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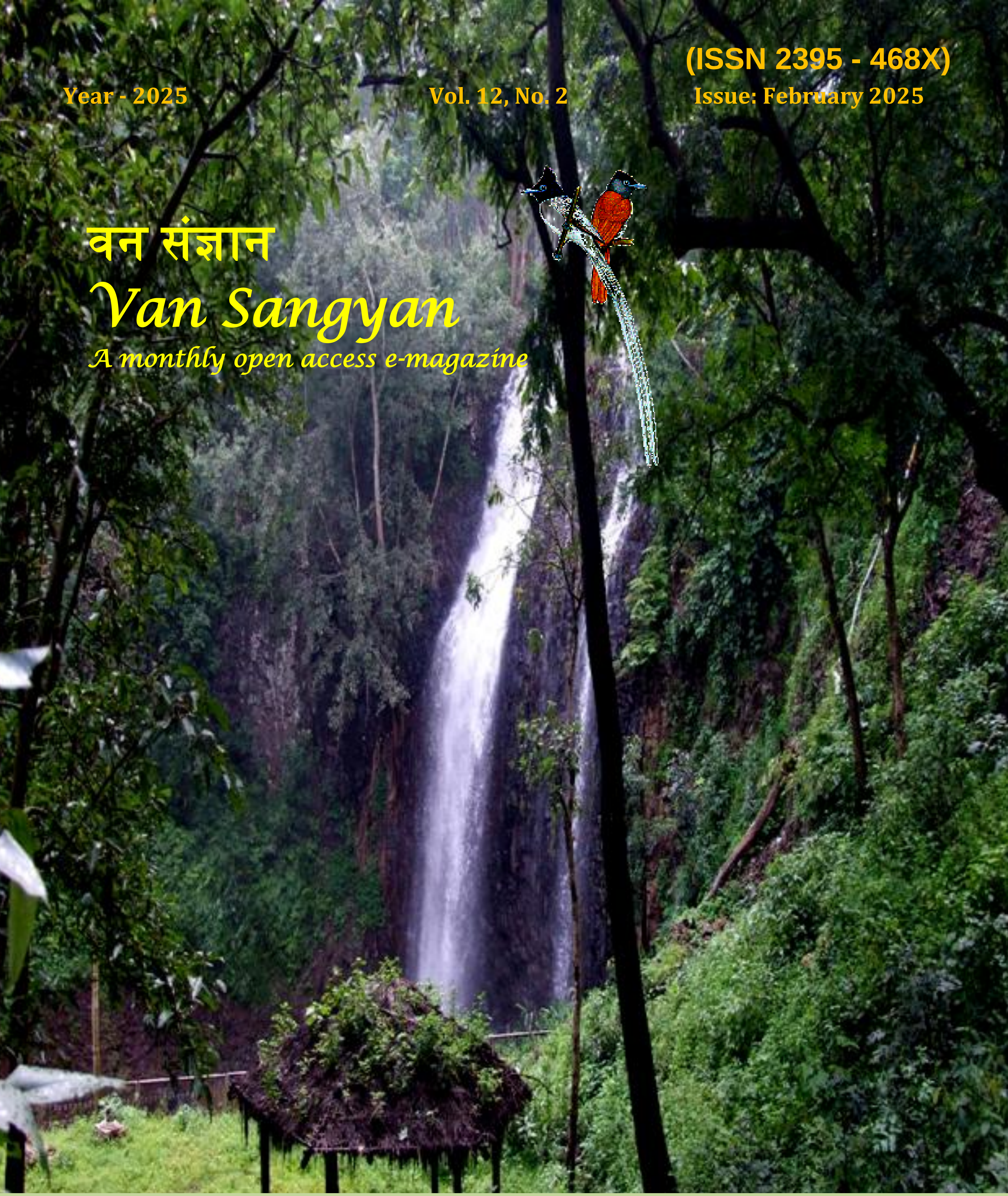

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Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve

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From the Editor's desk

Agroforestry is a sustainable land-use system that integrates trees, crops, and livestock on the same piece of land, offering a holistic approach to environmental management. It plays a significant role in combating climate change by enhancing carbon sequestration, improving soil health, and increasing biodiversity. By promoting tree planting alongside agricultural activities, agroforestry helps reduce greenhouse gas emissions, conserve water, and mitigate the effects of soil erosion. Additionally, it provides farmers with diverse income sources, making it a resilient strategy to adapt to changing climatic conditions while supporting both environmental and economic sustainability.

In this context, this issue of Van Sangyan features an article on Agroforestry: A land use system for combating climate change. There are also useful articles viz… Application of remote sensing (RS) and geographic information system (GIS) in soil and water conservation measures, जलवायु परिवर्तन एक चुनौती , Medicinal and economic value of Canarium strictum Roxb., Lac farming: An alternative income source for farmers, Snow leopards: The king of mountains, Phytochemical and pharmacological potential of diospyros lotus: A comprehensive review, Essential oils as a natural wood preservative, आर्थिक समृद्धि हेतु- केथेरेन्थस रोजीयस (सदाबहार) की खेती, Advancing agroforestry: The transformative role of remote sensing in monitoring and management.

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Agroforestry: A land use system for combating climate change

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Introduction

Change is a fundamental aspect of nature, and the climate has always fluctuated. However, the current concern lies in the rapid pace of climate change, driven by both natural events like volcanic eruptions and, more significantly, human activities such as burning fossil fuels and pollution. NASA describes 'Climate change as a shift in average conditions, including temperature and precipitation, over long periods in a specific region'; whereas, World Meteorological Organization's State of the Global Climate report highlights the global average temperature reached 1.45°C, marking 2023 as the hottest year and part of the warmest decade on record. Natural disasters like hurricanes, heatwaves, droughts, floods, wildfires, and severe cyclones contribute to widespread devastation, impacting millions and causing substantial economic losses worldwide.

In India, from the hustling bustling cities to the remotest villages, the consequences of climate change in the form of intense heatwaves or the erratic rainfalls impose damage not just to crop but also to all life forms including humans. A report by Press Information Bureau 2023 issued concern that without anyproperactions, rainfed rice harvests in India are expected to decrease by 20% in 2050 and 47% in 2080 while, wheat harvest is likely to decrease by 19.3% in 2050 and 40% in 2080. This worsens the plight of our farmers who are already burdened by the ongoing crop failures owing to climate change shattering their remaining hope alive.

As the world grapples with the escalating impacts of climate change, innovative solutions are emerging to combat this existential threat. Among these, agroforestry stands out as a beacon of hope, offering a multifaceted approach to not only mitigate climate change but also to enhance food security, biodiversity, and rural livelihoods.

Agroforestry: Concept and functions

Agroforestry is a term given for the combination of arable crops, woody perennials and/or livestock in a same unit of land in such a way that their collective benefits is more sustainable and successful than raising any one of them. The failing scenario of traditional farming can be altered by a more adaptive and resilient practice of farming which is ecologically necessary, practically achievable, technically sound and socially suitable for farmers is Agroforestry. Although trees raised in afforestation and reforestation programs help to mitigate the effects of climate change but agroforestry systems (AFS) offers some unique advantages. The raising of trees in the farmland not only helps to offer ecological benefits like carbon sequestration, enhanced soil fertility, improved nutrient cycling, *etc.* but also gives economic benefits like food security, additional source of income through small wood, provision of pasture for animals.

Agroforestry for mitigating climate change

Carbon sequestration potential of AFS

It is the process of absorbing carbon present in the atmosphere and transforming it into terrestrial biomass (leaves, branches, twigs, roots, stem) essentially performed by green plantswho are the natural carbon sinks through photosynthesis. It is one of the most efficient ways to compensate for the accelerating Green House Gases (GHGs) emissions. Agroforestry systems, rich in trees and diverse plant life, are highly effective at sequestering carbon, thus helping to mitigate the greenhouse effect. The ability of an agroforestry system to sequester carbon depends on various factors like climatic, edaphic, topographic and biotic factors of a site. As for example, agroforestry systems can sequester carbon over 70 Mg ha^{-1} in the top 20 cm soil in the humid tropics (Mutuo *et al.*, 2005). Agroforestry systems, with their diverse land uses, have been shown to enhance both the quantity and the resilience of soil carbon storage in comparison to pastureland. Alley cropping system a type of AFS had the potential to accumulate the maximum soil organic carbon (199.0 Mg ha^{-1}) compared to pasture land, homegarden and shade trees for crops (Suárez *et al.*, 2024). The total carbon biomass accumulation potential was significantly higher in *Gmelina arborea*based agroforestry system than in sole *G. arborea*system (Kumar *et al.*,2024).Out of the seven agroforestry systems studied, the Spider lily + Eucalyptus system demonstrated the highest carbon sequestration, with 34.05 t ha^{-1} per year above ground, 8.85 t ha^{-1} per year below ground, and a total of 42.90 t ha^{-1} per year (Panchal, 2013).Joshi *et al.* (2013) found that an 8years old *Eucalyptushybrid* plantation in the Terai region of the central Himalayas sequestered carbon at a rate of 7.88 t C ha^{-1} yr^{-1}.The Carbon sequestration potential of Agrisilviculture in the Southern plateau and hill zone is reported to be 25,11,360 Mg CO_2 $yr^{-1}$and in other Agro-climatic zones of the country has been provided in table 1 below.

Table 1: Carbon sequestration potential of agroforestry systems across various states in India

Agro-climatic zone	States	AF system	Area (ha)	Relative Change in C stock (Mg ha^{-1} yr^{-1})	Potential C sequestration (Mg CO_2 yr^{-1})
Western Himalayas	Himachal Pradesh	Silvipasture	2,28,490	0.25	2,08,160
Western Himalayas	Uttarakhand	Agrihorticulture	2,65,110	0.17	1,62,490
Eastern Himalayas	Arunachal Pradesh,	Agrisilviculture	68,740	0.1	25,730

	Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, West Bengal, Sikkim				
Indo-Gangetic plains	West Bengal, Bihar, Uttar Pradesh, Haryana, Punjab	Agrisilviculture	6,71,500	0.76	18,72,940
	Uttar Pradesh	Agrihorticulture	3,72,980	0.15	2,05,330
Eastern plateau & hills	Delhi, Bihar	Agrisilviculture	1,85,770	2.21	15,06,740
Central plateau & hills	Rajasthan, Uttar Pradesh	Agrihorticulture	1,33,430	0.22	1,07,730
Southern plateau & hill	Andhra Pradesh, Karnataka	Agrisilviculture	5,79,910	1.18	25,11,360
East coast plains & hills	Andhra Pradesh, Tamil Nadu, Pondicherry	Agrisilviculture	61,100	1.1	2,46,670
West coast plains &hills	Kerala, Maharashtra	Agrisilviculture	44,630	0.25	40,950
	Goa, Karnataka	Agrisilviculture	66,940	1.34	3,29,220
Western dry region	Rajasthan	Agrisilviculture	1,93,770	0.09	64,000

	Total		**28,72,370**		**72,81,320**

Source: Dhyani and Handa (2014)

Reduced use of fertilizers in AFS

Excess addition of inorganic fertilisers is harmful for the soil health reducing the crop yields. It also poses great damage to the environment when the leachates pollute the nearby rivers and ecosystem. An AFS comprising of *Coffeacanephora*+ leguminous trees in the Amazon showed higher accumulation of N, K, Ca and Mg in the soil whereas only coffee cultivation had significantly lesser accumulation of nutrients. This was because of the regular incorporation of tree parts residues enriching the soil with essential macro and micronutrients continually thus reducing the need for the use of inorganic fertilizers which are non-eco-friendly also (Tinoco-Jaramillo *et al.*, 2024).

An AFS comprising alfa-alfa and mulberry demonstrated positive effects on soil fungal structure and fungal diversity in the rhizosphere soil of both mulberry and alfa-alfa (Zhang *et al.*, 2019). Adopting Piliostigmareticulatum shrubs with annual crop pearl millet doubled the yield of pearl millet without any application of fertilizer in Senegal. The macronutrients (N, K, Ca, Mg and S) and micronutrients (Mn and Cu) significantly increased in the *P. reticulatum*+ pearl millet/ groundnut intercropping continuously for a 11years period (Bright *et al.*, 2017).

An outline comparing the beneficial effects of trees on soil properties in an AFS than crops in a monoculture system for climate change adaptation is illustrated in Figure I. It elaborates the overall benefits of AFS in microclimate, soil structure, water stress, nutrients status, microbiota as compared to monoculture.

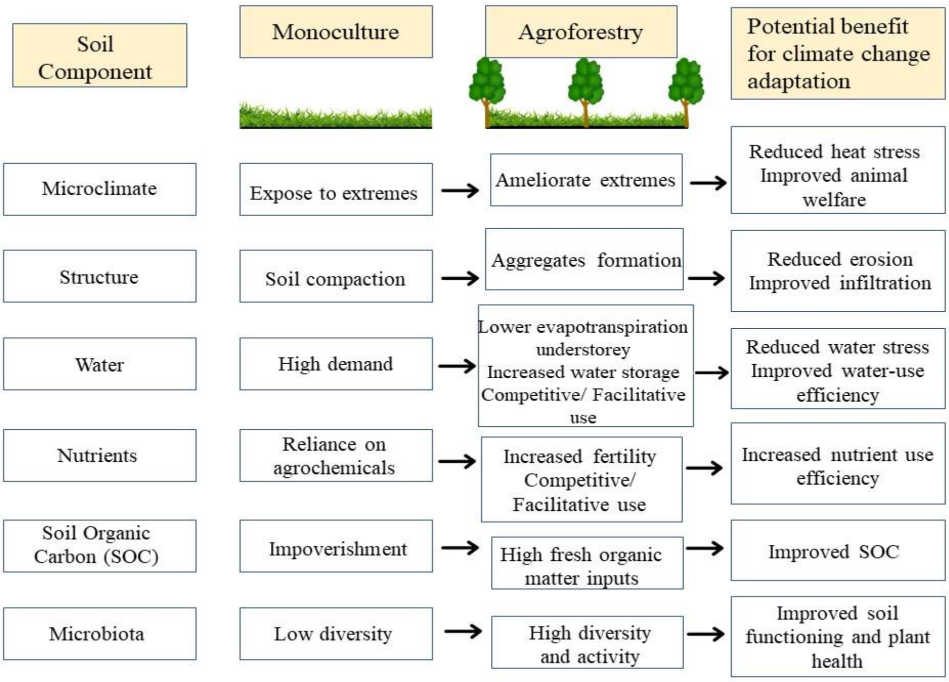

Fig 1: Comparing beneficial effects of AFS and crops in a monoculture system for climate change adaptation (Source: Rolo *et al.*, 2023)

Improvement of Microclimate in AFS

The trees present in an AFS helps to provide shade to the crops thereby improving the microclimatic conditions which enhances the crop yield in turn. For instance, cocoa based agroforestry system displays great resiliency against climate stresses by providing protection and a desirable shade environment for maximum crop yield. Shade trees like *Miliciaindica*and *M. excels* with cocoa based AFS allowed minimum transmission of light and were capable of maintaining a sound microclimate throughout by regulating the day to day temperature and relative humidity changes. However, it was ascertained that the type of shade tree species did not mattered more rather the distance between the shade trees creating buffer determined the growth potential of cocoa. A well developed canopy closure in an AFS helps to enhance the soil microbial activity which increases the litter decomposition and protects from high temperature consequences and drought effects (Martius *et al.*, 2004). *Hardwickiabinata* trees planted at a density of 200 trees ha^{-1} provided a favourable microclimatic environment for the growth of intercrops like mustard and soybean (Shanker *et al.*, 2005). Amalgamation of shade trees like camphor, bishop wood and jacaranda with coffee, increased soil organic matter by 10% and soil microbial community by 64% as compared to open coffee system. The yield from shade tree + coffee was similar to that of open coffee system except under camphor trees (Rigal *et al.*, 2020).

AFS Increases Soil Quality

Climate change induced prolonged drought leads to increase in soil compaction and soil quality deterioration which hinders the proper root development of crops. The presence of trees with intercrops in an agroforestry system helps in addition of huge extent of organic matter to soil via litterfall (twigs, leaves, branches, prunings, decayed roots) especially in the alleycropping system which involves nitrogen fixing leguminous trees like Acacia, Gliricidia, Albizzia, Cassia, Bauhinia, Prosopis, Casuarina, *etc.* The extensive deep networks of roots in trees are able to break through the compact soil pans present in the bottom soil horizons and absorb nutrients from deeper layers bringing it back to upper soil layer (nutrient pumping, safety net). This further improves the water percolation and infiltration. The litterfalls ensures a perennial surface cover within the intercrops that help to minimize the effect of soil and water erosion. The soil beneath the trees are carbon rich thus hosting a wide spectrum of soil microbial fauna like symbiotic bacteria and fungi that actively participates in the decomposition of organic matter into inorganic substrates. The occurrence of soil invertebrates and other fauna composition is higher in AFS as compared to agriculture (Uttam *et al.*, 2014). The N rhizodeposition was 60.4 mg plant^{-1} in Walnut-chickpea AFS while it was 47.2 mg plant^{-1} in chickpea as sole crop. Further, the supply of N from soil to chickpea in AFS was 28.2 kg N ha^{-1} when it was just 2.2 kg N ha^{-1} in solecropping (Mahieu *et al.*, 2016).

Role of AFS in conserving water in peatlands

As the land areas for agriculture is falling short to meet the demand for global food security, the cutting of forest land for cropping is not a wise option with the current climate change scenario. It becomes necessary and sustainable to consider challenging land use systems like Peatlands for utilization in agriculture. Peatlands are difficult for cropping due to constantly remaining wet and sometimes with presence of water table at much lower depths from the surface. The introduction of AFS in peatlands curb down the problem of lower water retention as the leaflitter produced from trees enhance the amount of organic matter in soil thereby increasing the water holding power of the soil. The trees help to regularly absorb CO_2 and enhance in their biomass thus addition of more organic matter. Not only this, the microclimate is also improved in the site by reduction of temperature and increase in humidity (Lestari and Mukhlis, 2021).

Water saving and cycling benefits by AFS

The Green House Gases (GHGs) emissions and high use of non-renewable resources such as water is more evident in agriculture. Balancing the energy uptake, water and carbon footprint is a key step to ensure sustainable farming practices. One of the main aims of Paris agreement is to reduce the emissions of GHGs. Agroforestry is a way of achieving such objectives as it promotes the sustainable practice of cultivation by reducing the GHGs which is a novel climate based solution (Platis *et al.*, 2019).The prunings obtained from trees can be used as mulch on surface which increases the water storing potential in the ground by reducing soil evaporation. Additionally, weed growth is also checked. Study reveals that the available water capacity and the root length density in Coffee + Gliricidia and Coffee + Subabul is significantly higher than pure Coffee plantation (Khoirunnisak *et al.*, 2023).

Resiliency of AFS to pest and diseases due to climate change

The consequences of climate change are more pronounced as in the increased harboring of certain pest and diseases by plant species causing their failure and eventually mortality. Many minor pest and diseases are becoming major due to climate change. The monoculture system is riskier to pest attack than a diverse multispecies farming system like agroforestry. Adequate shade management by pruning of shade trees in cacao based AFS reduces the spread of fungal diseases due to more shade or light loving insects (Mortimer *et al.*, 2018). Maize grown with hedgerows had significantly lower infestations of stalk borers (*Busseola fusca* (Füller) and *Chilo* spp.) and aphids (*Rhopalosiphum maidis* (Fitch.)) compared to maize grown as a monocrop (Girma *et al.*, 2000). Coconut trees planted alongside cocoa provided nesting sites for predatory ants, Dolicoderus and Oecophylla, which helped reduce Helopeltis damage to the cocoa plants (Way and Khoo, 1990).In maizebased agroforestry systems, there has been a greater presence of belowground natural predators, including ants, carabid beetle larvae, and centipedes, compared to monoculture practices (Sileshi and Mafongoya, 2006 a&b).

Reduction of Leaching and GHGs in AFS

Alleycropping helps to reduce nitrate leaching by 91 % in Maize-Soybean Rotation (MSR) system facing a loss of about 88.5 kg N ha^{-1} yr^{-1}. Additionally, the N_2O emissions in MSR were also decreased upto 83 % by alleycropping system (Wolz*et al.*, 2018). The high presence of soil microorganisms with denitrifying genes under poplar trees in a poplar AFS indicates the maximum potential for removing the nitrates thus reducing its leaching (Beule*et al.*, 2020). In Canada, a poplar based AFS was able to significantly reduce the subsoil nitrate leaching @ 227 kg N ha^{-1} and dissolved organic N leaching @ 156 kg N ha^{-1} (Bergeron *et al.*, 2011).

Conclusion

Agroforestry is a multifaceted approach to addressing the impacts of climate change. By integrating trees, crops, and livestock, agroforestry systems enhance carbon sequestration, reduce the need for chemical fertilizers, improve soil quality, and provide a buffer against extreme weather events. These systems contribute to biodiversity conservation, increase water retention, and offer economic benefits to farmers. As the world faces the escalating effects of climate change, agroforestry stands as a viable and hopeful solution for the future of agriculture.

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Application of remote sensing (RS) and geographic information system (GIS) in soil and water conservation measures

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Introduction

Soil and water are two crucial natural resources that are essential to both the long-term viability of human life. An estimated 50% of India's agricultural land requires corrective action due to severe soil erosion. To increase and maintain agricultural productivity, water is essential. It is not surprisingthat there are thousands of distinct types of soil in the world, given the variety of factors (landscape, climate, geology, plant, time, and man) that contribute to soil formation worldwide. RS and GIS technologies have effectively studied the numerous facets of soil in the spatial and temporal domains. One might interpret the data as a function of soil parameters derived from sensors installed in satellites, aircraft, or at ground level (Parmar et al., 2022). The integration of RS and GIS in soil and water conservation measures is a critical advancement in environmental management.

RS is basically acquiring information about an object without being in physical contact with it, and GIS is a computer-based system for capturing, storing, checking, and displaying data related to positions on Earth's surface.Both RS and GIS arehighly effective tools for collecting, analyzing, visualizing, and interpreting data. It is well known that RS and GIS significantly contribute to the mapping and monitoring of natural resources, especially for soil and water conservation systems, enabling better decision-making for the implementation of conservation practices and other initiatives. The technology helps to pinpoint the vulnerable areas for erosion, study current soil health and manage water resources in a more prolific way (Raj et al., 2023).

RS and GIS are helpful for environmental scientists, land planners, and conservationists because theyenable data visualization of complex relations. The degradation of soil by factors such as erosion, compaction, salinity and loss of organic matter poses a significant threat to world food security and ecosystem health. Similarly, the lack of water due to over-abstraction, degradation, and climate fluctuations exacerbates these problems (Raj et al., 2023). Soil and water conservation are critical and significant to support ecological stability and sustainable use of resources.

Applications of RS and GIS in soil conservation

Soil erosion mapping

Land degradation due tosoil erosion is a global problem that results in agricultural land loss and digression of ecosystems. RS and GIS are essential tools for identifying areas at risk of erosion.

Topographic Analysis

Using elevation data (digital elevation models) and other remotely sensed data, GIS can calculate slope steepness and aspectsthatdefine erosion potential.

Land Use and Land Cover (LULC) Classification

Remotely sensed data can be used to study the changes of LULC (forest, agriculture land settlement and so on). High-resolution satellite imagery or aerial orthophoto, as well as the integration of GIS software, make it easy to study the changes in LULC in large areas (cities) and their suburbs (Gadrani et al., 2018).

Rainfall Data Integration

GIS predicts erosion rates across landscapes when it feeds rainfall intensity data into erosion models (such as the Revised Universal Soil Loss Equation-RUSLE) (Mahmoud, 2014).

These analyses produce provisional erosion risk maps to assist in applying appropriate conservation measures such as contour farming, vegetative buffer strips and so on.

Soil Resource Inventory

Conventional soil surveys pose some challenges because they may require a lot of man hours. RS and GIS improvessoil resource inventory in the following ways:

Remote Sensing

Geoscience analysis of satellite image helps to distinguish various types of soils by spectral reflectance.

Data Integration

Accomplished remote sensing proposes integrating with conventional soil databases to produce enhanced soil maps that support land management.

Soil Quality Assessment

GIS can compare geographical variations in soil qualities, such as its pH or organic matter, to identify which sites require action or redevelopment (Thilagam and Sivasamy, 2013).

This approach not only saves time but will also help devise a correct picture of the quantity and quality of soil resources that are available for conservation.

Site Selection for Conservation Structures

Effective placement of conservation structures such as check dams or silt fences requires careful planning. RS and GIS assist in:

Hydrological Modeling

Through such characteristics of the watershed as drainage patterns, GIS allows determining the most appropriate locations for structures that are likely to effectively capture runoff and minimize sediment transport (Pandey et al., 2011).

Soil Stability Analysis

Evaluating the stability of different soil types is important to determine where structures will work best without possibly collapsing (Pandey et al., 2011).

Cost-Benefit Analysis

RS and GIS can help to figure out how much different site configurations cost, which could be because of the work that needs to be done or the benefits that come from less erosion or better water control.

These capabilities lead to more strategic investments in conservation infrastructure.

Applications of RS and GIS in Water Conservation

Water Resource Mapping

Mapping water resources is essential for effective management. RS and GIS contribute by:

Surface Water Mapping

Using remote sensing methods, surveys of rivers, lakes, reservoirs, wetland, and other surface water extents facilitate resource endowment evaluations (Pande et al., 2018).

Groundwater Mapping

When geological data are combined with hydrological models, aquifer boundaries and groundwater recharge areas can be determined.

Water Quality Monitoring

GIS incorporates data about water quality, such as nutrient concentrations or the presence of contaminants, for analysis of the spatial distribution and temporal changes in pollution sources (Pandey et al., 2011).

Such mapping works assistin planning convenient water usage and pollution conservation.

Watershed Management

Watershed management, therefore, refers to a process of planning, developing, and managing land resources for a watershed unit. RS and GIS support this process through:

Hydrological Modeling

Using models like SWAT (Soil & Water Assessment Tool) in the GIS framework for carrying capacity assessment aids in simulating the movement of water, sediment, and pollutants under various land use conditions (MasudandBastiaanssen, 2017).

Pollution Source Identification

GIS can identify areas where pollution, such as runoff from farms, is causing deteriorating water quality and necessitates management intervention (MasudandBastiaanssen, 2017).

Conservation Planning

The Water Information Management System enables to plan integrated watershed management because it displayshow different conservation measures change hydrological processes and the overall state of the ecosystem (Pandey et al., 2011)

An adequate watershed management system is critical for the preservation of both water and soil to enhance their sustainability.

Drought Assessment

Water scarcity, especially during drought periods, presents formidable challenges to water supply. GIS can assist in:

Drought Monitoring

Since remote sensing data captures precipitation, their analysis makes it possible to monitor drought conditions in regions in real time.

Vegetation Health Assessment

NDVI (Normalized Difference Vegetation Index), RS and GIS products can evaluate the vegetation conditions to reflect moisture stress in drought time.

Resource Allocation Planning

In this sense, GIS provides arobust and reliable assessment of drought severity based on data trends obtained in the past and on current conditions with the goalof performing anticipatory resource management during drought periods.

These applications improve the ability to withstand the effects of drought on agricultural production and ecosystems.

Benefits of Using RS and GIS in Soil and Water Conservation

The integration of GIS into soil and water conservation practices offers a number of benefits:

Control of soil erosion

The integration of RS and GIS in soil and water conservation can aid in controlling soil erosion, identifying areas that are highly susceptible to erosion, and implementing conservation and remedial measures.

Enhanced Decision-Making

Stakeholders can make sensible choices concerning the conservation practices that can go down in different landscapes based on the complex spatial relation.

Cost Efficiency

In terms of application, RS and GIS help to optimize and minimize the costs of traditional survey methods of data collection because they focus on high-value additions in assessments to meet conservation intervention objectives.

Improved Collaboration

Through participation in the project, researchers, policymakers, NGOs, and local communities establish an environment for sharing data and knowledge on effective resource management.

Challenges in Implementing

Despite its advantages, several challenges hinder the widespread application of RS and GIS in soil and water conservation:

Data Availability

Spatial data is the foundation of almost all RS and GIS applications; however, the quality of current data sets is frequently poor, and many developing countries lack adequate coverage due to a lack of funding for area surveys or a shortage of qualified personnel.

Technical Expertise

GIS application demands skilled personnel with the ability to understand and operate GIS and apply the technology in the environment, which limits its application to some extent.

Integration with Traditional Practices

The lack of acceptance from local government employees and local people in particular may slow the growth of technology such as GIS, even when it has merits.

Future Directions

As technology advances, the future of using GIS in soil and water conservation looks promising.

Integration with Big Data

The growth ofbig data in today's world from different sources, such asIoT (Internet of Things) devices, will allow for a better model and live monitoring of different environmental issues.

Machine Learning Applications

Operational remote GIS using machine learning may improve the predictive claims to service abilities such as rates of soil erosion or changes in water quality when different land uses are considered.

Community Engagement Tools

Creating effective interfaces through which local communities can easily interact with GIS tools will result in increased contributions to conservation while guaranteeing that implemented solutions are appropriate to each location.

Conclusion

Soil and water conservation measures implemented through RS and GIS representa significantmilestone in our abilityto develop natural resources in a sustainable manner. Due to its ability to facilitate the evaluation and presentation of spatially referenced soil and hydrologic data, GIS proved to be a very practical, effective, and efficient tool for layer integration and incorporating the decision-making guidelines for creating the plan.Given these challenges in soil and water salinization and given the current conditions towards climatic change and the exerted human pressure on the available natural resources, RS and GIS will be a valuable technology to respond to the current conditions and will be crucial to elaborate new solutions that help in the reinforcement of ecosystems for the benefit of future generations.

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जलवायु परिवर्तन एक चुनौती

सरोज शुक्ला

सह-संपादक
ग्रामीण विकास संदेश
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जलवायु संकट, भोजन संकट और जल संकट का एक दूसरे से घनिष्ठ सम्बंध है तथा इन संकटों का समाधान इन तत्वों संरक्षण में ही अंतर्निहित है। ये सभी घटक एक-दूसरे से किसी तरह भी अलग नहीं हैं।देश का नागरिक होने के नाते हमारा कर्तव्य है कि हम अपने प्राकृतिक संसाधनों का संरक्षण कर इस धरती की रक्षा करें। धरती हमारी मां है और उसकी रक्षा में ही हम सबकी भलाई और हमारा भविष्य सुरक्षित है।जीवाश्म- ईंधन पर आधारित हावी तकनीक और आर्थिक माडल प्राकृतिक संसाधनों का क्षरण करते जा रहे हैं। यह सब पृथ्वी के लिए विनाशकारी सिद्ध हो रहे हैं। जलवायु संकट, भुखमरी, गरीबी, बेरोजगारी, अपराध, षणयंत्र, युद्ध, जबरन पलायान तथा शरणार्थी संकट ये सभी लोगों से जीवन, आजीविका तथा भूमि को छीन रहे हैं, जो कि धरती पर हमारे जीवन का प्रमुख आधार 'मिट्टी' और मानवता दोनों संकट की स्थिति से गुजर रहे हैं।जीवाश्म-ईंधन कोई स्थाई विकल्प नहीं है। इस अस्थाई ऊर्जा स्रोत पर आधारित औद्योगिक कृषि प्रणाली ने अब तक कोई 2 अरब हेक्टेयर कृषि भूमि को बर्बाद कर दिया है। आंकलन करने से ज्ञात होता है कि संकट में पड़ी यह कृषि भूमि पूरी धरती के कुल उपजाऊ क्षेत्र से अधिक है। इसी तरह से अफ्रीका के चारागाहों के अकुशल प्रबंधन से 80 प्रतिशत से अधिक भू-भाग के उत्पादन स्तर में गिरावट आ गई है। औद्योगिक कृषि भी जी.एम.ओ. बीज जीवाश्म- ईंधन तथा रासायनिक खादों पर आधारित खेती के समान ही जलवायु पर बुरा प्रभाव डालती है। इस तरह की खेती, जलवायु बुरी तरह से प्रभावित करती है। प्रत्येक बीज में एक सृष्टि समाहित होती है। यह प्रकृति अपनी यात्रा को इन बीजों की सृष्टि के बल पर ही आगे बढ़ाती है। प्रकृति के इस कार्य को सरल बनाने में किसान बहुत बड़ी भूमिका निभाता है। वह अपनी नई फसल के लिए बीजों को तैयार करता है और बीज प्रजनक कहलाता है। जलवायु परिवर्तन के इस दौर में किसान के पास कृषि जैव-विविधता को बढ़ाने और उसे बनाए रखने की बहुत बड़ी चुनौती है। इस चुनौती को छोटे किसान ज्यादा अच्छे से निभा सकते हैं। छोटे किसानों के द्वारा ही इस विश्व के 70 प्रतिशत लोगों को भोजन मात्र 30 प्रतिशत संसाधनों के उपयोग के आधार पर पैदा किया जाता है। वहीं औद्योगिक खेती 70 प्रतिशत संसाधनों का उपयोग के बदले में 40 प्रतिशत ग्रीन हाउस गैस उत्सर्जन का उत्सर्जन करती है। जैविक खेती वातावरण से अतिरिक्त कार्बन-डाइऑक्साइड को प्रकाश संश्लेषण के माध्यम से मिट्टी में वापस भेजती है। ऐसी खेती के माध्यम से मिट्टी की जलधारण क्षमता में भी वृद्धि होती है, जिससे सूखे की स्थिति से निपटने में सहायता मिलती है। इस तरह से जैविक खेती ही वह माध्यम है जिससे वातावरण में लगातार बढ़ रही कार्बन डाइऑक्साइड की मात्रा पर नियंत्रण कि साथ गिरते हुए भू-जल स्तर में सुधार लाया जा सकता है। दुनिया भर में सभी छोटे किसान और बागवान अपने पारम्परिक ज्ञान के माध्यम से मिट्टी और बीजों का संरक्षण

कर रहे है। ऐसे किसान शुद्ध, स्वस्थ एवं पोषण युक्त भोजन पैदाकर जहां अपने समुदाय को भोजन प्रदान कर रहे हैं वहीं पेट्रो-केमिकल्स को चुनौती देकर पृथ्वी-ग्रह को बचाने में अपना योगदान दे रहे हैं। इस तरह से छोटे किसान अपने अथक प्रयासों से इस धरती पर 'भोजन का गणतंत्र' स्थापित कर कर रहे हैं।हमारे लिए धरती पर सभी मानव एक समान हैं। इसलिए हम सम्पूर्ण धरती को एक परिवार (वसुधैव कुटुम्बकम) मानते हैं। हम इस अखिल विश्व-परिवार के नागरिक हैं और अपने ग्रह यानी इस धरती को बचाना हम सभी का कर्तव्य और धर्म है। इसीलिए आज हम समूचे मानव समाज के साथ पृथ्वी और उसके सबसे अद्भुत प्राणी यानि मानव को बचाने का समझौता यानि संधि प्रस्तुत करते हैं। यह सार्वभौमिक सत्य है कि पृथ्वी है तो मानव है। यह पृथ्वी चिरायु रहेगी तो मनुष्य भविष्य में इस भूमि की उर्वरा-शक्ति तथा विविध फसलों के बीजों की अंकुरण-शक्ति से अपने समुदाय का पालन-पोषण कर सकेगा। हां, मानव नामक इस प्राणी के संरक्षण के लिए इस प्रकृति में सम्पूर्ण जैव विविधता का सुरक्षति रहना अति आवश्यक है। आज लगातार अपभोगवादी संस्कृति और अति स्वार्थपूर्ण कार्पोरेट जगत को अपने नजरिये को बदलने की आवश्यकता है। हम सभी को मिलकर अपने स्वार्थ और लालच को ईमानदारी और जिम्मेदारी में बदलना होगा, तभी मानवता रूपी बीजों को संरक्षण प्रदान किया जा सकेगा। जलवायु परिवर्तन पर संयुक्त राष्ट्र सम्मेलन ऐतिहासिक अवसर पर सम्पूर्ण विश्व के लोगों को प्राकृतिक संसाधनों के शोषण और निजीकरण के स्थान पर कृतज्ञतापूर्ण लौटाने की प्रवृति के साथ जल, वायु, मिट्टी बीज और भोजन पर जनसामान्य का अधिकार हेतु चैतन्य करने के लिए आमंत्रित किया जाना चाहिए। सन् 2000 के बाद समूची दुनिया ने इस वातावरण में कार्बन की लगभग 100 अरब टन मात्रा छोड़ी है। वर्तमान में ग्लोबल वार्मिंग की इस बढ़ती दर के कारण बड़े पैमाने पर जमीन बंजर और फसलें खराब हो रही हैं। एक तरफ जहां तटीय क्षेत्रों पर बाढ़ का कहर बरप रहा है तो हिमनदों से तेजी के साथ बर्फ पिघल रही है। वनस्पतियां और जंतु तेजी से विलुप्त होते जा रहे हैं। लोग बड़ी संख्या में अपनी स्थाई जगहों को छोड़कर पलायन कर रहे हैं, उनमें भोजन और पानी के लिए संघर्ष तेजी से बढ़ रहे हैं। स्थिति यह है कई तरह की बीमारियां देखने और सुनने को मिल रही हैं और समाज पतन की तरफ जा रहा है।जीवाश्म-कार्बन ने हमारे जीवन के प्रत्येक पहलू यथा हवा, पानी, भोजन, चिकित्सा, ईंधन, और कृषि में हर प्रकार से प्रवेश कर लिया है। वायुमंडलीय उत्सर्जन और पारिस्थितिकी तंत्र में प्लास्टिक प्रदूषण के माध्यम से यह कार्बन हमारी वनस्पति प्रजातियों से लेकर मानव स्वास्थ्य तक को प्रदूषित कर रहा है। प्रकृति ने जल को सभी के लिए स्वतंत्र स्रोतों के माध्यम से उपलब्ध किया था, उसका भी हमने निजीकरण कर दिया है। पीने के पानी को अब बड़ी-बड़ी कम्पनियां प्लास्टिक की बोतलों में भरकर बेच रही हैं। यह प्लास्टिक हमारे पानी के साथ ही हमारे जल-स्रोतों सहित समुद्र का भी नाश कर रहे है, जिससे जीवन संटक ग्रस्त होता जा रहा है। हमारे खेतों की मिट्टी पेट्रो-केमिकल्स रसायनों से पट गई है, जिससे इस मिट्टी में उपस्थित सूक्ष्म जीवों का नाश हो रहा है। जीवाश्म-कार्बन पर हमारी निर्भरता ने हमारे सोचने, समझने, जीने-खाने यहां तक कि जैव-विविधता आधारित हरित-कार्बन को भी आर्थिक रूप से महंगा कर दिया है। कच्चे तेल के प्रति हमारी निर्भरता ने एक तो हमारी आर्थिक व्यवस्था में जबरन घुसपैठ कर ली है और ऊपर से इसके कारण लाखों लोग काल के ग्रास बन गये। अब तक कई युद्ध और विस्थापन इस तेल के कारण हो चुके हैं।हम लगातार बढ़ रहे

जलवायु परिवर्तन से तब तक नहीं निपट सकते, जब तक कि विश्व के भोजन-तंत्र और उसकी पद्धतियों में संतुलन स्थापित नही कर देते। औद्योगिक कृषि हमारे पर्यावरण के लिए एक ऐसा राक्षस सिद्ध हो रही है, जिस पर समय रहते नियंत्रण करना अति आवश्यक है। वनों की कटाई, जानवरों के लिए चारा उत्पादन के बहाने जैव-विविधताओं के विनाश, लम्बी दूरी के परिवहन तथा भोजन की बर्बादी के कारण 40 प्रतिशत ग्रीन-हाउस गैसों का उत्सर्जन होता है, जोकि ओजोन परत के लिए जहर का कार्य करती हैं। हम तब तक जलवायु परिवर्तन पर नियंत्रण नहीं पा सकते, जब तक छोटे-छोटे पैमाने तक पारस्थितिक कृषि, जैव-विविधता पर आधारित जैविक बीज, जैविक-मिट्टी, तथा स्थानीय खाद्य-प्रणाली के साथ कम से कम भोजन की बर्बादी, तथा प्लास्टिक के उपयोग पर नियंत्रण नहीं पा लेते। आज जीवाश्म-ईंधन आधारित गहन-औद्योगिक कृषि तथा 'मुक्त व्यापार संधि' पृथ्वी पर सामाजिक और पारिस्थितिक नुकसान के लिए सर्वाधिक जिम्मेदार हैं। यह वस्तु आधारित कृषि 75 प्रतिशत मिट्टी का विनाश, 75 प्रतिशत जल संसाधनों का विनाश और तथाकथित उन्नत-बीज और पोषण-रहित खोखले तथा विषाक्त खाद्यान से 93 प्रतिशत जैव-विविधता के ह्रास के साथ ही नदी, झील और महासागरों के जल के विनाश के लिए उत्तरदाई है। बड़ी-बड़ी बहुदेशीय कम्पनियों द्वारा हर वस्तु को 'क्लाइमेट स्मार्ट' यानि 'जलवायु सहिष्णु' करार देने की रणनीति एक मात्र छलावा है।पारिस्थितिकी के आधार पर जैविक-कृषि और स्थानीय खाद्य-प्रणाली से ही कुपोषण एवं स्वास्थ्य सम्बंधी संकटों के साथ जल तथा जलवायु परिवर्तन जैसी आपदाओं पर नियंत्रण पाया जा सकता है। स्थानीय खाद्य-अर्थव्यवस्था को निर्मित करने से मानव को स्वास्थ्य सम्पन्न और पर्यावरण को संकट मुक्त बनाया जा सकता है। स्थानीय खाद्य अर्थव्यवस्था के लिए, हमें स्थानीय भोजन की जरूरत है और स्थानीय भोजन के लिए आवश्यक है कि हम स्थानीय बीजों को उपयोग में लाएं तथा किसान अपने बीजों को स्वयं उगाएं। बीज प्रकृति का अनमोल उपहार है। यदि कोई भी कानून अथवा प्रौद्योगिकी हमारी बीज-स्वतंत्रता को कमजोर करने का प्रयास करेगा हम ऐसे प्रयासों का विरोध करेंगे। हम अपने बीजों की रक्षा करने के साथ ही जी.एम.ओ. तथा पेटेंट के विरोध में एक साथ खड़े रहेंगे।हम अपनी मिट्टी और जैव-विविधता की रक्षा के लिए प्रतिबद्ध हैं। हमारी जैविक मिट्टी कार्बन को ग्रहण करती है और पानी का संग्रह करती है। पारिस्थितिकीय संतुलन पर आधारित कृषि पुर्नचक्रीकरण के आधार पर कार्बनिक पदार्थों को पोषक तत्वों में बदलती है। सर अलबर्ट हावर्ड ने कहा था कि इस मिट्टी को कुछ दिये बिना ही धरती से विभिन्न वस्तुएं प्राप्त करना डकैती करने जैसा है। हम धरती द्वारा द्वारा किये गये उपकारों के आभारी हैं और लौटाने की रीति को ध्यान में रखते हुए अपनी जिम्मेदारी को मानते हुए हम उसे जैविक कार्बन को जैविक पदार्थ के रूप में वापस लौटायेंगे।पृथ्वी ने हमें जीवन रूपी महत्वपूर्ण उपहार दिया है। यह उपहार सभी के लिए समान अधिकार, कर्तव्य, आजीविका और रक्षा लिए हुए है। हमारी जैव- विविधता और विभिन्न तरह के बीज जनसाधारण के लिए है। इनको पेटेंट करने का अर्थ है अपनी जैव-विविधता को विनाश और किसानों को कर्ज की गर्त में धकेलना। बिना मिट्टी के न तो जीवन और ना ही भोजन की प्राप्ति सम्भव है। जल भी जनसाधारण के लिए है। यह कोई व्यापार की वस्तु नहीं है। 'जल है तो जीवन' है। वातावरण और उससे मिलने वाली वायु हमें जीवन-शक्ति देती है। वातावरण जितना स्वस्थ रहेगा हमारी जलवायु उतनी ही स्वस्थ होगी। आज मिट्टी, हवा, और जल

का लगातार निजीकरण होता जा रहा है जिसके कारण हमारा वातावरण लगातार प्रदूषित हो रहा है। बढ़ती आधुनिकता और ग्लोबल वार्मिंग ने जिन नई-नई बीमारियों को जन्म दिया है, उसमें रासायनिक खादों का बहुत बड़ा हाथ है। ऐसे में जैविक खादों का उपयोग अत्यंत जरूरी हो जाता है। एक दौर में खेती को बढ़ावा देने और अनाज की अधिक उपज के लिए जो वैज्ञानिक उर्वरक खादों के उपयोग पर जोर देते थे, वही वैज्ञानिक आज अनेक बीमारियों से बचने के लिए फसलों में जैविक खादों के प्रयोग पर बल दे रहे हैं। एक आंकड़े के अनुसार देश में पौष्टिक तत्वों की कुल खपत में रासायनिक खादों से उगाए गए खाद्य बाजारों में अधिक मात्रा में उपलब्ध हैं। हरित क्रांति के बाद के युग में बहु पौष्टिक तत्वों में तकरीबन अस्सी प्रतिशत की कमी आई है और उसी क्रम में मानव स्वास्थ्य के साथ-साथ जीव-जंतुओं के स्वास्थ्य में तकरीबन 70 प्रतिशत की गिरावट आई है। इसके अलावा औसत आयु में काफी कमी आयी है । जैविक खेती (व्तहंदपब ंिितउपदह) कृषि की वह विधि है जो संश्लेषित उर्वरकों एवं संश्लेषित कीटनाशकों के अप्रयोग या न्यूनतम प्रयोग पर आधारित है तथा जो भूमि की उर्वरा शक्ति को बनाए रखने के लिये फसल चक्र, हरी खाद, कम्पोस्ट आदि का प्रयोग करती है। अगर भारत की बात करे तो भारत में आजादी से पहले पारम्परिक खेती जैविक तरीके से ही की जाती थी जिसमे किसी भी प्रकार के रसायन के बिना फसलें पैदा की जाती थी लेकिन आजादी के बाद भारत को फसलों के मामले में आत्मनिर्भर बनने के लिए हरित क्रान्ति की शुरुवात हुयी जिसमें रसायनों और कीटनाशको की मदद से उन फसलों का भी भरपूर मात्रा में उत्पादन किया जाने लगा जिसके बारे में कभी सोच भी नही सकता था द्य हरित क्रान्ति के कारण गेहूँ, ज्वार, बाजरा और मक्का की खेती में काफी विकास हुआ था द्यइस हरित क्रान्ति के दौरान 1962 के दशक में जहाँ प्रति हेक्टेयर 2.5 किलोग्राम रासायनिक उर्वरक का प्रयोग किया जाता था वहीं आज प्रति हेक्टेयर बढकर 120 किलोग्राम से भी ज्यादा हो चुका है तो सोचिये कि फसलो में कितना रसायन का उपयोग किया जा रहा है द्य हरित क्रान्ति के कारण जिस जैविक खेती को भारत बरसों से आजमा रहा था वो खत्म हो चुकी थी द्य वर्तमान की इस पारम्परिक खेती में हालांकि खाद्यानो का काफी उत्पादन हो रहा है लेकिन मृदा की उर्वरा शक्ति घटती जा रही है जिसके कारण कई खेत बंजर हो चुके है द्य जैविक खेती केवल जैविक अपशिष्ट, खेतों के अपशिष्ट, पशु अपशिष्ट, खाद आदि जैसे प्राकृतिक खादों का उपयोग करके किया जाता है। यह मूल रूप से मिट्टी के स्वास्थ्य को बनाए रखने के साथ उसे अच्छा और उपजाऊ बनाने में भी मदद करती है। जैविक खेती में फसल परिक्रमण, मिश्रित फसल और जैविक कीट नियंत्रण आदि जैसे कुछ प्रक्रियाओं का पालन किया जाता है। वर्तमान में रासायनिक खेती के बढ़ते प्रभाव को देखकर वैज्ञनिको ने इसे घातक सिद्ध कर दिया जिससे ना केवल मृदा बल्कि इंसानों की सेहत पर भी इसका प्रभाव पड़ रहा है | आज अनेको बीमारियों से पीड़ित लोगों को जैविक खेती से उपजी फसलों को खाने की हिदायत दी जाती है जिसके कारण कई किसानो ने जैविक खेती अपनाना शुरू कर दिया है द्य हालांकि अभी जैविक खेती बहुत ही छोटे स्तर पर हो रही है लेकिन अगर जागरूकता फैलाई जाए तो आने वाले समय में यह पारम्परिक खेती का रूप ले लेगी वर्तमान समय में रासायनिक खाद, कीटनाशकों के अत्याधिक प्रयोग से भूमि की उर्वरा शक्ति समाप्त होते जा रही है जिससे किसानों को भविष्य में खतरा मंडराने लगा है। यदि समय रहते आवश्यक कदम नहीं उठाया गया तो किसानों के लिए भविष्य में भारी संकट उत्पन्न

हो सकता है। पशु से जहां एक तरफ हमें दूध, दही, घी इत्यादि के रुप मे पौष्टिक आहार की प्राप्ति होती है दूसरी तरफ गौ मूत्र एवं गोबर भी उतना ही महत्वपूर्ण है। हमें अधिक से अधिक जैविक खाद का प्रयोग करना चाहिए। नाइट्रोजनी जैविक खाद वे जैविक खाद होती है जो मृदा में नाइट्रोजन की मात्रा को बढ़ाती है। प्रकृति में कई ऐसे जीवाणु और नील हरित शैवाल हैं जो वायुमण्डलीय नाइट्रोजन का यौगिकीकरण करते हैं। राइजोबियम, एजोटोबैक्टर , बेजरिंकिया, क्लॉस्ट्रिडियम, रोडोस्पाइरिलम , हर्बास्पाइरिलम और एजोस्पाइरिलम नाइट्रोजन यौगिकीकरण करने वाले कुछ महत्वपूर्ण जीवाणु हैं।हमें इन तत्वों का किसी भी कीमत पर निजीकरण होने से रोकना होगा। हमें इन जीवन तत्वों को सहयोग, देखभाल और एकजुटता के आधार पर रक्षा करके उन्हें पुनः प्राप्त होगा।हम बीज-स्वतंत्रता के लिए प्रतिबद्ध हैं। हम सभी मानव समुदायों के साथ मिलकर ईमानदारीपूर्वक संगठनात्क रूप में जैव-विविधता को बचाकर सभी के लिए बीजों की उपलब्धता निश्चित करेंगे। खुले परागण के आधार पर बढ़ाये गए गैर-जी.एम.ओ और गैर-पेटेंट बीजों का आदान-प्रदान करना हमारा अभिन्न अधिकार है। किसानों के अधिकार स्वयं प्रकृति द्वारा संरक्षित हैं। यह धरती हमें आदिकाल से हमारी पीढ़ियों को अपनी जैव-विविधता के माध्यम से पाल-पोष रही है। पृथ्वी तथा उसके प्राणियों के कल्याण हेतु साझेदारी और विविधता में एकता के सिद्धांत को अपना आदर्श मानते हैं। हिंसा और अधःपतन के दुष्चक्र को तोड़ने और सभी लोगों और सभी प्रजातियों की भलाई के लिए अहिंसा और उत्थान के आधार पर सद्भाव बढ़ाने हेतु प्रतिबद्ध हैं।

Medicinal and economic value of *Canarium strictum* Roxb.

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Introduction

Canarium strictum Roxb., commonly known as “Black Dammar”, is a polygamodioecious tree belonging to the Burseraceae family. It is of significant ecological, cultural, and economic importance. Traditionally, the resin of *C. strictum*, known as "Dhoop," is extracted and used in ceremonial rituals. The species is also noted for its antimicrobial, antibacterial, anti-inflammatory, antipyretic, and ethnomedicinal properties, with leaf extracts demonstrating varying levels of activity against different bacteria and fungi, particularly with methanolic extracts showing notable efficacy. Given its status in sacred groves and the integration of traditional ecological knowledge with modern scientific approaches, the conservation of *C. strictum* is crucial for sustainable management.

Distribution and Habitat

C. strictum is predominantly found in tropical moist evergreen forests and moist mixed deciduous forests. In India, it is distributed across states such as Sikkim, Arunachal Pradesh, Assam, Meghalaya, Odisha, Maharashtra, Karnataka, Kerala, Tamil Nadu, and the Andaman Islands, typically at altitudes up to 1600 meters. The species is listed as vulnerable on the IUCN Red List in regions like Kerala and Karnataka due to overexploitation. However, detailed information on harvesting and trade practices in certain areas remains scarce, necessitating further research and conservation efforts.

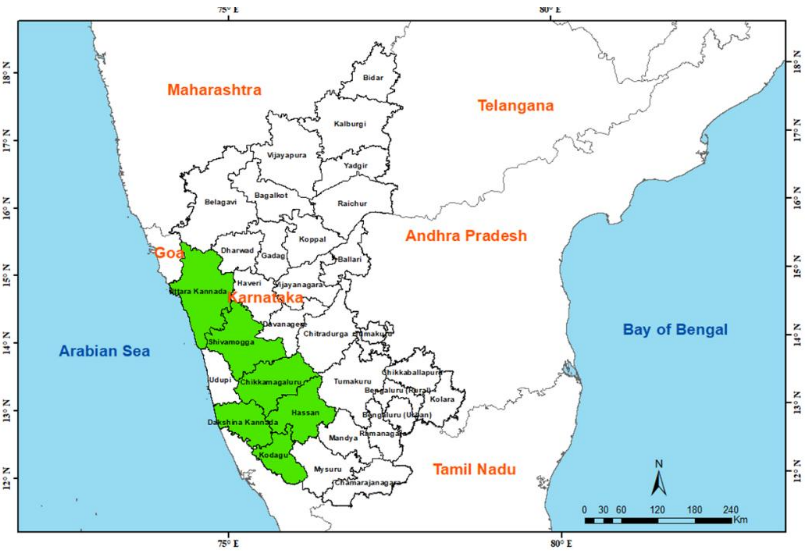

Fig.1 Distribution of *Canarium strictum* across the Western Ghats of Karnataka

Botanical Description

Canarium strictum is a large tree species identifiable by its rounded crown and a straight, unbranched trunk that can extend up to 30-45 meters in height. This species is polygamodioecious, meaning it has both male and hermaphroditic individuals. The compound leaves are arranged alternately and spirally and are covered with rust-colored hairs. The flowers are trimerous and exhibit polygamy, with distinct morphologies for male and bisexual flowers. The fruits are drupaceous, oblong, and pointed at the ends, featuring a fleshy mesocarp and a hard, aromatic stone.

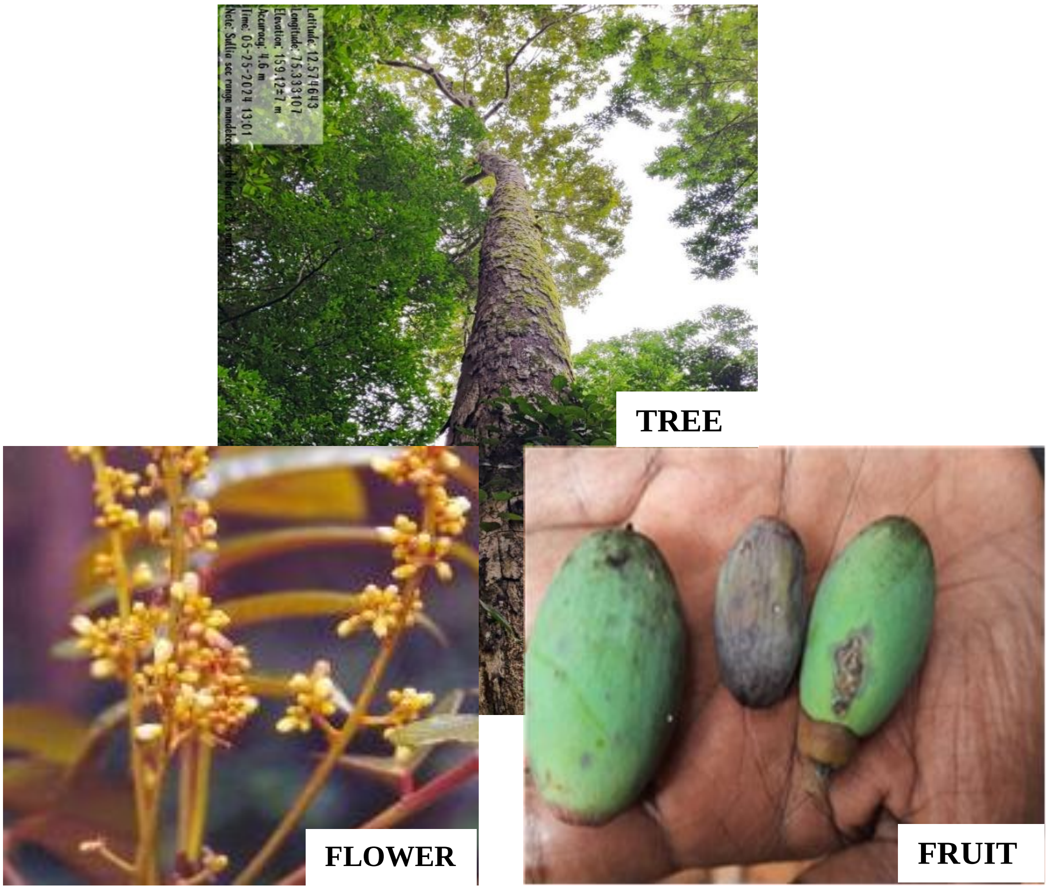

Fig.2 Morphological characteristics of *Canarium strictum*

Economic Importance

Resin (Sambrani or Dammar)

Canarium strictum produces a resin known locally as 'Sambrani' or 'Dammar', which is both medicinal and commercially valuable. The resin has a long history of use among tribal and folk communities in India for treating various ailments. It is a key ingredient in traditional medicine, including the Siddha system, and is commonly used in incense production and varnish industries. Additionally, the resin serves as a substitute for burgundy pitch in the creation of medicinal plasters.

Medicinal Uses of Resin

The resin is renowned for its therapeutic properties. It is commonly used to treat a variety of conditions, including bronchial ailments such as asthma and cough, as well as chronic skin disorders, fever, rheumatism, epilepsy, syphilis, and hernia. Oral consumption of resin powder is also believed to improve complexion and skin health.

Timber Uses

The wood is characterized by its grayish-white color with a pinkish hue in the heartwood, has various practical applications. It is primarily used for making ceiling boards, flooring, and partitions from well-seasoned timber. The wood is also employed in the production of packing cases, low-cost utility furniture, and plywood tea boxes, owing to its good glue-holding capacity.

Seed and Oil Uses

The seeds are edible, and their oil is used in confectionery production. This highlights the plant's economic importance beyond its resin and timber.

Domestic markets for black dammar

Market trends and usage

In India, the trade of Black Dammar is largely concentrated in Kerala due to restrictions on resin collection in Tamil Nadu. Between 2004 and 2008, approximately 150 tons of Black Dammar were sold through auctions in Kerala. The rising domestic prices of Dammar have reduced its demand in matchstick and fireworks industries by about 50% in recent years.

The agarbatti industry, a major consumer of Dammar, produces an estimated 4,200 million incense sticks annually, with 1,100 to 1,200 tons of gum Dammar used as a binding agent. High-quality incense manufacturers prefer Indian Dammar due to its superior fragrance.

Additional Uses

In Kerala, the boat-building industry utilizes Dammar gum for waterproofing wooden boat parts and caulking, consuming approximately 50–60 tons annually. Overall, nearly 60% of Dammar consumption in India is attributed to the incense industry, with the domestic usage estimated at 18,000 tons annually. Major procurement hubs, such as Virudhnagar, supply Dammar to both local industries and importers.

Ecological Impacts of Tapping Practices

Sustainability Concerns

The sustainability of resin extraction from *Canarium strictum* is closely linked to the frequency and intensity of tapping. Increased commercial demand, forest encroachment, and a decline in traditional land tenure systems have led to unsustainable harvesting practices. Frequent tapping not only reduces the quality of resin but also negatively impacts the tree's health by increasing adult mortality and lowering reproductive output.

Impact on Reproductive Success

Excessive resin tapping decreases the fruit-to-flower ratio and results in higher production of non-viable seeds. This decline in reproductive success also disrupts the ecological balance, as the tree supports various fauna, including pollinators and frugivores such as hornbills and imperial pigeons.

Population Decline and Genetic Fitness

Ecological surveys indicate a shrinking population of *Canarium strictum*, which may result in long-term population declines. Research has shown higher seedling mortality when seeds are collected from smaller groves compared to larger groves. Reduced grove sizes increase the likelihood of inbreeding, leading to lower seedling fitness and accumulation of deleterious genetic traits.

Threats and Conservation Status

Canarium strictum faces significant threats to its survival, primarily due to habitat fragmentation and human activities. A reduction of 20% in its population has been observed over the past decade, with particular concerns arising from habitat destruction in regions like the Kolli Hills in the Eastern Ghats and Silent Valley in the Western Ghats. The decline in pollination and seed dispersal, coupled with the overexploitation of resin and wood, has contributed to the species' endangered status.

Unsustainable tapping practices for resin extraction have been identified as a major factor driving the decline of its populations in the wild, especially in South India, where it is listed as a vulnerable species. As a result, urgent measures are required to promote its cultivation, ensuring a sustainable supply for trade and local subsistence needs while protecting the species from extinction.

Regeneration and viability

Regeneration potential

Canarium strictum demonstrates a relatively high potential for regeneration under proper conditions. The species can recover rapidly if areas are protected from further clearance and degradation. The tree's seeds, which typically fall near the parent tree, are easy to germinate and can be propagated artificially by sowing seeds in shaded mother beds. Seeds should be soaked for 24 hours, drained, and planted at a depth of 1.5 to 2.0 cm, with the micropyle facing upwards. Germination is epigeal, and it typically begins three weeks after sowing, continuing for up to 120 days, especially when seeds are sown during the winter months. Germination rates of up to 95% have been observed when using sand substratum.

Seedling Growth and Transplanting

Once the seeds have germinated, the seedlings grow quickly and can be transplanted into polythene bags when they reach the three-leaf stage. After about two months, these seedlings are ready for plantation. *Canarium strictum* can also be successfully grown by direct sowing in the fields at the onset of the monsoon season, with high germination rates observed under controlled conditions. Establishing a nursery at the study site could enhance seedling survival rates and improve the seed-to-seedling ratio.

By promoting the cultivation and regeneration of *C. strictum* through these methods, there is potential to stabilize its population, ensuring its continued availability for medicinal and economic purposes.

Conservation implications

To mitigate these impacts, sustainable tapping practices and habitat restoration efforts are crucial. Protecting larger groves and promoting traditional knowledge can enhance genetic diversity, improve reproductive success, and ensure the long-term viability of *Canarium strictum* populations.

Conclusion

Canarium strictum holds significant medicinal and economic value but is now endangered due to overexploitation and habitat loss. The erosion of indigenous knowledge, coupled with unsustainable harvesting, exacerbates its decline. Comprehensive studies on its population, ecology, and reproductive biology are needed to ensure its survival. Preserving this species is vital for both biodiversity conservation and the livelihoods of local communities.However, the species' ability to regenerate and its medicinal and economic significance offer hope for conservation. Collaboration between forest departments, conservationists, and NGOs is essential to protect this endangered species and ensure its sustainable use for future generations.

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Lac farming: An alternative income source for farmers

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Introduction

Lac farming is an important agro-based enterprise that involves cultivating lac insects to produce lac, a valuable natural resin. In India, this sector complements various agricultural activities, such as crop production, horticulture, dairy, and poultry farming, all of which contribute to enhancing agricultural productivity and economic growth. Lac farming can be adapted to both small and large-scale operations, making it an attractive option for entrepreneurs. By rearing lac insects, farmers can achieve substantial production levels. This cultivation is particularly effective on marginal lands where host trees can be planted, offering a low-cost opportunity that integrates well with other agricultural practices.

India leads the world in lac production, generating approximately 70% of the global supply. The primary regions for lac cultivation are Jharkhand and Chhattisgarh. Lac is the second most lucrative insect-derived product after honey and silk, providing numerous benefits through its wide range of applications in various industries. Historically, lac has been utilized since ancient times, including during the era of the Mahabharata, and it continues to be relevant today. Different varieties of lac produced in India are transformed into a variety of essential goods, fueling interest among farmers and enhancing their income prospects. As farmers seek additional revenue streams alongside traditional crop production, lac farming emerges as a viable option. By providing guidance and support in this field, we can help increase farmers' earnings while contributing to the broader economic development of the nation.

Why should we consider lac cultivation?

Sustainable Livelihood

Lac cultivation provides a reliable source of income for poor farmers, helping to prevent rural-to-urban migration.

Income stability

It ensures a source of income even during drought years, offering financial security.

Suitable for marginal lands: Lac can be effectively grown on marginal and degraded land, making it accessible for many farmers.

No land competition

It does not compete with other horticultural or agricultural crops for land and resources.

Beneficial for ecosystem

Lac cultivation does not harm the health of host trees or other flora and fauna.

Empowerment for women

It is a women-friendly business that encourages female participation.

Support for vulnerable groups

Lac farming is an ideal opportunity for weaker sections of society, promoting inclusivity.

High returns on low investment

It offers maximum returns with minimal investment, making it an attractive venture.

Environmentally friendly

Lac cultivation is an eco-friendly activity that contributes positively to the environment.

What is Lac?

Lac is a valuable resin secreted by lac insects from glands located in their abdomens. The secretion process begins as soon as the larvae settle on young, tender shoots. These insects feed on the sap of specific plants, continuously producing resin to form a protective covering throughout their lifespan. The lac glands are located on the dorsal surface of the body and open through various pores, while the mouth, two breathing pores, and anus remain free of these glands. Initially, the secretion appears as a shiny layer, which hardens upon contact with air.

Economic importance of lac culture

Bangle production

Lac is widely used in the manufacture of bangles.

Jewelry filling

It serves as a filling material for gold ornaments.

Toy manufacturing

Lac is utilized in the production of toys.

Inks and polishes

It is a key ingredient in the formulation of inks and polishes.

Sealing wax and adhesives

Lac is primarily used as sealing wax and an adhesive in optical instruments.

Woodwork and ornamentation

It is valuable in woodworking and for creating ornamental items.

Mirror processing

Lac is employed in the silvering process of mirror backs.

Electrical applications

Due to its excellent insulating properties, lac is extensively used in the electrical industry.

Laminating materials

Lac is also used for laminating paperboard, photographs, and molded articles.

General morphology of lac insects

The adult male and female lac insects exhibit significant differences in size and morphology. The female is approximately two to three times larger than the male. Adult males are typically pinkish-red and come in two forms: winged and wingless.

Winged males

These males possess a pair of membranous anterior wings and are primarily observed during the dry seasons of Baisakhi and Jethvi. They have a short lifespan of about 3 to 4 days, dying shortly after mating. The male's body is segmented into the head, thorax, and abdomen. The head features antennae and a pair of eyes. The thorax contains three pairs of legs, and while some may have wings, others do not. The abdomen is the largest section, equipped with a pair of caudal setae and a sheath containing the penis at the rear. Due to their vestigial mouthparts, they do not consume food.

Female lac insects

The female lac insect, measuring about 1.5 mm in length, has a pink head and a flat ventral surface, while its dorsal surface is convex. Females lack wings, eyes, and legs, and their antennae are vestigial, consisting of 3 to 4 small segments. The mouthparts are adapted for stinging and sucking, enabling them to extract sap from the host plant. The female remains attached to the host and feeds on its juices. Her abdomen is rounded, featuring a spine on the dorsal surface, and the last abdominal segment is divided into two parts with a fringed anus.

Life cycle and biology of lac insects

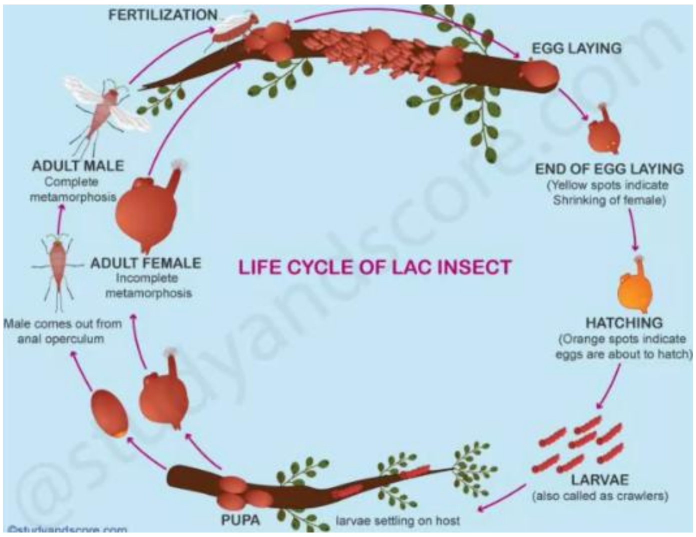
The life cycle of the lac insect consists of three developmental stages: egg, nymph, and adult. Female lac insects lay their eggs within a lac cell, depositing approximately 200 to 500 eggs, which may be either fertilized or unfertilized. Both types can give rise to male and female nymphs. Each egg measures about 0.4 mm by 0.2 mm and is initially pinkish in color, turning brown over time. Females typically lay well-developed eggs that hatch within a few hours.

The newly hatched nymphs are predominantly pink and measure around 0.6 mm by 0.25 mm. They possess a pair of antennae, three pairs of legs, two compound eyes, and six anal setae. The nymphs emerge in large numbers and crawl over the surfaces of twigs and branches in search of suitable spots for settlement, often settling gregariously on new shoots. Once they settle, nymphs thrust their proboscis into the bark and remain stationary. After one or two days, they begin secreting resin from glands distributed under their cuticle, except near the mouthparts, breathing pores, and anus. This secretion encases the nymph in a protective cell that expands as the insect grows.

Nymphs molt three times before reaching maturity. After one of these molts, the nymph loses its eyes, legs, and antennae, with the anal setae increasing from six to ten.

Adult males are pinkish-red and come in two forms: winged and wingless. Winged males have a single pair of translucent membranous forewings and typically live for only 3 to 4 days, dying shortly after mating. They have antennae and a pair of eyes on their head, and their thorax contains three pairs of legs. The mouthparts are vestigial, meaning they do not feed, contributing to their brief lifespan.

Female lac insects have a pink head, measuring about 1.5 mm in length. The ventral surface of their body is flat, while the dorsal surface is convex. Females lack wings, eyes, and legs, but possess 3 to 4 small vestigial antennae made up of several segments.



Host plants of lac

The primary host trees for rearing lac insects include Palas, Ber, Kusum, Ghont, Jallari, Arher, Pipal, and Babul.

Lac cultivation

In India, lac cultivation primarily yields two types of crops: Kusumi and Rangeni. Each strain produces two crops annually, resulting in a total of four crops each year. Notably, 90% of the country's total lac production comes from Rangeni crops, while only 10% is derived from Kusumi crops. Although Kusumi is produced in smaller quantities, it is renowned for its superior quality. The production figures for these crops are as follows:

- **Baisakhi Crop**: 290,600 quintals
- **Katki Crop**: 113,200 quintals
- **Flax Crop**: 34,200 quintals
- **Jethvi Crop**: 15,500 quintals

Two popular methods of lac cultivation

Local cultivation

This method involves the unscientific collection of lac from trees in the forest. Unfortunately, this approach often yields low-quality lac and does not ensure a consistent supply of brood lac for optimal production. As a result, local cultivation is not widely practiced.

Modern method

This scientific approach to lac cultivation contrasts sharply with local practices. In this method, instead of continuously harvesting all the trees, a specific number of trees in a designated area (or coupe) are fully inoculated. Once the lac matures, it is harvested, allowing the trees to regenerate new shoots and foliage. This resting period helps them regain vigor before the next inoculation occurs. To achieve a successful crop of lac, the following factors should be considered:

Selection of suitable site

Choose a site based on the presence of host plants that thrive under favorable environmental conditions. The area should have a balanced climate, with average rainfall around 60 cm.

Pruning of host plants

Pruning is essential to encourage the growth of new shoots, which facilitate successful colonization by lac larvae. Before starting lac farming, light pruning should be performed on branches with a diameter of 1.25 to 2.5 cm. The extent of pruning varies by host plant; some trees, like plum, require more pruning, while others, such as Palas and Kusum, generally need less. Common pruning tools include secateurs, shears, axes, and knives.

Inoculation of brood lac

This step involves introducing lac insects to the new host plants. There are two primary types of inoculation methods used in this process.

Natural inoculation

Natural inoculation occurs when lac insects move from one plant to another, facilitating infection without human intervention.

Collection of brood lac

Brood lac refers to the sticks that contain mature female lac insects, ready to produce the next generation. Approximately two weeks before hatching, these lac-bearing sticks are cut into lengths of 15 to 20 cm, known as brood lac. It is essential to select healthy brood lac for optimal results.

Artificial inoculation

In this method, brood lac is stored in a cool place for about two weeks until the larvae begin to emerge and are ready for inoculation. The brood lac sticks should be cut to a convenient length of 15 to 20 cm and tied to the succulent shoots of the host tree. This tying can be done either longitudinally or laterally. Once hatched, the larvae will transfer themselves to the succulent shoots. It is crucial not to leave the brood lac on the tree for more than three weeks, as prolonged exposure increases the risk of predation.

Scrapping of brood lac

When the brood lac sticks are removed from the trees, any remaining sticks that are dead or deemed unfit for brood purposes should be scrapped promptly.

Washing of lac

The lac obtained after scrapping is washed with water and then dried in the shade. This washing process enhances the color of the lac, making it suitable for various applications.

Conclusion

India is home to a variety of forests that host many valuable tree species, which are utilized for various industrial purposes. By leveraging these trees for lac cultivation, significant employment and income opportunities can be created. The situation of rural farmers is often challenging; however, if they focus on rearing lac insects on host trees instead of cutting them down, their circumstances could improve. Host trees have minimal negative impact on the environment, making them ideal for lac farming.

Lac cultivation can thrive by planting host trees along the edges of infertile land or fields. Additionally, the wood biomass generated from scraping lac can be used as fuel by rural communities. Overall, lac culture holds great potential as an alternative livelihood option that could significantly enhance the economic prospects of people in rural areas.

Snow leopards: The king of mountains

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Abstract

Snow leopard symbolizes the rich cultural heritage of the Indian high-altitudes. Their thick white-gray coat spotted with large black rosettes blends perfectly with Asia's steep, rocky, high mountains. They inhabit the high mountains of central Asia, with a large portion of their range being predominantly treeless due to either alpine or desert conditions, at elevations of about 600–4000 m in the northern part of their range to 1800–5800 m in the southern portions. Adult snow leopards are generally solitary, although groups of 2–4 may form during the breeding season or with the birth of cubs and measure 100–130 cm from nose to tail, with a tail length of 80–100 cm. They stalk and kill their prey as in other large solitary felids. In the wild and in captivity snow leopards breed during late winter (January–March), commonly with 2–3 cubs born in April–June following a 90–105-day gestation period. Captive-born snow leopard cubs weigh 0.3–0.6 kg at birth, 1–2 kg after 25 days, 3–5 kg after 50 days, and continue to gain about 1 kg every 2 weeks until they weigh 25–30 kg at age 1 year. Snow leopard mortality in the wild has been primarily attributed to human trapping and hunting. They have been given the highest level of legal protection in India under the Indian Wildlife (Protection) Act, 1972. The government of India has taken various conservation measures, including declaring the habitats as Biosphere Reserves, National Parks, Sanctuaries and Protected Areas to protect species from poaching and hunting. Despite these efforts, still some species are declining in their population in wild and may become extinct in future. In such cases captive breeding and reintroduction are viable alternatives. Assisted reproduction holds the last promise for the conservation of the most critically endangered species and also the captive breeding helps by exercising control over breeding to avoid inbreeding ultimately leading to an increase in the reproductive rate.

Key Words: Snow Leopard, critically endangered, Conservation

Introduction

Snow leopard (***Panthera uncia***) is an endangered species and its population size is steadily declining. A cryptic predator of the alpine and subalpine zones of central and south Asia, Snow leopards have a strong affinity for rugged mountain terrain, usually devoid of large forest patches. Snow leopards are top predators in their environment, and their prey includes mountain sheep and goats. Without the snow leopard, the ecological balance would be disrupted. Because of herbivore populations would increase, resulting in changes to the vegetation, and also affecting other wildlife that lives in these areas. The same mountainous landscape also contributes to human well-being, locally and regionally. They provide natural resources upon which millions of people depend in addition to being headwaters for river systems that benefit over 2 billion of the world's human population. So, by protecting the snow leopard, we're benefitting the natural environment in these areas and the people who rely on it. India has an estimated 718 snow leopards in the wild. Their distribution spans 1.2–1.6 million km^2 of high mountain habitat in 12 countries of Central Asia. Snow leopards primarily share the landscape with livestock herders and only a small proportion of the species range (14–19%) is set aside in protected areas. The snow leopard is classified as endangered by IUCN, where the main threats to the species are retaliatory killing in response to livestock predation, poaching for trade in fur and bones, depletion of wild prey and habitat degradation and fragmentation resulting from mining and development. Despite their wide geographic range, snow leopards are sparsely distributed and occur at low densities. They are often killed in retaliation for livestock depredation by herders and for their pelts by poachers, while their prey species are also widely persecuted and displaced due to over-exploitation of alpine habitat. Because of these threats, the snow leopard is listed as an endangered species requiring urgent conservation attention. Climate change has now emerged as another potential threat to snow leopards. Intergovernmental Panel on Climate Change (IPCC) projects that the average annual temperature in South Asia and Tibet will increase by 3-4^{o}C by 2080-2099 based on comparison with historical averages from 1980-1999, while annual precipitation is expected to increase throughout this region as well. Previous studies have shown a distinct correlation between treeline and climate. Therefore, the warmer and wetter conditions consistent with climate change predictions in this region may result in forests ascending into alpine areas, the snow leopard's preferred habitat. This review attempts to introduce the ecological aspects of the species and analyze the main factors threatening the snow leopard population as well as their conservation concerns.

Ecology of the snow leopard

The snow leopard's powerful build allows it to scale great steep slopes with ease. Its hind legs give the snow leopard the ability to leap six times the length of its body. A long tail enables agility, provides balance and wraps around the resting snow leopard as protection from the cold.

Distribution

The snow leopard's habitat range extends across the mountainous regions of 12 countries across Asia: Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyz Republic, Mongolia, Nepal, Pakistan, Russia, Tajikistan, and Uzbekistan. The total range covers an area of close to 772,204 square miles, with 60% of the habitat found in China. However, more than 70% of snow leopard habitat remains unexplored (Alexander et al., 2022). The snow leopard is distributed from the west of Lake Baikal through southern Siberia, in the Kunlun Mountains, Altai Mountains, Sayan and Tannu-Ola Mountains, in the Tian Shan, through Tajikistan, Kyrgyzstan, Uzbekistan and Kazakhstan to the Hindu Kush in eastern Afghanistan, Karakoram in northern Pakistan, in the Pamir Mountains, the Tibetan Plateau and in the high elevations of the Himalayas in India, Nepal and Bhutan. In Mongolia, they inhabit the Mongolian and Gobi Altai Mountains and the Khangai Mountains. In Tibet, they occur up to the Altyn-Tagh in the north (Janecka et al., 2008).

Vegetation

Snow leopards are closely associated with arid and semi-arid shrubland, grassland or barren habitats. Inhabit the high mountains of central Asia, with a large portion of their range being predominantly treeless due to either alpine or desert conditions, at elevations of about 600–4000 m in the northern part of their range to 1800–5800 m in the southern portions (Dang, 1967 and Fox, 1989). Snow leopard habitat in the Indian Himalayas is estimated at less than 90,000 km^2 in Jammu and Kashmir, Ladakh, Uttarakhand, Himachal Pradesh, Sikkim and Arunachal Pradesh, of which about 34,000 km^2 is considered good habitat. In summer, the snow leopard usually lives above the tree line on alpine meadows and in rocky regions at elevations of 2,700 to 6,000 m. In winter, they descend to elevations around 1,200 to 2,000 m. They prefer rocky, broken terrain, and can move in 85 cm deep snow, but prefer to use existing trails made by other animals. The climate is cold and dry at the snow leopard's typical elevation, and only grasses and small shrubs can grow on the steep mountain slopes. Snow leopards prefer the broken terrain of cliffs, rocky outcrops, and ravines (Jackson, 1996).

Terrain

Snow leopards showed a strong preference for bedding in steep, rocky or broken terrain, on or close to a natural vegetation or landform edge. Linear landform features, such as a cliff or major ridgeline, were preferred for traveling and daytime resting. This behaviour would tend to place a snow leopard close to its preferred prey, blue sheep (*Pseudoisnayaur*), which use the same habitat at night (Jackson., 1996).

Behaviour

Adult snow leopards are generally solitary, although groups of 2–4 may form during the breeding season or with the birth of cubs. Adult females and cubs stay together for about 1–2 years. Snow leopard walking, running, leaping, and climbing movements are as in the closely related members of the Pantherinae, with an especially highly developed jumping ability (Johansson et al., 2016). The long tail appears to be important for balance in rugged terrain, in thermoregulation, and in several communication functions that indicate current mood to conspecifics. Snow leopard movements of up to 7 km and average straight-line distance movements of 0.8 km per day reported in a ground-based tracking research in western Nepal and Ladakh (Fox et al., 2024). Captive male and female snow leopard pairs were found to be inactive about 70% of daylight hours. About 15% of the time was spent walking, 6% grooming or other active social contact, 4% sniffing and flehmen on either objects or mate, and the remaining 5% in marking activities, vocalizations, or back-rolling (Fox et al., 1988).

The vocal repertoire of the snow leopard is similar to other Felidae. Vocalizations include the nonaggressive prusten (a puffing sound emitted through the nostrils), mew calls, the mew/ main call, copulatory hissing, growling (females) and a loud cry (males) and agonistic spitting, hissing, growling, and screaming/roaring (Hemmer 1972; Peters, 1980). Snow leopards, however, do not roar like other Pantherinae due to differences in their larynx morphology. The mew/main call, associated primarily with the breeding period, and the copulatory cry or yowl are probably the vocalizations that can most easily be heard in the wild (Fox et al., 2024). Marking behavior includes scraping, claw raking, spraying (squirting urine and scent), and cheek/head rubbing. In wild snow leopards, both sexes (age > 1.5 years) commonly make scrapes and spray marks, scraping being more common, and such marking occurs most frequently during January–March. Scrape dimensions averaged 36 cm total length, 20 cm pit length, 19 cm pit width, 5 cm pit depth, and 6 cm height of scraped-up material (Fox et al., 1988). Where trees are present, isolated trees or ones along travel routes or crossroads are sometimes marked by snow leopards raking their claws vertically along the trunks. Snow leopards spray mark by elevating their tails vertically upright and squirting urine and scent backward and up against near-vertical surfaces, the underside of rock overhangs or bushes (Ahlborn and Jackson, 1988).

Food procurement/ prey behavior

Snow leopards have long been reported as preying mainly on mountain ungulates and domestic livestock, supplemented by smaller mammals and gamebirds. Snow leopards stalk and kill their prey as in other large solitary felids and large prey items may be killed with either a nape bite or suffocation associated with a throat bite. The primary prey of snow leopards is wild sheep and goats whose typical habitat is the rugged terrain of mountainous regions. Smaller mammalian species (e.g., marmots, Marmota spp.; hares, Lepus spp.; pikas, Ochotona spp.) and various birds have been reported in snow leopard diet. Domestic livestock, primarily sheep and goats, comprise a significant component of the snow leopard diet in many areas, and occasionally horses, yaks, and cattle are also taken. The two most frequently reported prey species of the snow leopard are the bharal (or blue sheep/ naur, *Pseudoisnayaur*) and Siberian ibex *(Capra sibirica*). The ranges of these two species together cover virtually the entire range of the snow leopard. Bharal and Siberian ibex have largely allopatric distributions, with some small zones and areas of overlap. Other mountain ungulates comprise a smaller element of the diet but are locally important (Mallon et al., 2016). The proportions of different categories of prey and individual species in the snow leopard diet vary. These in turn reflect variations in the availability and density of prey across the snow leopard range, seasonal effects, and site-specific factors such as elevation, vegetation, and terrain type (Lyngdoh et al. 2014).

Reproduction

In the wild and in captivity snow leopards breed during late winter (January–March), commonly with 2–3 (rarely 1 or 4–5) cubs born in April–June following a 90–105 days gestation period. The female's oestrus typically lasts five to eight days, and males tend not to seek out another partner after mating, probably because the short mating season does not allow sufficient time. Paired snow leopards mate in the usual felid posture, from 12 to 36 times a day. They are unusual among large cats in that they have a well-defined birth peak. They usually mate in late winter, marked by a noticeable increase in marking and calling (Rieger, 1984). Captive-born snow leopard cubs weigh 0.3–0.6 kg at birth, 1–2 kg after 25 days, 3–5 kg after 50 days, and continue to gain about 1 kg every 2 weeks until they weigh 25–30 kg at age 1 year. Young open their eyes after about 1 week, their ears after 2 weeks, walk at 2.5 weeks, retract claws at 3.5 weeks, eat voluntarily at 7 weeks, eat solid food and actively play at 8 weeks, and follow their mother at 12 weeks. Sexual maturity is reached at the age of 2–3 years (Koivisto et al., 1977; Wharton & Freeman 1988) and females in captivity have successfully bred until about 15 years. In captivity snow leopards have lived up to 21 years, whereas in the wild the oldest adult recorded to date was 11 years (McCarthy et al., 2005).

1. CONSERVATION CONCERNS:

There are no publications currently providing a comprehensive account of the mortality of free-ranging snow leopards. Natural deaths due, for example, to starvation or natural accidents are rarely observed. Reported snow leopard mortality in the wild has been primarily attributed to human trapping and hunting. Disease and natural mortality causes are not well-documented in wild populations. Snow leopards and their ungulate, prey in habit cold arid environments. Because of microbial abundance in soil correlates negatively with precipitation (Blankinship et al., 2011), it is predicted that they encounter lower microbial abundance than their counterparts in more mesic, temperate or tropical environments, and may have evolved correspondingly lower immune indices. This circumstance is preoccupying from a conservation standpoint as it may render these species particularly vulnerable to the emergence of pathogens disseminated by fast-spreading populations of domestic species and to changes in pathogen distribution resulting from climatic changes (Ostrowski and Gilbert, 2016). They have been given the highest level of legal protection in India under the Indian Wildlife (Protection) Act, of 1972. The government of India has taken various conservation measures, including declaring the habitats as Biosphere Reserves, National Parks, Sanctuaries and Protected Areas to protect species from poaching and hunting. To maximize conservation outcomes with limited resources, it is important to identify the regions with the highest conservation priorities. Weckworth et al., 2020 conducted a study on global snow leopard conservation, developed a spatial conservation plan for snow leopards by identifying Landscape Conservation Units (LCU), linkages and their primary threats and highlighted the necessity of transboundary cooperation in snow leopard conservation because of three of the seven LCUs cross national boundaries. Climate change is emerging as an important threat to biodiversity. Forrest et al., 2012 developed a hybrid approach that combines a habitat suitability model constructed using eld-based ecological data with a correlative bioclimatic model to determine the spatial vulnerability to climate change of a species, developed and tested a hybrid approach to predict the effects of climate change on the habitat of an endangered species involving both mechanistic and correlative models. The contributions of women to the conservation of large carnivores may be of particular significance (Dickman et al. 2013). They play critical roles in agro-pastoral and pastoral economies, which large carnivores can impact through costs incurred by livestock depredation and related protection measures (Suryawanshi et al. 2014). Studies suggest that women tend to have greater fears of and hold more negative views towards carnivores than men. Alexander et al., 2022 reported evidence of success in engaging women in large carnivore conservation remains scarce, however, although women play an important role in caring for livestock at risk of predation and could contribute to large-carnivore conservation and provided a concrete example of a community-based program that harnesses women's specific contributions to large carnivore conservation.

Conclusion

Snow leopards play a key role as a top predator, an indicator of the health of their high-altitude habitat, and, increasingly, an important indicator of the impacts of climate change on mountain environments. If snow leopards thrive, so will countless other species and the largest freshwater reservoirs of the planet. The climate crisis poses perhaps the greatest long-term threat to snow leopards. Impacts from a warming planet could result in a loss of up to 30% of the snow leopard habitat in the Himalayas alone. Healthy populations of snow leopards indicate good health of the ecosystem that it inhabits. In India, snow leopards are found high up in the Himalayas, the source of most of our fresh water, and 3 perennial rivers – The Ganga, Yamuna & Brahmaputra, the lifeline of 500 million Indians. It can be said that without the snow leopard, the Himalayan ecosystem will be negatively affected and this will impact the health of the rivers too - the source of our freshwater - without which life as we know it, appears impossible to visualise.Protecting the snow leopard, will also support the conservation of the Himalayan ecosystem - which is the source of 3 mighty rivers & most of our fresh water on which life of millions of Indians depend.

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Phytochemical and pharmacological potential of diospyros lotus: A comprehensive review

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Introduction

Diospyros lotus, a member of the Ebenaceae family, is a deciduous tree commonly known as "Date Plum" or "Wild Persimmon." It is indigenous to Asia and parts of Europe, particularly in regions such as China, Turkey, and the Himalayas. The plant has a long history of use in traditional medicine, where its fruits, leaves, and bark are utilized to treat various ailments such as digestive issues, respiratory problems, and inflammatory diseases. In recent years, interest in the pharmacological potential of Diospyros lotus has grown due to the discovery of its bioactive compounds, which are believed to offer significant health benefits. This review aims to consolidate the existing knowledge on the phytochemical and pharmacological properties of Diospyros lotus, emphasizing its potential as a source of natural therapeutic agents (Tang et al., 2019).

Species Distribution

Diospyros lotus is widely distributed across Asia and parts of southern Europe. It thrives in temperate and subtropical climates, and is often found in forested areas, mountainous regions, and riverbanks. Its distribution includes countries such as China, Japan, Turkey, Iran, and the Caucasus region. The plant is also cultivated in certain parts of southern Europe, particularly in Spain and Italy, where it is valued for its ornamental and medicinal purposes. The broad distribution of Diospyros lotus across diverse geographic regions has contributed to its extensive use in traditional medicine across cultures. In different regions, parts of the plant—such as its fruits, leaves, and bark—are used to address a variety of health concerns, ranging from gastrointestinal disorders to respiratory ailments (Tang et al., 2019).

Growth Habits

Diospyros lotus typically grows as a medium-sized deciduous tree, reaching heights of 15-20 meters. It has a rounded crown with broad, shiny, dark green leaves that turn yellow in autumn. The tree produces small, yellow-orange fruit that resemble small plums. These fruits are known for their sweet taste when fully ripe, but they can be astringent if harvested prematurely. The tree prefers well-drained soils and thrives in full sun, though it can tolerate partial shade. It is relatively hardy and resistant to drought, making it well-suited for cultivation in regions with dry climates. The growth cycle of Diospyros lotus follows the typical seasonal pattern of deciduous trees, with leaves emerging in the spring, flowers blooming in early summer, and fruits maturing in late summer or early autumn.

Uses

Traditional Medicine

In traditional medicine, various parts of Diospyros lotus have been used for therapeutic purposes-

Fruit: Used to treat digestive disorders, improve appetite, and act as a mild laxative.

Leaves

Known for their anti-inflammatory and astringent properties, used to alleviate respiratory issues and skin irritations.

Bark

Employed in traditional remedies to treat fevers, diarrhea, and as a general tonic.

Diospyros lotus has been traditionally used in Asia, particularly in China, for its ability to treat gastrointestinal problems, such as indigestion and bloating. It is also believed to have a calming effect on the body, making it a popular remedy for conditions associated with anxiety and stress. In Turkish folk medicine, the fruit is commonly used to lower blood pressure and improve cardiovascular health.

Culinary uses

The fruit of Diospyros lotus is edible and is often consumed fresh, dried, or processed into jams and jellies. In some cultures, the fruits are fermented to produce alcoholic beverages. The sweet flavor of the ripe fruit makes it a popular ingredient in desserts and traditional dishes.

Ornamental uses

Beyond its medicinal applications, Diospyros lotus is also cultivated for its ornamental value. Its glossy leaves, striking autumn colors, and attractive fruit make it a popular choice for landscaping in gardens and public parks.

Phytochemical composition

Research into the phytochemical composition of Diospyros lotus has identified a range of bioactive compounds that contribute to its medicinal properties. These compounds include:

- Flavonoids: Known for their antioxidant and anti-inflammatory properties.
- Tannins: Provide astringent qualities and contribute to its antimicrobial activities.
- Saponins: Have been shown to have hypoglycemic and cholesterol-lowering effects.
- Polyphenols: Offer strong antioxidant activity, protecting cells from oxidative stress.
- Terpenoids: Contribute to the plant's anti-inflammatory and antimicrobial effects.

These bioactive compounds collectively give Diospyros lotus its therapeutic potential, particularly in the treatment of oxidative stress-related diseases, inflammatory conditions, and metabolic disorders such as diabetes (Wu et al., 2024).

Pharmacological properties

Antioxidant activity

The antioxidant potential of Diospyros lotus is one of its most well-researched properties. The high concentration of flavonoids, polyphenols, and other antioxidant compounds helps neutralize free radicals, reducing oxidative stress and preventing cellular damage. Studies have shown that extracts from Diospyros lotus exhibit significant antioxidant activity, making the plant a promising candidate for developing treatments for diseases caused by oxidative stress, such as cancer and cardiovascular disease (Loizzo et al., 2009).

Antimicrobial Activity

Diospyros lotus has demonstrated potent antimicrobial effects, particularly against bacteria and fungi. The tannins and terpenoids present in the plant contribute to its ability to inhibit the growth of pathogenic microorganisms, making it useful in treating infections. Research has shown that extracts from the leaves and bark of Diospyros lotus have antimicrobial properties against common pathogens such as Staphylococcus aureus and Escherichia coli (Wang et al., 2024).

Anti-inflammatory effects

The anti-inflammatory properties of Diospyros lotus are attributed to its bioactive compounds, particularly flavonoids and terpenoids. These compounds reduce the production of pro-inflammatory cytokines, thereby alleviating inflammation. Traditional uses of the plant for treating conditions like arthritis, respiratory infections, and skin inflammations are supported by modern research, which has confirmed its ability to reduce inflammation in animal models and in vitro studies.

Hypoglycemic and antidiabetic effects

One of the most notable pharmacological properties of Diospyros lotus is its potential to regulate blood sugar levels. Research has shown that the saponins and flavonoids in the plant have hypoglycemic effects, making it beneficial for individuals with diabetes. In traditional medicine, Diospyros lotus fruits have been used to manage blood sugar levels and improve insulin sensitivity (Zhang et al., 2018).

Conclusion

Diospyros lotus is a plant with remarkable phytochemical and pharmacological potential, particularly as a natural therapeutic agent. Its rich composition of bioactive compounds, including flavonoids, tannins, polyphenols, and saponins, contributes to its wide array of medicinal properties, including antioxidant, antimicrobial, anti-inflammatory, and hypoglycemic effects. The traditional uses of Diospyros lotus in folk medicine are increasingly being validated by modern scientific research, highlighting its relevance in the development of natural therapies for a variety of diseases. As research into the medicinal properties of Diospyros lotus continues to expand, it is likely that the plant will gain further recognition as a valuable source of natural compounds for pharmacological applications. The findings of this review underscore the importance of continued investigation into the therapeutic potential of Diospyros lotus, as well as its broader role in the field of nature.

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Essential oils as a natural wood preservative

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Introduction

Wood is a naturally occurring, renewable, extremely adaptable, and high-performing material that has been widely utilized by humans from the beginning of time (Broda 2020).In order to extend the service life of wood and wood products, various methods and techniques are applied including impregnation with numerous substances and chemicals, chemical processing and thermal modification (Esteves 2009; Sandberg 2017; Spear et al. 2021; Evans et al. 2022; Zelinka et al. 2022). The types of wood, their service lifetime, treatment costs, potential hazards of decay, and end-of-life disposal all impact the treatment strategies and the use of certain chemicals (Tascioglu et al. 2013; Brischke and Thelandersson 2014). The desired level of protection determines the extent of wood preservation treatment.Thus, a number of these harmful preservatives, including chromated copper arsenate and other water-borne heavy metal compounds, have been outlawed in numerous nations. There is now a global movement to investigate natural substitutes for preventing wood degradation and prevent detrimental impacts on human health and surrounding conditions (Schultz and Nicholas 2002).

The need for more environmentally friendly technology has been driven by concerns about the effects of traditional hazardous chemical preservatives which incorporate metals for wood treatment, as well as the disposal challenges associated with these products (González-Laredo et al. 2015). Nowadays, a variety of methods are being studied extensively particularly when it comes to environmentally friendly wood treatment (Broda 2020).

Essential oils in protection of wood

Global interest in the study and application of essential oils as biocides is expanding quickly, and progress in this area is steadily being made natural substances, especially those that combat mold fungus (Yang and Clausen 2007; Matan and Matan 2008). Plant extracts with secondary metabolites primarily constitute essential oils (Chittenden and Singh 2011). Essential oils are naturally occurring hydrophobic aromatic molecules that help plants thrive and protect them from diseases, predators, and rivals. These substances exhibit promise as natural preservatives for wood protection due to their strong antioxidant, antibacterial, and antifungal characteristics (Singh and Singh 2012; Dao 2013).

The key components in essential oils, includes terpenes and phenolics, which are particularly effective against wood-destroying organisms. For example: Tea tree oil which is known for its antifungal properties, tea tree oil can prevent mould and mildew growth on wood surfaces. The cedar wood oilcontains natural insect-repelling properties and is effective against wood-boring insects.

A variety of white- and brown-rot fungi, such as *Coriolus versicolor* and *Laetiporus sulphureus*, have been reported to be effectively inhibited by an essential oil derived from the leaves of the Taiwan cinnamon tree, *Cinnamomum osmophloeum Kaneh.* The oil's most abundant antifungal component is cinnamonaldehyde (Wang et al. 2005).The antimicrobial properties of

Fig.1. Cedar essential oil

Source: https://www.indiamart.com/proddetail/cedar-wood-essential-oil-2852049620497.html?mTd=1

seven essential oils: thyme oil, ajowan, dill weed, lemongrass, rosemary, tea tree, and Egyptian geranium. They observed that wood was successfully protected against the growth of *A. niger, Trichodermaviride, and Penicilliumchysogenum* for at least 20 weeks by the vapours from dill weed oil and the dip treatment of Southern yellow pine samples with thyme or geranium (Yang and Clausen 2007). The antifungal effectiveness and stability of beech wood treated with 10% solutions of ten different essential oils (birch, clove, lavender, oregano, sweet flag, savoury, sage, tea tree, thyme, and a mixture of eucalyptus, lavender, lemon, sage, and thyme oils) against brown-rot fungus *C. puteana* and white-rot fungus *T. versicolor* (Pánek et al. 2014). The application of lavender, lemongrass, and thyme oils for the purpose of impregnating *Fagus orientalis* and *Pinustadea* wood to provide effective protection against *A. niger, Penicillium commune, C. pututna, T. versicolor*, and *Chaetomium globosum* (Bahmani et al. 2018).

Promising potential of essential oils as wood preservatives

The use of essential oils as wood preservatives presents promising prospects. As consumers become more environmentally conscious, there is a growing demand for natural and non-toxic alternatives to traditional synthetic preservatives. They can provide effective antimicrobial and antifungal properties without the harmful chemicals.Many essential oils, such as tea tree oil, cedar wood oil, and clove oil, have been shown to possess significant antifungal and insect-repellent properties, making them suitable candidates for wood preservation.

These are derived from plants, which can be sustainably harvested. This aligns with the increasing focus on sustainable practices in various industries, including construction and furniture-making.The global market for natural and eco-friendly products is expanding. Wood products treated with essential oils may appeal to both manufacturers and consumers looking for environmentally friendly options.As regulations on chemical preservatives become stricter, there may be more support for using natural alternatives, further encouraging research and adoption of essential oils.Ongoing research into the efficacy and application methods of essential oils in wood preservation could enhance their practical use and effectiveness, potentially leading to new formulations and treatments.While promising, there are challenges, including the need for consistency in efficacy, potential volatility, and the longevity of the treatment. Continued research will be essential to address these issues.

Methods of application of essential oils in wood

The essential oils can be applied to wood in several ways:

Soaking

Wood can be soaked in a solution containing essential oils, allowing for deep penetration.

Spraying

A diluted essential oil mixture can be sprayed on wood surfaces, forming a protective layer.

Impregnation

Vacuum or pressure treatment methods can be used to ensure that essential oils penetrate thoroughly into the wood fibers.

Effectiveness and longevity of essentials oils as wood preservatives

Research indicates that wood treated with essential oils can demonstrate significant resistance to fungal decay and insect attack. However, the longevity of these treatments can vary based on several factors:

Type of wood

Some wood species naturally have higher resistance to decay and may require less treatment.

Environmental conditions

Exposure to moisture and sunlight can influence the effectiveness of essential oils over time.

Concentration and mixture

The specific essential oils used and their concentrations can impact preservation effectiveness.

Challenges

There are various challenges when employing essential oils as wood treatments. Although some essential oils are insect- and fungal-repellent, their efficacy varies greatly based on the oil and the organism it is intended to treat. Not every essential oil offers persistent defence. Since many essential oils evaporate easily, their usefulness gradually decreases over time. This may reduce how long they can be used as preservatives. Since these oils are typically hydrophobic, including them into compositions that contain water might be difficult. Finding appropriate solvents or carriers may makedifficult. Finding appropriate solvents or carriers may make using them more difficult. When compared to conventional chemical preservatives, essential oils can be pricey, which could restrict their commercial viability. Certain essential oils might not be permitted for use in wood preservation because of environmental or regulatory requirements.

Future prospects of essential oils as wood preservatives

While promising, the use of essential oils in wood preservation is still an area of ongoing research. Future studies can aim to Identification of Optimal Combinations: Understanding which combinations of essential oils yield the best protective effects. Enhance Longevity: Developing methods to enhance the durability and retention of essential oils in wood. Furthermore Field Trials can be conducted in real-world tests to evaluate the effectiveness of essential oils in various environmental conditions.

Conclusion

Essential oils represent a natural and eco-friendly alternative for wood preservation. Their antimicrobial properties and lower toxicity make them an appealing option for both manufacturers and consumers seeking sustainable practices. As research advances, essential oils may play an increasingly prominent role in the future of wood treatment, offering an effective solution to protect wood while minimizing environmental impact.

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आर्थिक समृद्धि हेतु- *केथेरेन्थस रोजीयस* (सदाबहार) की खेती

अनुभा श्रीवास्तव एवं अनीता तोमर

भा. वा. अ. शि. प.- पारि-पुनर्स्थापन केंद्र, प्रयागराज

परिचय

सदाबहार या सदाफली का वानस्पतिक नाम *कैथरेन्थस रोसीय्स* है| सदाबहार अंग्रेजी में पेरिविन्कल नाम से जाना जाता है। यह पुष्पीय पौधों के एपोसाइनेसी कुल का सदस्य है। यह एक सदाबहार जड़ी-बूटी है जो नाम के अनुरूप वर्ष भर पाया जाने वाला एक महत्वपूर्ण औषधीय पौधा है इसके पत्ते चमकीले, जिनका आकार अंडाकार से लम्भकार होता है| इसके फूलों की 5 पत्तियां होती है तथा गुलाबी, बैंगनी अथवा सफेद रंग के होते हैं, जिसके बीच में पीले-गुलाबी या जामुनी रंग की आंख होती है| इसका उपयोग मधुमेह, ल्यूकेमिया, लिम्फोमा और कुछ अन्य कैंसरयुक्त और गैर-कैंसरजन्य स्थितियों को ठीक करने के लिए किया जाता है। इसका मूल स्थान मैड़ागैसकर है और इसकी फसल पूरे भारत मै उगाई जाती है | सदाबहार की अधिकतम ऊँचाई 1 मीटर तक होती है। पौधे की पत्तियाँ हरी एवं चमकदार होती हैं । फल फालिकल प्रकार का होता है, तथा एक फल में कई बीज होते हैं। सामान्यतः सदाबहार को बागवानी हेतु बीज तथा कटिंग द्वारा तैयार किया जाता है।

पर्यावरणीय महत्व

अधिकतर विदेशी मूल के पौधे फैलकर खर-पतवार का रूप धारण कर लेते हैं जिसके कारण इन्हें 'जैवप्रदूषक' कहा जाता है लेकिन सदाबहार पर्यावरण हेतु हानिकारक नहीं है तथा जैव विविधता पर कोई विपरीत प्रभाव नहीं पड़ता है।

सदाबहार नाम के अनुसार ही सदाबहार पौधा है जिसको उगाने से आस-पास में सदैव हरियाली बनी रहती है।

- कसैले स्वाद के कारण तृष्णभोजी जानवर इस पौधे का तिरस्कार करते हैं।
- सदाबहार पौधों के आस-पास कीट, बिच्छू तथा सर्प आदि नहीं फटकते (सर्पगंधा समूह के क्षारों की उपस्थिति के कारण) जिससे क्षेत्र स्वच्छ रहता है।
- सदाबहार की पत्तियाँ मृदास्वस्थ्य हेतु लाभप्रद हैं।

प्रसिद्ध किस्में और पैदावार

फूल के रंग के आधार पर, दो-तीन किस्में ज्ञात हैं, इनमें अल्बा /अल्बोप्लेना किस्म जिसमें सफेद फूल होते हैं, एट्रोपुरप्यूरिया जिसमें बैंगनी गुलाबी फूल होते हैं

पोषण संबंधी घटक	मूल्य प्रति 100 ग्राम
ऊर्जा	354 किलो कैलोरी
प्रोटीन	52 ग्राम
मोटा	33 ग्राम
रेशा	24 ग्राम
कैल्शियम	340 मिलीग्राम
लोहा	27 मिलीग्राम
विटामिन सी	002 मिग्रा

सदाबहार के गुण / उपयोग

सदाबहार की पत्तियाँ और फूलों की पंखुड़ियाँ फ्लेवोनोइड्स, एल्कलॉइड्स, कार्बोहाइड्रेट और फाइटोकेमिकल्स जैसे विन्क्रिस्टाइन, विन्ब्लास्टाइन, विन्कार्डिन आदि से भरपूर होती हैं।

- बैक्टीरियल और वायरल संक्रमण को कम करने का
- सूजन कम करने का
- एंटीट्यूमर
- रक्त शर्करा के स्तर को कम करने की क्षमता
- रक्तचाप को प्रबंधित करने की क्षमता
- हाइपोकोलेस्ट्रोलेमिक प्रभाव

मधुमेह नियंत्रण हेतु

सदाबहार में मधुमेह विरोधी प्रभाव होता है, जिसका कारण अग्न्याशय की बीटा कोशिकाओं से इंसुलिन का स्राव बढ़ना है। सदाबहार की पत्तियां मधुमेह के प्रबंधन में मदद कर सकती हैं।

कैंसर पर संभावित उपयोग

विनब्लास्टाइन, एक महत्वपूर्ण विंका एल्कलॉइड, में ट्यूमर-रोधी गतिविधि होती है और इसका व्यापक रूप से वृषण कैंसर के प्रबंधन के लिए उपयोग किया जाता है। विनोरेलबाइन, सदाबहार का एक अन्य अल्कलॉइड, स्तन कैंसर और ओस्टियोसार कोमा (हड्डी कैंसर कोशिकाओं) के प्रबंधन के लिए उपयोग किया जाता है। इससे पता चलता है कि सदाबहार कैंसर के प्रबंधन में

मदद कर सकता है । शक्तिशाली कैंसर रोधी विंकाएल्कलॉइड पूरी तरह से संसाधित होते हैं, और उपयोग से पहले सुरक्षा और विषाक्तता का परीक्षण किया जाता है ।

अन्य उपयोग

- सदाबहार में कसैले गुण होते हैं और यह नासूर घावों के दर्द को शांत करने में मदद कर सकता है।
- यूरोपीय हर्बल विशेषज्ञों ने मसूड़ों से रक्तस्राव और दस्त जैसी स्थितियों में पानी के स्राव के प्रबंधन के लिए पेरिविंकल का उपयोग किया है ।
- सदाबहार में विनपोसेटिन की मौजूदगी उम्र बढ़ने के कारण होने वाली सुनने की क्षति पर लाभकारी प्रभाव डालती है । इसके अतिरिक्त, विनपोसेटिन हाइपर कैल्सीमिया (शरीर में कैल्शियम की मात्रा में वृद्धि) में मदद कर सकता है जो अधिकतर गुर्दे की विफलता वाले रोगियों में देखा जाता है।
- हर्बलिस्टों ने सिरदर्द, खराब याददाश्त और चक्कर के प्रबंधन के लिए पेरिविंकल का उपयोग किया है ।
- सदाबहार की पत्तियों का सेवन त्वचा पर सकारात्मक प्रभाव डाल सकता है ।
- भारत में सदाबहार की पत्तियों के रस का उपयोग ततैया के डंक के इलाज के लिए किया जाता है।

फसल की खेती

जलवायु

- तापमान- 15-45°से.ग्रे.
- वर्षा – 100सेमी
- बिजाई तापमान- 15-23° से.ग्रे.
- फसल कटाई तापमान- 15-25° से.ग्रे.

मृदा

- धूप में पूरी तरह से सूखी और उत्तम निकास वाली मिट्टी इसकी खेती के लिए अच्छी होतीहै|
- इसको लगभग प्रत्येकप्रकार की मिट्टी में उगाया जा सकता है|
- इसकी खेती अनुपजाऊ मिट्टी में भी की जा सकती है|
- इसके लिए मिट्टी का पीएच 6-6.5 होना चाहिए|

भूमि की तैयारी

- इसकी खेती के लिए, ज्यादा उपजाऊ मिट्टी की आवश्यकता नहीं होती है|
- अच्छी उपजके लिए इसे जैविक मिट्टी में उगाया जा सकता है|
- 6 इंच गहरे बेड खोदे और बिजाई से पहले कम्पोस्ट खाद की एक इंच पतली परत बिछानाचाहिए|

खाद

- ज़मीन की तैयारी के समय 50-100 क्विंटल/हेक्टेयरगोबरकीखाद डालनाचाहिए|
- पोटाशियम और फासफोरस दो बराबर भागमेंडालनाचाहिए|
- पहली वार्षिक कांट-छांट के बाद और दूसरी जुलाई के महीने में डालनाचाहिए|

सिचाई

- गर्म और शुष्क मौसम या पौधे के विकास के समय पौधे के विकास के लिए नियमित पानी डालनाचाहिए|
- प्रत्येक 3 माहपश्चात् 15-15 दिनों के अंतर पर सिंचाई करें|

रोपण तथा प्रबंधन

- बिजाई अच्छी तरह से नम ज़मीन में करें और पौधों के बीच का अंतर 30 सेमी रखें| इनकी जड़ें 3-4 हफ्तों में निकल आती है और फिर यह सामान्य पौधे की तरह ही

विकास करते है| सर्दी के अंत या बसंत के प्रारंभ मेंबीजों कीबुवाईकरनाचाहिए

- कुछ बीजों को लेकर ट्रे में बोयें जिसमे जड़ों में नमी बनी रहें| ट्रे को पतले कपड़े से ढक दें, जिससे ट्रे में नमी बनी रहें|
- बीज 2-3 हफ्तों में अंकुरण शुरू कर देते है, तत्पश्चात ट्रे से कपड़ा हटा दें और नए पौधों को थोड़ा-थोड़ा पानी दें|
- जब नए पौधे 1 सेमी ऊंचाई के हो जाये तब इन्हें 8 सेमी गोल गमलों में लगा दें|

फसल की कटाई

- सदाबहार की पत्तियों की फसल दो बार काटी जाती है।
- पहली बुवाई के 6 माह बाद तथा दूसरी 9 माह बाद काटी जाती है।
- पत्तियों की दूसरी कटाई तभी करना चाहिए, जब पौधों को जमीन से लगभग अलग कर लिया जाता है।
- बुवाई के 12 माह बाद जड़ों की खुदाई करनी चाहिए। तोड़ी गई पत्तियों एवं जड़ों को धूप में सुखाकर एक एकत्रित कर लेना चाहिए।
- फसल के परिपक्व होने पर फलियों को धूप में सुखाकर एकत्रित कर लेनी चाहिए।
- जड़ें, पत्तियां, बीज और फूल अलग-अलग एकत्र किए जाते हैं और औषधीय प्रयोजनों या वानस्पतिक प्रसार के लिए उपयोग किए जाते हैं।

सदाबहार की उपयोग विधि

- स्वास्थ्य लाभ पाने के लिए सदाबहार की पत्तियों का उपयोग जूस बना कर सेवन करने के लिए किया जाता है।
- सदाबहार की पत्तियों और फूलों की पंखुड़ियों को उबालकर भारत में एक पारंपरिक औषधीय पेय "काढ़ा" बनाने के लिए उपयोग किया जाता है।
- सदाबहार की ताजी पत्तियों को या तो सीधे चबाया जाता है या सुखाया जाता है और पीसकर पाउडर बनाया जाता है, जिसका सेवन किया जाता है।

आजीविका वृद्धि हेतु कृषिवानिकी

- सदाबहार की अच्छी फसल के पत्तियों,तना व जड़ों (सभी सूखे हुए) से क्रमशः 30, 10 तथा 8 क्विंटल प्रति हेक्टेयर तक प्राप्त होती है।
- सदाबहार की सूखी जड़े, पत्ती और तने का वर्तमान बाजार मूल्य क्रमशः रुपया 80-90, 30-35 तथा रुपया 20-30 प्रति किग्रा तक होता है।
- प्रति हेक्टेयर सदाबहार की खेती का व्यय रुपया 10,000 तथा कुल लाभ रुपया 2,08,600 होता है , अर्थात इसकी खेती से लाभ /व्यय का अनुपात 1:19 है

अतः इसकी खेती अंतर्फसल के रूप में कृषिवानिकी वृक्षों के साथ करने से आजीविका वृद्धि हेतु एक उपयुक्त मॉडल विकसित हो सकता है ।

सदाबहार के व्यावसायिक उत्पाद

इनका उपयोग विभिन्न हर्बल औषधियों के निर्माण में किया जाता है:

- फूलों का पाउडर
- पत्तियों का पाउडर
- संपूर्ण पौधे का पाउडर
- बीज
- जड़ों का पाउडर






निष्कर्ष

सदाबहार विदेशी मूल का पौधा होने के कारण भारत में जंगली अवस्था में नहीं पाया जाता है

और इसका उपयोग केवल सजावटी पौधे के रूप में विशेषकर देश के शहरी क्षेत्रों तक ही सीमित है। देश के ग्रामीण क्षेत्रों में न तो यह पौधा उगाया जाता है न ही इस पौधे के औषधीय महत्व के विषय में कोई विशेष जानकारी है। यहाँ तक कि शहरी क्षेत्रों में भी इसके औषधीय गुणों के ज्ञान का सर्वथा अभाव है। आज देश के ग्रामीण क्षेत्रों में इस औषधीय पादप के प्रचार-प्रसार की आवश्यकता है, जिससे इस पौधे को कृषिवानिकी के माध्यम से विस्तार मिल सके क्योंकि यह पौधा देश में सर्पगन्धा का आदर्श विकल्प बनने की क्षमता रखता है जो संकटग्रस्त प्रजाति होने के कारण दुर्लभ है। अतः सदाबहार का औषधीय उपयोग सर्पगन्धा के विकल्प के रूप में उच्च रक्तचाप, मानसिक विकार (चिन्तारोग, अनिद्रा, अवसाद, पागलपन) आदि के उपचार के साथ-साथ विषनाशक के रूप में भी किया जा सकता है। इसके अतिरिक्त, सदाबहार मधुमेह, डिप्थिरीया, हैजा जैसी बीमारियों के उपचार में भी उपयोगी सिद्ध हो सकता है।

सात फूल ले लीजिए,सुंदर सदाबहार,
दूर करे मधुमेह को,जीवन में हो बहार|

सन्दर्भ

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Advancing agroforestry: The transformative role of remote sensing in monitoring and management

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Abstract

Agroforestry, an integrated approach to land use combining trees, crops, and livestock, offers numerous ecological and economic benefits, including biodiversity conservation, climate change mitigation, and improved rural livelihoods. Yet, managing and optimizing agroforestry systems require robust monitoring techniques that can operate at large scales. Remote sensing has emerged as a powerful tool in this context, providing high-resolution, real-time data on key agroforestry metrics such as tree cover, vegetation health, soil characteristics, and biodiversity. This article explores the transformative role of remote sensing in advancing agroforestry management, highlighting applications such as tree health monitoring, soil quality assessment, carbon sequestration measurement, and biodiversity mapping. Recent advancements, including multispectral and hyperspectral imaging, and drone applications, have further enhanced remote sensing capabilities, making it possible to support adaptive, efficient, and scalable agroforestry practices. By leveraging these technologies, agroforestry can be more precisely managed, leading to optimized productivity and sustainable land restoration outcomes that benefit both ecosystems and communities.

Keywords: climate change, biodiversity, sustainable, ecosystems, communities.

Introduction

Agroforestry stands at the intersection of sustainable agriculture, forest management, and ecosystem restoration, offering a multifaceted approach to land use that supports biodiversity, combats climate change, and enhances rural livelihoods (Gupta et al. 2023). In recent years, the practice of integrating trees and shrubs with agricultural crops and livestock systems has gained recognition for its capacity to provide ecosystem services, such as carbon sequestration, soil health improvement, and habitat preservation (Vinodhini et al. 2023). However, unlocking the full potential of agroforestry systems demands advanced monitoring and management techniques that can scale across diverse landscapes, and this is where remote sensing technology plays a transformative role.

Remote sensing—through satellite, aerial, and drone-based observations—has emerged as a vital tool in tracking and analyzing agroforestry ecosystems on a large scale (Rejeb et al. 2022). By offering high-resolution, real-time data, remote sensing allows for the efficient monitoring of tree cover, vegetation health, and soil characteristics across various terrains and climate zones. This technology provides a powerful means to assess the growth, productivity, and ecological impacts of agroforestry species, thereby supporting adaptive management practices that optimize both environmental and economic outcomes (Ntawuruhunga et al. 2023).

With advances in remote sensing methods, including multispectral and hyperspectral imaging, agroforestry practitioners can now gain insights into the genetic, phenotypic, and morphological traits of various species, enabling data-driven decisions that enhance productivity and resilience (Lu et al. 2020). The integration of remote sensing in agroforestry thus marks a significant leap forward, offering precise monitoring, improved planning, and better resource management—key elements in achieving sustainable land restoration and rehabilitation at scale (Wang et al. 2023). This article explores how remote sensing can revolutionize agroforestry by enhancing monitoring accuracy and supporting more effective management practices, paving the way for sustainable agroforestry systems that benefit both people and the planet.

The Growing Importance of Agroforestry

Agroforestry is increasingly recognized for its potential to address environmental, economic, and social challenges (Pantera, 2021). By integrating trees and vegetation within agricultural systems, agroforestry promotes carbon sequestration, improves soil quality, conserves water, and increases biodiversity. These systems also help combat desertification, reduce erosion, and enhance resilience against climate change (Nair, 2011). Despite these benefits, effective management is essential for agroforestry to achieve its full potential, especially at a scale that can drive meaningful environmental and economic outcomes.

Remote Sensing: A Tool for Large-Scale Monitoring

Remote sensing, which involves collecting data from satellites, drones, and aircraft, has emerged as an essential technology in agroforestry monitoring (Guimaraes, 2020). Through remote sensing, land managers and researchers can obtain detailed information on tree cover, biomass, vegetation health, and soil characteristics across large and diverse areas (Lawley et al. 2016). Key advantages include:

Scalability

Enables monitoring over vast and remote landscapes.

Precision

Offers high-resolution imagery to detect subtle changes in vegetation and soil.

Timeliness

Provides near-real-time data, supporting adaptive management.

These benefits make remote sensing a powerful tool to manage the dynamic and complex agroforestry systems effectively.

Applications of Remote Sensing in Agroforestry

Remote sensing technology offers numerous applications within agroforestry, enhancing our understanding of plant health, soil quality, and ecosystem services. Some key applications include:

Monitoring Tree Health and Biomass

Using multispectral and hyperspectral imaging, remote sensing enables the monitoring of tree health and biomass across agroforestry landscapes (Paula et al. 2023). Vegetation indices, such as the Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI), can indicate plant health, productivity, and stress levels, providing crucial insights for managing species and optimizing growth (Xue and Su, 2017).

Soil Moisture and Quality Assessment

Remote sensing can evaluate soil characteristics essential for agroforestry management, such as moisture levels and organic carbon content (Abdulraheem et al. 2023). By analyzing soil reflectance and thermal data, remote sensing technologies help monitor soil health, assess soil fertility, and predict areas prone to degradation. Soil condition monitoring allows practitioners to make informed decisions about irrigation, fertilization, and soil conservation practices (Getahun and Gelaye, 2024).

Carbon Sequestration Measurement

Agroforestry plays a significant role in carbon sequestration, helping mitigate climate change. Remote sensing supports the estimation of carbon stocks in agroforestry systems by measuring biomass, tree canopy, and land cover (Graves et al. 2018). Through precise data on carbon storage potential, remote sensing aids in developing strategies to enhance carbon sequestration and assess the impact of agroforestry on greenhouse gas mitigation.

Mapping Biodiversity and Habitat Connectivity

By capturing details about vegetation structure and diversity, remote sensing can assist in biodiversity monitoring within agroforestry systems (Zhu et al. 2024). It helps identify plant species distribution, detect changes in habitat conditions, and assess connectivity between forest patches, which is vital for wildlife conservation and ecosystem health.

Advancements in Remote Sensing Technology for Agroforestry

Recent technological advancements have significantly improved the capabilities of remote sensing for agroforestry management. Key innovations include:

High-Resolution Imaging and Multispectral Sensors

High-resolution imaging and multispectral sensors offer detailed information on vegetation health, soil properties, and water stress. Multispectral sensors, which capture data across various wavelengths, enable accurate monitoring of photosynthesis, leaf water content, and other critical indicators of plant health (Khose and Mailapalli, 2024).

Hyperspectral Imaging for Species Identification

Hyperspectral imaging captures hundreds of wavelengths, allowing for species-specific analysis. This technology is particularly useful for identifying genetic, phenotypic, and morphological traits in agroforestry species, supporting selective breeding and optimizing species choice for land restoration and productivity (Garciavera et al. 2024).

Use of Drones and Aerial Surveys

Drones have become a valuable tool in agroforestry for capturing high-resolution imagery at low costs (Rejeb et al. 2022). Drones enable targeted data collection, allowing land managers to monitor areas that may be difficult to access, such as hilly or remote regions (Daud et al. 2022). Their use complements satellite data and provides a closer view of plant health, growth, and species diversity.

Benefits of Integrating Remote Sensing in Agroforestry Management

The integration of remote sensing in agroforestry offers numerous benefits that support sustainable land management:

Enhanced Decision-Making

Real-time data on tree health, soil moisture, and biodiversity inform adaptive management decisions.

Increased Efficiency: Remote sensing automates data collection, reducing time and resource demands.

Scalability

Remote sensing enables large-scale monitoring, making it possible to manage agroforestry systems across diverse landscapes.

Economic and Environmental Benefits

By optimizing agroforestry practices; remote sensing contributes to improved productivity, economic profitability, and ecosystem health.

Challenges and Limitations of Remote Sensing in Agroforestry

Despite its advantages, remote sensing in agroforestry also faces challenges. Cloud cover can interfere with data quality, and interpreting complex data requires expertise and specialized software. Additionally, remote sensing may require validation with ground data to ensure accuracy, particularly for soil quality and carbon sequestration assessments (Li et al. 2024).

Future Directions and Innovations

Looking forward, integrating remote sensing with emerging technologies like artificial intelligence (AI) and machine learning could further enhance its applications in agroforestry. AI-based algorithms can analyze vast datasets to detect patterns and predict outcomes, supporting advanced decision-making (Guerri et al. 2024). As sensor technology improves, new opportunities will emerge for agroforestry practitioners to manage systems with greater precision and efficiency.

Conclusion

Remote sensing has revolutionized agroforestry by providing the tools to monitor and manage complex, integrated systems at scale. From assessing soil and tree health to mapping biodiversity and estimating carbon storage, remote sensing enables sustainable management that can enhance productivity, restore degraded lands, and mitigate climate change. As technology advances, remote sensing will continue to play a pivotal role in agroforestry, helping to unlock its full potential as a sustainable, resilient land-use practice that supports both people and ecosystems.

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