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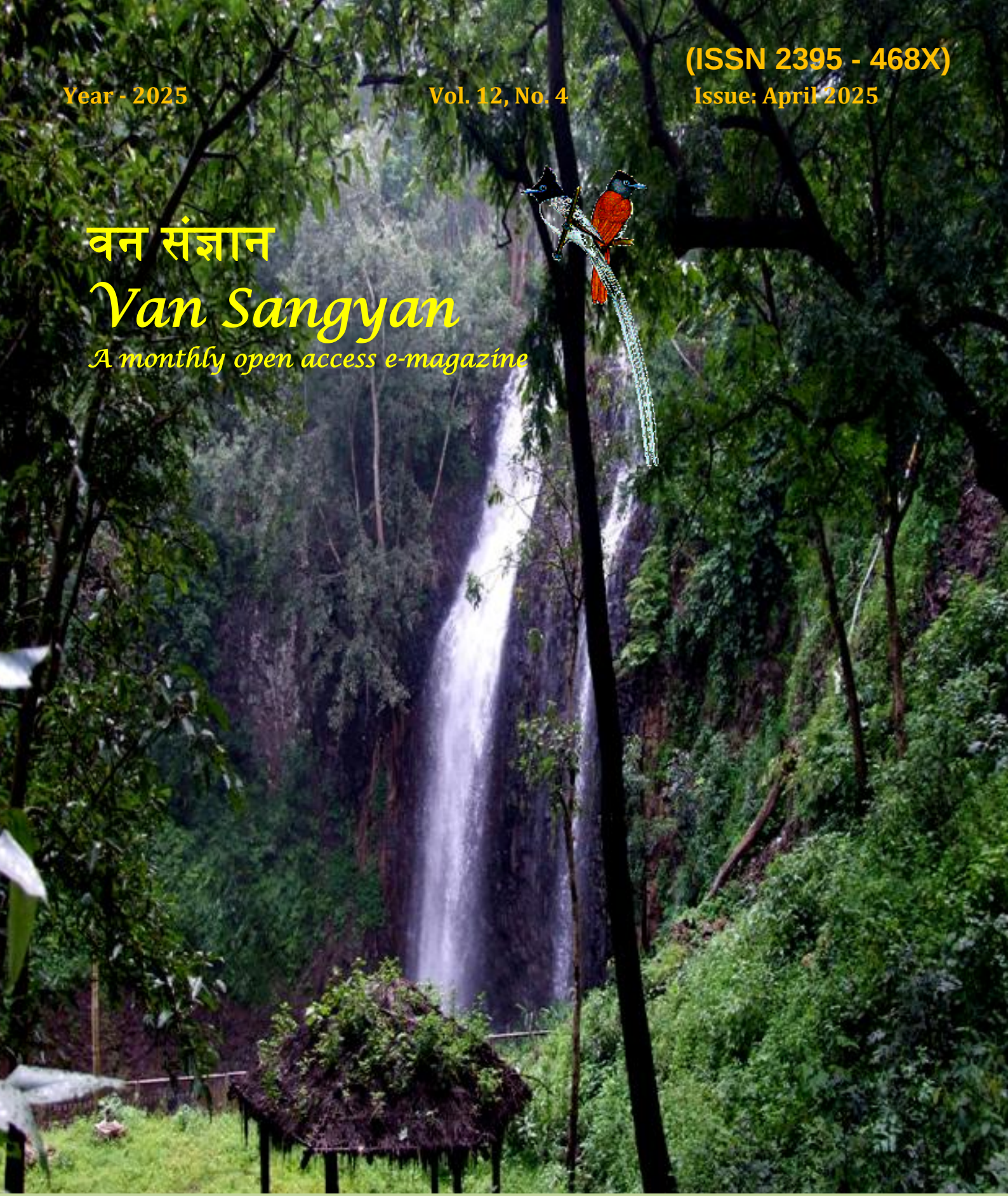

वन संज्ञान
Van Sangyan
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Van Sangyan

Note to Authors:

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

by e-mail to vansangyan_tfri@icfre.org

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

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

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve

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From the Editor's desk

Gardenia jasminoides, commonly known as Gardenia or Cape Jasmine, is a highly prized evergreen shrub celebrated for its exquisite beauty and intoxicating fragrance, making it a true "glossy garden maker." Its lustrous, deep green leaves provide a striking backdrop for the waxy, pure white, and often double-petaled blooms that emerge from late spring through summer. These intensely fragrant flowers are a sensory delight, filling the air with their sweet, heavy perfume and making the gardenia a perfect choice for planting near entryways, patios, or windows where their scent can be fully appreciated. While they can be a bit demanding in their care, requiring acidic, well-drained soil and consistent moisture, the unparalleled beauty and aroma of Gardenia jasminoides truly reward the dedicated gardener, transforming any space into a fragrant oasis. Culturally, they symbolize purity and secret love, with a scent cherished in perfumery and tradition.

In line with the above, this issue of Van Sangyan contains a compelling array of articles, starting with a crucial examination of "Understanding fruit drop: A barrier to sustaining wild fruits in forests" by Manish Kumar Vijay, shedding light on a significant ecological challenge. We then delve into the rich biodiversity of our planet with an insightful piece on "Global Forests: Understanding their types, spread, and the forces shaping their future," offering a comprehensive overview of these vital ecosystems. Furthermore, we explore specific botanical wonders, from the unique "Bay Laurel: The unique and special spice of kitchen" to the "Miraculous Moringa (Moringa oleifera L.): A Review of its cultural significance, medicinal properties, and nutritional characterization," highlighting their diverse benefits. This issue also features important contributions such as भारत में भूमि क्षरण*, Coconut crop conquerors: A close look at invasive insect pests in India, Indian medicinal trees - Obvious source of indigenous medicine in India, The nutritional power of wild edible mushrooms and* बाओबाब वृक्ष (खोरासानी इमली)*. We trust this collection will be both informative and inspiring for our readers.*

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Gardenia jasminoides: The Glossy Garden Makers

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Abstract

Gardenia jasminoides Ellis, also named as gardenia or cape Jessamine, is a popular evergreen shrub in the coffee family Rubiaceae. Its dried fruits used as a traditional herbal medicine. The dried fruits of this plant are well known and frequently used not only as an excellent natural colourant, but also as an important traditional medicine for the treatment of different diseases, such as reducing fire except vexed, clearing away heat evil and cooling blood and eliminating stasis to activate blood circulation. The oil extract from *G. jasminoides* demonstrates antidepressant activity. It is hoped that, in the near future, *Gardenia jasminoides* could be developed as a kind of therapeutic agent in various diseases.

Keywords: Gardenia, Ethnobotanical and Pharmacological uses, therapeutic plant

Introduction

Gardenia jasminoides, found in various regions of tropical Asia, has historically served as a natural yellow dye and remains a favored ornamental plant due to its white, sweetly fragrant flowers. This species is indigenous to certain areas of Southeast Asia. In the wild, these plants can grow between 30 cm and 3 m tall, exhibiting a rounded growth form with dense branching. The leaves are opposite, lanceolate-oblong, leathery and often clustered at the same node, characterized by a dark green, glossy and slightly waxy surface with prominent veins. Gardenia has been cultivated in China for over a thousand years and was introduced to English gardens in the mid-18th century. The flowers are frequently used as offerings in Buddhist temples throughout tropical Asia. Additionally, Gardenia is widely recognized as a natural food colorant and is employed in traditional medicine for treating hepatic and inflammatory conditions (Chen *et al*., 2020). Primarily, it is cultivated for its aromatic flowers, which find applications in perfumery, cosmetics and as decorative elements in gardens and landscapes.

Systematic Position

Kingdom : Plantae
Phylum : Tracheophyta
Class : Magnoliopsida
Order : Gentianales
Family : Rubiaceae
Genus : Gardenia
Species : *Gardenia jasminoides*

German-Dutch botanist Georg Rumphius observed *Gardenia jasminoides* on the island of Amboina (Ambon) and recorded it in his Herbarium Amboinense during the 1700s, referring to it as a “delightful ornament” known as catsjopiri, a term

published in 1754. He later classified the species as *Varneria augusta* in 1759. In 1761, English naturalist John Ellis provided a description of *Gardenia jasminoides*. The following year, Linnaeus named it Gardenia florida in the second edition of his Species Plantarum. Building on Rumphius' findings, Swedish naturalist Carl Peter Thunberg designated it *Gardenia radicans* in his 1780 work, Dissertatio botanica de Gardenia. In 1821, London nurseryman Conrad Loddiges described a cultivated variant with narrow leaves as *Gardenia angustifolia*, considering it a distinct form. W.C. Chen later named a large, double-flowered sterile variant *G. jasminoides* var. *fortuneana*, which is widely cultivated and does not produce seeds. The common name Cape jasmine originated from the misconception that the plant was native to the Cape of Good Hope in South Africa. Additional common names include danh-danh and jasmine.

Distribution

Gardenia jasminoides is native to the southeastern and eastern Asia including Bangladesh, Cambodia, China, East Himalayas, Hainan, Japan, Laos, Nansei Islands, Taiwan, Thailand, and Vietnam. The wild natural habitat for the plant is forests, and scrub by streams or on slopes and hills with an altitude up to 1,500 meters. It is native to tropical and subtropical areas of the world. This species has been suitable for introduction in other parts of the region, mainly those with warm temperate or subtropical conditions. It grows on soil with good drainage and it tolerates full sun and partial shade. The acid pH ranges from 5.0 to 6.5. Poor soil acidity can reduce the availability of such nutrients, especially iron compounds, which are less soluble in water and, therefore, less available to the plant's roots. *Gardenia jasminoides* exhibits notable resistance to harmful gases, possesses a robust ability to sprout and tolerates pruning effectively.

Botany

Gardenia jasminoides is a shrub characterized by its cylindrical to flat branches, which are initially covered with deciduous hairs that shed early, resulting in a smooth surface. The leaves may be subsessile or attached to short petioles measuring 0.5 to 1 cm in length. They vary in size from 3 to 25 cm long and 1.5 to 8 cm wide, exhibiting shapes such as oblong-lanceolate, obovate-oblong, obovate, oblanceolate, or elliptic. Each leaf features 8 to 15 pairs of secondary veins. The flowers are solitary and located at the terminal ends of the stems. These white flowers possess a matte finish, contrasting with the glossy appearance of the leaves. Over time, they develop a creamy yellow hue and a waxy texture. The flowers can reach a diameter of up to 10 cm, are loosely funnel-shaped and include double-flowered varieties, renowned for their intense fragrance. Following the flowering phase, which lasts between 3 to 7 months, small oval fruits emerge. The fruiting period extends from May to February of the subsequent year. The dried, mature fruits of *G. jasminoides* are dark red or red-yellow, featuring 5 to 8 longitudinal ridges. When immersed in water, these fruits can impart a bright yellow color to the liquid.

Propagation

The predominant technique for propagating gardenias involves taking

stem cuttings in early summer. Additionally, propagation can occur through seeds, as well as greenwood or semi-hardwood cuttings. Seeds usually take two to three years to bloom. In early winter, plant the seeds in a pot filled with a mixture of soil, peat moss and perlite to help them grow. The soil has to remain moist. The seeds should germinate in 4 to 6 weeks. When the seedlings form two to three leaves they it be transplanted in the open area.

Ethnobotanical Uses

The ethnobotanical significance of *Gardenia jasminoides* is well documented with traditional medicine usages predominantly in Chinese, Korean and Southeast Asian medicinal compendium. The various parts of the *Gardenia jasminoides* like its flowers, fruits and leaves have been known to possess several health-related applications. The extract application are mention under:

Dye Production

The fruits of *Gardenia jasminoides* are used to produce natural dyes in shades of yellow, blue and green, commonly found in the food industry, textiles, and cosmetics. These fruits contain high levels of iridoid glycosides, including crocin and geniposide, which are the key compounds that contribute to their vibrant colors.

Ornamental Use

The gardenia is widely planted as an ornamental species and its beautiful glossy leaves with fragrant white flowers. It is especially admired for its aesthetic beauty and appealing scent. Gardenias can also be grown indoors but they need higher humidity and bright light to thrive.

Perfumery and Fragrance

The gardenia flowers are also commonly used in perfumes, candles and essential oils, due to their linalool and methyl benzoate content. The gardenia essential oil is valued for its sweet and floral scent, so it may be added to perfumes or used in aromatherapy to help promote relaxation.

Culinary Use

In some Asian cuisines, dried fruits are used for color or flavor in other dishes rather than being eaten on their own.

Potential Modern Research and ***Pharmaceutical Uses***

The recent investigations have tested *Gardenia jasminoides* for its potential makes use of in current pharmacology, specifically in the management of diabetes, enhancement of cardiovascular fitness and its neuroprotective consequences on the subject of illnesses like Alzheimer's (Zhou *et al*., 2019).

Chemical Composition and Pharmacological Uses

A study performed in 2020 found that there are a total of 162 identified compounds present in *Gardenia jasminoides*. Isolation researches have been successful for various classes of compound viz., iridoid glycosides, flavonoids, organic acids, saffron glycosides, monoterpenes and triterpenoids. Iridoid glycosides, organic acids, flavonoids, saffron glycosides and triterpenoids are the majority of active constituents identified in this species. These compounds have several biological activities (Zheng and Liu, 2009).

Anti-Inflammatory Effects

Gardenia is rich in iridoid glycosides, drastically genipin and geniposide, which showcase robust anti-inflammatory outcomes. These compounds are believed

to suppress seasoned-inflammatory cytokines that are vital in mediating the inflammatory reaction. Research suggests that both genipin and geniposide may additionally alleviate inflammation throughout unique mobile kinds, positioning them as capability healing retailers for situations which include arthritis and inflammatory bowel disorder.

Antioxidant Properties

Gardenia possesses a excessive attention of antioxidants, basically attributed to the compound geniposide. This substance performs a essential position in neutralizing unfastened radicals, which can be acknowledged to make contributions to oxidative stress and tissue damage. Research has explored the antioxidant properties of this plant in terms of neuroprotection and cardiovascular nicely-being, highlighting the benefits of mitigating oxidative damage.

Neuroprotective Potential

Geniposide has verified neuroprotective houses in experimental models of neurodegenerative problems, consisting of Alzheimer's and Parkinson's illnesses. Its mechanism of motion is notion to involve the discount of infection in the mind, the inhibition of unique enzymes associated with neurodegeneration and the enhancement of neuronal survival. However, genipin is another bioactive compound for it have an impact on neurotransmitter structures, especially dopamine, which might also offer advantages within the remedy of mood problems and neurodegenerative sicknesses.

Antidiabetic Effects

The extracts derived from *Gardenia jasminoides* may assist in the regulation of blood glucose levels by enhancing insulin sensitivity and mitigating inflammation linked to diabetes. Geniposide, has been recognized for its function in influencing glucose metabolism, which may prove beneficial in the treatment of type 2 diabetes.

Liver Protection

The *Gardenia jasminoides* extracts contribute to the reduction of liver damage by alleviating inflammation and oxidative stress. In traditional medicine, gardenia has been utilized to enhance liver function, a gain that may be attributed to the presence of these bioactive compounds.

Antimicrobial and Antifungal Activity

The compounds derived from *Gardenia jasminoides* have shown to have mild antimicrobial activity against wide range of bacterial and fungal strains. This evidence supports the historical use of gardenia for managing infections and wounds; however, further studies are needed to determine its efficacy and safety.

Anticancer Activity

The specific compounds found in gardenia, such as genipin and crocetin, have demonstrated cytotoxic properties against cancer cells in laboratory settings. It is believed that these effects stem from the compounds' capacity to trigger apoptosis, or programmed cell death, in malignant cells. While the findings are encouraging, further investigation is required to fully comprehend the potential of gardenia-derived compounds as anticancer agents.

Cardiovascular Benefits

Gardenia compounds, particularly geniposide and crocetin, might also play a substantial position in cardioprotection by

lowering infection and oxidative stress within cardiovascular tissues. This can also cause decrease blood stress, a discounted probability of atherosclerosis and an enhancement of common cardiovascular nicely-being.

Conclusion

Gardenia jasminoides Ellis is a high-quality traditional medicinal plant utilized in both healthcare and culinary applications. The scientific studies have corroborated its ancient medicinal uses, suggesting that this herb may also effectively address various fitness situations. The presence of iridoid glycosides suggests its potential as a therapeutic agent. Additionally, the yellow pigment derived from Gardenia has served as a considerable natural colorant for food, textiles and paints for millennia. *Gardenia jasminoides* has performed a crucial position in enhancing human survival and improvement, contributing notably to numerous factors of life, along with fitness and the arts. Its multifaceted packages underscore its importance not handiest in conventional medicinal drug, but additionally in cultural practices, reflecting its enduring legacy throughout history.

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Understanding fruit drop: A barrier to sustaining wild fruits in forests

Manish Kumar Vijay

ICFRE – Tropical Forest Research Institute, Jabalpur, M.P
(Indian Council of Forestry Research and Education)
(An Autonomous body of Ministry of Environment, Forests and Climate Change, Govt. of India)

Forests are a treasure trove of biodiversity, providing us with food, medicine, and livelihoods. Among the many resources they offer, wild fruits hold immense significance. These fruits are not only vital for the sustenance of wildlife but also serve as a critical source of nutrition and income for local communities. However, one of the major challenges affecting fruit production, both in cultivated orchards and forests, is fruit drop. This phenomenon—where fruits fall prematurely before ripening—poses a serious threat to the productivity and sustainability of wild fruit species in forests.

What is Fruit Drop?

Fruit drop refers to the premature shedding of fruits due to various causes, including structural, physiological, environmental, and pathological factors. While early flower and fruit shedding are natural processes to prevent overbearing of trees, excessive fruit drop can significantly reduce yields, creating challenges for forest ecosystems and the people dependent on them.In wild fruits, such as *Semecarpus anacardium* (bhilawa),*Flaocurtia indica* (kakai), *Phnera vahlii* (mahul) and *Dilleniapentagyna* (Suarukh), fruit drop impacts both regeneration and resource availability. Understanding the causes of this phenomenon is crucial for conserving and managing these valuable forest species.

Causes of Fruit Drop in Wild Forest Fruits

Physiological Factors

In many wild fruit trees, physiological imbalances like inadequate hormone levels (auxins, gibberellins, cytokinins) can lead to significant fruit drop. For instance, in mango (Mangifera indica), embryo abortion during the second phase of fruit development is a primary cause of fruit drop. This issue is compounded by poor soil fertility in forests, where trees often face nutrient deficiencies.

Environmental and Climatic Conditions

Environmental stressors such as high temperatures, drought, and erratic rainfall patterns contribute significantly to fruit drop in forest trees. Species like *Dilleniapentagyna* and *Holarrhena pubescens* are particularly sensitive to these changes. Lack of soil moisture and exposure to extreme weather during flowering and fruit-setting stages further aggravates the issue.

Nutritional Deficiencies

Wild fruits often grow in nutrient-poor soils, and deficiencies of nitrogen, phosphorus, potassium, calcium, and zinc are common. For instance, research on kinnow mandarin highlights that low levels of key nutrients in leaves are directly associated with higher fruit drop.

Wild fruit species like *Semecarpus anacardium* may face similar challenges, leading to lower fruit retention.

Insect Pests and Diseases

Insects and pathogens are a major cause of fruit drop in wild fruits. Pests like seed borers, weevils, and fruit flies can destroy fruits at an early stage, making them prone to dropping. For instance, in *Dilleniapentagyna*, infestations by fruit borers significantly reduce fruit yield. Diseases like anthracnose, powdery mildew, and fungal rots also accelerate fruit drop, especially in species like *Aegle marmelos.*

Implications for Forest Ecosystems and Communities

Loss of Regeneration Potential

For many forest species, fruit drop directly affects seed dispersal and regeneration. Species like Cordia myxa and Bauhinia vahlii, which rely on their fruits for propagation, struggle to maintain their populations in the wild due to excessive fruit drop. This can lead to long-term declines in biodiversity.

Reduced Availability for Wildlife and Humans

Wild fruits are a critical food source for forest-dwelling animals such as birds, primates, and rodents. Excessive fruit drop means fewer ripe fruits for consumption, disrupting food chains. Additionally, forest-dependent communities rely on wild fruits for nutrition and income. The loss of fruits due to premature drop reduces their access to these resources, impacting livelihoods.

Economic and Cultural Impact

In many regions, wild fruits hold cultural and economic significance. Species like bhilawa (Semecarpus anacardium) and bael (Aegle marmelos) are used in traditional medicine, rituals, and as raw materials for value-added products. Premature fruit drop affects the collection and trade of these fruits, diminishing their economic value.

Strategies to Address Fruit Drop in Wild Fruits

Nutrient Management

Incorporating nutrient recycling practices, such as adding organic matter and leaf litter to the forest floor, can improve soil fertility and reduce fruit drop. Targeted interventions, like foliar sprays of essential nutrients, may also help.

Pest and Disease Control

Promoting biocontrol agents and integrated pest management techniques can curb pest and disease-related fruit drop in forest species. For example, the use of pheromone traps for fruit flies or natural predators for seed borers can be effective.

Conservation of Genetic Diversity

Studying and conserving the genetic diversity of wild fruit species is vital. Identifying resilient varieties that naturally exhibit lower fruit drop rates can help in reforestation and plantation efforts.The Indian Council of Forestry Research and Education - Tropical Forest Research Institute (ICFRE-TFRI), Jabalpur, is undertaking dedicated and focused efforts to study the maturation processes and ensure the conservation of biodiversity of various plant species. These initiatives are being carried out under multiple projects funded by the Compensatory Afforestation Management and Planning Authority (CAMPA) and the Indian Council of Forestry Research and Education (ICFRE). These projects aim to address critical

aspects of ecological preservation, genetic diversity, and sustainable management of forest resources.

Water and Climate Management

Enhancing water availability through rainwater harvesting and mulching can mitigate drought stress in forest species. Long-term strategies to address climate change, including afforestation and maintaining microclimates, are also critical.

Conclusion

Fruit drop is a multifaceted problem that impacts both cultivated orchards and wild fruits in forests. By understanding the underlying causes—ranging from physiological imbalances to pest infestations—we can develop strategies to mitigate its effects. Addressing fruit drop in wild fruits is essential not only for biodiversity conservation but also for supporting the livelihoods of forest-dependent communities and ensuring food security for wildlife.With a concerted effort involving research, community participation, and sustainable management practices, we can safeguard the future of wild fruits and the invaluable benefits they offer.

बाओबाब वृक्ष (खोरासानी, इमली)

मनोज पूसाम, प्रमोद कुमार, कोमल रानी, नसीर मोहम्मद एवं फ़ातिमा शिरीन

आनुवांशिकी एवं वृक्ष सुधार प्रभाग

भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद–उष्णकटिबंधीय वन अनुसंधान संस्थान,जबलपुर

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बाओबाब एक पर्णपाती वृक्ष है, जिसे वैज्ञानिक रूप से ऐडनसोनिया डिजिटाटा(*Adansonia digitata*) के नाम से जाना जाता है, ऐडनसोनिया एक संकट ग्रस्त जीव वैज्ञानिक वंश है, जिसमें कुल आठ प्रजातियाँ शामिल हैं। भारत में इसे गोरक्षी और गोरख इमली के नाम से भी जाना जाता है। बाओबाब कुल की सबसे आम प्रजाति अफ़्रीकी बाओबाब (एडंसोनिया डिजिटाटा) है। यह वृक्ष अपनी लंबाई और बल्बनुमा आकृति के कारण पृथ्वी पर चलते हुए दिग्गजों की तरह प्रतीत होता है। इसकी छाल चिकनी होती है, और यह शीर्ष तक पहुँचने पर बिना किसी शाखा या पत्ते के होता है, जबकि शीर्ष पर घुंघराले बालों की तरह शाखाएँ और पत्तियाँ होती हैं। इस प्रजाति के ये अद्वितीय वृक्ष हमारी पृथ्वी के दक्षिणी गोलार्ध में पाए जाते हैं। ये विशाल और दीर्घकालिक होते हैं, और उनके विशाल तने कई जीवों के लिए जीवन दायिनी बाओबाब वृक्ष के रूप में प्रसिद्ध हैं। यह अफ़्रीकी जीवों और मानव समुदायों के लिए आश्रय, वस्त्र, भोजन और जल का महत्वपूर्ण स्रोत हैं। इनके तने में 120,000 लीटर (32,000 अमेरिकी गैलन) तक जल संग्रहित किया जा सकता है। बाओबाब को अक्सर उनकी जड़ जैसी उलझी हुई शाखाओं की उपस्थिति के कारण उल्टा पेड़ कहा जाता है। सूखे की कठोर मौसम स्थितियों से बचने के लिए, बाओबाब अपनी सूंड में पानी जमा करते हैं।

(Baobab tree photo by Manoj Poosam)*

बाओबाब के परिपक्व पेड़ों में पत्तियाँ ताड़ के आकार की होती हैं, जबकि युवा अंकुरों और पुनर्जीवित टहनियों में साधारण पत्तियाँ पाई जा सकती हैं। बाओबाब की पत्तियों के आधार पर स्टीप्यूल्स होते हैं, लेकिन अधिकांश प्रजातियों में

ये जल्दी गिर जाते हैं। बाओबाब के पेड़ पर फूल पहली बार 20 वर्ष की आयु में , अप्रैल से मई के बीच खिलते हैं।फूल रात्रि में खिलते हैं, और इनका रंग सफेद होता है, जबकि आकार 12 सेमी तक लंबा होता है। इन फूलों के पराग कणों से गोंद का उत्पादन भी किया जाता है। शुष्क मौसम के दौरान, बाओबाब अपने पत्तों को उसी तरह गिराता है, जैसे उत्तरी गोलार्ध में सर्दियों में पर्णपाती पेड़ करते हैं। बाओबाब के फूल अत्यंत आकर्षक होते हैं, जिनका कैलेक्स 5 पंखुड़ियों से बना होता है, और इसका व्यास 12 सेंटीमीटर (4.7 इंच) तक हो सकता है। ये सफेद, मलाईदार या हल्के पीले रंग के होते हैं, लेकिन जल्दी ही मुरझा जाते हैं, और सूखने पर अक्सर गहरे लाल रंग में परिवर्तित हो जाते हैं। अधिकांश बाओबाब प्रजातियाँ चमगादड़ या लीमर द्वारा परागित होती हैं, जबकि कुछ को स्फिंगिडे परिवार के पतंगों द्वारा परागित किया जाता है। बाओबाब प्रजाति में फूलों की प्रजनन प्रक्रिया भी महत्वपूर्ण है।

बाओबाब के फूल बड़े होते हैं, और इनकी प्रजनन क्षमता अधिकतम 15 घंटों तक ही रहती है। ये संध्या के समय इतनी तेजी से खिलते हैं, कि इन्हें मानव आंखों से खुलते हुए देखा जा सकता है, और अगले दिन सुबह तक ये मुरझा जाते हैं। इसके फल बड़े, बेल के समान अंडाकार या गोल होते हैं, जिनमें सूखे फल के अंदर राजमा के आकार का एक बीज होता है। बाओबाब के कई अन्य स्थानीय नाम भी हैं, जैसे "उल्टापेड़" और "बंदर रोटी पेड़"। अफ्रीका के आर्थिक विकास में इसके योगदान के कारण इसे 'द वर्ल्ड ट्री' की उपाधि दी गई है, और इसे एक संरक्षित वृक्ष के रूप में मान्यता प्राप्त है। इसका वैज्ञानिक नाम मिशेल एडनसन के सम्मान में रखा गया है, जो एक फ्रांसीसी प्रकृतिवादी और अन्वेषक थे, जिन्होंने इस वृक्ष का पहला वर्णन किया था।

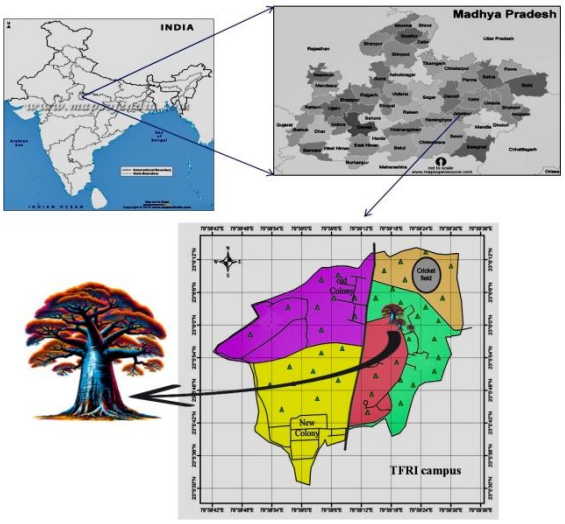
उष्णकटिबंधीय वन अनुसंधान संस्थान परिसर में बाओबाब के पांच वृक्ष है। अनुमान है, कि इन वृक्षों की आयु लगभग 40 वर्ष है। 5 वृक्षों में से है, 2 की ऊंचाई 20 मीटर के लगभग है, एवं 03 वृक्षों की ऊंचाई 18-19 मीटर के लगभग है। वास्तव में, ये वृक्ष TFRI की सुंदरता को बढ़ाते हैं, क्योंकि ये किसी भी व्यक्ति की दृष्टि से ओझल नहीं हो सकते। इनका विशाल आकार लोगों को आकर्षित करता है, ठीक उसी प्रकार जैसे मांडू में बाओबाब देखने के लिए पर्यटक आते हैं। संभवतः जब ये और भी विशाल हो जाएंगे, तो TFRI में पर्यटकों की संख्या में वृद्धि होगी और तब TFRI बाओबाब का महत्व स्पष्ट रूप से समझ में आएगा। वर्तमान में भी, यह वृक्ष हमारे TFRI की शोभा को बढ़ा रहा है।

उष्णकटिबंधीय वन अनुसंधान संस्थान जबलपुर,भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद, देहरादून के अधीन आने वाले आठ क्षेत्रीय संस्थानों में से एक है। इस संस्थान की स्थापना अप्रैल 1988 में हुई, जबकि इसकी गतिविधियों की शुरुआत 1973 में हुई थी, जब मध्य भारत में वन प्रबंधन से संबंधित समस्याओं के समाधान के लिए जबलपुर में वन अनुसंधान संस्थान, देहरादून का एक क्षेत्रीय केंद्र स्थापित

किया गया। यह संस्थान NH-12A पर जबलपुर से 10 किलो मीटर दक्षिण-पूर्व दिशा में स्थित है, और इसका परिसर 109 हेक्टेयर क्षेत्र में फैला हुआ है, जो एक सुरम्य वातावरण में स्थित है।

भौगोलिक वितरण

यह प्रजाति 25 मीटर (82 फीट) तक ऊंची होती है, और तना 10 से 14 मीटर (32 से 46 फीट) के व्यास तक पहुंच सकता है। भारत में बाओबाब की मौजूदगी 600 साल से भी अधिक पुरानी है। मुख्य भूमि अफ्रीका और मेडागास्कर के द्वीपों के मूल निवासी, पर्णपाती बाओबाब (एडानसोनिया डिजिटाटा) 2,000 वर्षों तक जीवित रह सकते हैं, और यह एक वैश्विक स्तर पर संकट ग्रस्त प्रजाति मानी जाती है। जिसके पत्ते केवल 6 महीने तक ही रहते हैं। शुष्क मौसम में इसके पत्ते गिर जाते हैं, जिससे यह सूखा दिखाई देता है। इस वृक्ष के तने में हजारों लीटर (1,20,000 लीटर तक) शुद्ध जल संग्रहित रहता है, जो वर्षा की कमी के दौरान उपयोगी होता है। बाओबाब वृक्ष की आयु अत्यधिक लंबी होती है। इसकी लकड़ी में वृद्धि वलयों का अभाव होता है, इसलिए इसकी आयु का निर्धारण करने के लिए कार्बन काल निर्धारण विधि का सहारा लिया जाता है। कुछ बाओबाब वृक्षों की आयु 6000 वर्ष तक मापी गई है। ज़िम्बाबवे का एक बाओबाब सन् 2011 में अपनी मृत्यु से पहले 2,450 वर्ष की आयु प्राप्त करके विश्व का सबसे दीर्घ जीवी ज्ञात सपुष्पक वनस्पति हो चुका था। अब तक ज्ञात सबसे प्राचीन बाओबाब की आयु 2450 वर्ष है, जिसे पैंके नाम दिया गया था और यह जिम्बाब्वे में उगाया गया था।



*(1) Baobab trunk **

*(2) Baobab bark **

*(3) Baobab bark **

*(4)Baobab leaf**

*(5) Baobab Flowers **

*(6) Baobab flower **

*(7) Baobab fruits **

दुर्भाग्यवश, यह पेड़ 2011 में समाप्त हो गया। 21वीं सदी की शुरुआत में, दक्षिण अफ्रीका में बाओबाब के पेड़ अचानक मरने लगे। इस असामान्य घटना का कारण अभी तक स्पष्ट नहीं हो पाया है। अधिकांश वैज्ञानिक इस बात से असहमत हैं, कि कोई बीमारी या परजीवी इतनी तेजी से इतने पेड़ों को नष्ट कर सकता है, और वे इस सिद्धांत का समर्थन करते हैं, कि ग्लोबल वार्मिंग के कारण होने वाला निर्जलीकरण बाओबाब की मृत्यु का मुख्य कारण है।

भारत में बाओबाब की उपलब्धता :- भारत में इनकी संख्या अत्यंत सीमित है, लेकिन मध्य प्रदेश के मांडू शहर में इनकी प्रचुरता देखी जाती है, जहां भील जनजाति ने इन्हें ऐतिहासिक रूप से संरक्षित किया है। ये लचीले और लुप्त प्राय पेड़ सदियों से जनजातीय जीवन यापन का आधार बने हुए हैं। शायद मांडू का सूखा इलाका इन पेड़ों को वहां बहुतायत में उगने में मदद करता है। बाओबाब के पेड़ उत्तर प्रदेश के प्रयागराज (पूर्व में इलाहाबाद), महाराष्ट्र के वाई, तथा गुजरात और आंध्रप्रदेश के कुछ क्षेत्रों में भी देखे गए हैं। भारत में बाओबाब पेड़ों के आगमन का कोई ठोस प्रमाण उपलब्ध नहीं है। सूरत के कतारगाम में अनाथाश्रम के सामने दो बाओबाब पेड़ और सरथाणा चुंगीनाका के निकट स्थित चिड़िया घर

में भालू के पिंजरे के पास एक पेड़, हजारों वर्षों से विद्यमान हैं। गुजराती में इसे गोरख आंबली के नाम से जाना जाता है। हुबली के निकट सावनूर के पास भी एक बाओबाब का पेड़ है, जिसका संरक्षण एक ऐतिहासिक पृष्ठ भूमि वाले लिंगायतस्वामी द्वारा किया जाता है। वास्तव में, ये बाओबाब पेड़ उन क्षेत्रों में उगते हैं, जहां बहमनी साम्राज्य का प्रभाव था। इसका मुख्य कारण यह है, कि बहमनी साम्राज्य के पास लंबे इथियोपियाई सैनिक थे, जो हाथियों के समक्ष हमले का नेतृत्व करते थे, जिससे उनके शत्रु भयभीत हो जाते थे। इन इथियोपियाई लोगों का मुख्य आहार बाओबाब फल था, और इसी कारण से भारत में बाओबाब के पेड़ उगने लगे। पहले इन पेड़ों की संख्या अधिक थी, लेकिन अंधविश्वास और कृषि के कारण इनकी संख्या में कमी आई।

बाओबाब पेड़ों की 8 प्रजातियाँ हैं।

ऐडनसोनिया डिजिटाटा (Adansonia digitata)
ऐडनसोनिया ग्रैण्डिडिएरी (Adansonia grandidieri)
ऐडनसोनिया ग्रेगोरी (Adansonia gregorii)
ऐडनसोनिया माडागास्करिएन्सिस (Adansonia madagascariensis)
ऐडनसोनिया पेरिएरी (Adansonia perrieri)
ऐडनसोनिया रुब्रोस्टीपा (Adansonia rubrostipa)
ऐडनसोनिया सुआरेज़ेन्सिस (Adansonia suarezensis)
ऐडनसोनिया ज़ा (Adansonia za)

पक्षी निरीक्षण

एक सुबह जब में बर्ड वाचिंग कर रहा था, तभी बाओबाब वृक्ष पर मुझे अचानक बार्न आउल दिखा में आश्चर्चकित हो गया, क्योकि यह बड्र्स है, इस क्षेत्र में सामान्यतः नहीं पाया जाता है। यह पहली बार है, जब मैं रिपोर्ट प्रस्तुत कर रहा हूँ। यह मेरे लिए एक अत्यंत सकारात्मक अनुभव रहा। जब भी मैं बाओबाब के वृक्ष को देखूँगा,

(Nest of Barneowlin Baobab tree Photo by Manoj Poosam)

यह मुझे बार्न आउल की याद दिलाएगा। बाओबाब वृक्ष कुछ पक्षियों के लिए महत्वपूर्ण घोंसले के स्थान प्रदान करते हैं। विशेष रूप से , ये धब्बेदार स्पिनटेल और बुनकरों की चार प्रजातियों के लिए घोंसले बनाने के लिए अत्यंत उपयुक्त होते हैं।

खलिहान उल्लू (टायटो अल्बा) भारत में एक सामान्य उल्लू प्रजाति है, जो हिमालय की तराई के दक्षिणी हिस्से में विभिन्न क्षेत्रों में फैला हुआ है। खलिहान उल्लू खुले ग्रामीण इलाकों, खेतों, और शहरी तथा ग्रामीण क्षेत्रों में निवास करना पसंद

करते हैं। ये प्रायः इमारतों, खलिहानों, कारखानों और पुरानी संरचनाओं में घोंसला बनाते हैं। खलिहान उल्लू का आकार लगभग 35 सेंटीमीटर होता है। इसका ऊपरी शरीर हल्का सुनहरा-पीला होता है, जिसमें काले और सफेद रंग के बारीक धब्बे होते हैं, जबकि निचला शरीर सफेद होता है, जिसमें बारीक काले धब्बे होते हैं। इनके चेहरे पर हृदय के आकार की डिस्क, काली आंखें, चौड़े गोल पंख और लंबे, विरल पंखयुक्त पैर होते हैं। खलिहान उल्लुओं की तेज और कर्कश चीखें अंटार्कटिका को छोड़कर सभी महाद्वीपों पर सुनी जा सकती हैं। उनकी आवाज़ में कर्कश, असंगत चीखों के साथ-साथ अजीब खर्राटे और फुफकार का मिश्रण होता है।

फल

बाओबाब का फल आंतरिक भाग सूखे कस्टर्ड सेब के समान प्रतीत होता है। इसमें बीज वाले सफेद गूदे के टुकड़े होते हैं, जिन्हें निकाला जा सकता है, और चबाया जा सकता है। सूखी इमली के पैकेट बाजार में उपलब्ध हैं, बीज के चारों ओर गूदे की मात्रा भी बहुत कम होती हैं। एक फल में लगभग 30 बीज पाए जाते हैं। इन बीजों का उपयोग विभिन्न प्रकार की औषधियों, गोंद, कच्चे तेल और साबुन बनाने में किया जाता है। कैल्शियम से समृद्ध पत्तियों का उपयोग सब्जी बनाने में किया जाता है, जिन्हें उबालकर डिटर्जेंट पाउडर के रूप में भी इस्तेमाल किया जा सकता है। इसके पत्तों को भी सब्जियों की तरह पकाने में उपयोग किया जाता है। इसकी छाल रेशेदार होती है, जिससे इसे विभिन्न कार्यों में प्रयोग किया जाता है।

यह माना जाता है, कि इसमें विटामिन सी की प्रचुरता होती है, जो इसे स्वास्थ्य के लिए लाभकारी बनाती है। इसका उपयोग करी में एक विशेष स्वाद जोड़ने के लिए भी किया जाता है। बाओबाब की छाल में 40% तक नमी होती है, जिससे यह जलाने के लिए उपयुक्त नहीं है। हालांकि, इसके तने की भीतरी छाल फाइबर जैसी होती है, जिसका उपयोग कागज, कपड़े, रस्सी, मछली पकड़ने के जाल, धागे, बास्केट और कंबल जैसी वस्तुओं के निर्माण में किया जाता है। बाओबाब वृक्ष मांडू के निवासियों के लिए आजीविका का एक महत्वपूर्ण स्रोत है। स्थानीय व्यापारी पर्यटकों को स्मृति चिन्ह के रूप में बाओबाब के फलों की फलियाँ बेचते हैं। "फलियों के आकार के अनुसार उनकी कीमत निर्धारित होती है, इसके अतिरिक्त, गूदा और बीज भी अलग-अलग बेचे जाते हैं। उनके औषधीय गुणों के कारण प्रति पैकेट 10 रुपये की दर से बिक्री होती है। ये व्यापारी, जो मुख्यतः भील जनजाति के सदस्य हैं, या तो इन फलियों को निकटवर्ती जंगलों से इकट्ठा करते हैं, या उन किसानों से खरीदते हैं, जो बाओबाब की खेती करते हैं।

किंवदंती

बाओबाब वृक्ष की विशेषता यह है, कि इसका आकार उल्टा प्रतीत होता है, जिससे ऐसा लगता है, कि इसकी जड़ें ऊपर और तना नीचे हैं। इस वृक्ष के बारे में एक किंवदंती प्रचलित है, कि पहले यह वृक्ष सीधा था, लेकिन जब यह फल-फूल रहा था, तब इसने अन्य पौधों और वृक्षों को मिलने वाली हवा और सूर्य की रोशनी को अवरुद्ध कर दिया। इस पर परमात्मा ने क्रोधित होकर इस

वृक्ष को जड़ से उखाड़कर उल्टा लगा दिया। बाओबाब ने भगवान से बहुत प्रार्थना की, जिसके फलस्वरूप उन्हें यह छूट मिली कि साल के छह महीने तक इस पर पत्ते रह सकते हैं, जबकि बाकी समय यह वृक्ष सूखे ठूंठ की तरह दिखाई देता है। यह किंवदंती भले ही हो, लेकिन आज भी इस वृक्ष पर साल में केवल छह महीने तक ही पत्तियां रहती है। जबकि शेष समय में यह पूरी तरह से सूखा नजर आता है।

बाओबाब के बीज मांडू में अफगान शासकों या अरब व्यापारियों द्वारा लाए गए थे, जो लगभग 1400 ईस्वी के आस-पास वहां पहुंचे थे। यह पेड़ न केवल अन्य औषधीय गुणों के लिए जाना जाता है, बल्कि यह प्यास को भी शांत करता है। बाओबाब का आकार बोतल के समान होता है, और इसका तना चौड़ा होता है, जो ऊपर की ओर बढ़ते समय संकरा हो जाता है, जहां इसकी कुछ शाखाएं होती हैं। यह ऐसा प्रतीत होता है, जैसे कोई पेड़ उल्टा लगा हो। इस जीनस की विशेष संरचना इसे बड़ी मात्रा में पानी संचित करने की क्षमता प्रदान करती है।

उपयोग

बाओबाब पानी को संचित करता है, और विशेष रूप से शुष्क मौसम में, जब जल की कमी होती है, हाथी अपनी प्यास बुझाने के लिए बाओबाब की ओर आकर्षित होते हैं। हाथियों द्वारा बार-बार बाओबाब के उपयोग से पौधे के तने को गंभीर क्षति पहुँच सकती है, जिसके परिणाम स्वरूप पेड़ गिरने का खतरा होता है। इस पौधे के फल का गूदा खट्टे स्वाद का होता है, और इसका उपयोग ताज़ा पेय बनाने में किया जाता है। यह विटामिन सी, फाइबर, कार्बोहाइड्रेट, पोटेशियम और फास्फोरस का एक उत्कृष्ट स्रोत है। अंगोला में, सूखे बाओबाब फलों को पौष्टिक शोरबा बनाने के लिए पकाया जाता है, जो रस और क्षेत्र की विशेष आइसक्रीम, जिसे गेलाडो डी मुकुआ कहा जाता है, का आधार बनता है। इसके फल, जो ककड़ी या खीरे के समान होते हैं, गूदेदार होते हैं, और उनकी लंबाई 1 फुट तक हो सकती है (कभी-कभी ये गोल भी होते हैं)। ये फल बंदरों के लिए अत्यंत प्रिय होते हैं, इसलिए इसे "बंदर रोटी वृक्ष" भी कहा जाता है। इसके फलों से विभिन्न प्रकार की औषधियाँ भी बनाई जाती हैं। इस फल को सुखा कर चूरा बनाया जाता है, जिसे पानी में मिलाने पर नींबू पानी जैसा खट्टा पेय प्राप्त होता है।

इसके अलावा , छाल से प्राप्त मजबूत रेशे का उपयोग कई क्षेत्रों में रस्सियाँ और कपड़े बनाने के लिए किया जाता है। यह वृक्ष शिकार के लिए आवश्यक कच्चा माल और मछली पकड़ने के उपकरण भी उपलब्ध कराता है। बाओबाब के तने का उपयोग अक्सर दफन स्थलों के रूप में किया जाता है, और कभी-कभी इसे जेल या बार के रूप में भी परिवर्तित किया जाता है। अफ्रीकी समुदाय इस वृक्ष को जीवन प्रतीक के रूप में “जीवन का वृक्ष" मानते हैं। वे इस पेड़ से बहुत सारा जल संचय करते हैं, और गर्मियों में या जब भूमि सूख जाती है, तब लोग अपनी प्यास बुझाने के लिए इसकी छाल को काटते हैं।

औषधि का महत्व

बाओबाब वृक्ष की विभिन्न प्रजातियाँ स्थानीय समुदायों द्वारा बड़े पैमाने पर उपयोग की जाती हैं। इनमें से अधिकांश प्रजातियों के पत्ते और फल

खाद्य होते हैं, जो हर्बल औषधियों के मिश्रण के लिए आधार प्रदान करते हैं। बाओबाब की पत्तियों में विटामिन सी और कैल्शियम की प्रचुरता होती है। बाओबाब के फल को पौष्टिक माना जाता है, और इसे पारंपरिक चिकित्सा में उपयोग किया जाता है। बीजों से प्राप्त तेल का उपयोग सौंदर्य प्रसाधन उद्योग में विशेष रूप से मॉइस्चराइजिंग क्रीम के निर्माण में किया जाता है। इसका फल विटामिन सी से समृद्ध है, जो संतरे में मौजूद विटामिन सी की तुलना में अधिक होता है। जैसे भारतीय केले के पेड़ का हर भाग उपयोगी होता है, वैसे ही इस पेड़ के सभी हिस्सों का भी किसी न किसी रूप में उपयोग किया जाता है एक अध्ययन के अनुसार, बाओबाब पेड़ के फल का गूदा, बीज और पत्तियां कब्ज, दस्त, आंतों की सूजन, बुखार, खांसी, अस्थमा, अन्य श्वसन समस्याओं, मलेरिया और अन्य के इलाज में सहायक होते हैं। यह फल विटामिन सी का एक उत्कृष्ट स्रोत है, और इसमें एंटीऑक्सीडेंट की भरपूर मात्रा पाई जाती है। इसका उपयोग आमतौर पर पेट से संबंधित समस्याओं के उपचार के लिए किया जाता है। इसके अलावा, इसकी छाल का उपयोग भी विभिन्न रोगों के उपचार में किया जाता है, जो पारंपरिक चिकित्सा पद्धतियों के अनुरूप हैं। जनजातीय इलाकों में उनकी आजीविका बाओबाब पर निर्भर हैं।

संरक्षण

हाल के समय में ऐसी घटनाएं सामने आई हैं, जिनमें स्थानीय निवासियों ने कृषि के लिए अधिक स्थान बनाने के उद्देश्य से अपनी भूमि से पेड़ काटने का कार्य किया है। क्योंकि बाओबाब के तने मोटे होते हैं, और काफी जगह घेरते हैं। अतः इनको भी काट दिया गया। हालांकि, बाओबाब पेड़ों की सुरक्षा के लिए स्पष्ट दिशा-निर्देशों की कमी के कारण इस प्रक्रिया को रोका नहीं जा सका। बाओबाब पेड़ न केवल समृद्ध ऐतिहासिक महत्व रखते हैं, बल्कि इनके औषधीय गुण भी हैं। यह स्थिति चिंता जनक है, क्योंकि बाओबाब पेड़ आर्थिक सहायता का भी स्रोत प्रदान करते हैं। हाल के दिनों में इन पेड़ों की संख्या में कमी आई है। इसलिए, सरकार को इनके संरक्षण के लिए ठोस कदम उठाने की आवश्यकता है।

यदि सरकार बाओबाब के संरक्षण को गंभीरता से लेती है, तो उसे यह सुनिश्चित करने के लिए विशेष प्रावधान लागू करने चाहिए कि कोई भी इन पेड़ों को न काट सके। बाओबाब पौधों को पानी की आवश्यकता नहीं होती है, और ये प्रतिकूल जलवायु में भी जीवित रह सकते हैं। इसलिए, सरकार को वार्षिक वृक्षारोपण अभियान के दौरान भी इस प्रजाति के रोपण को बढ़ावा देना चाहिए, खास कर शुष्क क्षेत्रों में भील समुदाय के लोगों ने वर्षों से इन पेड़ों की रक्षा की है, मांडू में बाओबाब पेड़ों को इस क्षेत्र के आदिवासी लोगों द्वारा सैकड़ों वर्षों से संरक्षित किया गया है। इन पेड़ों के संरक्षण में अब तक आदिवासी लोगों का ही मुख्य योगदान रहा है।

भारत में भूमि क्षरण

संजय गोस्वामी
यमुना जी/13, अणुशक्तिनगर, मुंबई

भूमि एक अत्यन्त ही महत्वपूर्ण प्राकृतिक संसाधन जो हमें भोजन, ईधन, चारा एवं लकड़ी प्रदान करती है। दुर्भाग्यवश भारत में सदियों से खाद्यान्न उत्पादन हेतु भूमि का शोषण किया गया है जो भूमि क्षरण के प्रमुख कारणों में से एक है। भूमि क्षरण के फलस्वरूप उसकी उपजाऊ क्षमता खत्म हो जाती है जिसके कारण उपजाऊ भूमि बंजर भूमि में तब्दील हो जाती है। क्षरित भूमि किसी भी देश की अर्थव्यवस्था के लिए बहुत बड़ी हानि है। भारत में विभिन्न कारणों से भूमि क्षरण की दर में लगातार वृद्धि हो रही है। सिकुड़ते भूमि संसाधन आज भारत जैसे विकासशील देश के लिए सबसे बड़ी समस्या है। देश में मनुष्य भूमि अनुपात मुश्किल से 0ण्48 हेक्टेयर प्रति व्यक्ति है जो दुनिया के न्यूनतम् अनुपातों में से एक है।

क्षरित भूमि के अन्तर्गत अपरदित भूमि, लवणीय एवं क्षारीय भूमि, जलजमाव से प्रभावित भूमि, बीहड़ भूमि, खनन गतिविधियों से प्रभावित भूमि आदि शामिल हैं। भारत की कुल भूमि क्षेत्रफल 329 मिलियन हेक्टेयर है जिसमें से लगभग 178 मिलियन हेक्टेयर भूमि (54 प्रतिशत) विभिन्न कारणों से बंजर भूमि में परिवर्तित हो चुकी है। इसमें लगभग 40 मिलियन हेक्टेयर क्षरित वन भी सम्मिलित है। देश की कुल कृषि योग्य भूमि का क्षेत्रफल 144 मिलियन हेक्टेयर है जिसमें लगभग 56 प्रतिशत (80ण्6 मिलियन हेक्टेयर) गलत कृषि कार्यों के परिणामस्वरूप बेकार या बंजर हो चुकी है और अब घने वन सिकुड़कर कुल भौगोलिक क्षेत्रफल का केवल 11 प्रतिशत (36ण्2 मिलियन हेक्टेयर) रह गये हैं।

वर्तमान में भारत में मृदा अपरदन की दर लगभग 2ए600 मिलियन टन प्रतिवर्ष है। देश की लगभग 140 मिलियन हेक्टेयर भूमि, जल तथा वायु मृदा अपरदन से प्रभावित है जिसके परिणामस्वरूप मिट्टी की ऊपरी परत की हानि की दर लगभग 6ए000 मिलियन टन प्रतिवर्ष है जिसमें 5ण्53 मिलियन टन नाइट्रोजन, फास्फोरस तथा पोटास की मात्रा होती है।

भारत के कुल क्षेत्रफल का लगभग एक-चौथाई भाग जल अपरदन से प्रभावित है। देश में सिर्फ जल अपरदन द्वारा प्रतिवर्ष लगभग 6ए000 टन ऊपरी मिट्टी का कटाव होता है जिसमें पोषक तत्वों की मात्रा की अनुमानित कीमत 1ए000 करोड़ रूपये से भी ज्यादा की
होती है।

जल द्वारा मृदा अपरदन दक्षिण एवं पूर्वी भारत के लाल एवं लैटराइट मृदा की एक प्रमुख समस्या है जहाँ तकरीबन 40 टन प्रति हेक्टेयर की दर से मिट्टी की ऊपरी सतह का हास प्रतिवर्ष होता है। मध्य भारत की काली मिट्टी के कुल क्षेत्रफल 70 मिलियन हेक्टेयर का लगभग 6ण्7 मिलियन हेक्टेयर क्षेत्र पहले से ही मृदा अपरदन के चलते बेकार हो चुका है। उत्तरी-पूर्वी भारत की लगभग 4ण्4 मिलियन हेक्टेयर भूमि झूम कृषि (स्थानान्तरी कृषि) के कारण गंभीर भूमि क्षरण से प्रभावित है।

भारत में तीव्र जल अपरदन के कारण लगभग 3ण्67 मिलियन हेक्टेयर भूमि बीहड़ भूमि में तब्दील हो चुकी है। बीहड़ मुख्यतः उत्तर प्रदेश, मध्य प्रदेश, राजस्थान और गुजरात राज्य में फैले हैं। यमुना, चम्बल, माही, बेतवा, साबरमती तथा उनकी सहायक नदियाँ इन राज्यों में भूमि अपरदन के लिए उत्तरदायी हैं। एक संरक्षित अनुमान के अनुसार भारत में बीहड़ भूमि

पुनरूत्थान न होने के कारण प्रतिवर्ष लगभग 157 करोड़ रूपये का घाटा हो रहा है। ऐसा अनुमान किया जाता है कि उत्तर प्रदेश, मध्य प्रदेश एवं राजस्थान के बीहड़ क्षेत्रों की अनाज उत्पादन क्षमता तकरीबन 3 मिलियन टन प्रतिवर्ष है।

देश की कुल लवण प्रभावित भूमि का लगभग 40 प्रतिशत क्षेत्रफल सिन्धु गंगा मैदानों के अन्तर्गत उत्तर प्रदेश, बिहार, दिल्ली, हरियाणा तथा पंजाब राज्यों में वितरित है।

वायु अपरदन आमतौर से देश के शुष्क एवं अर्धशुष्क क्षेत्रों की समस्या है जहाँ की मिट्टी मुख्यतः बलुई होती है जिसके कारण पेड़-पौधे कम संख्या में उगते हैं या पूर्णतः अनुपस्थित होते हैं। भारत में वायु अपरदन से लगभग 50 मिलियन हेक्टेयर भूमि प्रभावित है जिसमें से ज्यादातर भाग राजस्थान एवं गुजरात राज्य के अन्तर्गत आते हैं। इन क्षेत्रों में अत्यधिक चराई भूमि अपरदन का एक प्रमुख कारण है। एक अनुमान के अनुसार वायु अपरदन से प्रभावित इन क्षेत्रों में अपरदन के नियन्त्रण में लगभग 3ए000 करोड़ रूपये का खर्च आयेगा।

भूमि क्षरण के कारण

जनसंख्या विस्फोट, औद्योगीकरण, शहरीकरण, वनविनाश, अत्यधिक चराई, झूम कृषि तथा खनन गतिविधियाँ भूमि संसाधनों के क्षरण के प्रमुख कारण हैं। इनके अतिरिक्त रासायनिक उर्वरकों एवं नाशिजीवनाशकों (पेस्टीसाइड्स) पर आधारित पारम्परिक कृषि भी भूमि क्षरण का एक प्रमुख कारण है। हरित क्रान्ति के आगमन से कृषि उत्पादन में वृद्धि के लिए रासायनिक खादों, कीटनाशकों तथा शाकनाशकों के अंधाधुन्ध प्रयोग से न केवल वातावरण प्रदूषित हुआ है, अपितु भूमि की उर्वरा शक्ति बढ़ाने वाले सूक्ष्मजीवों की जनसंख्या में भी लगातार गिरावट दर्ज की गयी है जिससे मृदा की पैदावार शक्ति में कमी आयी है।

अत्यधिक रासायनिक उर्वरकों विशेषकर यूरिया के प्रयोग से भूमि अम्लीय हो जाती है। अम्लीय मृदा में सूक्ष्म पोषक तत्वों जैसे कापर तथा जिंक पौधों को उपलब्ध नही हो पाते हैं। इसके अतिरिक्त इस प्रकार की मृदा में आमतौर से कैल्शियम तथा पोटैशियम तत्वों का अभाव होता है। इसलिए इस प्रकार की मृदा में फसल की पैदावार में गिरावट आ जाती है।

रासायनिक उर्वरकों के अंधाधुन्ध प्रयोग से मृदा संरचना नष्ट हो जाती है जिससे मृदा के कण एक दूसरे से अलग हो जाते हैं परिणामस्वरूप मृदा अपरदन की दर में तीव्र वृद्धि की सम्भावना बढ़ जाती है।

कृषि में जल के अत्यधिक प्रयोग से जलजमाव के कारण मृदा की लवणता एवं क्षारीयता में वृद्धि होती है जिससे उपजाऊ भूमि उसर भूमि में परिवर्तित हो जाती है। सिंचाई जल के कुप्रबन्धन के कारण देश की लगभग 6 मिलियन हेक्टयर भूमि जल जमाव से प्रभावित है तथा तकरीबन 7 मिलियन हेक्टेयर भूमि लवणता एवं क्षारीयता से प्रभावित है।

भूमि क्षरण का निवारण

भूमि जैसे महत्वपूर्ण संसाधन का क्षरण देश के समक्ष एक गम्भीर समस्या है। अतः इस समस्या का निराकरण समय की सबसे बड़ी आवश्यकता है। अगर ऐसा नहीं हुआ तो निकट भविष्य में देश में खाद्यान्न उत्पादन की दर में गिरावट होगी परिणामस्वरूप आर्थिक विकास अवरूद्ध होगा और 121 करोड़ की आबादी वाले देश भारत में भूख और कुपोषण के चलते मृत्यु दर में अभूतवपूर्व बढ़ोत्तरी होगी। यद्यपि 1950 की तुलना में (लगभग 51 मिलियन टन) आज देश की कुल खाद्यान्न उत्पादन क्षमता में चार गुना से ज्यादा वृद्धि हुई है (लगभग 235 मिलियन टन)। फिर भी बढ़ती जनसंख्या एवं माँग को देखते हुए खाद्यान्न उत्पादन बढ़ाने की आवश्यकता है क्योंकि देश की

लगभग 42 करोड़ आबादी आज भी अत्यन्त ही गरीब होने के कारण भूखमरी एवं कुपोषण की शिकार है। इसलिए उपजाऊ भूमि का संरक्षण तथा क्षरित भूमि का पुनरुत्थान अत्यन्त ही आवश्यक है ताकि देश में खाद्यान्न उत्पादन को और बढ़ाया जा सके जिससे कृषि पर आधारित अर्थव्यवस्था को और सुदृढ़ किया जा सके। इसके लिए आवश्यक है कि पारम्परिक कृषि के स्थान पर संपोषित कृषि को अपनाया जाये जिसमें रासायनिक उर्वरकों, कीटनाशकों, शाकनाशकों आदि का प्रयोग केवल आवश्यकता पड़ने पर सीमित मात्रा में होता है। संपोषित कृषि में मृदा की उर्वरा शक्ति की वृद्धि के लिए हरी खाद, गोबर खाद, कम्पोस्ट, केंचुआ खाद, जैविक खाद आदि का उपयोग होता है जिससे मिट्टी का स्वास्थ्य बना रहता है परिणामस्वरूप मृदा संरक्षण को बढ़ावा मिलता है। साथ ही क्षरित अथवा बंजर भूमि को वनस्पतियों से आच्छादित कर उसे उपजाऊ बनाना तकनीकी दृष्टि से पिछड़े भारत जैसे देश के लिए भूमि पुनरूत्थान की सस्ती एवं उत्तम विधि है। इस प्रकार की भूमि पुनरूत्थान विधि को जैविक-पुनरूत्थान विधि के नाम से जाना जाता है।

जल अपरदन से प्रभावित कृषि भूमि का संरक्षण एवं पुनरूत्थान घास की प्रजातियों जैसे *दूब (साइनोडान डेक्टिलान)*, *अंजान (सिनक्रस सिलिएटस)* तथा *मुंज (सैक्रम मुंजा)* के रोपण से किया जा सकता है। उक्त घास की प्रजातियाँ आमतौर से बहुवर्षीय एवं कठोर प्रवृत्ति की होती हैं। इनकी जड़े मिट्टी के कड़ों को बाँधकर मृदा अपरदन को रोकने में सहायक होती हैं। घासों के निरन्तर उगने से मृदा में जीवांश पदार्थ की वृद्धि होती है जिससे मृदा संरचना में सुधार के साथ-साथ उसकी उपजाऊ क्षमता में भी वृद्धि होती है।

देश के शुष्क एवं अर्द्ध-शुष्क क्षेत्रों में वायु अपरदन एक गम्भीर समस्या है। वायु अपरदन से प्रभावित भूमि को *मेंहदी (लावसोनिया एल्बा)*, *कनेर (थीबेटिया नेरीफोलिया)*, *आक (कैलोट्रापिस प्रोसेरा)*, *मदार (कैलोट्रापिस जायिजेण्टिया)* *अरण्ड (रीसिनस कम्यूनिस)*, *बेर (जीजीफस मारिसियाना)*, *खैर (अकेसिया कटेचू)*, *सफेद कीकर (अकेसिया ल्यूकाफोलिया)* *शीशम (डेलबर्जिया शीशू)*, *ईमली (टेमरिण्डस इण्डिका)* तथा *खेजरी (प्रोसोपिस सिनेरेरिया)* जैसे कठोर पौधों की प्रजातियों के रोपण से संरक्षण प्रदान किये जाने की तत्काल आवश्यकता है।

यद्यपि बीहड़ भूमि का पुनरूत्थान मुश्किल कार्य है बावजूद इसके *खैर (अकेसिया कटेचू)*, *खेजरी (प्रोसोपिस सिनेरेरिया)*, *पलास (ब्यूटिया मोनोस्परमा)*, *शिरीष (एल्बिजिया लिबेक)*, *नीम (एजाडिराक्टा इण्डिका)*, *शीशम (डेलबर्जिया शीशू)*, *चिलबिल (होलोप्टीलिया इन्ट्ग्रीफोलिया)*, *करंज (पानगैमिया पिन्नेटा)* तथा *नरबॉस (डेण्ड्रोकेलैमस स्ट्रिक्ट्स)* जैसी काष्ठीय प्रजातियों का रोपण कर बीहड़ भूमि को स्थिरता प्रदान किये जाने की आवश्यकता है ताकि बीहड़ भूमि विस्तार को रोका जा सके।

यद्यपि खनन गतिविधयाँ पर्यावरण के दृष्टिकोण से हानिकारक होती हैं परन्तु आर्थिक विकास के लिए अत्यन्त ही आवश्यक होती हैं। खनन गतिविधयों के कारण भूमि में जबरदस्त उलटफेर होता है फलस्वरूप नीचे की मृदा जिसमें पोषक तत्वों तथा कार्बनिक पदार्थों का अभाव होता है ऊपर आ जाती है जबकि इसके विपरीत ऊपर की उपजाऊ मृदा की परत नीचे चली जाती है। इस प्रकार खनन कार्य से प्रभावित भूमि की उपजाऊ क्षमता शून्य हो जाती है। खनिज सम्पदा सम्पन्न भारत में खनन गतिविधियाँ भूमि क्षरण का एक प्रमुख कारण हैं। खननकार्य से अव्यवस्थित भूमि का पुनरूत्थान उस क्षेत्र विशेष में पायी जाने वाली वृक्षों की देसी प्रजातियों से किये जाने की आवश्यकता है। जैसे उष्णकटिबंधीय जलवायु के

लिए *शीशम (डेलबर्जिया शीशू), करंज (पानगैमिया पिन्नेटा), खैर (अकेसिया कटेचू), सागौन (टेक्टोना ग्राण्डिस), अर्जुन (टर्मिनेलिया अर्जुना), बहेड़ा (टर्मिनेलिया बेलेरिका), आंवला (फाइलैन्थस एम्बिलिका), शिरीष (एल्बिजिया लिबेक), सफेद शिरीष (एल्बिजिया प्रोसेरा), घमार (मेलाइना आरबोरिया)* तथा *नीम (एजाडिराक्टा इण्डिका) जैसे* वृक्षों की प्रजातियाँ जैविक-पुनरूत्थान प्रक्रिया के लिए उत्तम होती हैं। वृक्षों के अतिरिक्त *दीनानाथ (पेनिसिटम पेडीसिलेटम)* एवं *चुराट (हेट्रोपोगान कनटार्ट्स)* जैसी देसी प्रजाति की घासें भी इस प्रकार की जलवायु के लिए अति उत्तम होती हैं। उपरोक्त वनस्पतियाँ खनन गतिविधियों से अव्यवस्थित भूमि को स्थिरता प्रदान करने के साथ-साथ मृदा पुनर्विकास प्रक्रिया में सहायक होती हैं।

नीलहरित शैवाल (सूक्ष्मजीवी पौधे) लवणीय एवं क्षारीय भूमि के पुनरूत्थान में अत्यन्त ही कारगर होते हैं। नीलहरित शैवालो जैसे- *नास्टाक, एनाबीना, अलोसाइरा, साइटोनीमा, सिलेण्ड्रोस्परमम ग्लियोट्राइकिया, आसैलिटोरिया, ग्लियोकैप्सा* तथा *स्टाइगोनीमा* की प्रजातियाँ आमतौर से लवणीय एवं क्षारीय मृदा की सतह पर आसानी से उगती हैं जिसके फलस्वरूप न केवल जीवांश पदार्थो की मात्रा में वृद्धि होती है अपितु नीलहरित शैवालों द्वारा नाइट्रोजन स्थिरीकरण के परिणामस्वरूप नाइट्रोजन की मात्रा में भी पर्याप्त वृद्धि होती है। जलीय पौधा *एजोला पिन्नेटा* भी लवणीय तथा क्षारीय भूमि के पुनरूत्थान के लिए उत्तम है। इसके अतिरिक्त *नीम (एजाडिराक्टा इण्डिका), इमली (टेमरिण्डस इण्डिका), अर्जुन (टर्मिनेलिया अर्जुना), करंज (पानगैमिया पिन्नेटा), आंवला (फाइलैन्थस एम्बिलिका), सफेद शिरीष (एल्बिजिया प्रोसेरा), खेजरी (प्रासोपिस सिनेरेरिया), बेर (जीजीफस मारिसियाना), सफेद शहतूत (मोरस एल्बा)* तथा *काला शहतूत (मोरस नाइग्रा)* जैसी बहुउपयोगी वृक्षों की प्रजातियों के रोपण से भी लवणीय एवं क्षारीय भूमि के उद्धार की आवश्यकता है। उपर्युक्त वृक्षों की प्रजातियाँ लवणीय एवं क्षारीय भूमि पर सफलतापूर्वक उगती हैं तथा अपने मृत अवशेषों जैसे- पत्तियों, टहनियों, पंखुड़ियों, फलों आदि से मृदा के भौतिक तथा रासायनिक गुणों को परिवर्तित कर कृषि योग्य बना देती हैं।

जल-जमाव से ग्रसित बंजर भूमि का पुनरूत्थान केवल जल निकासी से ही संभव है। जल-जमाव की समस्या आमतौर से नहर से सिंचाई वाले क्षेत्रों की समस्या है। जल-जमाव से निपटने के लिए आवश्यक है कि सिंचाई के दौरान जल का प्रबन्धन ठीक प्रकार से हो साथ ही खेत से अतिरिक्त जल के निकास के लिए नाली की उपयुक्त व्यवस्था हो।

निष्कर्ष

सिकुड़ते भूमि संसाधन आज देश के लिए एक गंभीर समस्या है। भूमि क्षरण का प्रत्यक्ष प्रभाव खाद्यान्न उत्पादन पर पड़ेगा जिससे न सिर्फ भूखमरी और कुपोषण जैसी समस्याओं में वृद्धि होगी अपितु कृषि पर आधारित देश की अर्थव्यवस्था पर भी विपरीत प्रभाव पड़ेगा। अतः देश को भूखमरी और कुपोषण से बचाने के साथ-साथ अर्थव्यवस्था की मजबूती के लिए उपजाऊ भूमि का संरक्षण एवं क्षरित भूमि का पुनरुत्थान अति आवश्यक है। भूमि संरक्षण के लिए पारम्परिक कृषि के स्थान पर संपोषित कृषि को अपनाना आज समय की सबसे बड़ी आवश्यकता है।

Indian medicinal trees - Obvious source of indigenous medicine in India

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Abstract

Diversity in medicinal plants was listed as a provisioning ecosystem service in the United Nations Millennium Ecosystem Assessment and they are started shrinking, deteriorating or vanishing across globe. India has had an ancient history of traditional healing systems that use medicinal plants across the subcontinent. Medicinal plants play a crucial role in drug discovery, with at least 25 percent of modern medicine being derived either directly or indirectly from them. Revitalization of medicinal tree diversity is one of the important resource for economic and ecosystem benefits in sustainable resource management approaches in any kind of ecosystem. Our paper highlights the importance of tree medicines and their traditional knowledge conservation in different agro-ecological regions. Challenges to conserving medicinal plants include overharvesting, biodiversity loss, eroding traditional knowledge and climate change. Demand for medicinal plant is increasing in both developing and developed countries due to growing recognition of natural products, being non-toxic, having no side-effects, easily available at affordable prices. Cultivation of medicinal trees for production of raw materials for industries can be taken up as an alternative land use system through mixed cropping system or integrated cropping system on existing marginal lands, farm boundaries and agroforestry lands. UN-SDGs is suggesting that the integration and mainstreaming of indigenous biodiversity conservation and ecological restoration of degraded ecosystems are of fundamental importance to the achievement of sustainability of the planet.

Introduction

India is endowed with a rich wealth of medicinal plants. These plants have made a good contribution to the development of ancient Indian *Materia Medica*. One of the earliest treatises on Indian medicine, the Charak Samhita (1000 B.C), records the use of over 340 drugs of vegetable origin. Most of these continue to be gathered from wild plants to meet the demand of the medical profession. The father of medicine, Hippocrates, Greak Physician over the millennia ago, quoted “Let food be your medicine and medicine be your food” i.e. our health depends on what we intake. When Laxman was seriously injured in battle and become unconscious, Hanuman was sent to fetch a herb from the Himalayas, since he could not recognize the exact herb that was needed, he brought back part of hillock with different herbs, out of which the attending Ayurvedic vaithya selected the right one. Even animal choose to eat certain plants for their medicinal value to maintain their health

and prevent the occurrence of diseases. In dearth conditions, vegetative matter was found in tiger feces, they probably choose to eat plants for the vitamin when they are starving (Shanker and Johnson, 2002). The curative properties of drugs are due to the presence of complex chemical substances of varied composition (present as secondary plant metabolites) in one or more parts of plants. These plant metabolites in one, according to their composition, are grouped as alkaloids, glycosides, corticosteroids, essential oils, etc. Millions of rural households use medicinal plants in a self-help mode. Over 20,000 practitioners of the Indian System of Medicine in the oral and codified streams use medicinal plants in preventive, primitive and curative applications in India. In recent years, the growing demand for herbal product has led to a quantum jump in volume of plant materials traded within and across the countries (Kumar, 1996).

Forests have played key roles in the lives of people living in both mountains and lowland areas by supplying fresh water and oxygen as well as providing a diversity of valuable forest products for food and medicine. The age-old traditional values attached with the various forest types and the varieties of forest products (i.e., medicinal plants) have gained tremendous importance in the present century. Furthermore, the cosmetic industries are increasingly using natural ingredients in their products, and these natural ingredients include extracts of several medicinal plants. India and China are two of the largest countries in Asia, which have the richest arrays of registered and relatively well-known medicinal plants. Since the Indian subcontinent is well known for its diversity of forest products and the age-old healthcare traditions, there is an urgent need to establish these traditional values in both the national and international perspectives realizing the ongoing developmental trends in traditional knowledge. Apart from health care, medicinal plants are mainly the alternate income-generating source of underprivileged communities; therefore, strengthening this sector may benefit and improve the living standard of poor people.

Emergence of tree based drugs

Drug is the cornerstone of medical service and this has well been appreciated even in centuries past. Indeed, drugs were as strategic to national interest as energy is in modern times. History records that during the Hellenic civilization, Alexander the Great was advised to conquer the island of Socotra near the East African shores for the purpose of getting the drug Aloe to treat his wounded soldiers. More recently, the two world wars demonstrated a paradoxical synergy between military adventurism and drug development. As a consequence of the Japanese occupation of Java, the allied countries were deprived of access to this commercial source of *Cinchona febrifuge*, the only reputable remedy for malaria. They were forced to look for a substitute through synthesis. Using quinine, the active ingredient of *Cinchona*, first isolated in 1820, as template, a number of simpler molecules were independently studied in Germany, USA, and Soviet Union before and during the Second World War. The anti-malarial drug, chloroquine, emerged from this

effort but evidence later showed that it had been synthesized in Germany as far back as 1934 but was rejected in favour of sontoquine on the suspicion of toxicity. It is remarkable that the search for newer anti-malarial to support the USA military campaign in Asia led the US Army Medical Research and Development Command to Sponsor a massive research programme that led to the development of mefloquine as a third generation anti-malarial drug. There has been resurgence in the consumption and demand for medicinal plants. These plants are finding use as pharmaceuticals, neutraceuticals, cosmetics and food supplements. Even as traditional source of medicines and they continue to play pivotal role. The World Health Organization (WHO) estimated that 80% of the population of developing countries still relies on traditional medicines, mostly plant drugs, for their primary health care needs. Also, modern pharmacopoeia contains at least 50% drugs derived from plants. Many other are synthetic analogues built on prototype compounds isolated from plants. Demand for medicinal plant is increasing in both developing and developed countries due to growing recognition of natural products, being non-toxic, having no side-effects, easily available at affordable prices.

Status of plants as a source of Medicine

In India, both indigenous and introduced has been variously put of between 3000 to 3500 species of higher plant. Approximately, 2500 plants have been reported to be used in ethno medicine (Jain, 1991). Major export destinations for Indian medicinal plant based raw material include USA, Germany, Japan, UK, France, Taiwan, Italy, Pakistan and Hong Kong. The global market for medicinal plant based raw drugs is estimated to be worth US$ 1.03 billion per annum. India's export share in this global market is about 8% with China (24%) and USA (11%) being the leaders. However, India's global market share becomes negligible (0.3%) if the annual global herbal market including medicines, cosmetics and food supplements valued at US$ 62 billion is taken into consideration. The present major importer of medicinal plants is Hong Kong followed by USA, Japan and Germany. However, India's export share to Hong Kong is very low. Because of the problem of safety with modern system of medicine, there is increasing global interest in traditional and herbal medicines. According to WHO's 2013 report, over 80% of world population relies on traditional medicines, largely plant based, for their primary health care needs (WHO, 2013). India, one among 12 Bio-diverse countries of the world, is abode of 45000 floral species, out of which 15000 are those of Medicinal Plants. Approx. 85% to 90% of these come from the wild. Department of ISM and H, Ministry of Health and Family Welfare, Govt. of India, has identified 1500 medicinal plants of which 500 are commonly used in the preparation of herbal drugs. There are 150 species have been categorized as endangered'.

Distribution of Medicinal trees in India

It is evident that the Indian people have a tremendous passion for medicinal plants and use them for a wide range of health related applications from a common cold to memory improvement and treatment of poisonous snake bites to a cure for

muscular dystrophy and the enhancement of body's general immunity. In the oral traditions local communities in every ecosystem from the Trans Himalayas down to the coastal plains have discovered the medical uses of thousands of plants found locally in their ecosystem (Gadgil, 1992). India has one of the richest plant medical cultures in the world. It is a culture that is of tremendous contemporary relevance because it can on one hand ensures health security to millions of people and on the other hand it can provide new and safe herbal drugs to the entire world. Macro analysis of the distribution of medicinal plants shows that they are distributed across diverse habitats and landscape elements. Around 70% of India's medicinal plants are found in tropical areas mostly in the various forest types spread across the Western and Eastern ghats, the Vindhyas, Chotta Nagpur plateau, Aravalis and Himalayas. Although less than 30% of the medicinal plants are found in the temperate and alpine areas and higher altitudes they include species of high medicinal value. Macro studies were given clarity that a larger percentage of the known medicinal plants occur in the dry and moist deciduous vegetation as compared to the evergreen or temperate habitats. One third is trees and equal portion shrubs and the remaining one-third herbs, grasses and climbers. A very small proportion of the medicinal plants are lower plants like lichens, ferns algae, etc. Majority of the medicinal plant are higher flowering plants (Uniyal *et al.*, 2006**)**. Of the 386 families and 2200 genera in which medicinal plants are recorded, the families Asteraceae, Euphorbiacae, Laminaceae, Fabaceae, Rubiaceae., Poaceae, Acanthaceae, Rosaceae and Apiaceae share the larger proportion of medicinal plant species with the highest number of species (419) falling under Asteraceae . About 90% of medicinal plants used by the industries are collected from the wild. While over 800 species are used in production by industry, less than 20 species of plants are under commercial cultivation. Over 70% of the plant collections involve destructive harvesting because of the use of parts like roots, bark, wood, stem and the whole plant in case of herbs. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants if biodiversity is not sustainably used.

Trees in Indian Medicine System

Indian System of Medicine includes Ayurveda, Naturopathy, Ayurveda, Unani, Siddha and Homeopathy. Ayurveda originated in India long back in pre-vedic period, Rigveda and Atharva-veda (5000 years B.C.), the earliest documented ancient Indian knowledge had references on health and diseases. Ayurveda texts like *Charak Samhita* and *Sushruta Samhita* were documented about 1000 years B.C. The term Ayurveda means 'Science of Life'. It deals elaborately with measures for healthful living during the entire span of life and its various phases. Besides, dealing with principles for maintenance of health, it has also developed a wide range of therapeutic measures to combat illness. Thus Ayurveda becomes one of the oldest systems of health care dealing with both the preventive and curative aspects of life in a most comprehensive way and presents a close similarity to the WHO's concept of health propounded in the modern era. Naturopathy is a well-defined concept of

health care, that Natural Therapeutics is Naturopathy in action where patients are treated in a variety of non-suppressive ways in order to remove as many obstructions to self-healing as possible. It will stress the important role of Naturopathy in health maintenance and the avoidance of ill health. A radical rethinking by the patient of the meaning of health and disease and a radical change of lifestyle may often be called for, which makes it implicit that the practitioner is a re-educator as well as a therapist (Goodman, 1998).

Unani Medicine is based on the Greece philosophy (Khaleefathullah, 2000). According to Basic Principles of Unani the body is made up of the four Basic elements i.e. Earth, Air, Water, Fire which have different Temperaments i.e. Cold, Hot, Wet, Dry. After mixing and interaction of four elements a new compound having new temperament comes into existence i.e. Hot Wet, Hot Dry, Cold Wet, and Cold Dry. The body has the Simple and Compound Organs, which got their nourishment through four, Humours i.e. Blood, Phlegm, Yellow Bile, Black Bile. The humour also assigned temperament as blood is hot and wet, Phlegm is cold and hot, yellow bile is hot and dry and black bile is cold and dry. Siddha system is one of the oldest systems of medicine in India. The term Siddha means achievements and Siddhars were saintly persons who achieved results in medicine. Eighteen Siddhars were said to have contributed towards the development of this medical system. Siddha literature is in Tamil and it is practiced largely in Tamil speaking part of India and abroad. The Siddha System is largely therapeutic in nature. The Siddha was flouriest in south and Ayurveda prevalent in the north. Instead of giving the name of any of individual as the founder of these systems our ancestors attributed their origin to the creator. According to tradition, the origin of Siddha system of medicine is attributed to the great Siddha Agastiyar. Some of his works are still standard books of medicine and surgery in daily use among the Siddha Medical practitioners

Homeopathy is an effective and scientific system of medicine, which assists the natural tendency of your body to heal itself. It recognizes the individuality of each person and that disease is expressed through physical, mental and emotional symptoms in a pattern that is essentially unique. German physician Samuel Hahnemann was the founder of homeopathy. Homoeopathy today is a rapidly growing system and is being practiced almost all over the world. In India it has become a household name due the safety of its pills and gentleness of its cure. A rough study indicates that about 10% of the Indian population solely depends on Homoeopathy for their Health care needs. It is more than a century and a half now that Homoeopathy is being practiced in India. It has blended so well into the roots and traditions of the country that it has been recognized as one of the National Systems of Medicine and plays an important role in providing health care to a large number of people. Its strength lies in its evident effectiveness as it takes a holistic approach towards the sick individual through promotion of inner balance at mental, emotional, spiritual and physical levels.

Yoga is not strictly called as Indian System of Medicine. The tradition of Yoga was born in India several thousand years ago. Its founders were great Saints and Sages. The great Yogis gave rational interpretation of their experiences about Yoga and brought a practically sound and scientifically prepared method within every one's reach. Yoga philosophy is an Art and Science of living in tune with Brahmand- the Universe. The Science of Yoga and its techniques have now been re-oriented to suit modern sociological needs and lifestyle. Experts of various branches of medicine including modern medical science are realizing the role of these techniques in the prevention of disease and promotion of health. Yoga is a science as well an art of healthy living physically, mentally, morally and spiritually. It's systematic growth from his animal level to the normalcy, from there to the divinity, ultimately. It's no way limited by race, age, sex, religion, cast or creed and can be practiced by those who seek an education on better living and those who wants to have a more meaningful and peaceful life.

Indian medical systems, among them the ancient science of Ayurveda, have always been aware of the medicinal value of plants. To cite but one example, for at least 2500 years before the West recognized the medicinal properties of the *Rauwolfia* root that Indian medicine men had been using it to calm violently disturbed patients. They called it snakeroot and used it to treat, apart from `moon madness' or lunacy, a whole range of afflictions, from snakebite to cholera. In the 1940's Indian scientists isolated the active substances from *Rauwolfia* and discovered its added benefit as a remedy for high blood pressure. For thousands of years, Indian plants have been attracting attention in foreign countries. Dioscorides mentions many, including *Datura* smoke for treating asthma, *nux vomica* for paralysis and indigestion, croton as a purgative. Pliny complained of the heavy drain on Roman gold to buy costly Indian drugs (and spices). Many other plants that have been used exclusively in folk medicine now have allopathy hunting for them. These include small tree like *Cassia fistula*, which shows antibiotic activity (Tewari, 1994).

India has an impressive list of medicinal plants, almost all of them native to the soil. Towering above the rest is the Neem (Margosa). All parts of this ubiquitous tree are bitter and are used in medicine. A decoction of neem leaves helps fevers, particularly malarial fevers, and liver problems such as hepatitis, boils and all kinds of skin diseases. Amla (*Emblica officinalis*) has been hailed as a nugget of Vitamin C in heat stable form. One Amla fruit is said to pack more Vitamin C than a dozen oranges. It is great for treating respiratory complaints and for rejuvenation of both body and the hair. According to Charka, august physician of yore and father of Ayurveda, a regular intake of amla or amla-based preparations is a sure method of stalling the ageing process. A small thorny dry land tree known as beal (*Aegle marmelos*) which yields a fruit that is a panacea for digestive disorders (Photo-1). The bamboo has, on the inside of its stem a white, powder deposit known as 'tavashir' which has marked decongestant properties, particularly useful as a local application in tonsillitis. The large, handsome evergreen

camphor tree is the traditional (as opposed to synthetic) source of camphor. Used extensively in ritual worship, camphor is a favored ingredient of liniments and medicinal oils because it liquefies obstinate body secretions and causes them to flow. Gugul (*Commiphora mukul*), a small tree which grows in arid regions, produces a resin with marked anti-inflammatory properties, making it perhaps the best medicine going for arthritis. It also helps scrape away fat from the body (Chopra *et al.*, 1956). Some of the medicinal trees extensively used in all Indian System of Medicine (Table 1).

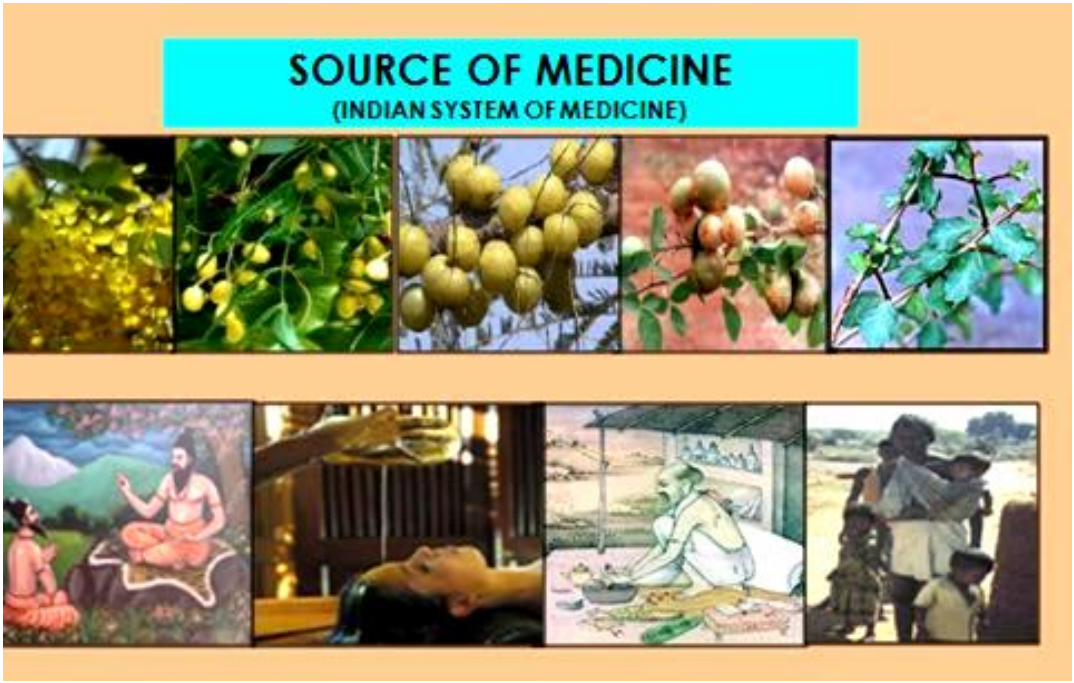

Photo-1: Indian Trees – Importance in Traditional Medicinal System
(*Sources: Few Images adopted from web source)*

Table 1. Medicinal trees to cure common ailments in Indian System of Medicine

Name of the medicinal tree	Part used	Uses
For relief, fever and pain		
Semicarpus anocardium	Oil extract from seed	Applied on forehead in headache
Bauhinia purpurea	Stem and bark decoction	Consumed in body pain and fever
Azadirachta indica	Fruits, seed and oil	Decoction for antiseptic lotion and applied in cuts, wounds and bites

Asthma, cough and cold		
Ailanthus excelsa	Bark decoction	Chronic bronchitis and asthma
Zizyphus sativa	Dried fruit shrub	Bronchitis
For Relict in gynecological disorders		
Bombax ceiba	Leaves and root decoction	Given to cure women suffering from white discharge in urine
Bambusa vulgaris	Leaf decoction	Cure urinary problem

Because of easy accessibilities, low cost, cultural acceptability, long term family association, elaborate patient healer relation and friendly attitude of the healers. The popularity of indigenous knowledge system between the tribal and draws the attention of phytochemist and pharmacologist for further scientific study especially to determine the active components of the plants, which are used by the tribal (Giradkar and Yeragi, 2006) (Table 2). Rheumatoid Arthritis is most common form of chronic inflammative joint disease. It is typical form of Rheumatoid Arthritis is a symmetrical, destructive and affecting small and large synovid joints, with associated systemic disturbance, a variety of extra-articular feature. Reddi *et al.*, 2005 reported that some common tree species are extensively used in this disease cure. In Indian medicine system, so far, totally 380 species were documented for curing this disease and out of which more than 100 species were from tree origin. Some important trees used to cure this disease are tabulated here under (Table 3).

Table 2. Preference of some indigenous trees to cure common diseases

Name of the tree	Family	Uses
Acacia catechu	Mimosaceae	Root is used in leprosy, skin disease and bark is used in leucoderma
Acacia leucophloea	Mimosaceae	Bark is given to malaria, stomachache toothache, hysteria
Haldinia cordifolia	Rubiaceae	Bark - skin allergies and ulcer
Aegle marmelos	Rutaceae	Fruit – dysentery, constipation, peptic ulcer and internal hemorrhages
Albizzia lebbeck	Mimosaceae	Root and bark – fever Leaves – diabetes

		Oil from seed – Leprosy
Anogeissus latifolia	Crassulaceae	Bark – anemic Fruit – constipation
Boswellia serrata	Burceraceae	Gum – rheumatism, nervous disorder, skin disease, urinary disorder Bark – blood dysentery
Buchania lanzan	Anacardiaceae	Seed – good for heart Oil from kernel – skin disease
Butea monosperma	Fabaceae	Seed – leucoderma
Cassia fistula	Caesalpiniaceae	Leaves – skin disease psoriasis, scabies and ringworm Pod – purgative
Dendrocalamus strictus	Poaceae	Jaundice, leucoderma
Diospyros melanoxylon	Ebenaceae	Dried flower used in urinary, skin and blood diseases
Madhuca latifolia	Sapotaceae	Flowers yield a distilled spirit which is astringent tonic nutritive, bark used for ulcer
Mangifera indica	Anacordiaceae	Fruit – Vitamin A, B, C, D
Pterocarpus marsupium	Fabaceae	Wood – reducing obesity
Schleichera oleosa	Sapindaceae	Oil from seed – promote hair growth
Tectona grandis	Verbenaceae	Seed – kidney stone Wood – headache, vomiting and obesity control Oil from flower – promote hair growth
Terminalia alata	Combrataceae	Ash of bark – paralysis and cough
Terminalia arjuna	Combrataceae	Bark – heart tonic
Terminalia bellerica	Combrataceae	Fruit – cough, sore throat and headache

Terminalia chebula	Combrataceae	Bark – diuretic and cardio tonic

Table 3. Trees for curing Rheumatoid Arthritis

Species	Chemical constituents	Uses
Acacia auricliformis	Tetracacidin,isotetracacidin	Flower juice
Acacia catechu	Kampferol,dihydrokampferol,taxifoline	Root paste
Adonsonia digitata	Ascorbic acid, pectin and quercetin	Young leaves
Adina cordifolia	Cordifoline, adifoline	Bark
Albizia procera	b-sistosterol,	Stem bark
Aquilaria agallocha	Agarospirol from oil	Wood
Boswellia serrata	Serratol,thujene	Bark, gum
Cassia fistula	Fistucadin from bark	Stem bark, Pulp and leaves
Cinnamomum zeylanicum	Cinnzeylanin and cinnamon quills	Oil from leaves
Ficus bengalensis	Stem bark-Leuco-anthocyanins	Milky juice of bark
Juglans regia	Juglone	Leaves
Madhuca indica	Lupeol acetate,b-amyrin acetate	Oil from seed, decoction of bark
Melia dubia	Salannin from fruit	Stem bark
Pongamia pinnata	Ponganones	Root bark and seed oil
Stercul;ia urens	Stercurensin	Stem bark
Strycnos nuxvomica	Isobrucine,isobrine	Pulp of fruits

Diabetes is a lifelong disease marked by high levels of sugar in the blood. It develops due to body's inability to make appropriate use of food as a result of insufficient insulin a hormone produced by the pancreas to regulate blood level. To compact the diabetes a number of plant products not only in from the drugs but as food can be included in diet. Higher fiber foods like fruits, vegetables and whole grain etc. A number of commonly available plants like *Asparagus* and *Mimosa* etc. can also be taken in the form of drugs to normalize the blood sugar. As per recent records, in Indian medicine system, totally 811 plant species documented for curing this diseases and out of which more than 200 species from tree origin (Mubeen *et al.*, 2005). Gupta and Uniyal, (2003) reported that the wood from various forest is also used in Indian System of medicine. These woods are highly priced in market for multipurpose use (Table 4 & Photo.2).

Table 4. Indian woods and their medicinal importance

Botanical name	Uses
Acacia catechu	Katha from Heartwood, used in digestion and cough and valued as astringent for chewing with betal
Aquilaria agallocha	Fragrant, carbonative, laxative, diuretic, chronic diarrhea, leucoderma, bad taste in mouth, disease of level, asthma, rheumatism, paralysis
Chinnamomum camphora	Antiseptic, every part is used, sedative, internally for cold and chillness and externally for inflammation
Dalbergia sissoo	Enriches the blood, eye diseases, nose, syphllis, stomach trouble, leprosy
Garuga pinnata	Juice from stem is dropped in the eye to cure opacities of the conjunctiva
Pterocarpus santalinus	Cooling tonic, aphrodisiac, thrust eye disease, blood disease, mental abrasion, ulcer and fever
Pterocarpus marsupium	Controlling diabetes
Santalum album	Cooling aphrodisiac, small parts heart diseases, cold and bronchitis
Strychnus nuxvomica	Juice of fresh wood given in dose of a few drops for cholera and acute dysentery, wood is popular remedy for dysentery

Photo. 2. Rare and indigenous medicinal Root, Fruit, Seeds, Bark, and Wood chips: Commonly available for sale in local markets in India

(Image adopted from web sources)

Conservation and Awareness Creation

There is a time bound need of collective efforts from botanist, ethnobotanists and Pharmacologists to document conserve and evaluate the efficiency of these valuable drugs. Therefore, awareness creation campaigns especially with school and college students are urgently needed to improve local community's knowledge on the importance and management of medicinal trees and native medicinal plants (Photo-3). *In situ* conservation has come to be widely regarded as the only viable and cost effective measure to allow the species to follow the natural evolutionary course in interaction with their habitat and within themselves. The existing information on the medicinal plant diversity in the country is sketchy and lies scattered with various research institutes across the country, Whereas the existing information needs to be compiled, a comprehensive programme to document the diversity and current status of medicinal plants in the country needs to be initiated.

Photo.3: Mass awareness creation programme about native medicinal plants

Conclusion

Cultivation of commercially important medicinal plants on private land is required both to conserve the species and to ensure the supply of quality raw material to the industry. Due respect must be given to the indigenous botanical knowledge of the local / traditional practioners to ensure equality in benefit sharing and increased participation in conservation. Since the local people are the custodians of the medicinal plant knowledge and the resources, their participation in conservation of medicinal plants is essential for long-term cooperation and sustainability. Hence, it will further helpful for several other bio-chemical studies for extracting commercial value through value addition of indigenous medicinal trees. Further bio prospecting will throw light on more medicinal trees in determination of their status, distribution and ecology will help in their propagation, commercial utilization and conservation. Cultivation efforts of medicinal trees for production of raw materials for industries can be taken up as an alternative land use system or mixed cropping system on existing marginal farm lands as a boundary plantation or agroforestry systems. Therefore, there is immediate need to conserve these important tree species for sustainable uses for the future. Efforts should be taken to start sustainable cultivation and harvesting programs in the dry regions. This may foster the reappearance of certain medicinal tree species valuable to local livelihoods and thereby promote local acceptance of forest expansion and medicinal tree conservation.

Coconut crop conquerors: A close look at invasive insect pests in India

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Introduction

In the 21st century, one of the greatest global threats is biological invasions, which disrupt ecosystems and significantly impact socio-economic sectors. These invasions, driven by globalization, are escalating at an alarming rate, posing persistent threats to biodiversity, ecosystem services, and agricultural productivity.

In agriculture, invasive pests, pathogens, weeds, and vertebrate species cause substantial losses to crops, often thriving unchecked due to the absence of natural enemies in their new environments. An invasive species is an introduced organism that proliferates uncontrollably, adversely affecting habitats and ecosystems.

This chapter provides an overview of invasive or alien species that pose significant challenges to coconut crops (*Cocos nucifera* L.) (Table 1.), highlighting their impacts and the urgent need for effective management strategies.

Table 1: Invasive pest species on coconut

S.N.	Crop	Pest common name	Scientific name	Introduced from	Year of introduction	Current IUCN status
1.	Coconut	Rugose spiraling whitefly	*Aleurodicusrugiopercul atus*	Central America	2004	Invasive and devastating pest
2.		Red palm weevil	*Rhynchophorus ferrugineus*	Middle east	1891, 1917	Invasive and threatened species
3.		Coconut perianth red mite	*Aceriaguerreronis*	Mexico	1990	Invasive and threatened
4.		Rhinoceros beetle	*Oryctes rhinoceros*	South east Asia and	1900	Invasive and

				Sri Lanka		endangered
5.		Coconut leaf beetle	*Brontispa longissimi*	Indonesia	1999	Invasive and threatened
6.		Bonders nesting whitefly	*Paraleyrodesbondari*	Uganda	2010	Invasive and devastating
7.		Black headed caterpillar	*Opisinaarenosella*	South Asia	1990	Invasive and damaging

(Selvaraj*et al*., 2019, 2020; Josephrajkumar*et al*., 2023)

Rugose spiraling whitefly–*Aleurodicusrugioperculatus* Martin (Hemiptera:Sternorrhynca: Aleyrodidae)**:**This pest has its nativity with Central America and was seen around the year 2004 and from there itspreaded widely to India in the year 2017 and was reported as invasive and devastating pest in Tamil Nadu, Andhra Pradesh, Karnataka and Gujarat (Fig. 1.).

Nature of damage and symptoms -The infestation due to the pest was observed very severe in all the palms present in the field and lower leaves were mostly infested as compared to the middle and upper leaves. The population of RSW was observed on both tall and dwarf palms, but it was severe in dwarf and hybrid coconut palms.

Both nymphal and adult stage cause damage to the plant. The nymphs suck the sap from the leaves and adults colonize on the lower surface of the leaves and lays eggs in a spiral manner. Due to the feeding, it produces honey dew which results in sooty mold growth and affects the photosynthetic metabolism of the plant.

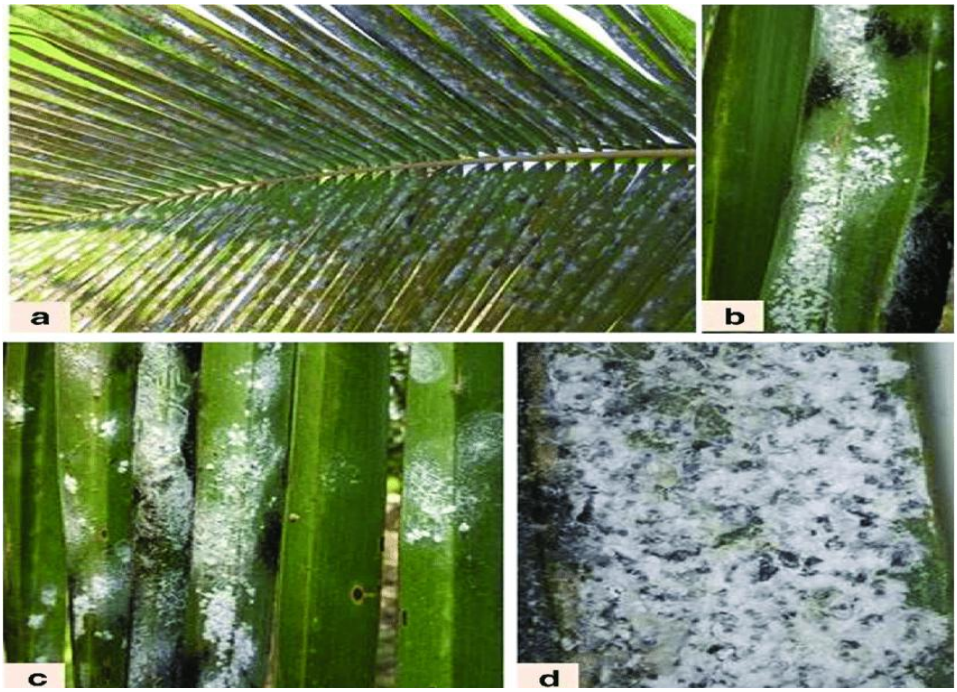
Management: -

1. Avoid transplanting of affected seedlings
2. Proper spacing
3. Encourage build-up of natural parasitoid *Encarsia*sp.
4. Targeting lower leaflets with water sprays.

Current status

The invasive pest, *A. rugioperculatus* has already caused significant damage in the India. Currently, this pest has invaded mainly in coconut fields of Saurashtra region of Gujarat state and also Pollachi region of Tamil Nadu. The morphological and molecular identification lead to confirmation of first ever report of the new invasive pest, rugose spiraling whitefly *A. rugioperculatus* Martin (Hemiptera: Aleyrodidae) in coconut fields of Gujarat state, India. The current incidence of RSW in Gujarat is alarming due to its polyphagous nature and hence it has a great potential to extend its host range and spread to other coconut growing areas in the Gujarat state (Rao *et al*., 2018).

5. Spray with 0.5% neem oil or 5% NSKE.
6. Installation of yellow sticky traps 15/ acre.
7. Build-up of natural predators like *Chrysoperlazastrowisillemi*and coccinellids.
8. Spraying with imidacloprid 0.005% in severe cases.



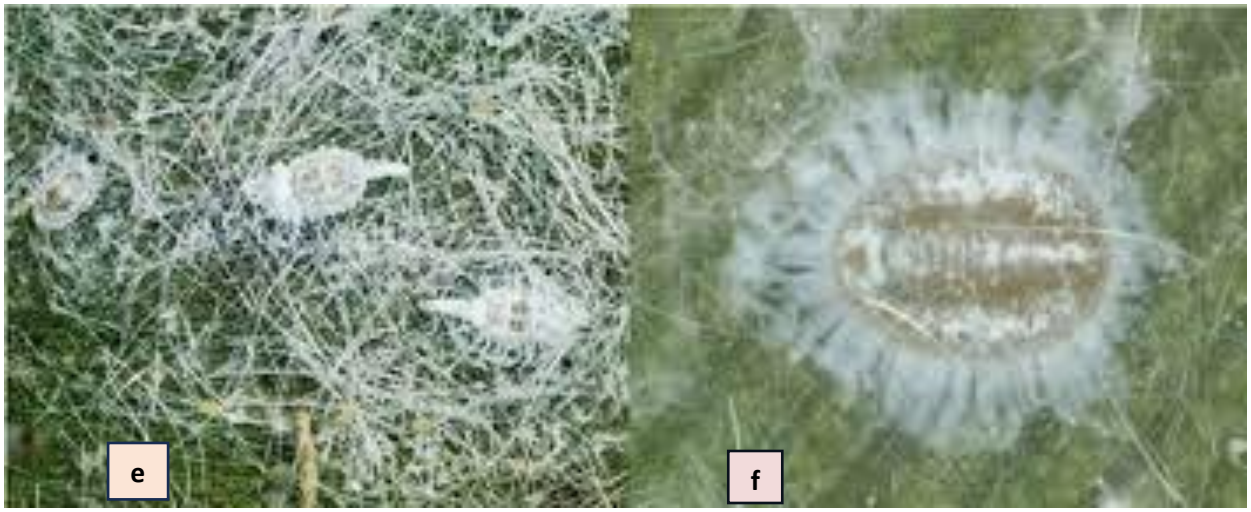


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Fig. 1. Different live stages of *A. rugioperculatus*(a-d),closer view (e-f), sooty mold (g).

Red palm weevil- *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae)**:** This pest has its nativity to Middle East around 1891 and widely spreaded to India and Malaysia in the year 1917. And from there it is being reported as invasive and threatened species around several parts of the world (Fig. 2).

Nature of damage and symptoms: - It affects both younger and matured trees and causes ambiguous damage to the crown and causes the death of crown part of the plant.

Adult and grub stage cause the symptoms. It causes holes on trunk with brownish ooze, yellowing of inner leaves and gradual wilting of central shoot in the crown.

Current status: - It has been recorded as serious invasive pest in parts of Malaysia and India (El-Shafie *et al*., 2020).

Management: -

1. Remove all wilted and damaged portion of stem and crown.
2. Fill the crown and axil of top three most leaves with a mixture of fine sand and neem powder 2:1 ratio.
3. Plug all the holes and inject 1% Carbaryl.
4. Root feeding with Monocrotophos.
5. Install pheromone traps Ferrolure @ 12/ ha.


Adult (100-120days)
Eggs (4-7 days)
Larvae (60-105 days)
Pupae (13-17 days)
Pre-pupae (3-6 days)

a

b

Fig. 2. Life cycle (a), Adult Weevil (b) and Damage symptoms (c)

Coconut perianth mite - *Aceriaguerreronis*, (Acarina: Eriophyiidae)**:**This pest has its nativity to Mexico and was introduced to India in the year 1990 through coconut imports and now it is a devastating pest in parts of Tamil Nadu, Karnataka, Kerala(Fig. 3.).

Nature of damage and symptoms: - It is an important pest species of coconut, date palm and other palms. It affects the coconut trees during the button formation stage and young seedlings highly susceptible.

Triangularpaleyellowpatches close to perianth, necrotic tissues. brown coloured patches, longitudinal fissures and split on the husk. oozing of gummy exudation from affected part. malformed nuts and reduced size and copra content.

Current status: - It is a serious pest in most of the eastern and western hemispheres of the world. Recently caused heavy economical damage to the farmers in Hassan district of Karnataka (Navia*et al*., 2010).

Management: -

1. Grow sun hemp as intercrop and casurina as border crop to prevent the air – borne mites.
2. Application of neem cake and organic manure.
3. Root feeding with TNAU Agro Biocide 30ml/tree.

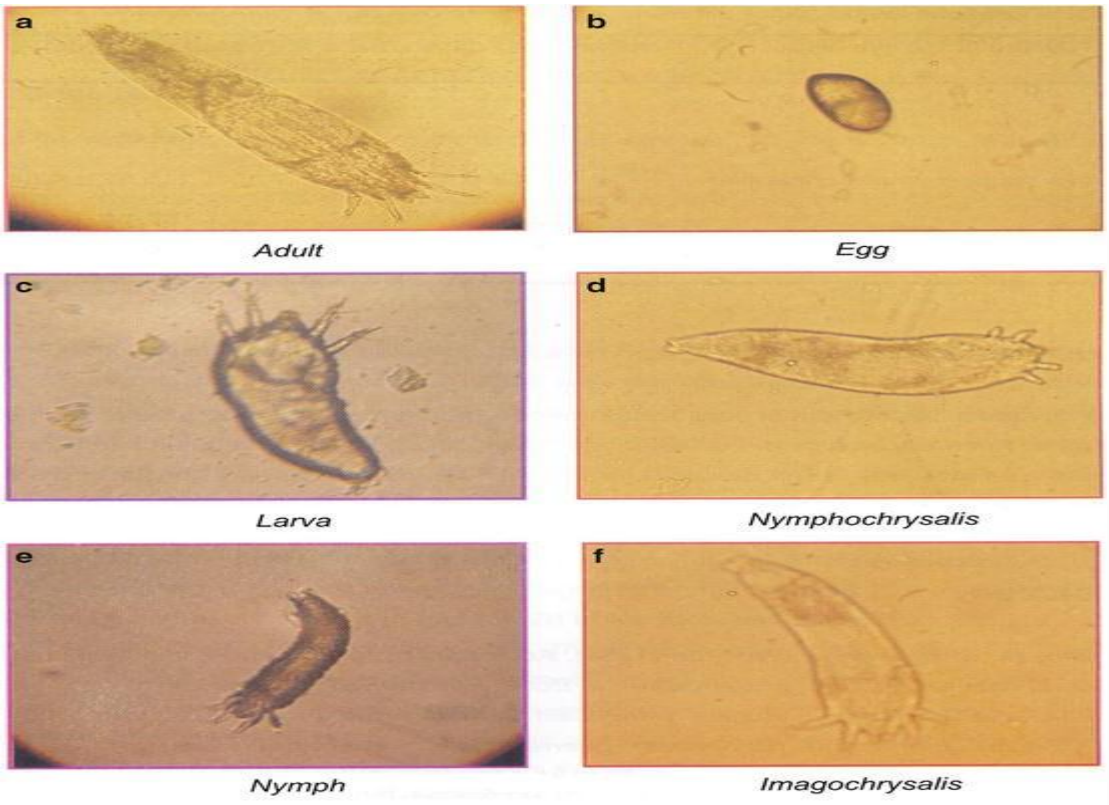

Fig. 3. Closer view of mites with different life stages (a-f)

Rhinoceros beetle –*Oryctesrhinoceros* (Coleoptera:Scarabaeidae)**:** This pest has its nativity to South East Asia and Sri Lanka and was introduced to India in the year 1900. From then it is considered as an invasive and damaging pest of coconut trees (Fig. 4).

Nature of damage and symptoms: - Adult stage is the damaging stage and young seedlings and matured trees both are infected.

Central spindles appear cut or toppled. Fully opened fronds showing characteristic diamond shaped or V– shaped cuttings. Holes with chewed fibre sticking out at the base of central spindle.

Current status: - It is a serious pest all over southern India (Bedford, 2013).

Management: -

1. Maintain sanitation in coconut fields.
2. Collect and destroy various stages from manure pits.
3. Use of entamopathogenic fungi, *Metarhizium anisopliae*.
4. Examine crowns of tree and kill the adults.
5. Place Phorate 10 G in perforated sachets in the inner most leaf axil.
6. Set up Rhinolure pheromone traps @ 1/ ha.

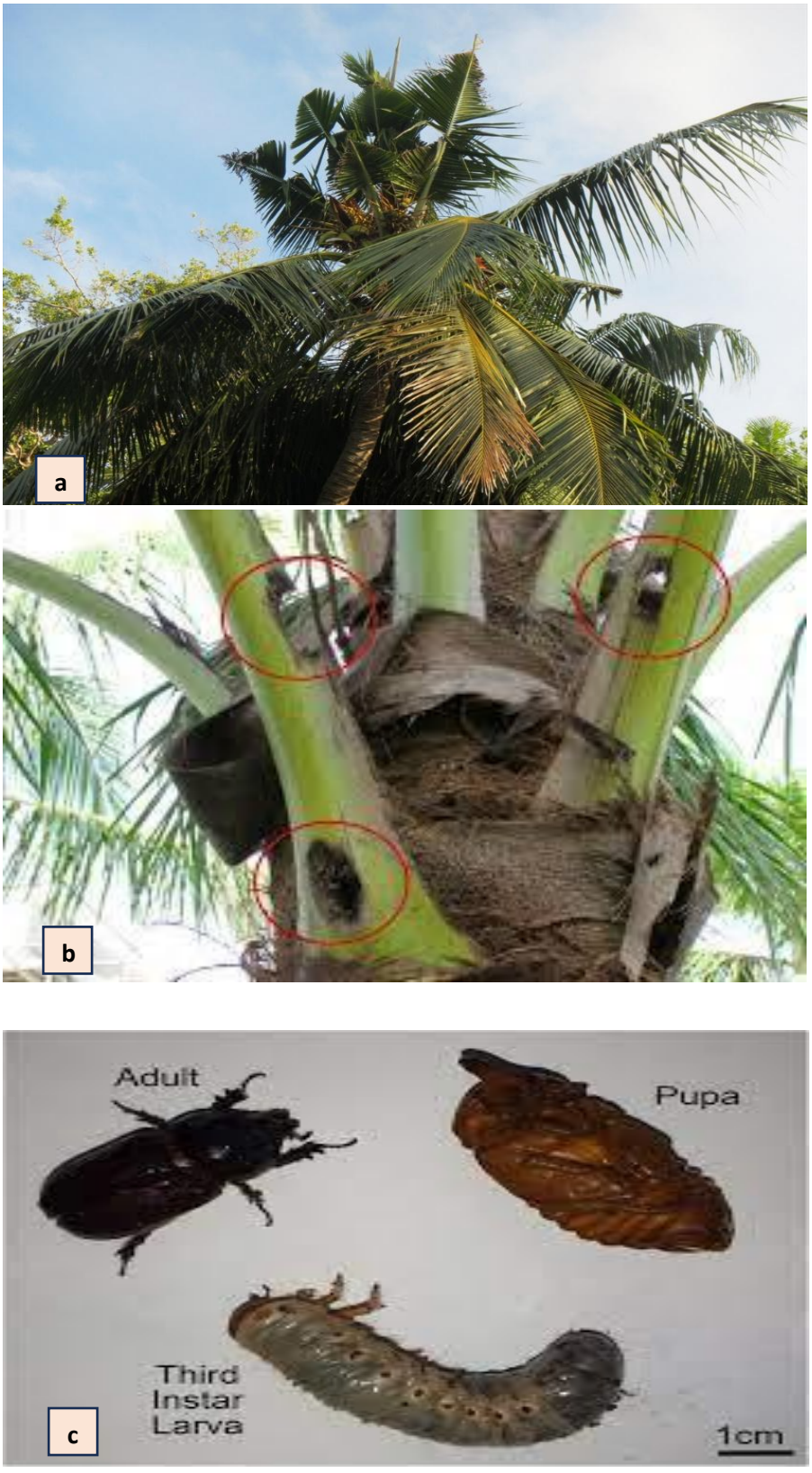

Fig. 4. Symptoms of infested palms (a), closer view of damage (b) and different live stages (c).

Coconut leaf beetle: - *Brontispa longissimi* (Coleoptera: Chrysomelidae)**:** This pest has its nativity to Indonesia and it has spreaded to India in the year 1999. It is an invasive and threatened species and causes serious economical damage (Fig. 5).

Nature of damage andsymptoms:-The coconut leaf beetle (*Brontispalongissima*) is one of the most damaging pests of coconut and other palms. The larvae and adults of the beetle feed on the soft tissues of the youngest leaf in the throat of the palm. Affected leaves dry up, resulting in stunting of the palm and reduced nut production. Prolonged attacks on young palms can lead to their death. The beetle attacks more than 20 palm species with coconut (*Cocos nucifera*) being the most favored host.

The beetle attacks palms of all ages, but young palms are more susceptible than older ones, because the heart leaves of old palms are firmer and less suitable as breeding grounds for the beetle. Larvae of the beetle chew on large areas of the surface of leaflets still in the throat of the palm (the spear leaf), which causes the death of underlying tissues. Such leaflets show longitudinal white streaks. As the leaf emerges, the leaflets curl and turn brown, giving a characteristic scorched and ragged appearance. Photosynthesis is reduced to zero in affected leaflets. As the spear unfurls, the beetle moves on to other palms or the next emerging spear. The beetle does not attack leaves that emerge undamaged. Severe attacks destroy unopened leaves, affect growth of the palm and reduce its productivity. In most cases, all the central leaves of affected palms appear brown and fruit shedding is common in such palms. Stunted palms with less compact hearts are more susceptible to leaf beetle attacks.

Current status:-It is widely spread and is a serious problem in Kerala and Tamil Nadu in India (Galicia*et al*., 2023).

Management: -

1. Blockading and cutting of coconut palms up to three kilometers from the infestation spot are done to prevent the beetle from spreading. The pest is also controlled by pruning, clean culture and proper disposal of infested coconut palms and parts thereof.
2. Several insecticides including imidacloprid, dieldrin, aldrin, phosdrin, aldicarb, dichlorvos, fenthion, monocrotophos, chlorfenvinfos, idiofenphos, trichlorophon, quinalphos, deltamethrin, dimethoate, cypermethrin, diazinon, azinophos, methidathion and chlordane are being used to control the coconut leaf beetle
3. Two parasitoids of coconut leaf beetle *viz*., *Tetrastichusbrontispae* and *Asecodeshispinarum*, have been successfully used in several countries to control the beetle.Use of the entomopathogenic fungus *Metarrhizium anisopliae.*

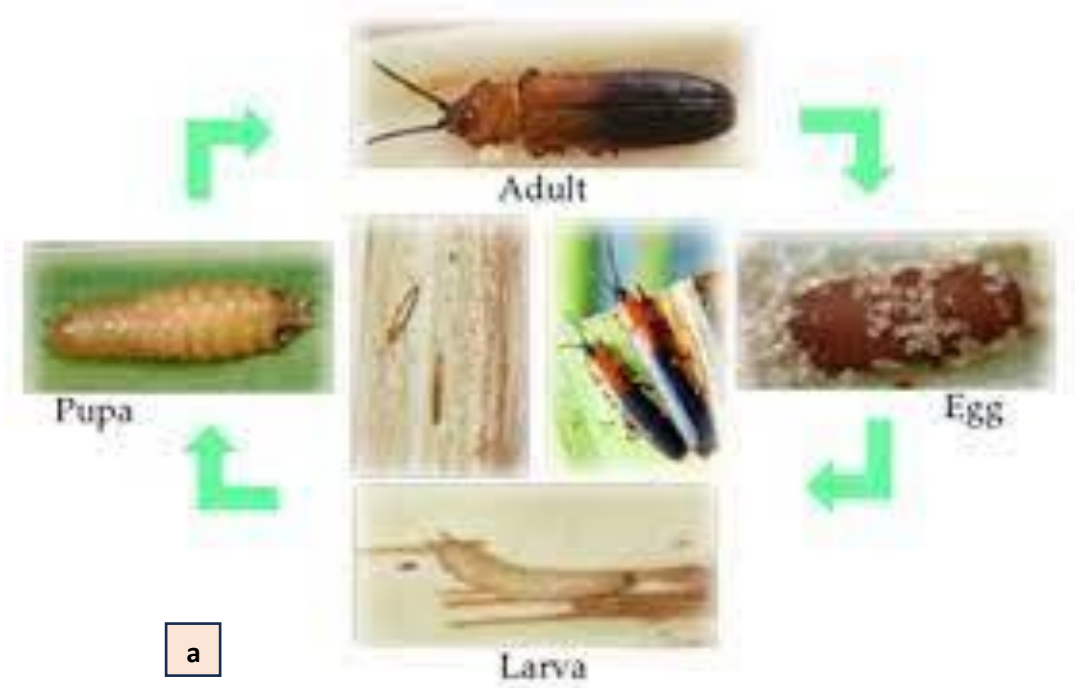

Fig. 5. Different live stages (a) and symptoms (b)

Bonder's nesting whitefly - *Paraleyrodesbondari*, (Hemiptera: Sternorrhynca: Aleyrodidae)**:** This pest has its nativity to Uganda and it spreaded to India in the year 2010. It is from then onwards reported as invasive and threatened species (Fig. 6).

Nature of damage and symptoms: - younger seedlings are mostly affected and lower leaves are infected first.

Adults and nymphs colonize in the lower surface and sucks sap and this results in honey dew secretion and finally results in secondary infestation by sooty mold fungus.

Current status: - It was first reported on Ficus in India but now itis becoming a devastating pest of coconut palms (Mohan *et al*., 2019).

Management: -

1. Use of neem oil 0.5%.
2. Use of yellow sticky traps.
3. Use of systemic insecticide like dimethoate and imidacloprid.

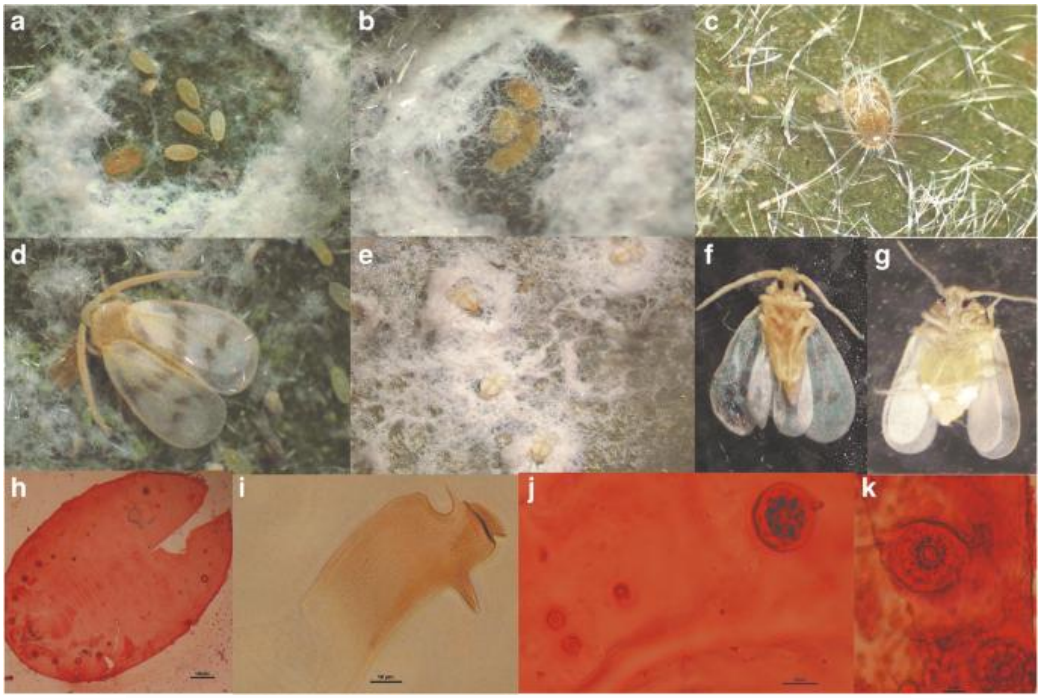

Fig. 6. Different live stages of bonder's nesting whitefly (a-k)

Black headed caterpillar: - *Opisinaarenosella* (Lepidoptera: Chryptophasidae)**:** This pest has its nativity to South Asia and was introduced to India in the year 1990. From then it is reported as invasive and damaging pest on Coconut (Fig. 7).

Nature of damage and symptoms: - Dried up patches on leaflets of the lower leaves showing burnt or scorching appearance. Galleries of silk and frass on under side of leaflet.

Current status: - It is a damaging pest all over India (Lu *et al*., 2023).

Management: -

1. Release of *Goniozusnephantidis*.
2. Remove all infected leaves.
3. Root feeding with systemic insecticides.

Fig. 7. Larvae of black headed caterpillar (a) and symptoms in the plantation (b).

Conclusion

Invasive insect pests pose a significant threat to coconut cultivation, a vital crop for millions of farmers and industries worldwide. These pests not only disrupt the natural balance of ecosystems but also cause substantial economic losses by reducing crop yields and quality. Understanding their nature of damage, symptoms, and invasion pathways is crucial for devising effective management strategies. Integrated pest management (IPM) approaches, including biological control, cultural practices, and timely interventions, are essential to mitigate the impact of these invasive species. Strengthening quarantine measures, promoting research, and enhancing farmer awareness are vital to preventing future invasions.

By adopting eco-friendly and sustainable pest control solutions, we can protect coconut crops and ensure the livelihoods of those who depend on them, safeguarding the environmental and economic significance of this invaluable resource.

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Global Forests: Understanding their types, spread, and the forces shaping their future

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Introduction

Forests are an essential part of our planet, serving as a lifeline for over 1.6 billion people who depend on them for resources like food, water, and fuel. Some 70 million individuals, including many Indigenous communities, live within forests, relying on them for sustenance and shelter. Beyond providing these immediate benefits, forests play a vital role in regulating ecological processes, supporting biodiversity, and combating climate change.Forests play a crucial role in soil conservation by preventing erosion, creating rich topsoil for agriculture, and protecting against natural disasters like landslides and floods. This topsoil, essential for crop production, is maintained by the organic material from decomposing forest vegetation. Forests also support the global water cycle, with trees releasing water vapor that helps maintain rainfall patterns, while their roots filter pollutants from water sources.Forests are linked to human health in significant ways. Studies have shown that spending time in forests can improve cardiovascular health, respiratory functions, and even mental well-being. Conversely, deforestation has been linked to a rise in zoonotic diseases, as animals that once lived in forests move closer to human settlements, increasing disease transmission risks.Forests are home to more than 80% of terrestrial species, with tropical forests alone containing a massive range of species, including 80% of amphibians, 75% of birds, and 68% of mammals. Deforestation threatens these habitats, causing biodiversity loss at an alarming rate; some tropical forests may lose up to 100 species a day. The health of these ecosystems depends on preserving forest environments, as each layer of plant and animal life forms part of an interconnected web.Forests are one of the most effective carbon sinks on Earth, second only to oceans. They absorb carbon dioxide and store it within their biomass and soil, offsetting emissions that would otherwise accelerate climate change. When forests are destroyed, this stored carbon is released, significantly contributing to the greenhouse effect. Forests also help protect communities from the impacts of climate change by acting as natural buffers against extreme weather events.

Types of Forests: Global forests are classified into four main types: tropical, subtropical, temperate, and boreal (taiga), each with unique ecological characteristics.

Tropical Forests

Location: Near the equator, including the Amazon, Central Africa, and Southeast Asia.

Climate: Warm and humid with high rainfall (200–400 cm annually).

Characteristics: These forests support dense canopies, rich biodiversity, and rapid growth rates. They house a vast array of species, from hardwood trees to exotic plants and numerous animal species.

Example: Amazon Rainforest.

Subtropical Forests

Location: Just outside tropical zones, found in regions like southern China, parts of India, and the southern United States.

Climate: Warm with seasonal rainfall, hot summers, and variable winters.

Characteristics: These forests feature a mix of evergreen and deciduous trees and support moderate biodiversity. Common trees include oaks, pines, and laurels.

Example: Southern China's subtropical forests.

Temperate Forests

Location: Mid-latitude regions, including North America, Europe, East Asia, and parts of Australia.

Climate: Distinct four seasons with moderate rainfall (75–150 cm annually).

Characteristics: Temperate forests consist of both deciduous and evergreen trees and display seasonal foliage changes. Trees like oaks, maples, and beeches are common, forming layered vegetation that includes shrubs and herbs.

Example: Appalachian forests in the United States.

Boreal Forests (Taiga)

Location: High northern latitudes, such as Canada, Russia, and Scandinavia.

Climate: Cold with short, moist summers and long, harsh winters, receiving moderate to low rainfall (40–100 cm annually).

Characteristics: These forests are dominated by conifers like pine, spruce, and fir. Due to slower decomposition, the soil is acidic and nutrient-poor, leading to lower biodiversity.

Example: Siberian Taiga in Russia.

Forests cover 4.06 billion hectares globally, about 31% of the Earth's land area, with an average of 0.52 hectares per person. Forests are unevenly distributed, with 45% in tropical regions, followed by boreal, temperate, and subtropical domains. Five countries—the Russian Federation, Brazil, Canada, the United States, and China—hold more than half of the world's forests. These forests are divided into 20 global ecological zones, where 49% of the forest area remains relatively intact, while 9% exists in fragmented patches. Tropical rainforests and boreal coniferous forests are the least fragmented, while subtropical dry and temperate oceanic forests experience higher fragmentation. Around 80% of forests are in patches exceeding 1 million hectares, with the remainder in over 34 million smaller patches.Approximately 34% of global forests are primary forests, naturally regenerated and largely undisturbed by human activity. Forest carbon is stored mainly in living biomass (44%) and soil organic matter (45%), with the rest in dead wood and litter. The global carbon stock in forests slightly declined from 668 gigatonnes in 1990 to 662 gigatonnes in 2020, although carbon density increased from 159 to 163 tonnes per hectare.

Globally, 1.15 billion hectares are managed for wood and non-wood production, while 749 million hectares serve multiple uses. Forests designated for production have remained stable, though multiple-use forest areas have decreased by 71 million hectares. Biodiversity conservation covers 424 million hectares, a growth that slowed in the past decade. Additionally, 398 million hectares are allocated for soil and water protection, an increase of 119 million hectares since 1990. Social services, including recreation, tourism, and cultural conservation, are allocated across 186 million hectares of forest worldwide.

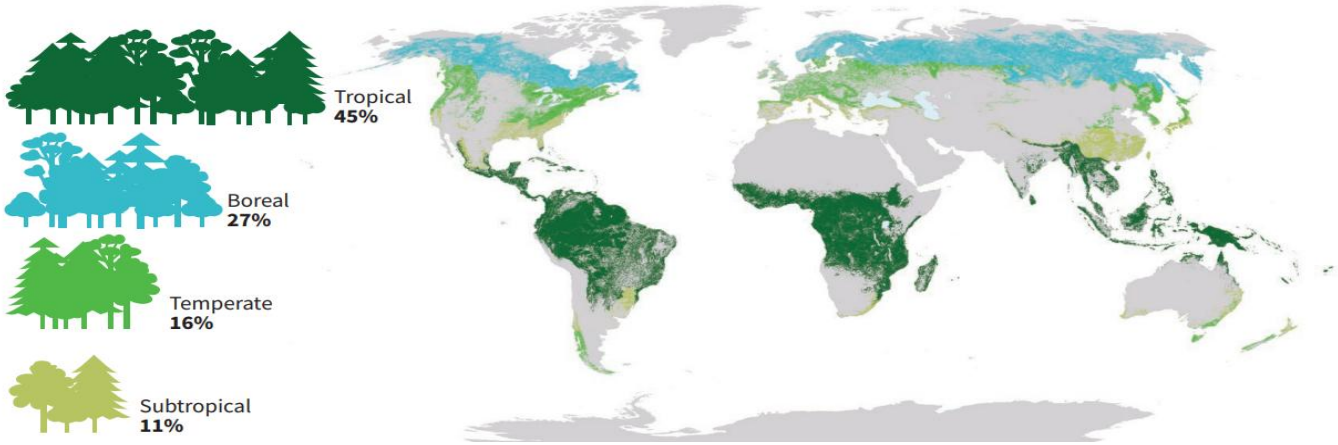

Fig:1- Proportion and distribution of global forest area by climatic domain, 2020
Source: FAO, 2020

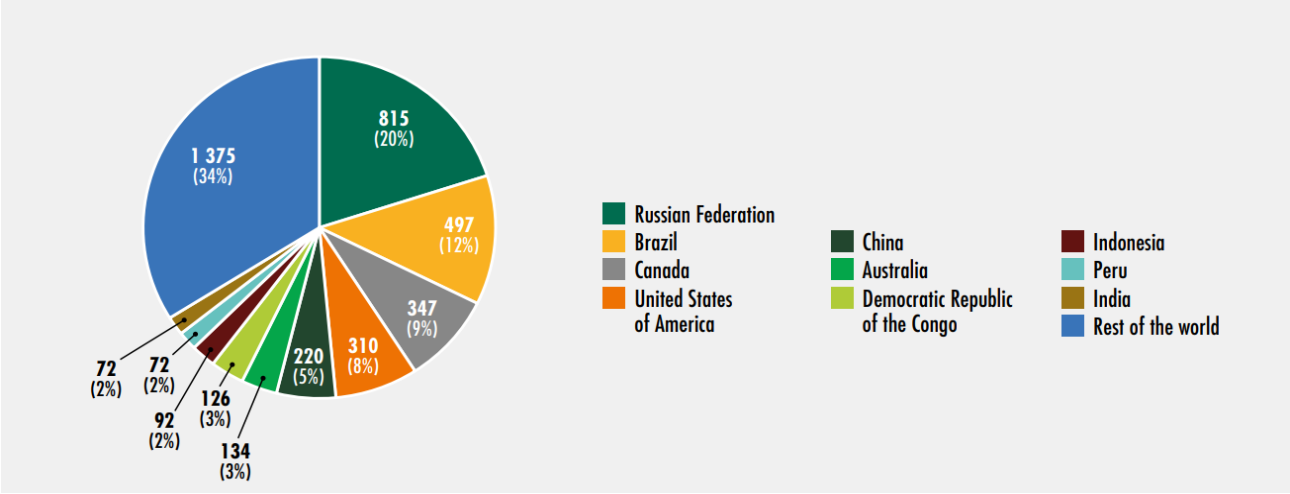

Fig:2- Global distribution of forests showing the ten countries with the largest forest area, 2020 (million hectares and % of world's forests)
Source: FAO, 2020.

The survival of our forests is critical not only for the wildlife that inhabits them but also for human society. Forests support essential environmental cycles, sustain biodiversity, and help mitigate climate change. As deforestation threatens these ecosystems, the loss of forest cover endangers biodiversity and undermines human health and agricultural productivity. Protecting forests is therefore imperative for a sustainable future where both people and the planet can thrive.

Forces Shaping the Future of Global Forests:

The future of global forests is shaped by a range of complex forces, from deforestation and forest degradation to biodiversity loss, climate change, and the pressures of human use and economic expansion. Below is an overview of the main factors influencing forest health, biodiversity, and conservation outcomes, alongside recent trends in forest area and ecosystem resilience.

Deforestation and Degradation Trends: Since 1990, an estimated 420 million hectares of forest have been lost due to conversion to other land uses, mainly agriculture. However, the annual deforestation rate has dropped from 16 million hectares in the 1990s to 10 million hectares in 2015–2020. Although deforestation rates are slowing, they still present a significant challenge, especially in tropical regions where biodiversity loss is most severe.

Forest Area Loss and Net Forest Loss: The net forest area loss has decreased from 7.8 million hectares per year in the 1990s to 4.7 million hectares annually between 2010 and 2020. While reforestation and afforestation efforts are underway in some regions, they do not fully offset losses in primary forests. The global goal of increasing forest area by 3% by 2030, as outlined in the United Nations Strategic Plan for Forests, remains out of reach if current trends continue.

Primary Forests and Biodiversity: Primary forests, critical for high biodiversity, have diminished by over 80 million hectares since 1990. With forest fragmentation, many species with narrow geographical distributions face heightened risk, particularly in regions like the Amazon, Southeast Asia, and parts of Africa. High-density human populations in areas such as Europe, North America, and China have reduced forest biodiversity, while northern Africa and southern Australia have also seen severe biodiversity losses.

Drivers of Deforestation: Agricultural Expansion: Agricultural expansion, particularly large-scale commercial agriculture (e.g., cattle ranching, soybean, and oil palm cultivation), drove 40% of tropical deforestation between 2000 and 2010. Subsistence farming contributed another 33%. Ironically, agriculture relies heavily on biodiversity, including pollinators and species that maintain soil health, highlighting the paradox of forest-dependent agricultural resilience and its role in driving deforestation.

Forest Degradation through Fires, Pests, and Extreme Weather: Forest degradation from fires, pests, diseases, and severe weather events affects over 100 million hectares of forests annually. For example, in 2015, fire impacted 98 million hectares, particularly in Africa and South America. Additionally, insects and extreme weather damaged 40 million

hectares, mostly in temperate and boreal forests. Climate change exacerbates these disturbances, adding pressures to already vulnerable ecosystems.

Climate Change and Forest Ecosystem Resilience: Forests play a crucial role in capturing and storing carbon, contributing to climate change mitigation. As global temperatures rise, forest ecosystems act as carbon sinks and help protect agricultural systems from the impacts of extreme weather. However, deforestation and forest degradation reduce the capacity of forests to sequester carbon, undermining global climate goals and intensifying the climate crisis.

Conservation Challenges and Species Endangerment: The biodiversity crisis is reflected in the Red List of the International Union for Conservation of Nature (IUCN), which identifies over 8,000 tree species as globally threatened, with more than 1,400 species critically endangered. Between 1970 and 2014, the forest-specialist index showed a 53% decline in monitored populations of mammals, birds, reptiles, and amphibians, indicating a high risk of species extinction without significant conservation action.

The Role of International Conservation Protocols: International agreements, such as the Nagoya Protocol and the International Treaty on Plant Genetic Resources, have seen increased adoption, providing frameworks for genetic resource access and benefit-sharing. These treaties help to protect forest biodiversity by ensuring that the benefits of biodiversity are distributed equitably and encouraging responsible resource use.

Economic and Social Dependency on Forests: Forests support approximately 86 million green jobs and provide livelihoods for an estimated 880 million people globally who depend on them for fuelwood or charcoal production. These jobs are vital in low-income regions with high biodiversity but often coincide with high poverty rates. Forest-dependent communities are particularly vulnerable to deforestation and climate change, which threaten their livelihoods and cultural heritage.

Forest Regeneration Efforts: Efforts to expand forests through afforestation and natural regeneration have led to an increase of 123 million hectares of planted forests since 1990. However, the rate of new forest establishment has slowed in the past decade, and naturally regenerating forests continue to decline. Currently, 93% of forest areas consist of natural forests, while the remaining 7% are planted. Although these initiatives contribute to offsetting deforestation impacts, naturally regenerating forests are irreplaceable in terms of biodiversity and ecosystem services.

Future Trajectories and Conservation Goals: While the decrease in deforestation and net forest loss rates are positive trends, meeting global forest conservation goals will require stronger measures. Protecting primary forests, fostering sustainable agriculture, restoring degraded lands, and enhancing conservation efforts for endangered species are crucial. Local and international efforts must continue to prioritize biodiversity and ecosystem resilience to achieve sustainable forest management, vital for climate stability, biodiversity conservation, and the livelihoods of forest-dependent communities.

Conclusion

Forests support biodiversity, regulate climate, and provide vital resources, benefiting billions. Yet, deforestation, degradation, and climate change threaten these ecosystems, impacting species, health, and carbon cycles. Global cooperation and sustainable management are essential to preserve biodiversity, mitigate climate impacts, and ensure resilience for communities and ecosystems worldwide.

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Bay Laurel: The unique and special spice of kitchen

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When we hear bay leaf, it is common to think of cinnamon or tejpatta we regularly use in our Indian kitchens for flavouring various dishes. It is often confused with the European bay leaf (*Laurusnobilis*) commonly used in Mediterranean cuisine.

The true bay leaf (*Laurusnobilis*) is an aromatic leaf that belongs to the family Lauraceae.Bay laurel is also known as sweet bay, true laurel, Roman laurel, noble laurel, daphne, laurel treeor Grecian laurel. It can be used whole or as dried and ground. Genuine bay leaf is often confused with Indian bay leaf obtained from *Cinnamomumtamala*. The leaves contain about 1.3% essential oils, consisting of 45% eucalyptol, 12% other terpenes, 8-12% terpinyl acetate, 3–4% sesquiterpenes, 3% methyleugenol, and other α- and β-pinenes, phellandrene, linalool, geraniol, te rpineol, and contain lauric acid also. If eaten whole, bay leaves are pungent and have a bitter taste. As with many spices and flavourings, the fragrance of the bay leaf is more noticeable than its taste. When dried, the fragrance is herbal, slightly floral, and somewhat similar to oregano and thyme. Both essential and fatty oils are present in the fruit. The fruit is pressed and water-extracted to obtain these products. The fruit contains up to 30% fatty oils and about 1% essential oils (terpenes, sesquiterpenes, alcohols, and ketones). The chemical compound lauroside B has been isolated from *Laurusnobilis*(Batool et al., 2020)

History: In Ancient Greece bay laurel was used to fashion the laurel wreath of ancient Greece, a symbol of the highest status. A wreath of bay laurels was given as the prize at the Pythian Games because the games were in honour of Apollo and the laurel was one of his symbols. In Rome culture,the laurel is a symbol of victory. It was also associated with immortality, ritual purification, prosperity and health. The leaves were used in diversified food, medicine and decoration purposes by Romans and Greeks (Nayak et al., 2006).

Uses of leaf: In Indian cuisine, bay laurel leaves are sometimes used instead of Indian bay leaf, although they have a different flavour. They are often used in rice dishes like biryani and as an ingredient in garam masala. Bay (laurel) leaves are frequently packaged as *tezpattā* (the Hindi term for Indian bay leaf), creating confusion between the two herbs. Dried bay laurel leaves are used in the Philippines and Filipino dishes such as Menudo, beef pares and adobo (Harisha and Singh, 2019).

Uses of wood: Apart from the bay leaf,which is used as a spice in various cuisines and the preparation of curry powders, the wood of the tree has also been found helpful in the industry in the making of bowls, spoons, furniture, jewellery boxes, etc. It is interesting to

know that bay leaf plant is associated with music and the California Bayleaf wood is much preferred for making musical instruments such as violins and guitars.

Other uses: The bay leaf is an excellent insect repellent. Though safe for humans, its smell is toxic to insects and pests. Dried and powdered lead can be sprinkled around the corners to repel cockroaches, ants and other household insects.

Plant description: The laurel is an evergreen shrub or small tree, variable in size and sometimes reaching 7–18 m (23–59 ft) tall. It is dioecious (unisexual), with male and female flowers on separate plants.The male and female flowers are formed on separate plants during the spring season. The flowers are whitish-green and developed into deep black-coloured fruitwhich are measuring 2 cm long (Ross, 2001).

Bay leaves come from several plants, such as:

Bay laurel (*Laurusnobilis*, Lauraceae)

Fresh or dried bay leaves are used in cooking for their distinctive flavour and fragrance. The leaves are often used to flavour soups and stews in many countries. The fresh leaves are very mild and do not develop their full flavour until several weeks after picking and drying.

California bay leaf (*Umbellul ariacalifornica*, Lauraceae) known as California laurel, Oregon myrtle and pepperwood, is similar to the Mediterranean bay laurel, but has a stronger flavour.

Indian bay leaf (*Cinnamomum tamala*, Lauraceae) also known astmalabathrum differs from bay laurel leaves, which are shorter and light to medium green in colour. Indian bay leaves are about twice as long and wider. Indian bay leaves are quite different from laurel in flavour, having a fragrance and taste similar to cinnamon (cassia) bark with mild flavour.

Indonesian bay leaf

(*Syzygium polyanthum*, Myrtaceae) Indonesian laurel is not commonly found outside Indonesia; this herb is applied to meat and, less often, to vegetables.

West Indian bay leaf (*Pimentaracemosa*, Myrtaceae)-leaf of the West Indian bay tree used culinarily (especially in Caribbean cuisine) and to produce the cologne called bay rum.

Mexican bay leaf (*Litseaglaucescens*, Lauraceae).

Ecology: *Laurusnobilis* is a widespread relic of the laurel forests that originally covered much of the Mediterranean Basin when the climate of the region was more humid. With the drying of the Mediterranean during the Pliocene era, the laurel forests gradually retreated and were replaced by the more drought-tolerant sclerophyll plant communities (Eucalyptus, wattle etc) familiar today. Most of the remaining laurel forests around the Mediterranean are believed to have disappeared. However, some remnants persist in the mountains of southern Turkey, northern Syria, southern Spain, north-central Portugal, northern Morocco, the Canary Islands and in Madeira.It is cultivated in India in Karnataka, Kerala, Uttar Pradesh, Bihar and North Eastern states.

Soil and climatic requirements: Well-fertile soils rich in organic matter with a pH ranging from 6.0 to 8.0are suitable. Soils in the backyard with more added manures with good soil moisture are favourable for leaf production.

Low lying area with water logging condition is unsuitable since it affects leaf quality and premature leaf fall due to poor respiration. Plants grow well in moist tropical conditions. Plants need plenty of sunlight and are sensitive to cold winds and frost. The coastal climate of India and the northeastern hill climate are most suitable for growing the bay leaf.

Propagation and planting: Bay leaf plantsare propagated by stem cuttings and air layering. Side shoots growing upwards are used for propagation since it gives a straight growing habit and a good tree canopy can be maintained. The best time for cuttings or layering is from March to May when good sunlight is available. Air layers can root in 2 months on plants and be planted in the nursery for better growth before field planting. Plants can be planted in field or backyards at 5-6m spacing. Pits should be filled with farm yard manure and red soil for better establishment rate and root growth.

Cultural practices: Pruning is important to induce more shoots-producing leaves and give the plants more sunlight. Hence thinning of branches affected by the disease and mechanical damage is removed from time to time. Mulching with dry leaf litter conserves moisture during dry periods and also maintains soil temperature, along with the additional benefit of adding organic matter to the soil.

Pests and disease are very low, and being in open conditions and high sunlight causes infestation with mealy bugs on tender leaves and shoots. This can be controlled by spraying neem oil with soap water.

Harvesting and processing: When the leaves have more volatile oil and aroma, the leaves were picked from the base to the top of the plant. The leaves have a high aroma in the drier/hottest months. Only matured green leaves are harvested and tender leaves are avoided. The harvested leaves are dried in shaded conditions to retain the green colour for 48-75 hours.One acre can accommodate 300

plants at 5 x 2.5 m spacing, yielding 2-5 quintals of dried leaves annually. A better and deeper flavour is observed in freshly dried leaves. Harvesting should be avoided when the plant is wet.

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The nutritional power of wild edible mushrooms

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Wild foods are a subgroup of NTFPs including bush-meat, insects, honey, fungi, wild vegetables, and wild edible fruits and constitute an essential source of nourishment for one in every six persons worldwide. Wild foods can provide an open supply of both food and cash,

particularly for vulnerable groups such as impoverished, malnourished children and HIV/AIDS patients. Diets containing wild foods frequently have higher nutrient diversity and quality than those containing cultivated foods. Wild foods have also been shown to enhance household food security under normal conditions as well as during times of crop scarcity, and in both rural and urban environments. Wild foods do not have to be obtained solely from forests, but also from managed landscapes such as fallows and agroforestry systems, where they augment and diversify food production and income while also improving ecosystem services and climate.

Mushrooms are macro-fungi with outstanding fruiting body that can be hypogeous or epigeous, large enough to be seen with the naked eye and can be picked by hand. These macro-fungi producing prominent sporocarps are categorized as gilled fungi, bracket fungi, coral fungi, jelly fungi, bird's nest fungi and puffballs. These are considered as forest indicators as they indicate about the ecosystem damage or maturity.

Of the approximately 27500 fungal species reported from India, 25% are macro-fungi. Mushroom species are markers of forest's life support system. The presence or absence of fungal species can be used to determine the health and maturity of an ecosystem. Data on the diversity of different vegetation types are critical for ecosystem biodiversity planning and management. However, reports describing the harvest of wild edible mushrooms are scarce or reported in publications published in less widely distributed journals.The edibility and therapeutic capabilitiesof macro-fungi have yet to be fully explored. Approximately 1,105 - 1,208 species of mushrooms belonging to 128-130 genera have been recorded, with 300-315 species belonging to 75-80 genera

considered edible. Knowledge of wild edible mushrooms and their nutritional value has been documented mainly in Assam, Arunachal Pradesh, Nagaland, and Manipur in Northeast India. A list of macro-fungi was also recorded from India reporting 1707 species in 387 genera,among which 74 species were evaluated for the Red List.

Wild mushrooms are a major natural source of food and income for many indigenous groups worldwide. Edible mushrooms are rich in proteins, fibers, vitamins, and minerals. Mushrooms thrive in a wide range of environments; however, most feed on dead and decaying organic matter. All wild mushrooms growing in similar habitats and climates are not necessarily edible, as some are poisonous and can be fatal. On the other hand, indigenous peoplehave been harvesting and ingesting wild mushrooms for generations using their ethno-mycological expertise.

India is geographically located in one of the world's most biodiversity-rich regions. The different climatic conditions that prevail in India support the presence of rich mushroom species.Wild edible mushrooms are sold in local markets in the hilly regions of India, providing food and sustenance to local people as well as forest residents during the rainy season, when other non-timber forest products are scarce in the forest.

In Tripura, nutritional value of three mushrooms namely *Lentinussquarrosulus*, *Lentinus tuber-regium* and *Macrocybegigantea* were evaluated quantitatively and the result indicated that mushrooms were rich in protein and carbohydrate with low fat content and

Macrocybegigantea proved to be the best source of protein and carbohydrate among the three mushrooms.Wild edible mushrooms are a natural resource with a high nutritional value and one of the main resources for the development of drugs and nutraceuticals.

Mushrooms occupy a position above vegetables and below the high protein content of meat and fish, and hence have the potential to alleviate the world's food scarcity problem. Mushrooms are used as food supplement in various cultures and known for their edibility and delicacy for

which they are collected from wild and also cultivated.Mushrooms are regarded as

a delicacy with high nutritional and functional value, as well as a nutraceutical food; they are of great interest due to their organoleptic worth, therapeutic properties, and economic relevance.

Edible mushrooms are high in nutrients and contribute significantly to the human

diet. Mushrooms have been recognized as therapeutic foods, effective in the prevention of disorders such as hypertension, hypercholesterolemia, and cancer. Mushrooms contain all of the essential amino acids and minerals.

Among mushrooms, *Pleurotus* spp. are the most farmed mushrooms due to their ease of cultivation and nutritional value. *Pleurotus* mushrooms are oyster or shell shaped and come in a variety of colors such as pink, cream, yellow, light brown, white, or grey. Around 40 *Pleurotus*species are recognized in temperate and tropical climates. Organic material is processed for nutrition through the ejection of extracellular enzymes. The damp tree trunks provide a home for the growth of *Pleurotus*spp. *Pleurotus* mushrooms are extremely nutritious. Except for lipids, they have high carbohydrates, protein, and mineral contents, with nutritional composition of 61.3-84.1% carbs and 28.6-15.4% protein. They also contain dietary fiber in amounts ranging from 3 to 33.33%.

Cultivation of Mushroom has been in vogue for almost 300 years. Its popularity is growing and it has become a business which is export- oriented.In Uttar Pradesh mushroom cultivation started in 1974 by Uttar Pradesh Department of Agriculture (UPDA) on trial basis at Vivekanand Parvatiya Krishi Anusandhan (VPKA) Almora (Now in Uttarkhand).

Some of the mushrooms cultivated in Uttar Pradesh are: a) Button Mushroom (Agaricus spp.) b) Oyster (Pleurotus spp.) c) Paddy Straw Mushroom (Volvariella spp.) Agaricusbisporus White Button mushroom (Agaricusbisporus) is the most popular, economically best and is extensively cultivated. However, commercial production of this mushroom was initiated in the hilly regions of India (17-18°C) like Himachal Pradesh followed by Kashmir and Ooty, then slowly spread to North western plains of India. In controlled conditions it can be grown anywhere. These conditions include- controlled temperature, moisture, ventilation and good spawn. The temperature requirement for the spread of the mycelium or the vegetative growth is 22 to 25° C. For the reproductive stage the temperature requirement is 14 to 18° C. Within the limits prescribed, the temperature should be uniform throughout the growth of the crop. If it is too cold the

development of the spawn will be retarded. A high temperature will favour the development of moulds and bacteria, which will soon destroy the spawn or crop. On an average the growers can take 3-4 crops of white button mushrooms in a year depending upon the type and varieties cultivated.

According to a FAO report, mushrooms are a significant nutrient source in rural India, and the species most commonly collected include members of the genera *Termitomyces* and *Russula*. Although our country is rich in mushroom diversity, widespread consumption is limited due to a lack of basic understanding on edible and dangerous nature. As a result, the region's wild edible mushroom remains unexplored scientifically.

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The Miraculous Moringa (*Moringa oleifera* L.): A Review of its cultural significance, medicinal properties, and nutritional characterization

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Abstract

Moringa oleifera, native to India, is a versatile plant thriving in tropical and subtropical regions worldwide. Known as the 'drumstick tree', 'horseradish tree', 'tree of life', or 'miracle tree', it offers immense medicinal and non-medicinal benefits. Traditionally, *Moringa oleifera* has been used to treat various ailments, including wounds, heart disease, asthma, and inflammation. Its leaves, seeds, bark, and roots are utilized for their medicinal properties. The plant is also cultivated for its edible seed pods and leaves, used as vegetables and in herbal medicine. Additionally, *M. oleifera* is used for water purification and handmade paper production, making it a valuable resource.

Keywords-: *Moringa oleifera*, Miracle tree, Traditional medicinal uses, Drumstick

Introduction

Moringa oleifera, a deciduous tree of the Moringaceae family, is a potent remedy for malnutrition. It grows rapidly, reaching 10-12 meters in height, with distinctive whitish-gray bark and feathery foliage. Various parts of the tree, including seeds, leaves, and bark, are used in traditional medicines. The leaves boast an impressive nutritional profile, comprising vitamins, minerals, amino acids, and fatty acids, as well as antioxidant compounds like ascorbic acid and flavonoids. Moringa trees can be cultivated from cuttings, but commercial cultivation requires large-scale intensive plantations with proper spacing for efficient management and harvesting.

Moringa trees can be cultivated from 1-meter-long cuttings, but commercial cultivation requires large-scale plantations with proper spacing. Interestingly, Moringa's nutrient composition varies by location, with Indian-grown trees having different profiles compared to those grown in Nigeria. Research shows that environmental factors, such as temperature and soil quality, impact Moringa's nutrient content. Fertilizer applications, including poultry manure, significantly enhance nutrient composition and plant growth. Despite nutrient variability, Moringa's overall profile remains consistent, making it an attractive candidate for cultivation and consumption worldwide as a potential nutraceutical.

Origin and Geographical Distribution

Moringa oleifera, native to the northern foothills of India, Pakistan, and Nepal, exhibits significant genetic diversity in Nepal's Tarai region and India's. The Moringa genus comprises 13 species, including *M. oleifera*, which is distinguishable by its unique leaf base glands, three-valved fruits, and pungent horseradish odor. These Moringa genus comprises *M. oleifera, M. arborea, M. borziana, M. concanensis, M. drouhardii, M. hildebrandtii, M. longituba, M. ovalifolia, M. peregrine, M. pygmaea, M. rivae, M. ruspoliana* and *M. stenopetala.* Some species, such as *M. arborea, M. borziana, M. longituba, M. pygmaea, M. rivae,* and *M. ruspoliana*, are endemic to specific African regions. *Moringa oleifera* is extensively cultivated and naturally occurs across tropical and subtropical regions globally, including Asia, Africa, North and Central America, the Caribbean, South America, and Oceania. Distinctive features of M. oleifera include stalked glands at the leaf base, rachis articulations, three-valved fruits, three-winged seeds, and a characteristic pungent horseradish odor emitted by its leaves (FNAEC, 2017).

Taxonomical Classification

Kingdom: Plantae, Subkingdom: Tracheobionta, Superdivision: Spermatophyta, Division: Magnoliophyta, Class: Magnoliopsida, Subclass: Dilleniidae, Order: Capparales, Family: Moringaceae, Genus: Moringa and Species: *M. oleifera*

Cultivation Requirements and Conditions

Moringa oleifera thrives in tropical and subtropical regions with temperatures between 25-35°C, preferring sandy or loamy soil with a pH of 5.0-9.0 and annual rainfall of 250-3000 mm. Ideal cultivation conditions include:

- Sowing seeds during the rainy season for germination and growth without irrigation.
- Drip irrigation for commercial purposes, enabling seed production during the dry season.
- Shallow soil treatment to minimize erosion, with plowing only necessary for high-density planting.
- Digging pits (30-50 cm deep and 20-40 cm wide) for low-density planting to ensure good root system penetration and reduce erosion.

Planting and Propagation

Moringa oleifera plants can be obtained through two primary methods:

1. Sowing: This method is preferred for seed production, allowing for the selection of improved varieties and optimal production. Direct seeding yields high germination rates within 5-12 days, with seeds sown 2 cm deep in the soil.
2. Cuttings: Moringa can also be propagated using containers filled with sandy or loamy soil. Saplings can be transplanted once they reach 30 cm in height.

Figure 1: Mass Production of Moringa (Drumstick) in root trainer during Nursery Management by Bihar Aushadhi Sugandhit Krishi Utpadan Paudha & Beej Utpadan Nursery, Shekhapura, Chapaith, Vaishali (Bihar) Source: Devendra Paswan (Advisor).

Nursery management

Seed requirement

M. oleifera is a dicotyledonous shrubby plant; its seeds are trivalves with longitudinal wings. Sowing Moringa requires good-quality seeds and once germinated they can be transplanted. The seeds usually germinate in two weeks at a depth of 2 cm and in the nursery, the seedlings can be transplanted when they reach 30 cm (Ojiako et al., 2011). The tree is an excellent seed producer, generating between 3,000 and 9,000 seeds per kilogram. For the production of new plants, seeds are recommended to be stored above 3 °C and with up to 8% humidity. Seed viability has been reported to decrease at room temperature and high humidity (Doria, 2010).

Germination percentage

Traditionally, Moringa is propagated by seed and its high rate and rapidity of germination (ranging between 60% and 90%) for fresh seeds, and between 7 to 30 days after sowing, respectively. Unfortunately, like many tropical seeds, Moringa seeds loose viability quickly, potentially due to their high metabolic rate and their high oil content. To exploit the potential of Moringa sprouts, it is necessary to study the germination process, in conditions not influenced by

environment and by the season. In this respect, the in vitro culture represents a valuable framework of analysis. Indeed, several studies reported that Moringa seeds respond well to in vitro conditions showing a time course of germination and growth faster than in greenhouse conditions.

Cultural operation

Moringa tree will generally grow well without adding very much fertilizer. Phosphorous can be added to encourage plant root development and Nitrogen will encourage Leaf canopy growth. In some parts of India, 15 cm deep ring trenches are dug 10 cm from the trees during the rainy season and filled with green leaves, manure and ash. These trenches are then covered with the soil and this approach is said to promote higher pod yields. Biodynamic composts yield the best results, with crop yield increases of 50% compared to ordinary composts. A fertilizer dose of 45:15:30 g of NPK/pit may be applied 3 months after sowing. Apply 45 g of N/pit after 6 months when the crop is in bearing.

Seed Production

For optimal seed production, *Moringa oleifera* plantations should be established with a low-density triangular pattern, using one of the following spacing options: 2.5 m × 2.5 m, 3 m × 3 m, and 1.2 m along rows and 5 m between rows in agroforestry system. These spacings have been shown to yield satisfactory results.

Leaf Production

For optimal leaf production, *Moringa oleifera* can be cultivated using three spatial distribution methods:

1. Intensive: 10 cm × 10 cm to 20 cm × 20 cm spacing
2. Semi-intensive: 50 cm × 100 cm spacing
3. Agroforestry system: 2-4 m spacing between rows

Growth and Yield

Moringa trees grow rapidly, tolerating temperatures up to 48 °C, frost, and varying soil conditions. They start bearing fruit within 6-8 months, with low initial yields increasing in subsequent years. The Indian cultivar PKM-1 yielded 258 kg/ha of oil in Argentina after three years.

Global Production

Moringa is commercially grown in various countries, including Africa, Mexico, Hawaii, and South America. However, nutrient content varies across regions due to differing soil conditions. India is the largest producer of *M. oleifera* fruits, with an annual production of 1.1-1.3 million tons from 38,000 ha. Andhra Pradesh, Karnataka, and Tamil Nadu are the top-producing states.

Breeding Programs

India, the likely origin of moringa, boasts a diverse range of wild types, providing a solid foundation for breeding programs. In contrast, other countries have lower diversity among cultivar types, although locally adapted wild types can be found.

Breeding objectives vary by region and cultivation method:

- Annual cultivation (India): Yield stability and higher pod production
- Perennial cultivation (less favorable locations): Reduced erosion and increased adaptability
- Pakistan: Enhanced nutritional composition of leaves
- Tanzania: Higher oil content in leaves These diverse breeding objectives reflect the varied uses

and cultivation methods of moringa worldwide.

Pest and Diseases

Moringa is generally resistant to most pests and diseases, but certain conditions can lead to outbreaks. Key pests and diseases to monitor include:

- Diplodia root rot: caused by waterlogged soils, leading to severe wilting and plant death
- Mite infestations: increased populations during dry and cool weather, causing yellowing leaves, but plants typically recover in warm weather
- Insect pests: termites, aphids, leaf miners, whiteflies, and caterpillars
- Termites can be a significant problem, especially when planting cuttings. To protect seedlings from termite attack, consider implementing preventive measures.

Moringa Kernel Oil Yield and Uses

The estimated yield of oil from Moringa kernels is approximately 250 L/ha (22 imperial gallons per acre). The versatile oil has various applications: Food supplement, Base for cosmetics, and Hair and skin care. Additionally, Moringa seeds can be utilized in the production of biofuel, offering a sustainable energy source.

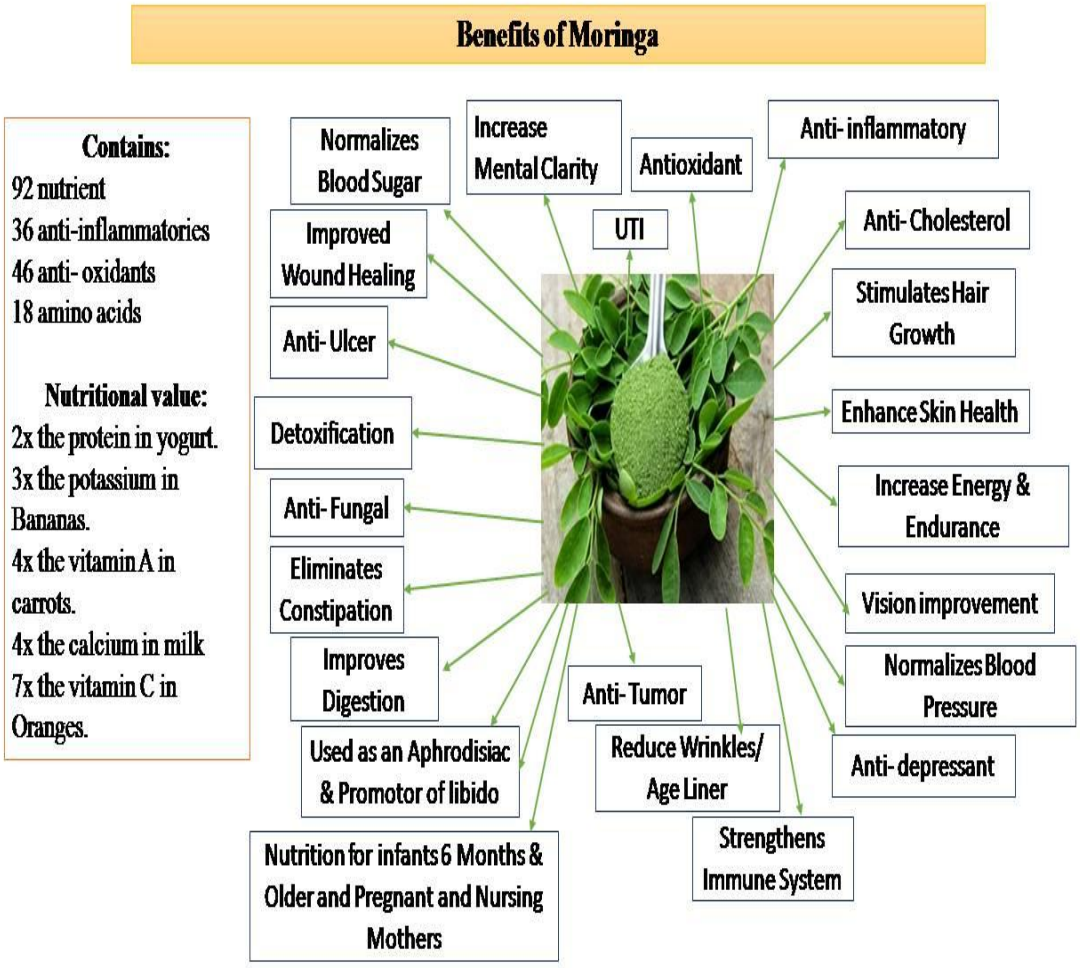

Figure 2: Multiple Benefits of *Moringa oleifera*

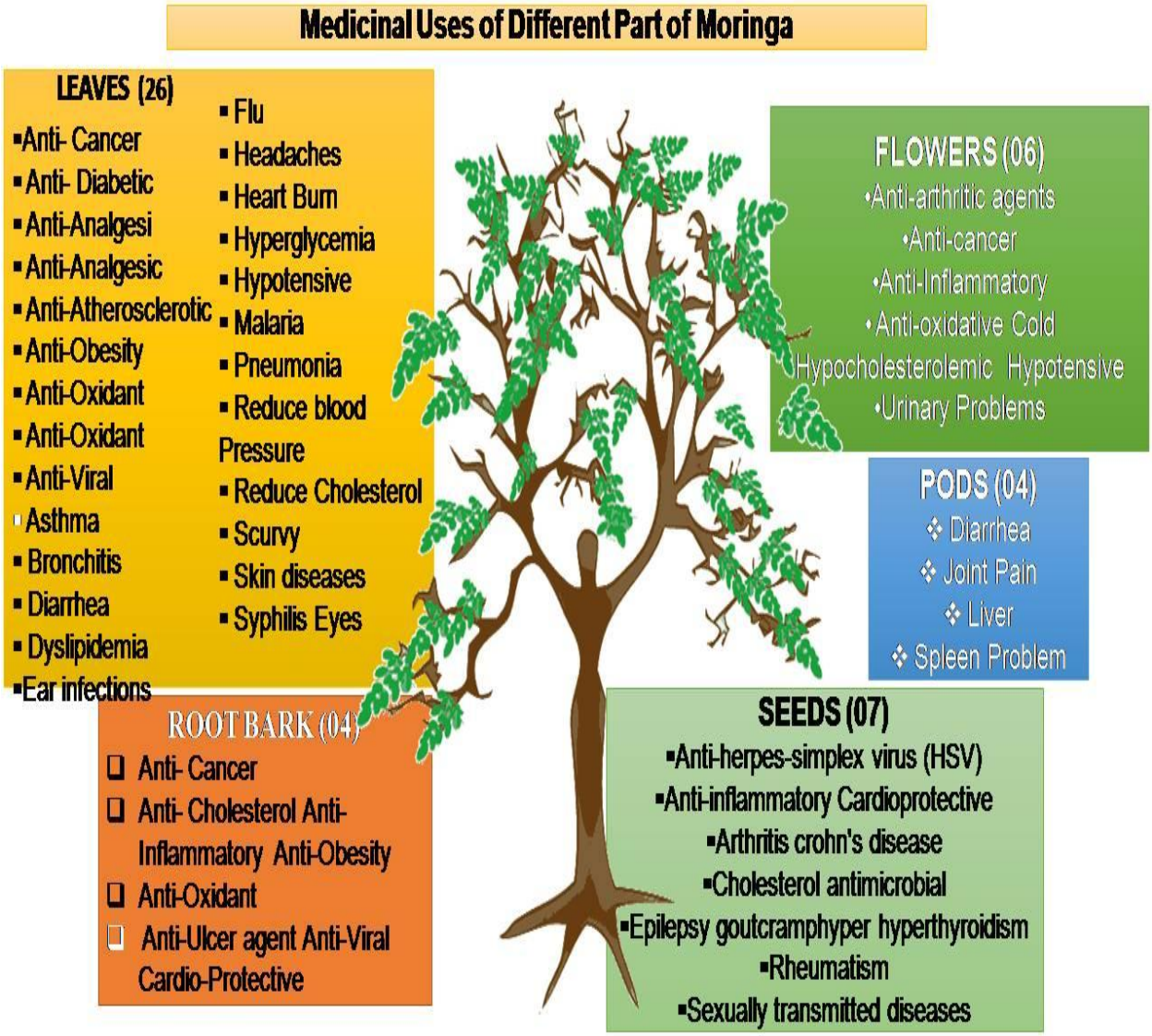

Figure 3: Medicinal Uses of Different Parts of *Moringa oleifera*

Multifaceted Uses of the Moringa Tree

The Moringa tree is a highly versatile species with a wide range of applications: Alley cropping and biomass production, Animal forage (leaves and seed cake), Biogas production (leaves), Cleaning agent (crushed leaves), Blue dye (wood), Fencing (living trees), Fertilizer (seed cake), - Foliar nutrient (leaf juice), Green manure (leaves), Gum (tree trunk), Honey and juice clarifier (powdered seed), Medicine (all plant parts), Ornamental planting, Bio-pesticide, Rope (bark), and Tannin (bark and gum). The Moringa tree holds significant economic importance due to its nutritional, industrial, and medicinal applications. Notably, almost all parts of the tree are utilized for human consumption across various countries.

Health Benefits of Moringa Leaves

Moringa leaves offer numerous health benefits, including: Protecting and nourishing hair and skin, Treating swelling, liver issues, and stomach upset,

Fighting foodborne bacterial infections, Improving eye health (Figure 3).

Nutritional Value: Moringa leaves are rich in: Vitamins A, C, B1, B2, B3, B6, and Folate. Minerals like magnesium, iron, calcium, phosphorus, and zinc. Antioxidants, including quercetin and chlorogenic acid. Amino acids, with 18 types found in the leaves (Figure 2).

Health Benefits

- Anti-oxidative properties protect against chronic diseases like type 2 diabetes, heart problems, and Alzheimer's
- Helps lower blood pressure and stabilize blood sugar levels
- Supports digestive health and may help prevent colon cancer
- Low calorific value makes it suitable for obese diets
- Additional Benefits:
- Pods are fibrous and valuable for treating digestive problems
- Immature pods contain 46.78% fiber and 20.66% protein content
- Pods, leaves, and flowers are rich in amino acids and fatty acids

Enhances Beautiful Skin

The moringa seeds are packed with Vitamin A which works as an effective antioxidant and also works on the collagen formation to boost skin firmness. The extracted oil from the Moringa seeds is an effective natural moisturizer which not only nourishes the skin giving it a radiant look, but also fights premature aging

Stimulates Healthy Hair

Vitamin C antioxidant properties present in the Moringa seeds helps to maintain the health of tresses and improves the circulation of blood in the scalp, stimulating follicles facilitating more absorption of nutrients. The Vitamin A and zinc nourishes hair tissues and helps keep the sebaceous glands unclogged.

Maintains Lower Blood Pressure

High blood pressure can be a severe cardiovascular health concern. There have been studies indicating that consumption of moringa seed extracts can lower blood pressure naturally by acting as a circulatory stimulant. The oleic acid present in the seeds also facilitates in keeping the heart healthy.The studies are known to be of a preliminary nature, and it is recommended to talk to the doctor before discontinuation of a prescribed treatment and get advice on the consumption of any supplements.

Helps Lower Cholesterol

Moringa seeds can facilitate the increase of high-density lipoprotein (HDL) cholesterol contributing lower cholesterol in the bloodstream. It is backed by observations from Dr. James Beckerman, a specialist in Cardiovascular disease, who states that high levels of HDL cholesterol can lower the amount of low-density lipoprotein (LDL) cholesterol in the blood.

Helps Regulate Blood Sugar Levels

The moringa seeds can control blood sugar levels naturally, which is a relief to people who have diabetes. The therapeutic health benefits of moringa seeds are reiterated in the Journal of Diabetes in the context of natural treatment for diabetes.

Effectively Reduces Inflammation and Relieves Pain

The moringa seeds health benefits encompass the treatment of inflammatory conditions and alleviate various types of joint pain. This is backed by reports published in the journal Inflammation, which highlights the use of moringa seeds

to reduce inflammation and in relieving pain from chronic inflammatory diseases.

Protects Liver

The antioxidant properties present in the Moringa seed oil can help protect the liver from damage. This is backed by a report in the Journal of Food Science which observed that the free radical scavenging capacity encapsulated in the moringa seed oil could help heal the liver damage that is caused by hepatitis. The seed extracts are also known to have curative properties for some liver disorders.

Cures Gastric Ulcers

The anti-inflammatory properties present in the Moringa seeds have a therapeutic effect on gastric or peptic ulcers and helps in healing the ulcers naturally. A study highlights that the antioxidant properties of the seeds could reduce the symptoms of ulcers.

Relieves Bronchial Asthma

Bronchial asthma and symptoms of asthma are observed to get natural relief due to the anti-inflammatory effect of Moringa seeds. This is backed by a study which was published in the Indian Journal of Pharmacology which observed that the consumption of 3 g of moringa seeds for three weeks could help improve the symptoms of bronchial asthma

Boosts the Immune System

Moringa seed extracts are packed with vital nutrients which can boost the immune system. The data presented in the Journal of Food Science and Human Wellness observes that moringa seed consumption had seven times more Vitamin C than oranges, 25 times more iron than spinach, 15 times more potassium than bananas, and ten times more Vitamin A than carrots.Moringa seeds nutrition facets can significantly contribute to augmenting the diet plan of vegetarians (vegans) who have low iron concerns.

Aids Sleep

Moringa seeds facilitate sound sleep and can leave you energized. Take some hot water and soak the moringa leaves for 15 minutes, strain the mixture, and drink the preparation just before you hit the bed. The blend is observed to help with a good night's rest.

Stops Growth of Cancer Cells

The Moringa seeds have anti-carcinogenic effects present, which are known to prevent the growth and development of cancer cells. Researchers have observed that consumption of moringa seed powder for three consecutive weeks can help with preventing colon cancer. With the endless list of health benefits of moringa seeds, it is no wonder that the research fraternity considers the medicinal value from the extracts highly significant.

***Benefit of Moringa Flowers*:** Moringa flowers are not just beautiful – they are also packed with essential nutrients and vitamins. They are rich in antioxidants, proteins, minerals, vitamins A and C, magnesium, iron, and calcium. These powerful nutrients make Moringa flowers a great choice for those looking to boost their health and immunity.

***Nutritional value of Moringa*:**

The drumstick tree, or *Moringa oleifera*, has a remarkable nutritional profile. Moringa nutritional value per 100g provides many health advantages because it is concentrated and full of vital minerals which representing Moringa nutritional value per 100g in detail: Calories - 64 kcal, Protein - 9.4 g, Carbohydrate - 8.3 g, Fat - 1.4 g, Dietary

Fiber - 2.0 g, Vitamin A - 7564 IU, Vitamin C - 51.7 mg, Vitamin E - 4.0mg, Vitamin K 0.0mcg, Calcium - 185 mg, Iron - 4.0 mg, Magnesium - 147 mg, Potassium - 337 mg, and Zinc - 0.6 mg

Importance of Moringa oleifera

Moringa oleifera is a highly valued plant due to its exceptional nutritional profile, versatility, and drought tolerance. Key importance of moringa includes:

1. Nutritional powerhouse: Moringa is one of the most nutrient-dense plants globally, rich in vitamins, minerals, protein, and antioxidants.
2. Multi-purpose uses: Almost every part of the moringa tree is utilized for its nutrients, including leaves, bark, roots, flowers, and seeds.
3. Drought tolerance: Moringa's ability to thrive in drought conditions makes it an ideal crop for water-scarce regions.
4. Food source: Moringa is a vital food source in various parts of the world, with its leaves used in beverages like the popular Indian drink "Zija".
5. Cosmetic applications: Dried moringa leaves contain 70% oleic acid, making them suitable for producing moisturizers.
6. Biofuel production: Moringa seeds can be used to produce biofuel, offering a sustainable energy solution.
7. Health benefits: Moringa is believed to have numerous health benefits, including boosting immunity, lowering blood pressure, and improving digestive health.
8. Arsenic toxicity prevention: Research has shown that moringa leaves can help combat the effects of arsenic toxicity in lab animals.

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