके इनका पोषण विश्लेषण पारिस्थितिक पुनर्स्थापन केन्द्र (प्रयागराज) की केंद्रीय प्रयोगशाला में किया जा रहा है। रोपण करने के साथ ही साथ उनमें पोषक तत्वो की वृद्धि की जाएगी जिससे पशुओं से दूध उत्पादन को बढ़ाया जा सकेगा। इस प्रकार की नीतियों के माध्यम से चारे का व्यापक संरक्षण और उपयोग किया जा सकता है, जिससे ग्रामीणों को रोजगार सृजन के साथ-साथ आबादी की पोषण स्थिति में सुधार तथा आर्थिक उत्थान में मदद मिलेगी।

चारे में उपयोग किये जाने वाले वृक्षों की कुछ प्रमुख प्रजातियां

प्रतिकूल मौसम में हरे चारे की पर्याप्त उपलब्धता न होने के कारण चारे के लिए कुछ वृक्षों की प्रजातियां किसानों के द्वारा प्रमुखता से उपयोग में लाई जाती हैं, गंगा के मैदानी क्षेत्रों तथा बुन्देलखण्ड सूखा प्रभावित क्षेत्रों के लिए उपयुक्त वृक्ष प्रजातियां तालिका न0-1 और 2 में दर्शायी गयी हैं–

तालिका न0 -1

गंगा के मैदानी क्षेत्र हेतु उपयुक्त वृक्ष प्रजातियां

क्र0स0	सामान्य नाम	वैज्ञानिक नाम
1.	Mulbery (शहतूत)	*Morus alba*
2.	Subabool (सुबबूल)	*Leucaenaleucocephala*
3.	Shisham (शीशम)	*Dalbergiasissoo*
4.	KachnarKashay (कचनार)	*Bauhinia purpurea*
5.	Babul (बबूल)	*Acacia Nilotica*
6.	Drum stick (सहजन)	*Moringaoleifera*
7.	Agasthi (अगस्त)	*Sesbaniagrandiflora*
8.	Ber (बेर)	*Ziziphusmauritiana*
9.	Neem (नीम)	*Azadirachtaindica*
10.	Khejri (खेजड़ी)	*Prosopiscinereria*
11.	Gamhar (गम्हार)	Gmelina arborea
12.	Peepal (पीपल)	Ficus religiosa

तालिका न0-2

बुन्देलखण्ड (सूखा प्रभावित क्षेत्र) हेतु उपयुक्त वृक्ष प्रजातियां

क्र0स0	सामान्य नाम	वैज्ञानिक नाम
1.	Mulbery (शहतूत)	Morus alba
2.	Subabool (सुबबूल)	Leucaena leucocephala
4.	Kachnar (कचनार)	Bauhinia purpurea
5.	Babul (बबूल)	Acacia nilotica
6.	Drum stick (सहजन)	Moringa oleifera
7.	Ber (बेर)	Ziziphus mauritiana
8.	Neem (नीम)	Azadirachta indica
9.	Peepal (पीपल)	Ficus religiosa
10.	Mahua (महुआ)	Madhuca longifolia

वृक्ष उत्पादित चारा और आपूर्ति परिदृश्य

वृक्ष उत्पादित चारा पशुधन के विकास के लिए सबसे महत्वपूर्ण हैं, वृक्ष उत्पादित चारे के विकास पर पूर्व में आवश्यक स्तर पर ध्यान नहीं दिया गया, अनुमानतः पशुधन उत्पादन में कुल लागत का 60-70 प्रतिशत भोजन (चारे) से आता है। चारे का उत्पादन और उसका उपयोग फसल चक्र, जलवायु, सामाजिक-आर्थिक स्थितियों और पशुओं की प्रजातियों पर निर्भर करता है। आम तौर पर खेती से उपलब्ध चारे मवेशियों को खिलाये जाते हैं, चारे की आपूर्ति के तीन प्रमुख स्रोत फसल अवशेष , खेती योग्य चारा तथा वृक्ष उत्पादित चारे हैं। अनुमानतः वर्तमान में देश को 63 प्रतिशत हरे चारे तथा 23.5 प्रतिशत सूखे चारे की कमी का सामना करना पड़ रहा है। जनसंख्या दबाव के कारण , कृषि योग्य भूमि का उपयोग भोजन और नकदी फसलों के लिए किया जाता है। इस प्रकार चारा उत्पादन हेतु उच्च गुणवत्ता वाली कृषि योग्य भूमि उपलब्ध होने की बहुत कम सम्मभावनाये बचती हैं । हम उपर्युक्त दर्शाई गई वृक्ष प्रजातियों (तालिका1 और 2) को पर्याप्त मात्रा में खेतों के मेड़ों पर लगाकर, हरे चारे की मांग को भी पूरा कर सकते हैं।

संरक्षण और विपणन

फसल के अवशेषों तथा घास और चारे की कटाई के बाद प्रबंधन महत्वपूर्ण है , क्योंकि उचित प्रबंधन से पोषक तत्वों की जैव उपलब्धता के साथ ही तैयार उत्पाद की गुणवत्ता बनी रहती है। चारे तथा घास को सूखा चारा या गीला चारा (साइलेज) के रूप में संरक्षित किया जा सकता है , जो मौसम की स्थिति तथा उपलब्ध संसाधनों के

आधार पर प्रतिकूल मौसम के दौरान पशुओं को खिलाया जा सकताहै। विभिन्न चारे के स्रोतों तथा मूल्यों के साथ उनके बाजार तथा उपभोक्ता सम्बन्धी विवरण दो अलग -अलग क्षेत्रों के अध्ययन को तालिका न0 3 और 4 के माध्यम से दर्शाया गया है –

तालिका न0 -3

गंगा का मैदानी क्षेत्र

क्र0स0	चारा विपणन सम्बन्धी विवरण	मूल्य व मात्रा
1.	सूखे चारे की कीमत (प्रति/किग्रा0)	रु. 8-10
2.	कृषि के हरे चारे की कीमत रुपये(प्रति किग्रा)	रु. 6
3.	वृक्ष उत्पादित (पत्ती) चारे की कीमत (औसतन) रु./ किग्रा0)	रु. 4
4.	संपूर्ण चारे के पेड़ की कीमत (औसतन) रु./वृक्ष)	रु. 400 प्रति/वृक्ष
5.	प्रति पेड़ वृक्ष उत्पादित चारे की मात्रा (औसतन) किग्रा0/वृक्ष)	100

तालिका न0-3 में गंगाके मैदानीक्षेत्र के किसानो तथा दुग्ध उत्पादकों के बीच किये गए सर्वेक्षण के उपरांत प्राप्त नतीजों के अनुसार सूखे चारे, हरे चारे, वृक्ष उत्पादित (पत्ती) चारे की कीमतरु./ प्रति किग्रा., संपूर्ण चारे के पेड़ की कीमत रु./वृक्ष तथा प्रति पेड़ वृक्ष उत्पादित चारे की मात्रा वृक्ष/किग्रा. को दर्शाया गया है।

तालिका न0 - 4

बुन्देलखण्ड (सूखा प्रभावित क्षेत्र)

क्र. स.	चारा विपणन सम्बन्धी विवरण	मूल्य व मात्रा
1.	सूखे चारे की कीमत प्रति/ किग्रा0	रु. 10-12
2.	कृषि द्वारा प्राप्त हरे चारे की कीमत रु0/ किग्रा0	रु. 6
3.	वृक्षपत्ती चारे की कीमत (औसतन) रु0/ किग्रा0	रु. 6
4.	संपूर्ण चारे के वृक्ष की कीमत (औसतन) रु0/वृक्ष	रु. 600/वृक्ष
5.	प्रति वृक्ष चारे की मात्रा (औसतन) किग्रा0/वृक्ष	100

तालिका न0-4 में बुन्देलखण्ड के कृषकों तथा यंहा के दुग्ध उत्पादकों के बीच किये गए सर्वेक्षण के उपरांत प्राप्त नतीजों के अनुसार सूखे चारे, हरे चारे, वृक्ष उत्पादित (पत्ती) चारे की कीमत रु./ प्रति किग्रा., संपूर्ण चारे के पेड़ की कीमत रु./वृक्ष तथा प्रति पेड़ वृक्ष उत्पादित चारे की मात्रा वृक्ष/किग्रा. को दर्शाया गया है।

वृक्ष उत्पादित चारे पर आधारित रोजगार एवं कृषकों के लिएआजीविका के संभावित स्रोत

पशुपालन तथा कृषि कार्य 70 प्रतिशत आबादी को वृक्ष उत्पादित (पत्ती) चारे के उत्पादन से साल भर रोजगार और आजीविका प्रदान कर सकता है। शहरी बाजारों और आजीविका प्रणालियों में चारे (सूखा और हरा) के विपणन पर प्रयागराज जिले में किए गए एक अध्ययन से ज्ञात होता है कि चारा उत्पादन से लेकर विपणन तक एक बहुस्तरीय प्रणाली है , वृक्ष उत्पादित तथा घास आधारित चारे के उत्पादन और विपणन के व्यापक संवर्धन द्वारा इस कमी को संतुलित किया जा सकता है।

इसी क्रम में प्रयागराज जनपद में वृक्ष एवं घास प्रजातियों के साथ दो प्रयोग शुरू किए गए-

प्रयोग संख्या 1

वृक्ष आधारित चारा उत्पादन के लिए पौधों के बीच अंतर तथा प्रति वृक्ष से प्राप्त जैव भार पर अध्ययन

प्रयोग सं0 1 में हमने हरे चारे के लिए उपयुक्त चार प्रमुख प्रजातियों को दो प्रकार की दूरियों (1m×1m तथा 1.5 m × 1.5 m) में लगाया, जिनमे अगस्त्य (*Sesbania grandiflora*), कचनार (*Bauhinia purpurea*), सहजन (*Moringa oleifera*) तथा गम्हार (*Gmelina arborea*) प्रमुख प्रजातियाँ हैं, चारों प्रजातियों का रोपण सितम्बर 2021 को किया गया तथा दो वर्ष पश्चात 2024 में इनका प्रथम उत्पादन प्राप्त किया गया, तालिका न0 5 में एक पौधे से दूसरे पौधे की दूरी के अंतर के अनुसार पौधों की ऊंचाई, ब्यास, हरी पत्तियों तथा हरी लकड़ी के जैव भार में पाए गए अंतर को दर्शाया गया है।

चित्र -1 AICRP-17 प्रयागराज जनपद में वृक्ष आधारित चारे का परीक्षण स्थल

तालिका न. - 5

वृक्ष प्रजातियों के बीच की दूरी तथा इनसे प्राप्त जैवभारों में अंतर

क्र सं.	वृक्ष प्रजाति का नाम	ऊंचाई (मी0)	व्यास (से0मी0)	हरी पत्तियों का जैवभार (कि ग्रा.)	हरी लकड़ी का जैवभार (कि. ग्रा.)

						(per tree after harvesting)		(per tree after harvesting)	
		1 m × 1 m	1.5 m × 1.5 m	1m× 1m	1.5 m × 1.5 m	1m× 1m	1.5m × 1.5m	1m × 1m	1.5m × 1.5m
1.	अगस्त्य *(Sesbania grandiflora)*	1.36	1.52	0.71	0.85	1.92	2.50	1.85	1.98
2.	कचनार (*Bauhinia purpurea*)	2.52	3.00	1.02	0.70	0.51	0.31	0.85	0.75
3.	सहजन (*Moringa oleifera*)	2.34	3.55	2.08	2.48	0.28	0.86	1.85	3.75
4.	गम्हार (*Gmelina arborea*)	2.05	3.80	2.12	2.08	0.72	0.91	1.28	2.65

प्रयोग स01 में लगाये गए पौधों में नमी (Moisture content (%)) तथा क्रूड प्रोटीन (Crude protein (%)) की मात्रा को प्रस्तुत तालिकान0-6 में दर्शाया गया है-

तालिका न.-6

Parameter	January 2023		October 2023	
	1m×1m	1.5m×1.5m	1m×1m	1.5m×1.5m
Moisture content (%)				
अगस्त्य *(Sesbania grandiflora)*	39.65	37.51	37.64	36.51
कचनार *(Bauhinia purpurea)*	45.59	44.71	46.94	47.16
सहजन *(Moringa oleifera)*	54.50	53.25	53.25	49.11
गम्हार *(Gmelina arborea)*	56.39	56.17	58.93	52.65
Crude protein (%)				

अगस्त्य *(Sesbania grandiflora)*	25.75	24.31	25.75	24.31
कचनार *(Bauhinia purpurea)*	26.44	25.88	26.44	25.88
सहजन *(Moringa oleifera)*	28.50	26.06	28.50	26.06
गम्हार *(Gmelina arborea*	21.94	27.13	21.94	27.13

प्रयोग संख्या 2 : चारा उत्पादन के लिए घास प्रजातियों पर अध्ययन

प्रयोग सं0 2 में हरे चारे के लिए उपयुक्त घास (बीज/मूल) प्रजातियों का चयन किया जिनमे *Stylosanthes hamate* (स्टाइलो), *Brachiaria mutica* (पारा घास) तथा *Pennisetum typhoides* (हाइब्रिड नेपियर) प्रमुख प्रजातियाँ हैं, तीनों प्रजातियों का रोपण जुलाई 2022 में किया गया तथा 6 महीने बाद इनका उत्पादन प्राप्त किया, तालिका न0 7 में रोपण के 6 महीने बाद प्रत्येक घास के जैवभार (क्विंटल/हेक्टेयर) के उत्पादन में आए अंतर को प्रदर्शित करता है, अधिकतम हरित जैवभार हाइब्रिड नेपियर में पाया गया।

तालिका न. – 7

घास प्रजातियों से प्राप्त जैवभारों में अंतर

क्र0 सं0	घास प्रजाति का नाम	घास की उपज का जैवभार (q/ ha-1)
1.	*Stylosanthes hamate* (स्टाइलो)	194.65
2.	*Brachiaria mutica* (पारा घास)	438.77
3.	*Pennisetum typhoides* (हाइब्रिड नेपियर)	860.16

स्टाइलोपारा घास नेपियर घास

चित्र-2 AICRP-17 प्रयागराज जनपद के परीक्षण क्षेत्र में लगाई गई घास प्रजातियाँ

भविष्य में लक्ष्य और चुनौतियाँ

विभिन्न शोध निष्कर्षों का प्रचार-प्रसार करने के लिए प्रायोगिक अध्ययन को बढ़ावा देने और क्षेत्र की परिस्थितियों के अनुसार उद्यमियों को प्रशिक्षण कराने के लिए क्षेत्र में अनुसंधान इकाइयों की स्थापना के साथ -साथ किसान संगठनों और स्वैच्छिक एजेंसियों के सहयोग से संयुक्त अनुसंधान अध्ययन करना चाहिए । पशुपालन विकास और कृषि विज्ञान केन्द्रों, विभिन्न किसान संगठनों , स्वैच्छिक संगठनों और कृषि प्रशिक्षण केंद्रों के साथ सहयोग करने के लिए एक विस्तार प्रभाग की स्थापना और नियमित रूप से उनकी प्रतिक्रिया प्राप्त करते हुए उद्यमियों का प्रसार करने के लिए किसान मेलों और गोष्ठियों में भागीदारी आदि के साथ ही महिलाओं को प्रोत्साहित करना भी लाभप्रद होगा। वर्ष भर हरे चारे की मांग को पूरा करने के लिए किसानों को वृक्षों की उन्नत प्रजातियों को लगाने के लिए प्रशिक्षण महत्वपूर्ण होगा , जिनसे गुणवत्तापूर्ण पत्तियों का उत्पादन हरे चारे के रूप में हो सके। कृषकों को नई तकनीकों के बारे में बहुत सीमित जानकारी है, जो उनके ज्ञान, कौशल, प्रथाओं और उत्पादकता को बढ़ा सकती है । कृषकों के प्रशिक्षण और नीति समर्थन से घरेलू स्तर पर बेहतर पोषण , आजीविका सुरक्षा और आर्थिक उत्थान में मदद मिलेगी।

पावती (Acknowledgement)

इस कार्य के लिए वित्तीय सहायता परियोजना "जंगल में अस्थिर चराई को कम करने के लिए चारे की उपलब्धता और गुणवत्ता में वृद्धि (AICRP-17)" चारा परियोजना की कैंपा योजना (MoEF&CC) के तहत प्रदान की गई है।

साल्विया हिस्पैनिका (चिया) नया 'सुपरफूड'

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[3]मूल विज्ञान विभाग, कॉलेज ऑफ़ हॉर्टिकल्चर एंड फॉरेस्ट्री नेरी, हमीरपुर (हि.प्र.)
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परिचय

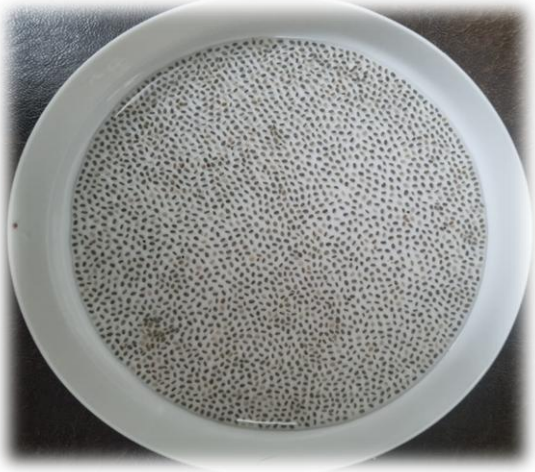
चिया (*साल्विया हिस्पानिका*) लमियासी प्रजाति का एक पौधा जो पुदीने की एक किस्म है। यह पौधा मूलरूप से मेक्सिको और दक्षिण अमेरिका में पाया जाता है l इसे बहुत धूप वाले स्थान और उष्णकटिबंधीय तापमान पसंद हैं। एज़्टेक शब्द 'चियान', जिसका अर्थ है चिकना, चिया शब्द का मूल है। लिनिअस ने स्पेन में उगाए गए पौधों की प्रजातियों का वर्णन किया, इस प्रकार इसका नाम हिस्पैनिका ("स्पेन का") पड़ा। चिया एक हरी-भरी, वार्षिक पुदीने की किस्म है और इसके बीजों को सुपरफूड के रूप में जाना जाता है। इसे इसके बीजों के लिए उगाया जाता है। बीज मुख्य रूप से दो प्रकार के होते हैं: एक काले रंग के चिया बीज और दूसरे सफेद चिया बीज। इन बीजों में विभिन्न प्रकार के उपयोगी तत्व शामिल होते हैं, जैसे फाइबर, पॉलीफेनोल्स, एंटीऑक्सिडेंट, विटामिन, खनिज, पेप्टाइड्स और ओमेगा-3 फैटी एसिड। इसके अलावा, ये बीज काफी मात्रा में ऐश अनसैचूरेटिड फैट, कार्बोहाइड्रेट और वनस्पति प्रोटीन प्रदान करते हैं। चिया बीज के घटक रक्तचाप, प्लेटलेट एकत्रीकरण और कोलेस्ट्रॉल को कम कर हृदय रोगों (कार्डियोवैस्कुलर डिज़ीज़िज़) से बचाता है। चिया फाइबर ब्लड ग्लूकोस के स्तर को कम करता है और मधुमेह और कब्ज जैसे विकारों के लिए लाभदायक है।

चिया का पौधा अंकुरण के चार महीने बाद आसमानी नीले, छोटे फूल पैदा करता है जो हरे तने के चारों ओर घने समूहों में व्यवस्थित होते हैं व 10 से 15 सेमी की लंबाई तक पहुंच सकते हैं। देर से वसंत ऋतु में फूलों की शुरुआत होती है, जो तेज़ गर्मी के दौरान जारी रहती है और पतझड़ के साथ ठंडा तापमान आने पर कम होने लगती है। पत्तियों का शीर्ष फैला हुआ व चमकीले मध्य हरे रंग का होता है।

वैज्ञानिक वर्गीकरण

किंगडम	**प्लांटे**
डिवीज़न	मैग्नोलिफाईटा
क्लास	मैग्नोलिओप्सिडा
आर्डर	लैमिऐलज़
फॅमिली	लैमिऐसी
जीनस	सैल्विया
स्पीशीज	ऐस. हिस्पैनिका

सूखे चिया बीज



भीगे हुए चिया बीज

चिया बीज की पोषक संरचना

अमेरिकी कृषि विभाग के अनुसार प्रति 100 ग्राम परोसने पर पोषण का विवरण:

नाम	मात्रा/100 ग्राम	नाम	मात्रा/100 ग्राम
पानी	5.8 ग्राम	मैंगनीज	2.72 मिली ग्राम
ऊर्जा	486 किलो कैलोरी	सेलेनियम	55.2 माइक्रोग्राम
प्रोटीन	5.8 ग्राम	विटामिन सी	1.6 मिली ग्राम
कुल लिपिड (वसा)	486 ग्राम	थायमिन	0.62 मिली ग्राम
राख	2030 ग्राम	राइबोफ्लेविन	0.17 मिली ग्राम

कार्बोहाइड्रेट	16.5 ग्राम	नियासिन	8.83 मिली ग्राम
रेशा	30.7 ग्राम	फलते	49 माइक्रोग्राम
कैल्शियम	631 मिली ग्राम	फोलेट टोटल	49 माइक्रोग्राम
आयरन	7.72 मिली ग्राम	विटामिन बी-12	0 माइक्रोग्राम
मैग्नीशियम	335 मिली ग्राम	विटामिन ए आई.यू.	54 आई.यू.
फॉस्फोरस	860 मिली ग्राम	विटामिन इ	0.5 मिली ग्राम
पोटैशियम	407 मिली ग्राम	सैचुरेटेड फैटी एसिड्स	3.33 ग्राम
सोडियम	16 मिली ग्राम	कोलेस्ट्रॉल	0 मिली ग्राम
जिंक	4.58 मिली ग्राम	कॉपर	0.924 मिली ग्राम

खेती

चिया के पौधे को अंकुर या बीज दोनों से उगाया किया जा सकता है। इसकी खेती के लिए अच्छी जल निकास वाली हल्की से मध्यम चिकनी मिट्टी या रेतीली मिट्टी की आवश्यकता होती है। यह पौधा अम्लीय और मध्यम सूखी मिट्टी का प्रतिरोध कर सकता है। बीज लगाने के दौरान अंकुर स्थापना के लिए पूरी तरह से नम मिट्टी की आवश्यकता होती है। बीजने के लिए गड्ढे खोदने की आवश्यकता नहीं होती है क्योंकि वे बहुत छोटे होते हैं, इसलिए बीज डालने के बाद मिट्टी को हल्के से भुरभुरा कर दिया जाता है। जैसे-जैसे अंकुर बड़े होते जाते हैं, पौधे पतले होते जाते हैं।

इन्हें गमलों में भी उगाया जा सकता है. जैविक खाद और गीली घास के नियमित उपयोग से पौधों की वृद्धि में सुधार होता है और खरपतवारों पर नियंत्रण होता है। इन पौधों को कम उर्वरक प्रयोग में उगाया जा सकता है लेकिन बेहतर उपज के लिए बार-बार सिंचाई करना आवश्यक है। इसकी खेती के लिए इष्टतम तापमान सीमा लगभग 16-26 डिग्री सेल्सियस है। बढ़ते चक्र की अवधि 100-150 दिनों के बीच है। चिया बीज की औसत उपज 350-400 किलोग्राम/एकड़ के बीच होती है। चिया की फसल मूंग बीन पीला मोज़ेक वायरस, ब्रॉड बीन विल्ट वायरस और ककड़ी मोज़ेक वायरस जैसे वायरस से संक्रमित हो सकती है।

चिया बीजों ने कम घनत्व वाले लिपोप्रोटीन (एलडीएल) कोलेस्ट्रॉल को कम कर उच्च घनत्व वाले लिपोप्रोटीन (एचडीएल) कोलेस्ट्रॉल के स्तर को बढ़ाता है । डी अब्रू एटआल (2021) के अनुसार एचडीएल कोलेस्ट्रॉल को " अच्छा" कोलेस्ट्रॉल भी कहा जाता है, जबकि एलडीएल कोलेस्ट्रॉल को " खराब" कोलेस्ट्रॉल के रूप में वर्गीकृत किया जाता है। हालाँकि, इस तथ्य को नजरअंदाज नहीं किया जाना चाहिए कि कोई भी आहार उच्च कोलेस्ट्रॉल को ठीक नहीं कर सकता है। चिया सीड्स में भरपूर मात्रा में फाइबर होता है। अध्ययनों के अनुसार, फाइबर रक्त शर्करा के स्तर और इंसुलिन प्रतिरोध को कम करने में मदद कर सकता है, जो टाइप 2 मधुमेह और चयापचय सिंड्रोम के खतरे को कम करता है। चिया सीड्स में कैफिक एसिड नामक एंटीऑक्सीडेंट होता है, जिसमें सूजन-रोधी गुण होते हैं। चिया बीजों के नियमित उपयोग से सूजन संबंधी लक्षणों को कम करने में भी मदद मिल सकती है । इसके अलावा

चिया बीज और उनके तेल में प्राकृतिक रूप से पाए जाने वाले एंटीऑक्सीडेंट की एक विस्तृत श्रृंखला शामिल होती है, जैसे टोकोफेरोल, फाइटोस्टेरॉल, कैरोटीनॉयड और पॉलीफेनोलिक यौगिक। चिया बीज में पॉलीफेनोलिक यौगिक मुख्य कॉम्प्लेक्स हैं जो इसकी एंटीऑक्सीडेंट गतिविधि में योगदान करते हैं। वे फ्री रेडिकल्स, शीलेट आयनों को नष्ट करने और हाइड्रोजन दान करने की अपनी क्षमता के लिए जाने जाते हैं। एंटीऑक्सिडेंट अणु मधुमेह, अल्जाइमर और पार्किंसंस रोग सहित कुछ बीमारियों से सुरक्षा प्रदान करने के अलावा कैंसर और दिल के दौरे जैसी पुरानी बीमारियों की संभावना को कम करते हैं।

चिया बीज भूख को कम कर सकते हैं क्योंकि उनमें आहार फाइबर की मात्रा अधिक होती है और कार्ब्स की मात्रा कम होती है। चिया बीज खाने से अधिक वजन वाले या मोटापे से ग्रस्त लोगों को वसा और वजन कम करने में मदद मिलती है। ग्रानसिएरी एट अल द्वारा 2019 में प्रकाशित एक समीक्षा लेख के अनुसार, मधुमेह और मोटापे से पीड़ित व्यक्ति जो चिया बीज का सेवन करते हैं, उन्हें वजन में कमी, छोटी कमर की परिधि और एडिपोनेक्टिन में वृद्धि का अनुभव हो सकता है - एक प्रोटीन हार्मोन जो रक्त में वसा के जमाव और सूजन को कम करता है।

खाद्य उद्योग में उपयोगिता

खाद्य व्यवसाय में चिया बीजों का अनुप्रयोग कई शोधों का विषय रहा है। चिया बीजों का उपयोग खाद्य व्यवसाय में साबुत, चूर्णित, आटा, तेल और जैल सहित विभिन्न रूपों में किया जाता है। 2000 में, अमेरिकी आहार दिशानिर्देशों ने प्रति दिन 48 ग्राम से अधिक चिया का सेवन नहीं करने की सिफारिश की। चिया का उपयोग प्राथमिक भोजन के रूप में किया जा सकता है, लेकिन केवल थोड़ी मात्रा में।

चिया बीज का सेवन बिस्कुट, स्पेगेटी, अनाज, स्नैक्स और पेस्ट्री के साथ मिलाकर किआ जा सकता है। चिया बीज एक हाइड्रोफिलिक भोजन है जो की अपने वजन से 12 गुना अधिक पानी सोख सकता है। इसकी चिपचिपाहट और पानी धारण करने की क्षमता के कारण, चिया म्यूसिलेज का उपयोग खाद्य उत्पादों में बाइंडर, इमल्सीफायर, फोम स्टेबलाइजर और सस्पेंडिंग एजेंट के रूप में किया जा सकता है। चिया बीज म्यूसिलेज को हाल के शोध में एक कार्यात्मक कोटिंग के रूप में उपयोगी दिखाया गया है। सेलूलोज़, संशोधित स्टार्च और गोंद अरबी जैसे अन्य हाइड्रोकोलॉइड के विपरीत चिया सीड गम एक नया और रोमांचक पदार्थ है। हालाँकि, इसका उपयोग अभी तक उद्योग में नहीं किया गया है क्योंकि इसकी संरचना पर अधिक जानकारी उपलब्ध नहीं है।

चिया बीज खाने के बुरे प्रभाव

चिया के बीज कम मात्रा में खाने के लिए सुरक्षित होते हैं । हालाँकि, चूँकि चिया बीजों में फाइबर की मात्रा बहुत अधिक होती है, इसलिए ज़्यादा खाने पर वे दस्त और गैस जैसे पाचन संबंधी विकार पैदा कर सकते हैं। पेय पदार्थों के संपर्क में आने पर चिया बीज फूल जाते हैं और उनमें गाढ़ी और चिपचिपी स्थिरता आ जाती है, जिससे निगलने में समस्या वाले लोगों के लिए खतरा पैदा हो सकता है क्योंकि वे अन्नप्रणाली में फंसकर फूल सकते हैं और रुकावट पैदा कर सकते हैं।

निष्कर्ष

चिया बीज में पाए जाने वाले कई पोषक तत्व बहुत फायदेमंद न्यूट्रास्युटिकल पदार्थ होने की क्षमता रखते हैं जो मानव स्वास्थ्य में सुधार करते हैं। घुलनशील और अघुलनशील फाइबर, ω-3 और - 6 फैटी एसिड से भरपूर तेल, आवश्यक अमीनो एसिड से भरपूर प्रोटीन, खनिज, विटामिन और एंटीऑक्सीडेंट गुणों वाले

फाइटोकेमिकल्स बीजों के सबसे महत्वपूर्ण घटकों में से हैं। क्योंकि उनमें ये सक्रिय अणु होते हैं, शोधकर्ता पिछले दस वर्षों से उनके गुणों, विशेष रूप से एंटीहाइपरटेन्सिव और एंटीऑक्सीडेंट प्रभावों की उनकी क्षमता को पहचानने और सुधारने के प्रयास में उन पर ध्यान केंद्रित कर रहे हैं। बेहतर न्यूट्रास्युटिकल गुणों और खाद्य क्षेत्र में गहन अनुप्रयोगों के साथ नई किस्में बनाने के लिए चिया पौधों पर नवीन आणविक प्रौद्योगिकी लागू की जा सकती है। इस प्रकार चिया इस सदी का स्वर्णिम बीज बन सकता है।

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