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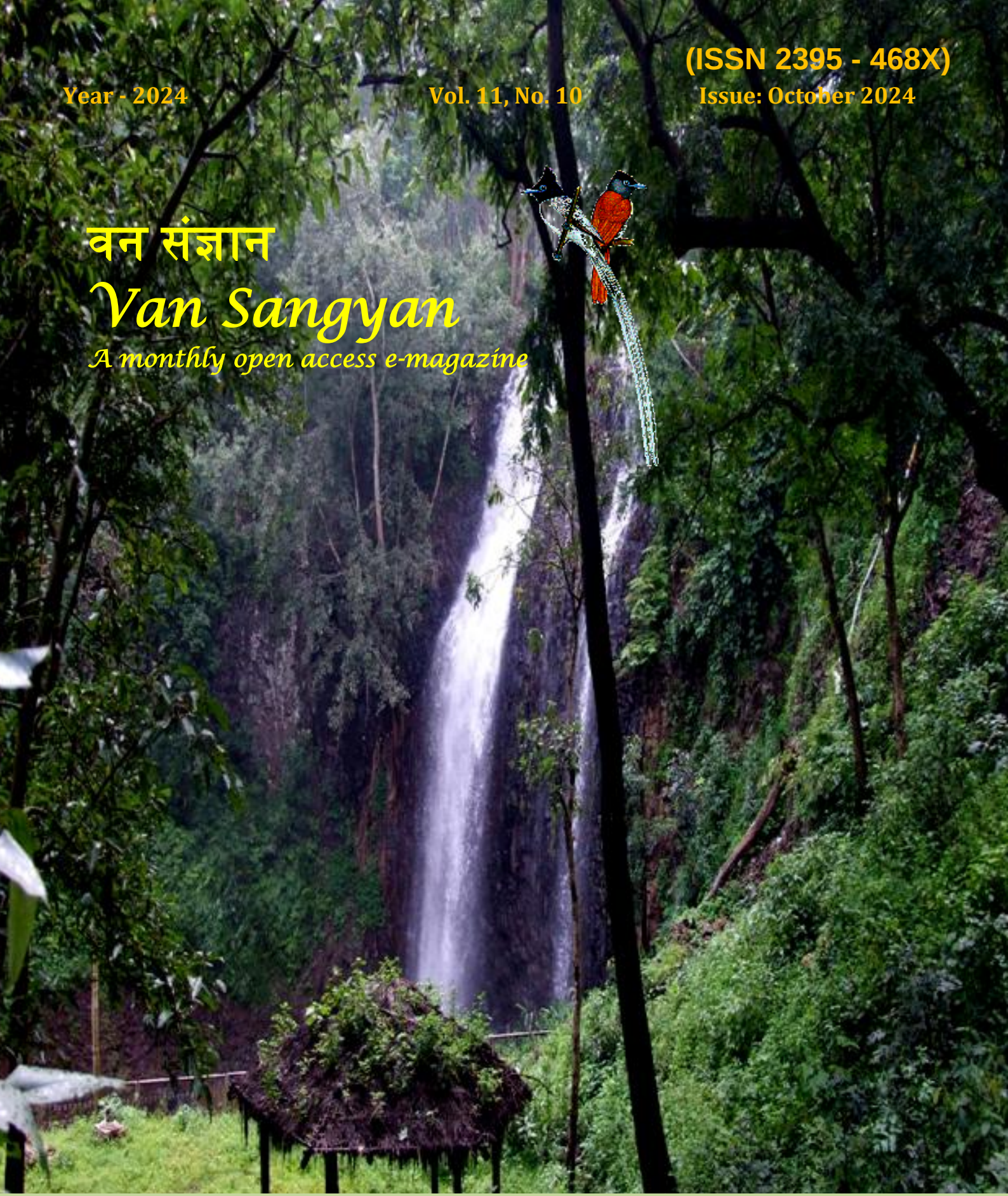

वन संज्ञान
Van Sangyan
A monthly open access e-magazine

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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:

by e-mail to vansangyan_tfri@icfre.org

or, through post to The Editor, Van Sangyan,
Tropical Forest Research Institute,
PO-RFRC, Mandla Road,
Jabalpur (M.P.) - 482021.

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

Neem, a versatile and ancient tree, has been a cornerstone of sustainable agriculture for centuries. In organic farming, neem plays a crucial role as a natural pesticide, fungicide, and fertilizer. Its compounds, such as azadirachtin, possess potent insecticidal properties that repel and kill a wide range of pests without harming beneficial insects. Neem oil, extracted from its seeds, is used in foliar sprays to protect crops from various diseases and pests. Additionally, neem cake, a byproduct of oil extraction, is an excellent organic fertilizer that enriches the soil with essential nutrients and improves soil structure. By incorporating neem into organic farming practices, farmers can enhance crop yields, reduce reliance on synthetic chemicals, and promote environmental health.

In line with the above this issue of Van Sangyan contains an article on जैविक कृषि में नीम का महत्व. *There are also useful articles viz. Green composite: Biopolymer-basedcomposites reinforced with agroforestry waste, Understanding nitrogen fixation in forests - Nature's fertilizer, Palash: A tree of many wonders, Opium Poppy – Its importance, illegal trafficking and economic significance, CRISPR/Cas 9 in Forestry, Integration of spices under various agroforestry systems, Greening Telangana: Exploring the vital role of trees outside forests and* Van Mitra: A scheme to boost green cover in Haryana.

I look forward to engaging with all of you through our upcoming issues!

Dr. Naseer Mohammad

Chief Editor

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जैविक कृषि में नीम का महत्व एवं उपयोग

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जैविक कृषि में नीम का उपयोग किसानों के लिए बहुत महत्वपूर्ण है नीम के जैविक उत्पाद जैसे- नीम की पत्तियां, तेल और खली, आदि जैविक कृषि में प्रयोग करते है जिससे पौधों में रोगों से बचाव और मृदा में पोशक तत्वों की उपलब्धता को बढ़ाता है और इसके उत्पाद में कीटनाशी, कवकनाशी, जीवाणुनाशी गुण पाये जाते हैं। नीम उत्पाद जैविक कृषि में प्रभावी ढंग से लाभ देते हैं, जिनके प्रयोग से मिट्टी की उर्वरता जैविक कीटनाशकों और उर्वरकों के रूप में किया जा सकता है। यह लेख जैविक कृषि में नीम का आधुनिक महत्व एवं उपयोग के बारे में पूरी जानकारी देता है।

परिचय

भारत में कृषि आज से लगभग 10000 वर्ष पूर्व से की जा रही है। इसलिए ही भारत को कृषि प्रधान देश कहा जाता है। क्योंकि भारत की अर्थव्यवस्था कृषि पर आधारित है जहाँ की लगभग 60 प्रतिशत आबादी कृषि एवं कृषि सम्बंधित उद्योगों पर निर्भर करता है। प्राचीन भारत में कृषि ही आय का मुख्य स्रोत था। यहाँ की भूमि बहुत उपजाऊ हुआ करती थी और प्राकृतिक तरीकों से खेती की जाती थी। प्राचीन समय में कीटनाशकों का कोई उपयोग नही होता था, वे कीटनाशकों के रूप में मवेशियों के अपशिष्ट का ही उपयोग करते थे। वे केवल प्राकृतिक जैविक खाद का उपयोग करते थे। भारत में हरित क्रांति की शुरुआत सन् 1960 में हुई। जिसमे मुख्य रुप से अधिक उपज वाले किस्म के बीज, मशीनीकृत कृषि उपकरण, सिंचाई सुविधाएं, कीटनाशकों और उर्वरक प्रयोग में लाए गये जिसके परिणामस्वरुप खाद्य उत्पादन में वृद्धि हुई। वैज्ञानिकों ने प्राचीन भारतीय खेती पर अध्ययन किया है, उन्होंने साबित किया है कि जैविक कीटनाशी फसलों में लगने वाले कीटों से मुक्त करने में मद्द करते हैं और फसलों की उत्पादन में बढ़ोत्तरी करते है, लेकिन आजकल खेती मुख्यतः रासायनिक कीटनाशकों पर निर्भर है। हालाँकि इन कीटनाशकों का प्रयोग करके अधिक लाभ मिलता है जबकि कीटनाशक मानव स्वास्थ्य और भूमि की उर्वरता के लिए हानिकारक होते हैं। नीम के यह विशेषताएं जैविक कृषि उत्पादन प्रणालियों में महत्वपूर्ण प्रभाव डालती हैं जो अधिक टिकाऊ और रासायनिक अवशेष उत्पन्न नहीं करती हैं। नीम लंबे समय तक उत्पादन सुनिश्चित करते हुए, मिट्टी की उत्पादकता बनाए रखने में मदद करता है।

जैविक कृषि में नीम का महत्व

नीम वनस्पति जगत का एक बहुउद्देशीय पेड़ है जो मानव के साथ-साथ पशुओं और कृषि फसलों के विभिन्न रोगों तथा हानिकारक कीट-पतंगों के उपचार की प्रभावी शक्ति रखता है। आधुनिक रासायनिक खेती की वजह से जहाँ मनुष्यों और पशुओं के स्वास्थ्य तथा पर्यावरण पर गम्भीर प्रभाव पड़ रहा है। इसलिए जैविक और प्राकृतिक खेती में नीम उत्पादों के उपयोग को बढ़ाने पर

जोर दिया जा रहा है। प्राचीन भारतीय ग्रन्थों और चिकित्सा शास्त्रों से लेकर आधुनिक वैज्ञानिक खोजों ने भी नीम के महत्वपूर्ण औषधीय गुणों को साबित किया है। परम्परागत तौर पर खेती-बाड़ी के मामले में नीम का मुख्य इस्तेमाल अन्न भंडारण और पशुओं के परजीवी कीड़ों के नियंत्रण तक सीमित रहा था लेकिन आज के समय में नीम का जैविक खेती में प्रयोग किया जा रहा है।

रासायनिक कीटनाशक कीड़ों के पाचन तंत्र को खराब करके या उनके तंत्रिका तंत्र को प्रभावित करके कीड़ों को मार देता हैं। लेकिन यह प्रभाव लंबे समय तक न रहकर कीड़ों को इन कीटनाशकों के प्रति प्रतिरोधी बना देते है। जब नीम की बात आती है, तो नीम सीधे कीड़ों के हार्मोनल सिस्टम को प्रभावित करता है जिससे आने वाली पीढ़ियों में प्रतिरोध की सम्भावना नहीं होती है। नीम में जीवाणुरोधी और कवकरोधी यौगिक पाये जाते हैं जिन्हें लिमोनोइड्स कहा जाता है। वर्तमान में कृषि की एक बड़ी चुनौती पर्यावरण को नुकसान पहुँचाए बिना विश्व की बढ़ती हुई जनसंख्या की जरूरतों को पूरा करने के लिए खाद्य उत्पादन में वृद्धि करना है, जिसके विपरीत कीटनाशकों का प्रयोग करने से पर्यावरण प्रदूषण के साथ साथ प्रतिरोधी कीटों का विकास हो रहा है और जैव कीटनाशक के स्थान पर कृत्रिम कीटनाशक के रुप में प्रयोग में लाया जा रहा है। जिससे कीटों की आबादी पर सुरक्षित नियंत्रण संभव है। हालाँकि, जैव कीटनाशक का जल्दी खराब होना, प्रकाश संवेदनशीलता और अस्थिरता जैव कीटनाशकों की सीमाएं बड़े पैमाने पर उनका उपयोग करना मुश्किल बना देती हैं। वैज्ञानिकों ने निकट भविष्य में टिकाऊ कृषि के विकास से जुड़ी समस्याओं पर विचार करते हुए, फसल सुरक्षा में नीम के तेल के संभावित उपयोग की समीक्षा की हैं। वैज्ञानिक, किसानों को एकीक्रत कीट प्रबन्धन अपनाने का सुझाव देते है। जिससे फसलों का कीटों से बचाना संभव हो पाता है।

कृषि कीट नियंत्रण में कृषि रसायनों के स्थान पर नीम के तेल के उपयोग पर ध्यान दिया जा रहा है। अतः नीम अपने बहुउद्देशीय लाभों के कारण कृषि में अत्यधिक महत्व रखता है। यह कई महत्वपूर्ण लाभ प्रदान करता है एवं पर्यावरण-अनुकूल कृषि पद्धतियों को बढ़ावा देता है।

नीम का टिकाऊ कृषि में भविष्य

नीम का प्रयोग पर्यावरण को नुकसान पहुंचाए बिना कीटों को नियंत्रण, मिट्टी के स्वास्थ्य में सुधार, फसलों की रक्षा एवं किसानों के लिए एक मूल्यवान स्रोत है जो कि कृषि में टिकाऊ भविष्य के लिए योगदान करता हैं। कृषि रणनीतियों में नीम को शामिल करते समय कृषि विशेषज्ञों से परामर्श करना और उनके द्वारा दिए गए दिशा निर्देश नीम के महत्व को दर्शाता है। जिससे नीम के प्रयोग के उचित परिणामों प्राप्त होते है।

नीम जीन बैंक

जैविक खेती में नीम की उपयोगिता

जैविक खेती के लिहाज से नीम एक उपयोगी पेड़ है। इसलिए जोधपुर स्थित केंद्रीय शुष्क क्षेत्र अनुसंधान संस्थान और मेरठ स्थित भारतीय कृषि प्रणाली अनुसंधान संस्थान के वैज्ञानिकों ने जैविक खेती में नीम का प्रयोग किया है और इन संस्थानों ने नीम से बनने वाले विभिन्न उत्पादों को बनाने और इनके प्रयोग की प्रक्रिया का मानकीकरण किया है। जैविक या प्राकृतिक खेती में रासायनिक खाद और कीटनाशकों का प्रयोग नहीं किया जाता है। मिट्टी में मुख्य तौर पर नाइट्रोजन जैसे पोषक तत्व की उपलब्धता और रासायनिक दवाईयों के बगैर बीमारियों की रोकथाम बड़ी चुनौती बन जाती है। लेकिन नीम का पेड़ इन चुनौतियों से निपटने में बेहद मददगार साबित होता है और जैविक खेती का एक ठोस आधार बनता है।

लाभकारी कीड़ों के लिए सुरक्षित

रासायनिक कीटनाशकों के विपरीत, नीम का तेल मुख्य रूप से हानिकारक कीटों के हार्मोनल और प्रजनन प्रणाली को प्रभावित करता है। जबकि मधुमक्खियों जैसे लाभकारी कीड़ों को कोई नुकसान नही होता है। इससे कृषि में एक स्वस्थ्य पारिस्थितिकी तंत्र बनाए रखने में मदद मिलती है।

रोग प्रबंधन

नीम के अर्क में कवकरोधी और जीवाणुरोधी गुण विद्यमान होते हैं, जो फसलों में विभिन्न कवक और जीवाणु रोगों के नियंत्रण में सहायता करते हैं, जिससे फसल का नुकसान कम होता है और उपज में वृद्धि होती है।

मृदा स्वास्थ्य में सुधार

मृदा को स्वस्थ रखने के लिए नाइट्रोजन पौधों के विकास के लिए आवश्यक पोषक तत्वों में से एक है, और यूरिया नाइट्रोजन उर्वरक का मुख्य स्रोत है जिसका उपयोग दुनिया भर में फसलों की नाइट्रोजन मांग को पूरा करने के लिए किया जाता है। नीम के जैविक उत्पाद यूरिया हाइड्रोलिसिस और नाइट्रिफिकेशन का नियंत्रण कृषि में नाइट्रोजन के नुकसान से बचाता है। नीम नाइट्रिफिकेशन अवरोधक के रूप में कार्य करता है, जो बैक्टीरिया की गतिविधि को धीमा करने में मदद करता है जो कि डिनाइट्रीकरण के लिए जिम्मेदार है, जिससे मिट्टी में यूरिया की हानि कम हो जाती है।

सूत्र कृमि का नियंत्रण

नीम की खली में निमैटीसाइडल गुण भी होते हैं, जो पौधों की जड़ों को नुकसान पहुंचाने वाले हानिकारक नेमाटोड की आबादी को कम करने में मदद करते हैं। यह स्वस्थ्य जड़ विकास को बढ़ावा देने के साथ फसल की उपज हानि से बचाता है।

भंडारण में सुरक्षा

अनाज और अन्य खाद्य पदार्थों के साथ भंडारण में रखी नीम की पत्तियां कीड़ों और कीटों को रोकती हैं, जिससे फसल के भंडारण में होने वाले नुकसान को कम किया जा सकता है। अतः नीम टिकाऊ कृषि में योगदान देता है, सुरक्षित और प्रभावी कीट नियंत्रण को बढ़ावा देता है और हानिकारक रसायनों पर निर्भरता भी कम करता है।

फसल स्वास्थ्य और उपज में सुधार

नीम बीमारियों को नियंत्रित कर और मिट्टी की उर्वरता को बढ़ाता है। पर्यावरण-अनुकूल कृषि प्रणाली का समर्थन करना तथा कृत्रिम रसायनो से जुड़े पर्यावरण प्रदूषण को कम करता है। नीम कीट नियंत्रण, रोग प्रबंधन और मिट्टी के स्वास्थ्य में सुधार के लिए एक सुरक्षित, प्रभावी और बहुआयामी दृष्टिकोण प्रदान करता है। यह किसानों को सशक्त बनाता है, और साथ ही लाभकारी कीड़ों की रक्षा, जैव विविधता, फसल स्वास्थ्य औरउपज में सुधार करता है।

कृषि के क्षेत्र में नीम के विभिन्न रुप में उपयोग

निष्कर्ष

नीम एक मूल्यवान और बहुउद्देशीय पेड़ हैं जो स्थायी जीवन और पर्यावरण संरक्षण में महत्वपूर्ण योगदान देता है। नीम मिट्टी की गुणवत्ता में सुधार, जल संरक्षण और कीटों को नियंत्रित करने की क्षमता रखता हैं और कृषिवानिकी और बागवानी के लिए एक महत्वपूर्ण विकल्प है। पर्यावरण संरक्षण के मामले में, नीम के पेड़ों की

जड़ें गहराई तक होती हैं जो भूमिगत जल स्रोतों में जा सकती हैं, जिससे वे सूखा-प्रवण क्षेत्रों के लिए एक उत्कृष्ट विकल्प बन जाते हैं। नीम़ औषधीय गुणों, कीट नियंत्रण, मिट्टी में सुधार और जल संरक्षण सहित कई प्रकार के लाभ प्रदान करती है।

CRISPR/Cas 9 in Forestry: Where are we?

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Introduction

The exacerbating surge in depleting forest areas due to various factors such as natural and manmade calamities, conversion of forest areas over non-forestry purposes, and ease in transportation and communication facilities has posed a threat to the emerging climate change issues. It requires improved stock with a shorter rotation period, resistance to sustain adverse biotic and abiotic stresses, improved quality of wood composition, and higher carbon content storing capacity.Conventional breeding techniques can take up longer periods to produce desirable results and also possess additional disadvantages of unexpected failures, leading to depletion of resources, and unnecessary wastage of capital and labor. It can be resolved by adopting modern edge biotechnological tools and diving into the molecular breeding of trees. Genomics serves as a potential tool in the subject of molecular tree improvement. Genomics deals with the complete set of DNA in an organism *i.e.* genome, organization of genes, genetic information within a genome, and their respective functions. Genome editing tools like ZFN (Zinc- finger nucleases), TALENS (Transcription activator-like effector nucleases), CRISPR/Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) perform target gene editing. These tools provide a venue to introduce targeted mutations, insertion/deletion (InDel), and precise modification in the genome using specific nucleases. CRISPR/Cas9 is preferred over ZFN and TALENS as it involves interaction between RNA and DNA while the latter two involve the interaction between protein and DNA which is technically more challenging and unpredictable.

What is CRISPR/Cas 9?

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) consists of two components; A guide RNA, which identifies the DNA sequence to be edited and a Cas9 enzyme (CRISPR Associated endonuclease protein) which cuts DNA at a specific location.

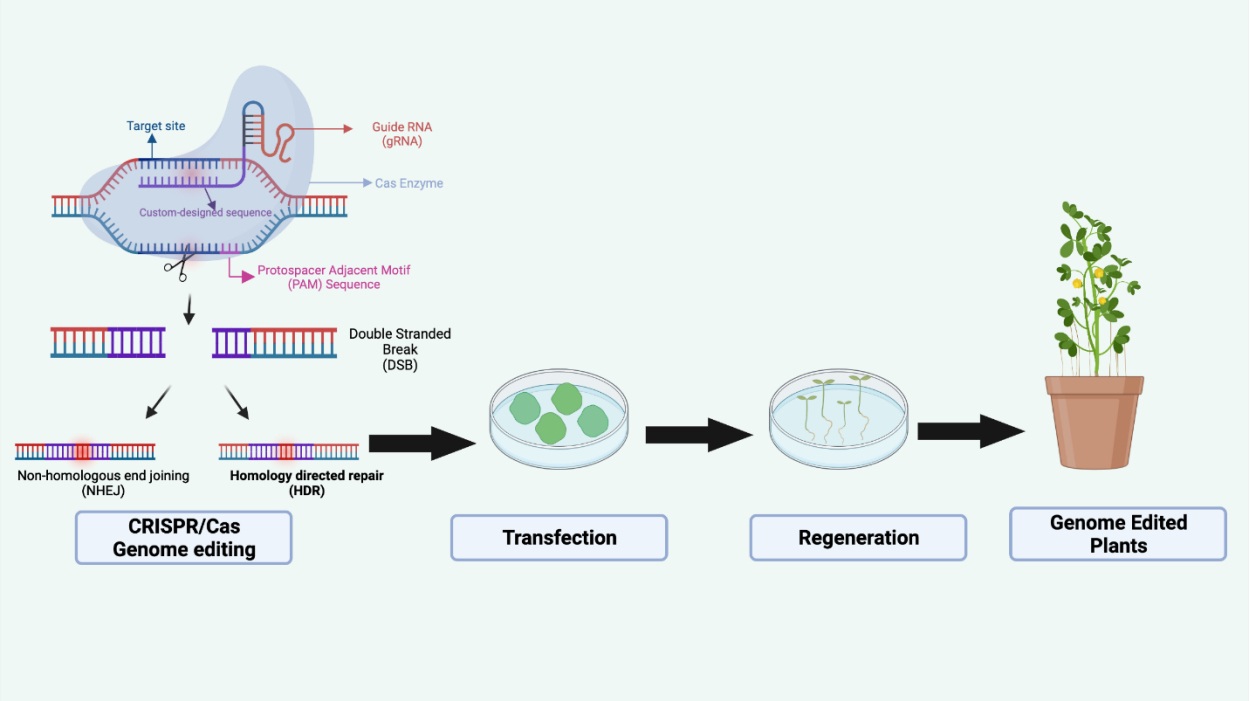

Fig. 1 Applications of CRISPR/Cas-mediated gene editing in tree improvement

The process starts with targeting a sequence of the genome that is to be altered. Consequently, a CRISPR RNA (CrRNA) sequence is selected to match with the targeted DNA sequence, ensuring complementarity. This CrRNA along with tracr-RNA forms a single guide RNA (sgRNA). The sgRNA binds with the Cas9 enzyme and is then incorporated into the cell. A PAM (Protospacer Adjacent Motif) site, short DNA sequence (2-6 base pairs long) is specific to the Cas 9 enzyme. Generally, the PAM site is located near the targeted DNA sequence, which helps the Cas9 to work efficiently. Once the sgRNA finds its complementary DNA sequence, binds to it. Near the PAM site, the Cas9 enzyme cuts the DNA on both strands forming a double-stranded break (DSB) and shutting off the targeted gene. This break triggers the cell's repair mechanism resulting in rejoining either by Non-Homologous End Joining (NHEJ) or Homologous Directed Repair (HDR). These DNA repair mechanisms can then be manipulated artificially and the required mutation can be carried out to modify genes according to the desired outcome.

Applications in forestry

Trees are constantly subjected to a wide range of abiotic and biotic stresses due to their longer lifespan. CRISPR/Cas9 has contributed significantly to building tolerance against abiotic and biotic stresses. Its application has reached different tree species such as *Populus*, *Parasponia andersonii*, *Jatropha curcas*, *Hevea brasiliensis*, *citrus*, etc. Drought stress is one of the major causative factors for reduction in biomass production and rate of photosynthesis. Although there have not been many successful results, it has helped in providing valuable insight into gene function and response to drought stress factors. Considering the not-so-note-worthy results in the case of drought

stress, striking results in the subject of tolerance towards salt stress have been observed. Many observations show notable findings, where plants like *Populus euphratica*, and *P. alba* have undergone CRISPR/Cas 9 knockout and tolerated salt stress with little damage to the plants as the plants remained green with little discolorations and cell disruptions during the salinity stress. Applications of CRISPR/Cas9 in trees promote the development of resistance to various diseases caused by fungal, viral, and bacterial pathogens. It has proved to be a potential tool for Poplar species, where CRISPR/Cas9 explains the function of genes and develops strategies against fungal pathogens like *Dothiorellagregaria* and *Melampsora* by synthesizing phenolic compounds like proanthocyanidins in leaves. CRISPR/Cas9 in the case of Jatropha species has helped in the regulation of growth, flowering, and enhancement of seed for efficacious biodiesel production.

Gene editing tool CRISPR/Cas9 has achieved substantial improvement in terms of bud growth proficiency, sylleptic branching, and shoot length leading toward a spiked biomass production. In the aspect of word composition alteration, it stands strong by achieving a 23% to 35% reduction in the lignin content of *Populus* Species. In addition, certain mutant Poplars has shown higher saccharification efficiency which opens the portal for efficient biofuel production. Going out strong, remarkable results with increased stem length and diameter, along with broadened xylem fiber cells favor positively to the paper and pulp industries.

Future prospects

The exploration of CRISPR/Cas9 in the field of tree improvement lies a lot behind, devoid of attention that demands significant effective measures. It can be well observed in Figure 2, where the log-transformed number of CRISPR publications shows a common trend of increasing publications for all areas except forestry. Therefore, research focusing on CRISPR/Cas9 for tree crops requires special attraction in addition; the establishment of a portal containing general genomic information of common tree varieties can help in keeping track of particular trees and act as a reference point for more research to be carried out. While most studies are prevalent on the growth and development of trees there is a need to divert attention towards tackling environmental stress which would help in developing the adaptability of trees to various extreme conditions. Furthermore, the focus needs to be established on the development of homozygous tree varieties within a short period for next-generation advancements to be carried out. Another issue that needs to be addressed is the sequence specificity of PAM, expanding the range of PAM-specific sequences would be a significant achievement.

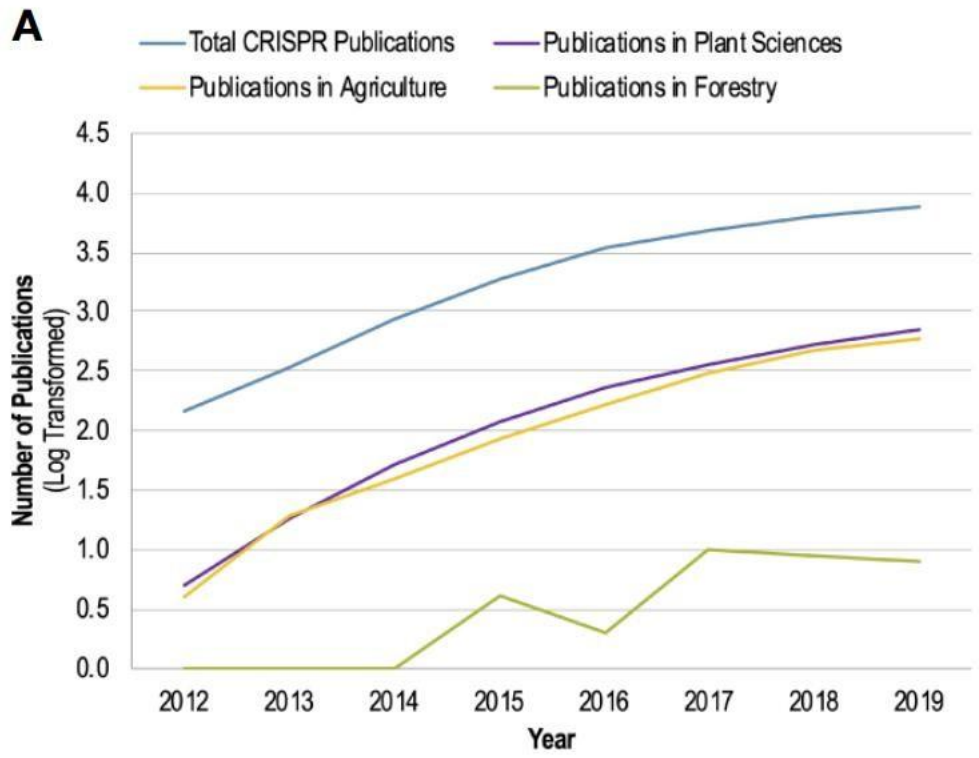

Fig. 2 The number of CRISPR publications by year since 2012 by Dort *et al.*, 2020

Conclusion

Amongst all the gene editing tools, CRISPR/Cas9 works with a high rate of efficiency, feasibility, and appreciable target specificity. This potential tool has achieved substantial tree improvement in terms of developing biotic and abiotic resistance, biomass production, and wood composition alteration. However, research focusing on CRISPR/Cas9 in tree crops stands a lot behind in comparison to agricultural crops. Furthermore, the unavailability of whole genome sequences in tree species poses more complications to genomic assemblage. In the field of forestry research, CRISPR has been able to stand out as a hotspot region for the exploration and creation of new scopes.

Reference

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बाघों की आबादी में भारी गिरावट

संजय गोस्वामी

यमुना जी -13, अणुशक्तिनगर, मुंबई -94

भारत के लिए बाघ संरक्षण एक ऐतिहासिक उपलब्धि है क्योंकि देश ने बाघों की संख्या को दोगुना करने के लक्ष्य को चार साल पहले ही प्राप्त कर लिया है। वर्तमान में भारत लगभग 3,000 बाघों के साथ सबसे बड़ा एवं सुरक्षित प्राकृतिक वास बन गया है। रिपोर्ट के अनुसार, बाघों की संख्या में 33 प्रतिशत की वृद्धि विभिन्न चक्रों के बीच दर्ज अब तक की सर्वाधिक वृद्धि है। उल्लेखनीय है कि बाघों की संख्या में वर्ष 2006 से वर्ष 2010 तक 21 प्रतिशत तथा वर्ष 2010 से वर्ष 2014 तक 30 प्रतिशत की वृद्धि दर्ज की गयी थी। बाघों की संख्या में वर्तमान वृद्धि वर्ष 2006 से बाघों की औसत वार्षिक वृद्धि दर के अनुरूप है।मध्य प्रदेश में बाघों की संख्या सबसे अधिक 526 पायी गयी। इसके बाद कर्नाटक में 524 और उत्तराखंड में इनकी संख्या 442 थी। छत्तीसगढ़ और मिज़ोरम में बाघों की संख्या में गिरावट देखने को मिली, जबकि ओडिशा में इनकी संख्या अपरिवर्तनशील रही। अन्य सभी राज्यों में सकारात्मक प्रवृत्ति देखने को मिली। बाघों के सभी पाँच प्राकृतिक वासों में उनकी संख्या में वृद्धि देखने को मिली। ग़ौरतलब है कि इस नयी रिपोर्ट में तीन टाइगर रिज़र्व बक्सा (पश्चिम बंगाल), डंपा (मिज़ोरम) और पलामू (झारखंड) में बाघों के अनुपस्थिति दर्ज की गयी है। हाल के वर्षों में सरकार ने वन्य क्षेत्रों में विनिर्माण परियोजनाओं के लिये 'पर्यावरणीय प्रभाव आकलन' से जुड़ी मंज़ूरी देने की प्रक्रिया को आसान कर दिया है, जिसके कारण वन्य क्षेत्रों के निकट औद्योगिक गतिविधियों में वृद्धि हुई है। टाइगर रिज़र्वों के बीच संपर्क मार्गों की स्थिति का ठीक न होना भी एक बड़ी चुनौती है, बाघों के संरक्षण के लिये देश के अलग-अलग हिस्सों से बाघों की आबादी के बीच जीन पूल का हस्तानान्तरण बहुत ही आवश्यक है। वर्ष 1969 में नई दिल्ली में आयोजित 'अंतर्राष्ट्रीय प्रकृति संरक्षण संघ' की 10 वीं आम सभा में बाघों की घटती आबादी का मुद्दा उठा। 1970 के दशक में केंद्र सरकार की तरफ से बाघों के संरक्षण के प्रति एक मज़बूत राजनीतिक प्रतिबद्धता देखने को मिली और सरकार द्वारा वन्य जीव संरक्षण अधिनियम का मसौदा तैयार हुआ। परिणामस्वरूप देश के विभिन्न हिस्सों में राष्ट्रीय उद्यानों और टाइगर रिज़र्वों की स्थापना हुई। राष्ट्रीय उद्यानों और टाइगर रिज़र्वों की स्थापना के माध्यम से वन्य जीवों के संरक्षण हेतु विशेष प्रावधान किये गये जो देश के सामान्य वनों में संभव/उपलब्ध नहीं थे। इसी दौरान सरकार ने 'प्रोज़ेक्ट टाइगर' जैसे कुछ बड़े प्रयास शुरू किये। प्रोज़ेक्ट टाइगर की शुरुआत केंद्रीय पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय द्वारा वर्ष 1973 में की गयी थी।देश के प्रसिद्ध जीव विज्ञानी कैलाश सांखला को इस कार्यक्रम का पहला निदेशक नियुक्त किया गया था। इस कार्यक्रम के तहत बाघ आबादी वाले राज्यों को बाघों के संरक्षण हेतु केंद्रीय सहायता उपलब्ध की जाती है। ग़ौरतलब है कि वर्ष 1973 में प्रोज़ेक्ट टाइगर की शुरुआत के समय देश में मात्र नौ टाइगर रिज़र्व थे।वर्तमान में देश में कुल टाइगर रिज़र्वों की संख्या बढ़कर 50 हो गयी है।लंबे समय से बाघों का शिकार शक्ति प्रदर्शन के लिये किया जाता रहा है। साथ ही बाघों के शरीर के प्रत्येक हिस्से का बाज़ार में अच्छा मूल्य प्राप्त

होता है। अतः व्यक्तिगत और कई कारणों से बड़े पैमाने पर बाघों का शिकार किया जाता है। बाघ संरक्षण के इतिहास में ऐसा पहली बार है जब बाघों की संख्या में वृद्धि देखी जा रही है। पर्यावरण एवं वन मंत्रालय, भारत सरकार के अंतर्गत भारतीय वन्यजीव संस्थान ने देश भर के टाइगर रिज़र्व, राष्ट्रीय उद्यान तथा अभयारण्यों में बाघों की गिनती की। नवीनतम गणना के अनुसार, देश में बाधों की अनुमानित संख्या 2,967 हैं। वर्तमान में विश्व के बाघों की आबादी का 75 % भारत में है । केंद्र सरकार द्वारा जारी रिपोर्ट के अनुसार, उत्तराखंड के जिम कॉर्बेट बाघ अभ्यारण्य (231) में देश में सबसे अधिक बाघों की आबादी मिली।ग़ौरतलब है कि वर्ष 2014 की बाघ जनगणना में भी जिम कॉर्बेट बाघ अभ्यारण्य में देश की सर्वाधिक बाघ आबादी (215) मिली थी।बाघों की संख्या के मामले में दूसरे स्थान पर कर्नाटक का नागरहोल टाइगर रिज़र्व (127), तीसरे स्थान पर बांदीपुर टाइगर रिज़र्व (126) और बांधवगढ़ टाइगर रिज़र्व (104) तथा काजीरंगा टाइगर रिज़र्व (104) थे।भारत, बांग्लादेश, भूटान, म्यांमार, नेपाल, रूस, कंबोडिया, चीन, इंडोनेशिया,मलेशिया, लाओस, थाईलैंड और वियतनाम सहित कुल 13 देश 'टाइगर रेंज कंट्रीज़' में शामिल हैं । उक्त रिपोर्ट के अनुसार, देश में बाघों की आबादी के मामले में पहले स्थान पर मध्यप्रदेश (526), दूसरे स्थान पर कर्नाटक (524), उत्तराखंड (442) तीसरे और महाराष्ट्र (312) तथा तमिलनाडु (264) क्रमशः चौथे और पाँचवें स्थान पर रहे बाघ भारत के वन्यजीवी जीवन का गर्व है। यह एक शक्तिशाली और साहसी प्राणी है जो अपनी रॉयल और गरिमामय वैज्ञानिकता के लिए प्रसिद्ध है। इसके खूबसूरत रंगीन खाल, पीली और बैले, जबरदस्त अकरातित चेहरा और विशाल पंजे उसको अलग बनाते हैं। बाघ मुख्य रूप से मांसाहारी होते हैं, जिसका मुख्य शिकार हिरण, सांभर और नीलगाय होती है। हमारे प्राकृतिक संसाधनों के अधिकांश खोने से, बाघों के आबादी में गिरावट हो रही है। वन्यजीवी संरक्षण के लिए, हमें उनके लिए उचित आवास और संरक्षण की व्यवस्था करनी चाहिए। बाघों की चोरी, विकसित इलाकों का विस्तार और विविधता के नुकसान से उन्हें बचाने के लिए हमें संवेदनशीलता और कदम उठाने की आवश्यकता है।बाघ हमारे पृथ्वी के संतुलन का महत्वपूर्ण अंग हैं, जो वन्यजीवी जीवन को संभालते हैं। हमें बाघों को संरक्षित रखकर अपनी प्राकृतिक धरोहर की रक्षा करनी चाहिए ताकि हमारी आने वाली पीढ़ियों को भी उनका सौंदर्य और गरिमा देखने का अवसर मिले। बाघों ने सहस्राब्दियों से विस्मय, प्रशंसा और श्रद्धा को प्रेरित किया है। बाघ सभी एशियाई विश्वास प्रणालियों के केंद्र में थे, यह दावा तब उजागर होता है जब यह विचार किया जाता है कि बंगाल टाइगर भारत का राष्ट्रीय पशु है, रॉयल बंगाल टाइगर बांग्लादेश का राष्ट्रीय पशु है, मलायन टाइगर मलेशिया का राष्ट्रीय पशु है, और वहाँ दक्षिण कोरिया में जानवरों के साथ मजबूत संबंध हैं। इन देशों में, बाघ हजारों साल पहले आध्यात्मिक हो गए और सृजन मिथकों, ब्रह्मांड विज्ञान, धर्मों और गूढ़ दर्शन में महत्वपूर्ण विशेषता बन गए। जनसंख्या वृद्धि, औद्योगिक विकास और अनियंत्रित शहरीकरण के कारण वन्य जीवों के प्रवास क्षेत्र का लगातार ह्रास हो रहा है। एक रिपोर्ट के अनुसार, देश में बाघों की संख्या में वृद्धि तो हुई है परंतु प्राकृतिक प्रवास स्थान के क्षरण के कारण बाघों को बहुत ही छोटे से क्षेत्र में सीमित रहना पड़ता है। इस रिपोर्ट के अनुसार, उत्तर भारत और दक्षिण के कुछ राज्यों में बाघों की संख्या में वृद्धि हुई है परंतु पूर्वोत्तर भारत और देश के कुछ अन्य हिस्सों में बाघों की आबादी में गिरावट देखी गयी है। ग़ौरतलब है कि

वर्तमान में भारत के तीन टाइगर रिज़र्वों (मिज़ोरम का दंपा अभ्यारण्य, पश्चिम बंगाल का बुक्सा अभ्यारण्य और झारखंड के पलामू अभ्यारण्य) में एक भी बाघ नहीं है। पिछले 100 वर्षों में वैश्विक स्तर पर बाघों की आबादी में भारी गिरावट देखने को मिली है और कई क्षेत्रों में बाघों की आबादी पूर्णतयः समाप्त हो चुकी है जो चिंता का विषय है।

Green composite: Biopolymer-basedcomposites reinforced with agroforestry waste

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Introduction

Plastic accumulation poses serious environmental concerns due to its long-lasting impact. Oceans are submerged with plastic debris adversely affecting over 250 marine species. Plastic degradation methods include thermal, photo-oxidative and UV degradation with complete disintegration taking several hundreds to thousands of years.Agricultural activities generate huge amounts of lignocellulosic residues (> 350 million tons per year)which are largely unaddressed (Madurwar *et al.*, 2013). Recycling these residues to produce renewable, biodegradable materials could mitigate waste accumulation. Natural polymers degrade enzymatically in moist environments driving research into green composites (i.e., fully biodegradable) composed of biopolymer matrices reinforced with lignocellulosic materials. Various natural fibers including bamboo, pineapple and henequen have been used to reinforce biopolymer matrices resulting in superior mechanical properties. Green materials derived from renewable sources exhibit eco-friendly traits like biodegradability and recyclability. The term "green composites" historically referred to synthetic polymer composites with natural organic fillers from renewable sources (La Mantia and Morreale, 2011). These composites incorporating natural fillers with petro-based polymers are more environmentally friendly and commercially available for various applications.Efforts are underway to develop all-green composites, replacing non-biodegradable polymer matrices with biodegradable alternatives like starch, PLA and polyhydroxyalkanoates. Some researchers argue for both matrix and filler to be eco-compatible for a composite to be labeled "green."

Biopolymer matrices

Biopolymers, sourced from living organisms or natural origins (La Mantia and Morreale, 2011) offer sustainable, non-toxic, biodegradable and compostable alternatives that minimize environmental effects. Their biodegradability and renewability are key advantages contributing to the development of carbon-neutral materials. However, limitations exist particularly in applications requiring prolonged use as biopolymer matrices are best suited for short-life-cycle applications like sustainable packaging and biomedicine. Additionally, their recyclability is limited with efforts underway to establish recycling indices.

Some biopolymers like PLA (Polylactic acid) and PHBV (Polyhydroxybutyrate-co-valerate) can be mechanically recycled multiple times with acceptable property

loss. While others like, starch-based materials exhibit poor recyclability and may find secondary use in composites.

Natural fillers and reinforcements

Agroforestry residues provide abundant lignocellulosic materials yielding various fillers like fibers, particles and whiskers. While these fillers can enhance mechanical properties in some instances they may simply reduce costs and enhance sustainability in others serving solely as filler.

Table 1. Various natural fillers and reinforcements obtained from agroforestry residues

S. No.	Fibers	Examples
1.	Bast Fibers	Flax (*Linum usitatissimum*), Jute (*Corchorus olitorius*), Hemp (*Cannabis sativa*), Kenaf (*Hibiscus cannabinus* L.), Ramie (*Boehmeria nivea*)
2.	Fruits	Banana (*Musa paradisiaca*), Cocoa (*Theobroma cacao* L.)
3.	Switch grass	Rod grass (*Panicum virgatum* L.), Napier grass (*Pennisetum purpureum*)
4.	Leaves	Sisal (*Agave sisalana*), Pineapple (*Anannus comosus*), Abaca (*Musa textilis*)
5.	Seeds	Coconut (*Cocos nucifera*), Oil palm (*Elaeis guineensis*), Mango (*Mangifera indica*)
6.	Stalks	Wheat (*Triticum aestivum*), Rice (*Oryza sativa*)

Composites Based on Agroforestry waste and biopolymers

Green composites are composed of a renewable, biodegradable and non-toxic biopolymeric matrix and lignocellulosic reinforcements sourced from agroforestry waste (Torres*et al.*, 2019). The development of these composites is rapidly growing to replace non-degradable materials and reduce their environmental impact.

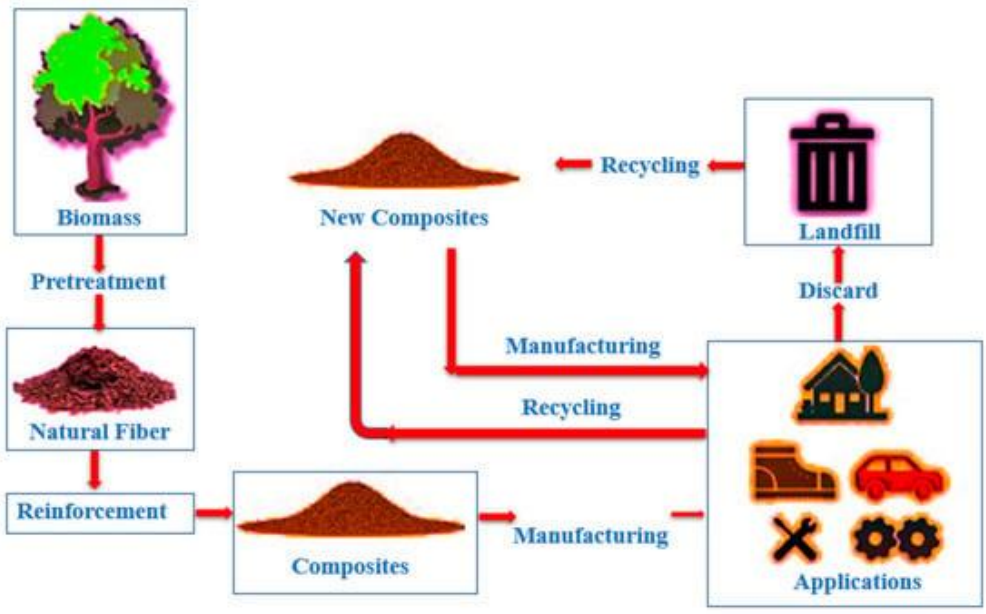

Fig. 1 Biopolymer-based composites from agroforestry residues (Chan *et al.*, 2022).

Polysaccharides-based composites with natural fillers

Starch-based composites			
Starch origin	**Natural fiber**	**Fabrication method**	**Results**
Potato	Sisal	Compression molding	Hightensile strength
Corn	Flax	Compression molding	Composites with fiber content < 50% presented low number of voids
Cellulose-based composites			
Cellulose derivative	**Filler**	**Fabrication method**	**Results**
BC (Bacterial Cellulose)	Hap (hydroxyapatite)	Solvent exchange drying	Biocompatibility
CMC (Carboxymethyl cellulose)	CNXLs (Cellulose nanocrystals)	Heat	Improvement of the mechanical properties
Chitin/Chitosan-based composites			
Filler	**Fabrication method**	**Results**	
Cellulose nanofiber	Mixing	Improvement of mechanical and water vapor barrier	

Cellulose whiskers	Casting	Thermal stability and Water resistance
Nanocrystalline cellulose	Solution casting	Strong filler–matrix interaction and Improvement of barrier properties
Natural rubber-based composites		
Filler	**Fabrication method**	**Results**
Oil palm fiber	Two-roll mill mixing	Increase of modulus & hardness and Better adhesion with treated fiber
Sisal/coir	Two-roll-open-mill mixing	Fiber orientation was greatest in 40 phrfiber composites
Pineapple leaf fiber	Two-roll mill mixing	The fiber surface was increased, fiber–matrix interaction and composite mechanical properties were improved

Polyesters-Based Composites with natural fillers

PHA/PHB-based composites			
Type	**Natural filler**	**Fabrication method**	**Results**
PHA (Polyhydroxyalkanoate)	Rice husk	Hot press	Enhanced mechanical properties
PHB (polyhydroxybutyrate)	Sugar bagasse	Compression molding	Better mechanical properties.
PLA-natural fiber composites			
PLA matrix	**Natural filler**	**Fabrication method**	**Results**
PLA (Ingeo™ 2002D)	Water bamboo husk	Compression and solidification	Mechanical and thermal properties were improved
PLA Ingeo™ 2003D	Sisal fibers	Mixing andinjection	The highest tensile strength values

Proteins-Based Composites

Protein-based composites			
Protein	**Natural filler**	**Fabrication method**	**Results**
Soy based plastic	Pineapple leaf fiber	Twin-screw extrusion&Injection molding	Compatabilizer facilitates the interaction
Soy protein resin	Sisal	Compression molding	Good interaction
Wheat gluten	HEC	Three-rolling mixer	Decreasing trend of

	(hydroxyethyl cellulose) powder		moisture

Conclusion

In recent years, there has been a notable rise in the development of composite materials using agricultural and forestry waste along with biopolymers. These composites offer benefits like complete biodegradability, renewable sourcing, and cost-effectiveness. They serve as an eco-friendly alternative to petroleum-based plastics, utilizing natural fibers and fillers from abundant agroforestry waste. However, challenges remain, such as the relatively weak mechanical properties due to the low strength of biopolymeric matrices and limited lifespan for applications due to their biodegradability. Various treatments, additives, and processing methods are being explored to address these limitations. Future efforts should focus on scaling up production techniques to make fully green composites economically viable. Our research has evaluated a range of fully biodegradable composites, categorized by the chemical structure of the host matrix and incorporating natural reinforcements. These composites find increasing applications in construction, food industry, and biomedicine, offering properties comparable to non-degradable materials while retaining eco-friendly advantages. The availability of diverse green composites with enhanced mechanical, thermal, and electrical properties motivates further efforts towards their widespread commercial adoption.

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Understanding nitrogen fixation in forests - Nature's fertilizer

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1. Introduction

The Earth's atmosphere consists of 78% nitrogen, 21% oxygen, 0.93% argon, 0.04% carbon dioxide, and trace amounts of other gases (Aresta and Dibenedetto, 2021). Nitrogen is essential for all species, including humans, plants, and animals, for various biological processes. However, the concentration of usable nitrogen is very low despite its abundance in the atmosphere.Nitrogen is crucial for plant development and a limiting factor for growth, comprising about 2% of the total plant dry matter in the food chain. It is the most absorbed mineral nutrient by forest trees, and adding it as fertilizer often enhances tree growth rates (Santi *et al.*, 2013). Plants absorb nitrogen from the soil, mainly as nitrate or ammonium ions, for protein synthesis. They cannot convert atmospheric nitrogen into a usable form due to the absence of the nitrogenase enzyme. Unlike carbon dioxide and oxygen, plants cannot take in atmospheric nitrogen through their leaf stomata. Nitrogen fixation is facilitated by certain bacteria and natural processes.

Nitrogen Fixation

Nitrogen fixation is a biological process where atmospheric nitrogen gas is converted into a usable form, such as ammonia, for plants and microbes. This initial stage of the nitrogen cycle is carried out by certain bacteria, like Rhizobium and Azotobacter, as well as through other natural phenomena (Bano and Iqbal, 2016).

Types of nitrogen fixation

Atmospheric fixation

A natural process in which lightning energy converts nitrogen into nitrogen oxides, that plants subsequently consume (Harrison, 2010).

Industrial nitrogen fixation

A man-made process that produces ammonia by combining nitrogen and hydrogen is then converted into fertilizers like urea (Chakraborty, 2023).

Biological Nitrogen Fixation

Plants and animals cannot directly use atmospheric nitrogen. Bacteria such as Rhizobium and blue-green algae convert it into more usable compounds, which these microbes then fix in the soil (Chakraborty, 2023).

Biological Nitrogen Fixation (BNF)

Certain bacteria and prokaryotes convert atmospheric nitrogen to ammonia using the enzyme nitrogenase. These nitrogen-fixing bacteria can be free-living, like Azotobacter, Beijerinckia, Rhodospirillum, and Cyanobacteria, or symbiotic, like Rhizobium (in legume root nodules) and Frankia (in non-leguminous root nodules).

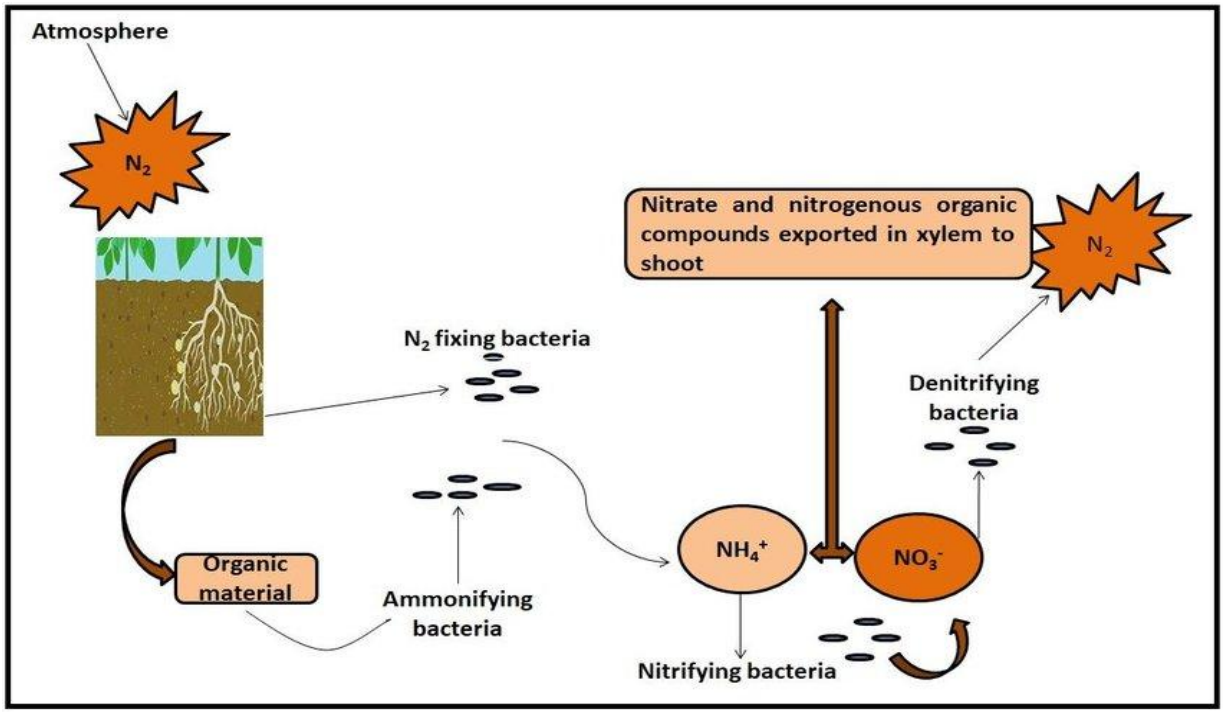

Fig 1. Biological Nitrogen Fixation by Plant growth-promoting rhizobacteria (PGPR) (Baber *et al.*, 2018).

Symbiotic nitrogen fixation

Many microorganisms fix nitrogen symbiotically with host plants, using sugars from photosynthesis as an energy source for nitrogen fixation. In return, the microbe provides fixed nitrogen to the host plant for growth.Symbiotic bacteria known as diazotrophs complete the process of nitrogen fixation. Azotobacter and Rhizobium play a major role in this process, containing the nitrogenase enzyme that combines gaseous nitrogen with hydrogen to form ammonia.Rhizobia assist legumes in extracting nitrogen from the air and storing it biologically. These bacteria, typically present as free-living organisms in the soil within a legume's native range, infect the plant's root hairs and reside in small root structures called nodules. The plant supplies energy to nourish the bacteria and drive the nitrogen fixation process. In exchange, the plant gains nitrogen for its growth.Whereas, non-leguminous plants form symbiotic associations with nitrogen-fixing bacteria of the genus Frankia, known as actinorhizal symbiosis. These plants develop root nodules similar to those of legumes, where nitrogen-fixing bacteria convert atmospheric nitrogen into ammonia (Chakraborty, 2023).

Non-symbiotic Nitrogen Fixation

Soil bacteria that are free-living fix atmospheric nitrogen in a process known as non-symbiotic nitrogen fixation, which occurs outside plant cells. Examples include the anaerobic bacterium Clostridium and the aerobic, free-living bacterium Azotobacter. In tropical regions, Azotobacter and Beijerinckia are major bacterial species involved in nitrogen fixation, supporting the growth of various

crops. The genus Frankia forms root nodules in association with plants such as Alnus, *Myrica gale*, and *Casuarina equisetifolia* (Roper and Gupta, 2016).

Nitrogen cycle

In forest ecosystems, the soil nitrogen cycle comprises three processes: input, transformation, and output. These processes include biological nitrogen fixation (BNF), litter decomposition, nitrogen mineralization, nitrification, denitrification, nitrous oxide emission, and nitrogen leaching. Undisturbed forest ecosystems mainly derive nitrogen from BNF and decomposition, with nitrogen transferring among plants, microorganisms, soil organic matter, and soil mineral matter, resulting in minimal nitrogen loss (Yunting *et al.*, 2004).

Forest ecosystems retain a portion of deposited nitrogen through biotic and abiotic mechanisms, including plant uptake, microbial immobilization, soil cation exchange capacity, and absorption by soil organic matter (Silver *et al.*, 2005; Templer *et al.*, 2008).

The soil nitrogen cycle is a vital and active component of the nitrogen cycle in forest ecosystems (Yunting *et al.*, 2004).

Nitrogen input

Nitrogen input in forest ecosystems primarily occurs through biological nitrogen fixation (BNF), where nitrogen-fixing microorganisms convert atmospheric dinitrogen (N_2) to ammonia using nitrogenases. Diazotrophs in symbiosis with plants have the highest nitrogen fixation rates. They utilize the plant as a carbon source and return fixed nitrogen to the plant through root excretion and litter decomposition.

In many forest ecosystems, most nutrients absorbed by plants, such as over 90% of nitrogen and phosphorus and 60% of other mineral elements, come from litter decomposition. The rate of litter decomposition influences nutrient cycling and soil nitrogen availability in these ecosystems (Berg and Claugherty, 2008).

During decomposition, microorganisms break down dead organic matter from plants, animals, and microbes, releasing nitrogen and phosphorus as dissolved organic matter (DOM) through exoenzyme action. This DOM is later mineralized into forms usable by plants and microorganisms (Chapin *et al.*, 2002).

Soil N transformation

In natural forest ecosystems, most soil nitrogen is stored in dead organic matter. Microorganisms convert insoluble organic nitrogen into dissolved organic N (DON). To overcome carbon limitation, microbes break down the DON, using the carbon skeleton for energy needs, and release NH_4^+ into the soil. This process is known as nitrogen mineralization or ammonification (Chapin *et al.*, 2002).

Some NH_4^+ is assimilated by plants, immobilized by microbes, or absorbed by clay minerals. The remainder is oxidized by nitrifying bacteria to NO_2^- and then to nitrate (NO_3^-). This conversion from ammonium to nitrate is called nitrification (Chapin *et al.*, 2002).

Denitrification is the process by which denitrifying bacteria reduce nitrate or nitrite to N_2O or N_2. It is an important pathway for balancing the nitrogen budget in ecosystems (Yunting*et al.*, 2004).

Soil N output

Nitrogen loss from forest soils in the form of gases such as NH_3, NO_x, and N_2O, with

N_2O and NO as by-products of nitrification and denitrification, depends on factors like nitrification rates, NO_3^- concentration, oxygen levels, and organic carbon supply (Ventereaet *al.*, 2003).

N-oxide emissions are higher in nitrogen-rich tropical rainforests than in temperate forests. NH_3 volatilization, influenced by soil conditions, and NO_3^- and dissolved organic nitrogen (DON) are major forms of nitrogen loss in solution (Yuntinget *al.*, 2004). Temperate forests with low nitrogen deposition have minimal nitrogen leaching, while tropical rainforests on heavily weathered soils have high potential for nitrogen leaching. Increased nitrogen deposition is expected to raise soil NO_3^- leaching in tropical and subtropical forests (Brookshire *et al.*, 2012).

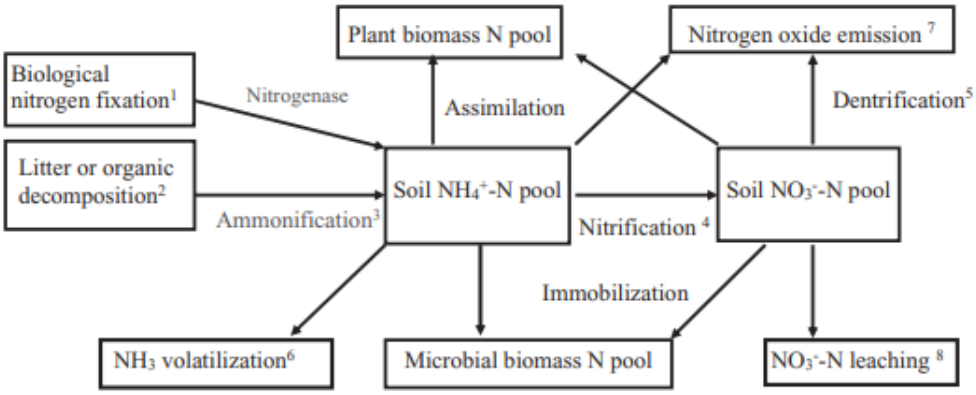

Fig. 2 Nitrogen pools and key processes of nitrogen cycle in forest ecosystems.
N input: 1, 2; N transformation: 3–5; N output: 6–8 (Zhu *et al.*, 2015).

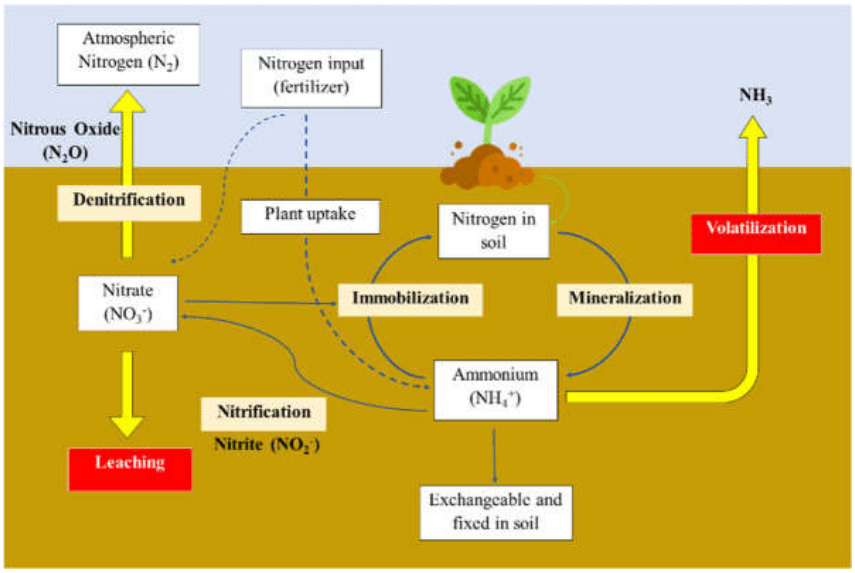

Fig 3. Nitrogen cycle in soil (Trenkel, 2021)

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Opium Poppy – Its importance, latex extraction, harvesting techniques, illegal trafficking and economic significance

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Papaver somniferum is among the limited Papaver species within the Papaveraceae family that produces opium. Over centuries of cultivation and selective breeding for opium, a distinct species of the plant

emerged, now recognized as somniferum (Butnariu*et al.* 2022). The term "Papaver" is derived from the Greek word for "poppy," while "somniferum" in Latin translates to "sleep-inducing". The opium poppy, scientifically known as *Papaver somniferum*, is a remarkable medicinal plant. Its derived products, namely opium and codeine, play crucial roles as medicines, valued for their analgesic and hypnotic properties. The semi-synthetic substance heroin, derived from morphine, has contributed to global social issues. Despite efforts to discover a synthetic alternative to morphine and codeine, success in this regard has been elusive. In India, the cultivation of opium poppy is limited to the states of Madhya Pradesh, Rajasthan, and Uttar Pradesh. Legal cultivation of opium for medicinal purposes is currently carried out in India, Turkey, and Australia. Annually, around two thousand tons of opium are

produced, meeting the global demand for the raw material required in the production of medicinal products.

Geographical distribution

Today, legal opium is primarily produced in government-regulated farms in India, Turkey, and Tasmania. Illegal cultivation thrives in Southwest Asia, covering Afghanistan, Pakistan, and Iran, and in Mainland Southeast Asia, known as the "Golden Triangle," including Burma, Laos, Vietnam, and Thailand. Opium poppy cultivation also occurs in Colombia, Mexico, and Lebanon, where the plant was introduced from abroad. Originally native to western Asia, *Papaver somniferum* spread to

Greece and then to far Eastern countries through Arab traders.

While the medicinal poppy is unquestionably indigenous to Western Asia, it is presently cultivated not only in its original distribution area but also in India, Iran, Turkey, and Europe. Although P. somniferum is occasionally found seemingly growing wild in Britain, it is extensively cultivated in most European states, not for opium as in India, Turkey, and Iran, but for the capsules and the oil derived from the seeds.In India, P. somniferum has been historically grown for its milky juice, obtained by scarifying the fully-grown green capsules. During the mid-18th century, Bihar was the primary Indian province producing the highest quality and largest quantity of opium. Presently, poppy cultivation is limited to the states of Uttar Pradesh, Madhya Pradesh, Rajasthan, and Himachal Pradesh, with the current average covering one-tenth of what it was four decades ago.

Varieties

The three main varieties of P. somniferum are:

***Papaver somniferum* var. nigrum**

It is a wild form of the opium poppy with purple-red flowers, roundish oblong capsules, opening by pores under the stigma, with seeds of a dull greyish-blackcolor.

***Papaver somniferum* var album**

It is also, a wild form with white flowers and roundish ovate capsules, not opening by pores under the stigma. Seeds white.

***Papaver somniferum* var. abnormal**

Its variety not infrequent in neglected poppy fields. Flowers small, streaked with dull green and red, the petals much crumpled, and never expanding fully, capsules roundish oblong, opening by pores under the stigma.

The prevalent varieties cultivated in the country have duration in the field ranging from 140 to 160 days. Noteworthy varieties include Talia, Ranghatak, and DholaChota Gothia, which are particularly favored for cultivation in rich black soils.

Chemical constituents

Opium, as dried latex of unripe capsules of P. somniferum, contains more than 80 isoquinoline alkaloids. The main alkaloids derived from opium are morphine (4-21%), followed by codeine, thebaine, papaverine, noscapine and narceine.

Importance

Opium was known to ancient Greek and Roman physicians as a powerful pain reliever. It was also used to induce sleep and to give relief to the bowels (Mani andDhawan2011). Opium was even thought to protect the user from being poisoned.

Actions and uses

Morphine and codeine are prescribed analgesics and cough-suppressing drugs. Alkaloids from poppy species have various uses: noscapine has antitussive and anti-tumorogenicproperties; Papaverine is a vasodilator and smooth muscle relaxant; Sanguinarine is antimicrobial and anti-inflammatory.

Climate and soil requirements

Grows in temperate climates but can be grown successfully during winter in subtropical regions. Cool climate favors higher yield, while higher day/night temperature generally affects the

yield.Prefers well-drained, highly fertile light black or loam soil. The annual rain requirement is 600–700 mm. It is ideal for 300–400 mm (Baser and Arslan2014).

Lancing and latex extraction

Opium typically begins flowering 95-115 days after sowing, with petal shedding

occurring 3-4 days after flowering. Capsules reach maturity approximately 15-20 days after flowering.Lancing the capsules at this stage yields maximum latex. Industrial maturity, characterized by capsule compactness and a color change from greenish to a light green ring, indicates the optimal lancing period. Lancing is carried out using a knife with three or four evenly spaced pointed ends, ensuring an incision depth of no more than 1-2 mm into the capsule. It is essential to avoid incisions that are either too deep or too shallow. Lancing is ideally performed early in the morning before 8:00 a.m. at two-day intervals for each capsule. The length of the incision should be 1/3 or less than the full length of the capsule.

Harvesting and separating seeds

Since ancient times, people have gathered the milky fluid that emerges from incisions made in the immature poppy seed pod, dried it through exposure to air, and thus produced what is commonly referred to as opium. To initiate this process, a multi-bladed tool is used to make incisions in the seedpod, allowing the opium "gum" to seep out. A curved spatula is employed to harvest the semi-dried "gum," which is subsequently

air-dried in open wooden containers. The dried opium resin is either packaged in bags or shaped into balls for sale.The crop is left to dry for approximately 20-25 days, during which the last round of incisions on the capsules ceases the exudation of latex. Subsequently, the capsules are gathered, and the plants are removed using sickles. The harvested capsules undergo drying in an open yard, and the seeds are separated by beating them with a wooden rod. The quantity of raw opium obtained per hectare can range from 50 to 60 kg.

Opium harvesting techniques

The process of scoring the pods also referred to as lancing, incising, or tapping, typically commences approximately two weeks after the petals of the flower have dropped from

the pods. Before scoring, farmers carefully inspect the pod and its small crown on the top. The grayish-green pod transforms, turning into a dark green color as it matures and increases in size. Another sign of the pod's readiness for tapping is the orientation of the points on its crown – standing straight out or curving upward indicates readiness, while downward-pointing suggests potential immaturity. It's important to note that not all plants in a field mature simultaneously, leading to staggered readiness for scoring. Each pod can be tapped two to four times.A tool consisting of three or four small blades made of iron, glass, or glass splinters tightly bound to a wooden handle is used to score two or three sides of the pod vertically. If the blades cut too deeply into the pod's wall, the opium (latex) drains into the interior rather than the surface, where it can be collected. Shallow incisions lead to slow flow, causing the opium to coagulate over the incisions and block the flow.

An incision depth of about 1 millimeter is optimal. Ideally, scoring begins in late afternoon to allow the white latex-like raw opium, with a 60 percent water content, to ooze out and slowly dry on the pod's surface overnight. Starting scoring too early in the afternoon may result in the opium drying and blocking the flow due to sunlight exposure. The opium undergoes oxidation, darkening, and thickening in the cool night air.Early the following morning, the sticky opium gum is scraped from the pod surfaces using a short-handled, crescent-shaped, flat iron blade measuring 3 to 4 inches wide. The collected opium gum is placed in a container hanging from the farmer’s neck or waist. Opium harvesters move backward across the field to minimize contact with scored (wet) pods, preventing unintentional spills of the sticky substance. Lower, mature pods are typically scored before taller ones. The pods continue to secrete opium for several days, prompting farmers to return to these plants – sometimes up to three or four times – to gather additional opium until the gum content is completely depleted.

Illegal trafficking of heroin

At present, three primary origins contribute to the illicit opium supply: Burma, Afghanistan, and Colombia. Opium and heroin serve as lucrative commodities due to high demand, profitable production, and their compact nature. Advancements in transportation enable swift movement of opium and heroin across borders within a matter of days or a few weeks. Additionally, these substances boast a prolonged and consistent shelf life, facilitating their storage for extended durations.

Economic significance

Posta holds widespread medicinal value, serving as a source for various poppy-based drugs such as morphine, codeine, narcotine, laudenine, papaverine, and other alkaloids.It functions as a stimulant, inducing euphoria and aiding in the alleviation of anxieties, tensions, fears, and inhibitions. The plant is employed in the treatment of intestinal stomach spasms and respiratory spasms associated with asthma attacks. Posta is utilized to address a diverse range of ailments, including bruises, cancer, colds, colic, conjunctivitis, diarrhea, dysentery, enteritis, fever, flu, headache, hemicrania, hypertension, hypochondria, hysteria,

inflammation, insomnia, malaria, melancholy, nausea, neuralgia, otitis, prolapse, rheumatism, snakebites, sprains, swelling, toothaches, tumors, ulcers, and warts.It is frequently administered to alleviate pain and induce a calming effect.The plant yields two essential food components: poppy seeds and poppy seed oil.Poppy seeds, devoid of opium, find extensive use in baking and as a topping for rolls and bread.Posta seeds serve as a source of drying oil, utilized in the production of paints, varnishes, and soaps.The oil cakes derived from Posta seeds are employed as fodder for cattle.

Caution

High doses of opium poppy can lead to addiction and a reduction in respiration.

Legality of cultivation

Engaging in the cultivation of poppy without government authorization is considered illegal. In India, the legal cultivation of opium for medicinal purposes is permitted only in specific areas and is subject to free licensing conditions (Singh and Chauhan2023). This legal cultivation aligns with the regulations outlined in the United Nations Single Convention on Narcotic Drugs of 1961. The oversight of cultivation activities falls under the purview of the Central Bureau of Narcotics (CBN), which operates under the provisions stipulated in the Narcotic Drugs and Psychotropic Substances Act (India) of 1985 and the Narcotic Drugs and Psychotropic Substances Rules (India) of 1985.The issuance of licenses to farmers for opium poppy cultivation is carried out by the Central Bureau of Narcotics (CBN) in Gwalior, Madhya Pradesh, under the supervision of the Narcotics Commissioner.

To ensure compliance with the licensed area, officers from the CBN individually measure the fields of every cultivator. Cultivators are obligated to deliver their entire opium yield to the CBN, receiving compensation at rates established by the Government.During the harvest season, weighed centers are set up by the CBN, where cultivators bring their opium and submit it for assessment. All procured opium is then sent to Government Opium and Alkaloid Factories located in Neemuch and Ghazipur. These factories undertake the drying and processing of opium for export purposes and the extraction of various products, including Codeine phosphate, Thebaine, Morphine sulfate and Noscapine, among others.

Conclusion

When used purposefully, Posta proves to be an economically valuable plant with a wide range of medicinal applications. However, the development of a synthetic derivative known as heroin from morphine has contributed to global social issues. Efforts to find a synthetic drug as a replacement for morphine and codeine have not yielded successful results thus far. The predominant production of heroin from the plant has been associated with the Golden Triangle, an area in mainland Southeast Asia that includes the Shan Plateau, Kachin Hills of northeastern Burma, and the highlands of northwestern Laos and northern Thailand. Unfortunately, this has resulted in widespread misuse of the ornamental and medicinal plant, causing harm to individuals globally.Plants are

bestowed upon us by nature as gifts, but their misuse can lead to the destruction of human lives. Therefore, all of us must utilize the Posta plant meaningfully and purposefully, prioritizing the well-being of humanity.

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Palash: A tree of many wonders

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Introduction

The Palash tree, also known as the Flame of the Forest, holds a special place in the Indian landscape and culture. Its scientific name is *Butea Monosperma*and it belongs to *Fabaceace* family. Palash or Bastard teak is a medium-sized deciduous tree that grows wild in various regions including the sub-Himalayan tract, upper Gangetic plains, central and eastern India, Burma, and Sri Lanka. The tree is a popular ornamental tree native to tropical and subtropical regions of the Indian subcontinent, such as Bangladesh, India, Nepal, Pakistan, and Sri Lanka. It has been recognized for its multiple uses for mankind from ancient times and has spread to many tropical districts worldwide.This is a moist-subtropical to tropical species. It can be found on various soil types like alluvial, red, black, and sandy, but prefers well-drained, fertile soils. It requires a monsoonal climate. Palash can succeed on various sites with sufficient soil moisture. It can be found mostly in eastern and central peninsular India, often growing in rocky, sandy, or marshy areas and profusely in the Chotanagpur plateau, Hazaribagh, and Palamu district of Jharkhand. The tree is best suited for a plantation established through direct seeding. Seeds have a high germination rate; the tree can fix nitrogen. It is the iconic and beautiful forest flower of India. The species is at lower risk by the World Conservation Union due to its wide distribution. Relatively narrow seed collections are recommended to cover the northeastern Indian provenances. The tree is sacred to Manasa, the Hindu Goddess of serpents. Butea produces the most important dye used by the monastery weavers -a brilliant yellow, producing as many as twenty distinct shades being extracted from the petals, together with various mordants. Palash, also known as Parapadrika in Sanskrit, is a magnificent tree that can grow up to a height of 10 meters with a magnificent spread of 10 meters. This tree, surrounded by beauty, is often hailed as the Tree of Fire due to its stunning appearance. It is a deciduous tree that bursts into bloom in the late winter months from January to March. The flowers of the Palash tree are bisexual, devoid of any fragrance, and typically last for only a day. They are delicately arranged in a raceme inflorescence. The fruit of the Palash tree is a slender cylindrical pod, measuring between 5 to 11 centimeters in length and tapering at both ends. In rural India, the branches of the Palash tree are prized for their use as firewood or as torches, especially during special occasions like weddings. Moreover, the seeds of the Palash tree have exhibited promising insecticidal properties, adding to its overall value and

significance in various cultural and agricultural practices.

Fig 1- Flowers of Palash

Fig 2 – Leaves of Palash

Major socio-cultural and economic Utilities

Like several other tree species, *B.monosperma* also has got a significant socio-economic importance particularly for the rural communities in many states of India. Besides its high therapeutic usefulness, every part of this tree species has a potential to be used for preparing various goods of economic importance to the depending communities

Socio-cultural importance

The tree holds sacred status and carries mythological importance, being central to rituals involving offerings and considered a repository of divine wealth. During ceremonies dedicated to the goddess Kali, flowers are offered instead of blood, and its dried stem fragments are employed to kindle sacred fires. Butea is a staple in Brahmin households for their ceremonial fires. Its wood is fashioned into sacred utensils, while its leaves are revered for their purity and beauty, often used to fashion cups and plates. (Burli and Khade, 2007) also noted its cultural significance.

Symbolism and Inspiration

Palash's striking red flowers have long been a source of inspiration for poets, painters, and artisans. These blossoms are often seen as symbols of passion, energy, and the fleeting nature of life. Throughout history, the vivid color of Palash flowers has been used in ancient texts and romantic literature to represent love and desire. Their bright and intense hue captures the imagination, serving as a powerful metaphor for the emotions and beauty of life's moments.

Holi Festival Connection

The Palash tree holds a special role in the celebration of Holi, one of India's most vibrant festivals. Holi marks the arrival of spring and is famous for its joyful throwing of colored powders. In many tribal areas, women decorate themselves with Palash flowers, and these blossoms are also used to

create natural dyes for the festival. The tree is worshipped as the God of Fire during Holi, underscoring its spiritual and cultural significance. This practice reflects a deep respect for the tree and highlights its integral role in one of India's most beloved traditions.

Sacred Rituals and Ceremonies

Palash is not just important during Holi but also plays a vital role in various Hindu rituals and ceremonies. The flowers, wood, resin, and gum of the Palash tree are utilized in numerous sacred activities:

Havan (Offering Prayers to Gods): Duringhavan, a ritual involving fire offerings, Palash flowers are used in place of blood to honor the goddess, Kali. This substitution underscores the reverence for the tree and its association with purity and divinity.

Fig.3*B. Monosperma* flower used in spirituality

Hindu Marriages

In Hindu wedding ceremonies, Palash flowers are incorporated into several rituals, symbolizing auspiciousness, and spiritual connection. The vibrant flowers enhance the beauty and sacredness of the ceremonies.

Sacred Utensils and Ceremonies

The wood, resin, and gum from the Palash tree are used to create sacred utensils and are integral to various religious ceremonies. These elements of the tree are believed to hold spiritual power and are essential in maintaining the sanctity of rituals

Economic importance

Fibers

The inner bark of both the stem and roots serves as a valuable source of fibers utilized in various applications such as cordage, caulking for boat seams, and paper production. Traditionally known as 'Bakambra' in Uttar Pradesh and 'Chhoel' in Bihar, these fibers hold significant utility for tribal communities, particularly in crafting sails and boats due to their robust and water-resistant properties. While these fibers may not command substantial commercial value, studies have demonstrated their suitability for manufacturing newsprints (Guha and Mukerji, 1961) and cooling pads (Jain and Hindoliya, 2011).

Fig.4 Extraction of fiber from the *B.Monosperam*

***Butea* dye and Holi colors**

The flowers of B.*Monosperma* serve as a valuable source of natural dye, ranging from bright yellow to deep orange-red hues, commonly employed in dyeing silk, cotton fabrics, leather goods, and food items. Additionally, this dye is utilized in Hindu rituals to mark the forehead. The bark is utilized in tanning processes by artisans and can also function as a coloring agent in soft drinks and fast-food products. Moreover, the purified and refined form of this dye shows immense potential in medicine, either as a standalone treatment or as an ingredient in other medications. Across generations, Butea flowers have been integral in the preparation of traditional Holi colors, particularly in the region near Brij (Mathura, Uttar Pradesh), offering a healthier and safer alternative to modern synthetic and potentially toxic Holi colors.

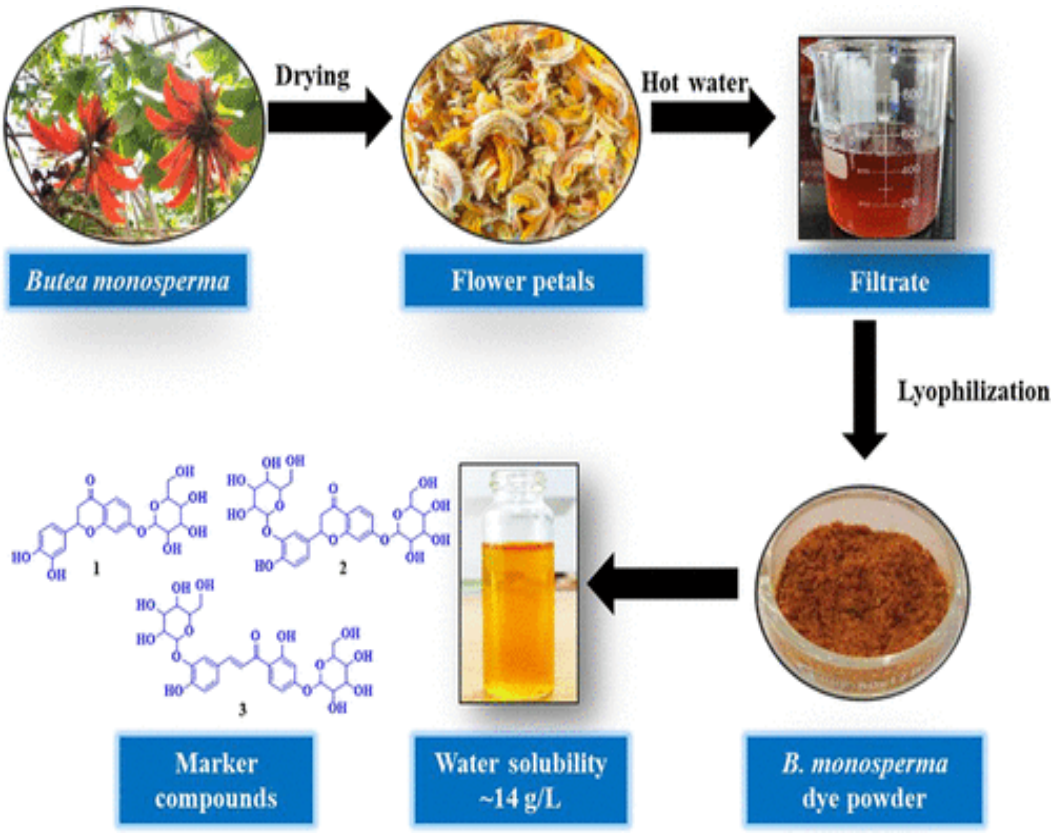

Fig.5 Extraction of dye from the *B.Monosperma*

Leaves

Palash leaves have been traditionally used for various eco-friendly applications. One popular use is in making eco-friendly plates and bowls, locally called as ‘Dona Pattal’ the leaves are naturally study and can hold hot or moist foods without getting soggy. This makes them a great alternative to disposable plastic or Styrofoam tableware, reducing plastic waste and contributing to a

healthier environment. Additionally, Palash leaves have also been used for making eco-friendly packaging materials, such as bags and wrappers. The natural strength and biodegradable properties of the leaves make them a sustainable choice for packaging various product.

Fig.6 Eco-friendly bowl made by *B.Monosperma*

Ornamental utility

B. Monosperma is occasionally cultivated as an ornamental tree due to its highly appealing flowers, which display vibrant shades of orange, yellow, and white in abundance. These flowers hold significance in various traditional rituals, serving as decorations and offerings to deities. Additionally, in certain regions, women utilize the flowers to create garlands for adorning their hair, a practice observed in states like Jharkhand and West Bengal, where Butea flowers are commonly used for worship and hair adornment. The flower of the *B.Monosperma* used as worship of the God.

Flowers

The traditional use of Palash flowers encompasses a range of practices, with one prominent use being dyeing and coloring. The vibrant hues of the Palash flowers have long been utilized to produce natural dyes for fabrics, with the flowers being boiled to extract the color. Dried flower powders are available and can be consumed in formulations for blood detoxification, treating spermatorrhoea and impotence in men, supporting urinary tract health, promoting body heat cooling and pile reduction, detoxifying skin, and blood, maintaining low blood uric acid levels, and ensuring proper urinary flow.

Medicinal Properties of Palash

Palash has been used in traditional Ayurvedic medicine for centuries. Various parts of the tree, including the flowers, leaves, and bark, are believed to have medicinal properties. One of the key benefits of Palash is its ability to fight inflammation. Inflammation is the body's natural response to injury or infection, but when it becomes chronic, it can lead to

various health problems. Palash contains compounds that help reduce inflammation, providing relief for conditions like arthritis, muscle pain, and more.Moreover, Palash is a powerful ally in pain management. Whether it is a headache, backache, or any other type of discomfort, Palash can help alleviate pain. Its analgesic properties make it particularly useful for individuals dealing with chronic pain conditions. Palash also boasts antioxidant benefits. In addition to its antioxidant properties, Palash exhibits antimicrobial action, meaning it can inhibit the growth of harmful microorganisms. This makes it a valuable tool in treating skin disorders and infections. Whether it is a rash, a wound, or a fungal infection, Palash can help promote healing and prevent further complications. Palash is known for its therapeutic potential in treating various dermatological issues. From soothing irritations to calming rashes, Palash is a gentle yet effective remedy for troubled skin. Its natural properties make it suitable for all skin types, providing relief without harsh chemicals or side effects. Palash offers digestive support through its seeds, which have long been used to address digestive problems. Whether it is indigestion, bloating, or constipation, Palash seeds can help ease discomfort. By aiding digestion and promoting regular bowel movements, Palash contributes to overall well-being. Emerging research suggests that Palash may play a role in diabetes management. By helping regulate blood sugar levels, Palash offers hope for individuals living with this chronic condition. While more studies are needed to fully understand its potential, Palash shows promise as a natural approach to diabetes management.Pre-made leaf extracts are available for immediate relief from sore throat, eye conditions like conjunctivitis, and menstrual care in women.

Environmental Benefits of Palash

Supporting Biodiversity

The Palash tree is incredibly important for the ecosystems where it grows. One of its most striking features is its bright orange-red flowers, which are more than just beautiful—they are essential for many insects. Bees and butterflies, for example, are attracted to these flowers because they provide a rich source of nectar. By drawing in these pollinators, the Palash tree helps support a wide range of plant and animal life, maintaining the area's biodiversity.

When the tree's leaves fall, they do not just litter the ground. As they break down, they turn into organic matter that enriches the soil. This process returns vital nutrients to the earth, helping other plants grow and thrive. In this way, the Palash tree plays a key role in keeping its habitat healthy and diverse.

Fig7– Palash Trees in a Forest

Improving Soil Quality

One of the remarkable features of the Palash tree is its ability to improve soil quality through a process called nitrogen fixation. This means the tree can take nitrogen from the air and convert it into a form that plants can use as a nutrient. Because of this ability, planting Palash trees can be very beneficial, especially in areas where the soil is poor. They can help restore fertility to the land, making it more productive for agriculture and other vegetation.

The Palash tree is also known for its resilience. It can grow in tough conditions, including soils that are salty, alkaline, or otherwise barren. This adaptability makes it an excellent choice for reforestation and soil restoration projects, as it can thrive where many other plants cannot.

Providing Wildlife Habitat

The Palash tree is more than just a plant—it is a home and a food source for a variety of wildlife. Birds, insects, and small mammals all find shelter among its branches. The tree's flowers are rich in nectar, providing an important food source for these creatures.

By offering both food and shelter, the Palash tree helps sustain local wildlife populations. This, in turn, contributes to the overall balance of the ecosystem, as each species plays a role in maintaining environmental health. The presence of the Palash tree thus supports a complex web of life, ensuring that the ecosystem remains vibrant and functional.

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Greening Telangana: Exploring the vital role of trees outside forests

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Introduction

According to ISFR 2021, Telangana has a total area of 21, 213, 98 sq. km. covered by forests; yet, trees found outside of forests only make up 6.21 percent of the state. As per the "State of Forests Report 2015," Telangana's total forest cover is only 14.72 percent, whereas the state's overall green cover now stands at 20 percent.The need to conserve remnants of representative forest ecosystems, the growing fragmentation of forests, and the loss of forest cover, combined with increasing demand for forest products in developing nations, necessitate the development of innovative sustainable management tools. In this regard, less studied tropical forest resources, like Trees Outside Forests (ToF), have a unique role. "Trees growing outside forests," or TOFs, are described as being essential to the social-economic fabric of rural India and providing crucial ecosystem services to both urban and rural areas of the nation. Since TOF-origin timber and panel products have become the main substitute for forest-derived timber, pressure from forests has been greatly reduced.

Significance of TOFs in Telangana

Trees outside forests have a significant role in enhancing biodiversity, contributing to soil health and water conservation, carbon sequestration, cultural and spiritual significance, climate resilience, and livelihood support for rural communities by providing valuable forest resources such as timber, fruits, medicinal plants, etc.

Role in enhancing biodiversity

In Telangana, TOFs enhance genetic diversity, native species conservation, and ecological resilience. The migration of wildlife is facilitated by TOFs, which serve as green corridors and support population viability and gene flow. The presence of TOFs in Telangana's rural and urban landscapes ensures the survival of a variety of flora and fauna and fosters ecological balance. Furthermore, TOFs support the preservation of healthy soil, the control of water, and the management of microclimates, all of which are essential for the survival of a wide range of species.

Contribution to soil health and water conservation

Promoting native tree species as TOFs in agro-ecological regions can enhance tree density, positively impacting soil health and water conservation in Telangana.

Carbon Sequestration

Trees outside of forests play a crucial role in carbon sequestration by acting as significant carbon sinks, helping to mitigate climate change. These trees absorb carbon dioxide from the atmosphere during photosynthesis and store it in their biomass and soil, thereby reducing the concentration of greenhouse gases in the atmosphere. In a recent study,

the total TOF biomass and carbon content above ground were calculated as 24.43 t/ha, 414.46 t/ha, and 556.36 t/ha, respectively, from the Vikarabad district of Telangana (Srinu and Reddy 2022).

Cultural and spiritual significance

In Telangana, people have a deep cultural connection with trees, worshipping them as a gesture of gratitude for their essential role in sustaining life. Trees outside forests play a vital role in regional festivals like Bathukamma, Bonalu, Ugadi, and Vinayakachavithi**,** where specific plants are worshipped as part of the rituals.Trees hold significance in the traditional healing system of Telangana, with ethnobotanical knowledge being utilized to treat common ailments, showcasing the practical importance of trees beyond their spiritual value.

Climate Resilience

Trees outside of forests contribute to enhancing climate resilience in Telangana by providing ecosystem services such as regulating local climate, conserving water, and reducing soil erosion**.**

Livelihood support for rural communities

Trees outside forests (TOFs) provide valuable timber resources, which can be utilized for various purposes such as construction, furniture making, and fuelwood. (e.g., *Acacia chundra, Acacia leucophloea, Acacia nilotica, Azardirecta indica, Mangifera indica, Tectonagrandis, Terminaliaarjuna, Pongamia pinnata*, etc.). Some TOFs in Telangana may bear fruits, which can have economic value through local consumption or sale in markets. These fruits can contribute to food security and provide additional income for communities (e.g., mango, guava, pomagranate, etc.) Certain TOFs may include medicinal plants that have economic benefits due to their use in traditional medicine, pharmaceuticals, or herbal products. These plants can be a potential source of income for local communities and contribute to healthcare. (e.g., Aswagandha, Sandal Wood, Red Sanders, Aloe vera, Mucuna, Tulsi, etc.)

Table 1. Major Trees outside forest (TOF) species in Telangana (ISFR, 2021)

Sl No	TOF (Rural)	TOP (Urban)
1	*Mangifera indica*	*Azadirachta indica*
2	*Azadirachta indica*	*Mangifera indica*
3	*Butea frondosa*	*Pongemia pinnata*
4	*Borassus flabelliformis*	*Tectona grandis*
5	*Tectona grandis*	*Cocus nucifera*

Mangifera indica **(Common name: Mamidi, Family: Anacardiaceae)**

Silviculture Characteristics

A shade-bearing tree that can resist occasional frosts but is susceptible to extreme droughts and frosts (Troup, 1975)

Wood properties

Mango wood has a golden to light brown appearance. Although it is a type of hardwood, its flexibility makes it perfect, and it has a fine, thick grain

Uses

Building material for homes, flooring, panelling, veneer, plywood, turned

objectives, furniture, and kitchen utensils (Srinivasanayaka and Sarath 2024)

***Tectona grandis* (Common name: Teeku, Family: Lamiaceae)**

Silviculture Characteristics

Warm, tropical temperatures, alluvial soils with a pH range of 6.5 to 7.5, and moderate perception levels are ideal for the growth of teak. It is a species that needs light and may be found anywhere from the seashore to an elevation of about 1200 m, with an average annual rainfall of 800-2500 mm (Troup, 1975).

Wood properties

Heartwood ranges in colour from yellow-brown to dark golden-brown, is evenly grained, medium-lustrous, and has greyish or white sapwood. It has a high level of durability, a moderate amount of hardness and weight, and little stiffness. Also, the wood has excellent dimensional stability. Steam bending and moderate bending strength

Uses

Framing tools, furniture, house, construction, boat building, walking sticks, veneer, carvings, and indoor furnishings. (Srinivasanayaka and Sarath, 2024)

***Azadirachta indica* (Common name: Vepa, Family: Meliaceae)**

Silviculture Characteristics

It is a light-demanding species and sensitive to frost and fire. It is drought-hardy. Though not a forest tree, it generally grows wild. It grows on a variety of soils, from sandy to clayey to black cotton soils. Neem does best where drainage is good and the sub-soil water level is fairly high (Troup, 1975).

Wood properties: Vepa heartwood has a reddish brown colour, is strong and durable, has a rough grain, high volumetric shrinkage, and is also aromatic and pest-resistant. It serves as a material for constructing oars, cart axles, and felloes for cart wheels. It is also a fairly heavy wood. Neem wood is highly sought-after in various industries. It has unique properties and an eco-friendly nature.

Uses

Agricultural implements, cabinetry, furniture, house construction, packing cages, used as fuel, charcoal making, medicine (Srinivasanayaka and Sarath, 2024)

***Butea frondosa* (Common name Moduga, Family: Papolionioideae)**

Silviculture Characteristics

It is common in mixed dry deciduous forests in Telangana, being in open grassland and scrub forests. The species is identified by trifoliate leaves and scarlet flowers. It is a light demander, drought-hardy, good coppice, and develops root suckers (Troup, 1975).

Wood properties

The wood is soft. Being durable under water, it is used for well curbs and water scoops.

Uses

The plant is used to produce dye, medicine, feed, lumber, and resin. In Hindu rites, ghee is poured into the fire using spoons and ladles made of this wood. Good charcoal can be obtained from it. To lessen soil erosion, farmers usually plant trees atop field bunds. (Srinivasanayaka and Sarath, 2024)

***Borassus flabelliformis* (Common name: Tadi, Tati, Family: Palmeae)**

Silviculture Characteristics

A native of tropical Africa but cultivated and naturalised through India. It is a very tall, single-stemmed evergreen palm tree that can eventually reach a height of 30 metres. Grow well in full sun, even when small, and prefer sandy soils.However, the established plants are quite drought-resistant and also survive waterlogging quite well (https://tropical.theferns.info)

Wood properties

Wood is usually light, pale and non-siliceous.

Uses

The uppermost young leaves are used to make fans, baskets, caps, and rice-storage boxes. String, rope, fencing, and other items are made from the fibre found in leaves. In order to stay hydrated throughout the summer, palm fruit is used

***Pongemia pinnata* (Common name: Ponga, Family: Leguminosae)**

Silviculture Characteristics

It is drought-resistant and can withstand frost. It is shade-tolerant but does well with full overhead light. It is an excellent coppicer; it puts forth root suckers readily. It is frequently pollarded in South India for green manure. Mature trees can withstand waterlogging, slight frost, and high salinity.

Wood properties

The texture of the wood is medium to coarse. Pongamia wood is not regarded as being very durable and is vulnerable to insect attack. It also has the propensity to split when in use. The wood is, therefore, not regarded as being of high grade (https://www.renature.com)

Uses

The leaves of the trees are lopped for fodder, even though their digestibility is poor. The seed cake after extraction is used in poultry rations.

***Cocusnucifera* (Common name: Narikal, Tati, Family: Arecaceae)**

Silviculture Characteristics

The coconut palm is a long-lived plant; it has a single trunk, 20–30 metres tall, and its bark is smooth and grey, marked by ringed scars left by fallen leaf bases. The tree can live as long as 100 years, producing an annual yield of 50 to 100 coconuts.

Wood properties

The average density of coconut palm wood ranges from 0.41 to 1.11 g/cm2, while its moisture content ranges from 50% to 400%. Coconut wood can be a promising material for the manufacture of furniture and other handicrafts due to its beautiful grain and attractive natural appearance.

Uses

Use in furniture and high-value products, Charcoal, chemicals, and coconut timber are suitable for housing components like trusses, purlins, walls, joists, doors, window frames and jalousies.

Fig 1. *Tectona grandis*
(Source: https // greencleanguide.com**)**

Fig 2. *Azadirachta indica*
(Source: https // greencleanguide.com**)**

Fig 3. *Mangifera indica*
(Source: https // greencleanguide.com**)**

Fig 4. *Buteafrondosa*
(Source: https // greencleanguide.com**)**

Fig 5. *Borassus flabelliformis*
(Source: https // greencleanguide.com**)**

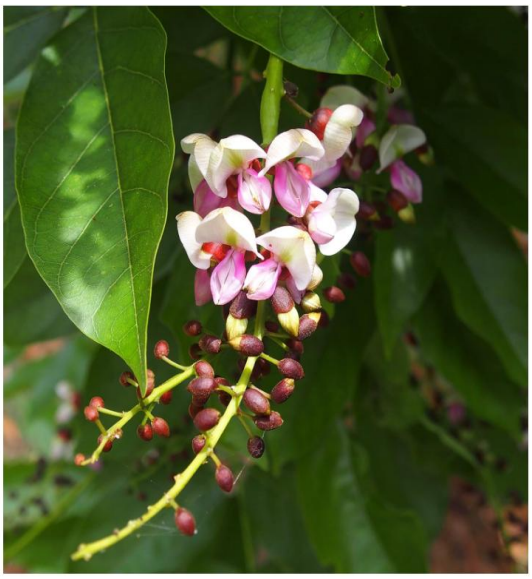

Fig 6. *Pongemia pinnata*
(Source: https // greencleanguide.com)

Fig 7. *Cocus nucifera* tree
(Source: https // greencleanguide.com)

Opportunities for the expansion of TOF

Trees outside forests (TOFs) offer alternative forest product sources and alleviate pressure on natural forests, which helps to prevent encroachment and changes in land use. Planting trees outside of forests

can help lessen the negative impacts of urbanization and unsustainable forest management on natural forest ecosystems, especially on public and institutional lands. Notwithstanding the advantages, TOFs' ability to fully address encroachment and land use changes in Telangana is constrained by problems such as precarious land tenure and unclear legal regulations. In Telangana, effective TOF management has the ability to improve rural livelihoods by promoting market-based diversification and subsistence, hence reducing the demand on the state's national forests. Telangana's long-term management of its TOF resources can be enhanced by implementing responsive service mechanisms that target households that grow trees, which will benefit both the rural populace and the environment.

Expanding trees outside forests (TOF) in Telangana offers an excellent approach to living sustainably and addressing the issues posed by climate change. The integration of technology and community participation in tree-outside forest initiatives in Telangana can enhance the effectiveness of participatory approaches, ensuring sustainable management of forest resources while addressing community needs.

Recommendations for policymakers and stakeholders

- Trees outside forests (TOF) improve the environment, diversify livelihoods, and increase wood production, all of which have a major positive impact on rural development.
- Policymakers should understand the value of TOF in boosting farmer income and reducing the burden on natural forests.
- Promoting agroforestry systems, which incorporate trees into farms and offer financial, social, and environmental advantages, can benefit every stakeholder involved.
- Establish precise guidelines for the management, harvesting, and sale of TOF timber in order to optimize the area's potential for timber production.
- Maximizing the benefits of TOFs in Telangana requires improving farmer access to markets for tree products, providing incentives, and improving stakeholder information.

Conclusion

Trees outside forests, or TOFs, are abundant in Telangana State and are essential to many facets of the environment as well as human subsistence. Small woodlots block plantations, and linear features like roads, canals, and embankments are examples of TOF in Telangana. These features sustain livelihoods, sequester carbon, and conserve biodiversity. Similar to forests, TOFs provide protection for agriculture and soil, reduction of drought and desertification, and assistance for water supply. To effectively design regulations for the forest sector and address environmental issues at the national and international levels, a precise evaluation of TOF resources is required.

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Van Mitra: A scheme to boost green cover in Haryana

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Introduction

According to India State of Forest report 2021, the percent of Forest and Tree cover is 6.85% in relation to its geographical area. Sustainable development goals like SDG 8 decent work and economic growth, SDG 11 sustainable cities and communities, SDG 13 climate action, and SDG 15 life on land involves in achieving the targets by 2030 with the help of Van Mitra scheme. Manohar Lal Khattar, the Chief Minister of Haryana, inaugurated the "Van Mitra" initiative along with its dedicated online platform, aiming to foster community engagement in tree planting ventures across non-forest areas. The scheme seeks to empower local residents to actively contribute to expanding Haryana's green canopy, enhancing the survival rates of newly planted trees, and promoting tree plantation beyond conventional forest zones. Families earning less than Rs. 1.80 lakh annually are eligible to participate, with individuals aged 18 to 60 encouraged to register as 'Van Mitras'.

Under the scheme, each 'Van Mitra' is entitled to receive incentives based on their sapling maintenance efforts over a maximum period of four years, with a cap of planting up to 1000 saplings. In the initial year, Van Mitras will be compensated Rs. 20 per pit dug, followed by Rs. 30 for each sapling planted thereafter. They are free to choose non-forest areas within their residential village, town, or city for plantation. With the aid of 7500 volunteers from economically weaker backgrounds, the program aims to instill a sense of environmental responsibility and personal commitment to tree planting and nurturing.

Environmental sustainability hinges on the quantity of vegetation covering the terrain. In states such as Haryana, which lack sufficient forests, there's a pressing requirement to boost tree coverage beyond designated forest zones to rebalance ecosystems and enhance the overall environment for residents. The Van Mitra initiative serves as a deliberate effort to rally community resources and foster enthusiasm for planting and nurturing trees, thereby aiding in the restoration of ecological equilibrium.

Objective of Van Mitra

Encouraging active involvement from the community in planting trees, with a focus on improving the survival rates of planted trees and expanding green cover in non-forest areas to foster a healthier living environment.

Operational procedure for selection and registration of Van Mitras

Public Awareness

The scheme will receive extensive promotion through both print and visual media, as well as via the forest department's website.

Identification of Eligible Families

Eligible families or individuals with an annual income below 1.8 lakh will be identified through the Parivar Pehchan Patra (PPP) data managed by the Citizens Resources Information Department (CRID). Notification of eligibility for scheme participation will be communicated to these families through various channels, informing them about the registration process on the Van Mitra portal/mobile app.

Registration

Eligible families will register one qualifying member aged between 18 to 60 years on the Van Mitra mobile app. Information regarding the maximum number of saplings to be planted, up to a limit of 1000 saplings, will be provided during registration. Priority will be given to families with lower incomes and younger applicants among the registered candidates.

Land Identification

Van Mitra will be responsible for securing land for plantation activities.

Training

Van Mitras will undergo basic training in plantation techniques and protective measures. Additionally, they will receive practical training on utilizing the Van Mitra mobile app.

Basic implementation guidelines for scheme

1. Only tree species saplings, excluding short rotation species such as eucalyptus and poplar used in agro-forestry will be planted under the scheme.
2. A minimum distance of eight meters will be maintained between planted trees.
3. Van Mitra will choose non-forest land within their residential village, town, or city for planting. If the plantation occurs on land not owned by Van Mitra, they will transfer the plants to the landowner after four years, who will then assume responsibility for the plants. Van Mitra will receive an honorarium of Rs. 25 per transferred plant. If the planted tree is on Van Mitra's land, they will be considered the owner and eligible for subsequent incentives. An agreement will be signed between Van Mitra and the landowner stipulating that the tree cannot be felled for at least 10 years. If the tree remains in the landowner's possession until it reaches 75 years of age, the government may consider providing an honorarium equivalent to Rs. 100. These trees will also be recognized under the State Government Scheme of Pran Vayu Devta, and custodians will receive an honorarium for their care under this scheme.

Role and responsibility of Van Mitra

1. Identify and secure necessary land for planting. If the chosen land isn't owned by the Van Mitra, obtain written permission from the landowner.
2. Excavate pits for planting and follow Standard Operating Procedures (SOPs) for planting and maintenance.
3. Guarantee successful growth of plantations by ensuring their healthy survival.

Role and responsibility of the Forest Department

1. Supply Van Mitra with robust saplings for planting.
2. Educate Van Mitra on plantation techniques, maintenance, and SOP preparation, covering tasks such as weeding, irrigation, and frost protection, etc.
3. Forest guards, foresters, and range officers will offer guidance on plantation to Van Mitras within their jurisdiction when needed.
4. Document the evaluation of plantation survival rates conducted by Van Mitra.

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https://www.undp.org/sustainable-development-goals

Integration of spices under various agroforestry systems: A critical appraisal

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Abstract

The backbone of the Indian economy is agriculture. Monocropping is one of the greatest constraints in Indian agriculture. Hence there is an immediate need for crop diversification. Cropdiversification can be possible through agroforestry.India is called as the land of spices.Integrating spices under various agroforestry systemsforesees greater scope in Indian agriculture.It helps in income generation, profitability and economic stability of the farmers.Various spices based agroforestry systems are present all across India. This necessitates more emphasize should be given to future researches on spices based agroforestry system.

Keywords

Agriculture, Agroforestry, Monocropping Crop diversification, Spices

Introduction

Spices can be defined as any dry part of a plant such as roots, leaves, bark, fruits, flowers and seeds thatare used as food adjuncts to enhance aroma and flavour to food products while condiments are also plant parts which are used as food adjuncts but just to add taste alone (Achinewu *et al.*, 1995). Spices are widely used in cooking for their flavour, nutritional benefits, and ability to preserve food.The largest producer, consumer, and exporter of spices worldwide is India. About 75 of the 109 kinds classified by ISO are produced in India. Pepper, cardamom, chilies, ginger, turmeric, coriander, cumin, celery, garlic, nutmeg, and mace are among the most widely produced and exported spices. Out of these spices the production of chilli, cumin, turmeric, ginger and coriander accounts for almost 76 per cent of the total production (Anon., 2023).India is called as the land of spices. The flagship organisation concerned with the export development and promotion of spices is Indian spices board.There are fifty two spices under the purview of Indian spices board but only twenty spices have production-area details.Spices share 14.8 per cent of the total geographical area (Kandiannan *et al.,* 2018). Other institutes that are concerned with spices are IISR (Indian institute of spices research) and Directorate of Arecanut and spices.Spices constitute an important sub-sector of the economy. Most perennial spices are cultivated in agroforestry types of farming systems.(Lindara*et al.*, 2004)

Table-1: Major state-wise area and production of spices in India
(Source: https://www.indianspices.com**)**

State	Area (ha)	Production (Tons)
Madhya Pradesh	724020	3473108
Rajasthan	971340	1161352
Gujarat	665098	992136
Andra Pradesh	201790	796339
Telangana	141621	793623
Karnataka	375082	709546
Maharashtra	128475	581033

Madhya Pradesh is the largest state in the production of spices followed by Rajasthan. Rajasthan has maximum area under spices followed by Madhya Pradesh. In terms of global spice production, India is the leader and produces a vast variety of spices. The varied climates of India, which range from tropical to subtropical to temperate, enable nearly all spices to grow. Almost all of India's states and union territories cultivate some type of spice.

Agriculture is the backbone of Indian economy. One among the constraints in Indian agriculture is monocropping. Hence there is an immediate need for crop diversification. Crop diversification can be possible through agroforestry.Agroforestry is a collective name for land-use systems involving trees combined with arable crops and/or animals, where woody perennials are deliberately used on the same land management system as agricultural crops and/or animals, in a spatial or temporal sequence, there being both ecological and economic interaction between the components (Kumar, 2016). The agroforestry area in India is 28.427 Mha that accounts for 8.65 per cent of total geographical area.(Arunachalam*et al.*, 2022)

Choice of species

- Sciophytes
- Climatic and Edaphic factors
- Farmer's need

The most often grown crops in agroforestry are ginger and turmeric. It can be cultivated underneath coconut, arecanut, poplar, rubber, litchi, guava, mango, papaya, *etc*. as long as it receives some partial shade.Cardamom can be planted with tree spices like clove, nutmeg, cinnamon, and allspice. The most favoured spices for plantation crops are tree spices. In fruit orchards, seed spices can also be grown as intercrops. In plantations, black pepper grows well with other crops. Coffee, tea, arecanut, and coconut are intercropped with pepper. Cardamom is a shade-loving plant that grows in the shade provided by large forest trees. It has a lot of potential as a mixed crop in coffee, coconut, and arecanut fields. (Kandiannan*et al.*, 2018)

Various agroforestry systems integrating spices

Kashmir

- Almond/Apple/ Walnut in rows with Saffron

North eastern states

- *Shorearobusta*/ *Grevillearobusta*/*Alnusnepalensis* with Cardamom, Turmeric and Ginger
- *Terminalia mircrocarpa*/ *Bischoffiajavanica* and *Alnusnepalensis* with Cardamom
- *Areca catechu*+ Cardamom
- *Areca catechu* + Black pepper

Alluvial plains

- *Leucaena leucocephala*/ *Shorea robusta*/ *Tectona grandis*/ *Michelia champaka*and *Chukrasia tabularis* are the main tree crops grown with Ginger, Turmeric, Bamboo and Black Pepper (Daniel and Hegde, 2007)

Southern India

- *Mangifera indica/Artocarpus heterophyllus/ Cocos nucifera*in upper storey; banana and coffee in the second storey; food crops, fodder, cardamom, black pepper,turmeric, ginger and chilli *etc.*,in the lower storey. This system is popularly known as homegarden. It is also known as multitier cropping system and is mostly practiced in Kerala.
- *Glyricidiasepium* / *Grevillearobusta*/*Areca catechu* are the main tree crops grown with black pepper, coffee, vanilla and turmeric. Coffee based agroforestry system integrating spices is practiced in Karnataka.

Special system integrating spices

Integration of spices with fresh water aquaculture-

It is type of integrated farming system and is predominantly practiced in island regions especially Andaman and Nicobar islands. Through this practice fish farmers can achieve higher income through fish cultivation. They may also earn more by cultivating Arecanut plantation on sloppy areas and spices on the dykes of the fish ponds.Suitable fish species for integrated fish-spices farming are the Indian major carps (IMCs), grass carp, silver carp, common carp and prawns. The short-term varieties of spices (ginger, turmeric, green chillies, and coriander) can be raised on dyke/sloppy terrains for additional annual income.

Advantages of spices based agroforestry system-

- Growing spices with tree components can increase farm income, profitability and economic stability
- It helps to increase the foreign exchange and contributes to the country's GDP.
- Integrating trees in spice cultivation such as pepper, cardamom *etc.*, reduce CO_2 emissionsin two ways –
- Carbon capture and storage by afforestation and as a substitute to fossil fuels
- Captured carbon by the tree component is transferred to the belowground through root growth and storing carbon in various tree parts.
- Boosting soil organic pool.
- It improves the agro-biodiversity and soil properties.
- It helps to fulfil the sustainable development goals

Constraints in spice based agroforestry- Lindara*et al.* (2004)

1. Population Growth
2. Lack of government policies
3. Fluctuation of world market prices
4. Lack of fund for R and D
5. Lack of market access
6. Lack of financial assistance
7. Pest and disease infestation of the crops
8. Education level of the farmers'
9. Neglect of agroforestry system
10. Out migration of labourers

Conclusion

Adopting spices based agroforestry system offers many advantages to the farmers. It helps to achieve higherfarm income, profitability and economic security.

Integrating tree components in spice cultivation such as pepper, cardamom *etc.*, helps in carbon sequestration and improving soil properties through nitrogen fixing trees. India's population is expected to reach 166.8 crore by the year 2050. Due to severe demographic pressure intensive agriculture should be adopted in India. Hence spice based agroforestry could be one option for intensive and sustainable land use in India.

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