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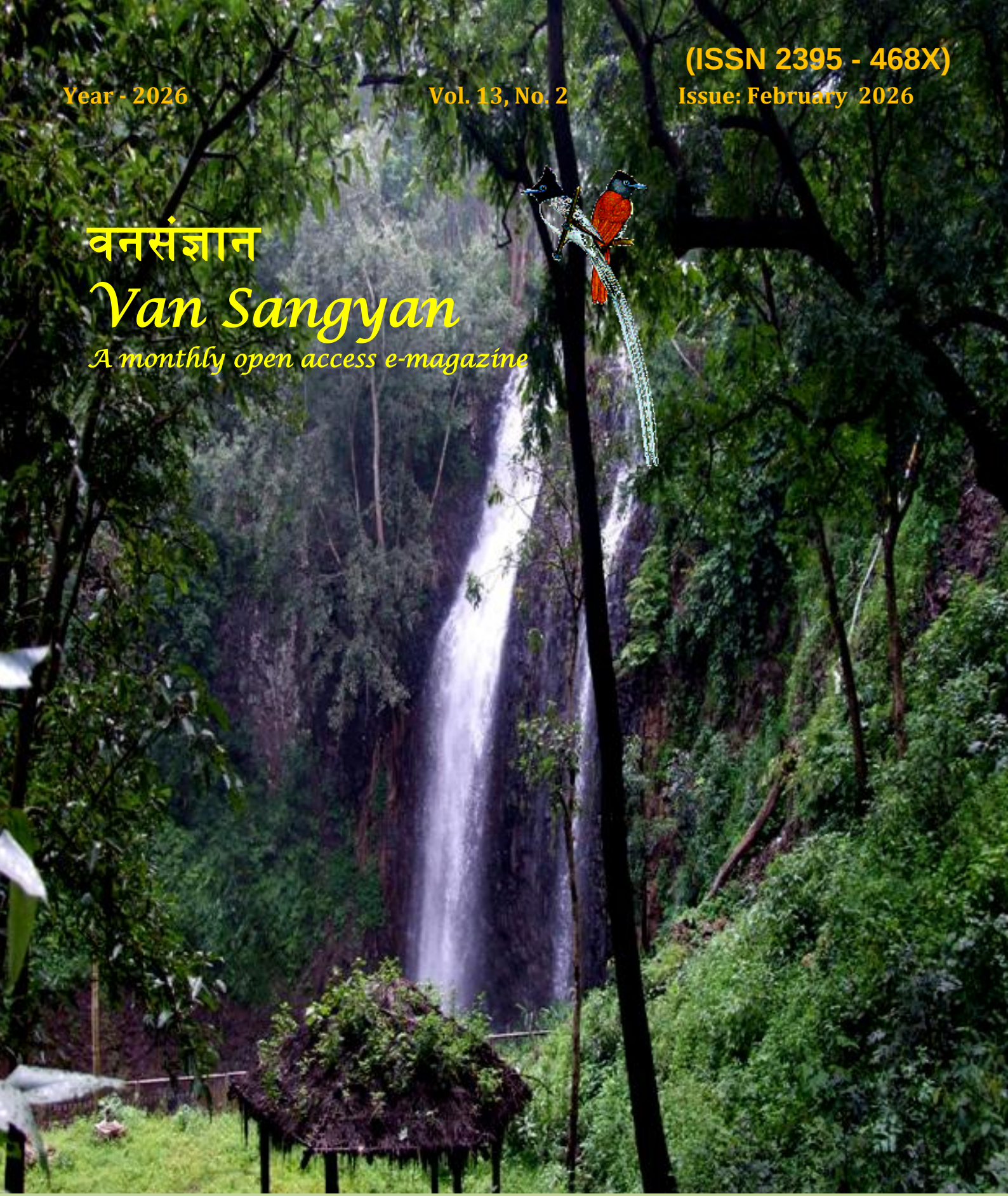

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Van Sangyan

Note to Authors:

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

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

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve

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From the Editor's desk

Tamarind (Tamarindus indica L.) stands out as a quintessential multipurpose tree species that seamlessly integrates agroforestry, nutrition, and sustainable land use. Valued for its remarkable adaptability to semi-arid and marginal environments, tamarind contributes significantly to climate-resilient farming systems by improving soil structure, reducing erosion, and providing long-term ecological stability. Nutritionally, its fruit pulp is rich in organic acids, minerals, and antioxidants, supporting food security, traditional diets, and diverse value-added products. Beyond nutrition, tamarind offers economic benefits through timber, fuelwood, medicinal uses, and marketable non-timber forest products, making it a vital livelihood resource for rural communities. As global attention shifts toward sustainable land management and diversified agroforestry systems, tamarind exemplifies how indigenous, underutilized tree species can bridge environmental conservation with economic and nutritional well-being, reinforcing their relevance in sustainable development strategies.

In line with the above this issue of Van Sangyan contains an article on Tamarind (Tamarindus Indica L.): A multipurpose tree species for agroforestry, nutrition, and sustainable land use.There are also useful articles viz. Fire in the Pines (Pinus roxburghii): Survival and change, Climate-smart agroforestry is not enough: The case for heat-adaptive agroforestry, The role of medicinal herbs, Natural distribution of medicinal plants growing in and around PCIM&H, Ghaziabad, Standardization and quality control issues in herbal non-timber forest products (NTFPs), The magic shrub: Carissa spinarum, The resurgence of Alexandrine Parakeets: A tale of triumph in Jhalawar, PCIM&H infrastructure- A blend of modern facilities and therapeutic thematic gardens and Agroforestry Potential of Moringa oleifera Lam. for sustainable farming systems.

Looking forward to meet you allthrough forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Tamarind (*Tamarindus Indica* L.): A multipurpose tree species for agroforestry, nutrition, and sustainable land use

Ajay Patel, Yashmita Ulman and Devendra Kumar
Department of Silviculture and Agroforestry
College of Horticulture and Forestry, ANDUAT University, Ayodhya (UP)-224229, India
E-mail: ajaypatel969628@gmail.com

Abstract
Tamarindus indica L., commonly known as the tamarind tree, is a long-lived, multipurpose leguminous species native to tropical Africa and widely cultivated across South Asia. Renowned for its tangy fruit pulp, the species contributes significantly to rural economies through food, fodder, timber, fuelwood, and medicinal uses. Its adaptability to semi-arid and degraded lands, nitrogen-fixing ability, and deep-rooted structure make it suitable for agroforestry and reforestation initiatives. This article comprehensively reviews the botany, ecological adaptability, propagation techniques, uses, and socioeconomic importance of tamarind, highlighting its potential in climate-resilient agriculture and land restoration programs.

Keywords: *Tamarindus indica*, agroforestry, arid zone tree, non-timber forest product (NTFP), ethnobotany, sustainable agriculture, dryland horticulture

Introduction

The tamarind tree (*Tamarindus indica* L.) belongs to the family Fabaceae and is one of the most versatile and economically important tropical fruit trees. While its origin is traced to Africa, it has become naturalized and widely cultivated in South Asia, particularly in India, which is currently the largest producer and exporter. The species thrives in diverse agroclimatic zones, ranging from semi-arid to sub-humid regions, and is commonly incorporated in homesteads, boundary plantations, and agroforestry systems.

Botanical description

Tamarindus indica is a slow-growing, deciduous to semi-ergreen tree that can

Fig. 1 Tamarind Tree

attain a height of 20–25 meters with a broad, dome-shaped crown. It exhibits pinnately compound leaves, yellowish flowers with reddish streaks, and indehiscent pods containing a sticky, acidic pulp. The seed is hard-coated, brown, and viable for several months if stored under appropriate conditions.

Taxonomy:
Kingdom: Plantae
Order: Fabales
Family: Fabaceae
Genus: ***Tamarindus***
Species: ***T. indica***

Ecological Adaptability

Tamarind is known for its hardiness and drought tolerance. It thrives well in Annual rainfall of 500–1500 mm, Soil pH range of 5.5–8.5, Temperatures ranging from 25–35°C. It grows well on marginal lands, gravelly soils, and light-textured lateritic

areas. Its deep-rooting system prevents soil erosion and enhances soil structure, making it an ideal candidate for soil and water conservation efforts.

Propagation and cultivation practices

Propagation

Traditionally propagated by seeds; however, grafting, air-layering, and budding are increasingly used for faster fruiting and true-to-type plant production.

Planting

Spacing: 10–12 m × 10–12 m in orchard systems

Pit size: 1 m^3 filled with FYM and topsoil

Irrigation: Required during establishment and dry spells

Pruning: Minimal pruning required to shape young trees

Pests and diseases

Generally resistant but may be affected by mealybugs, borers, and fungal leaf spots.

Uses and economic importance

Fruit and food products

The pulp is used in culinary preparations, beverages, chutneys, candies, and preservatives. It is rich in tartaric acid, vitamin C, calcium and dietary fiber.

Timber and fuelwood

The heartwood is durable, termite-resistant, and used for furniture, tool handles, and agricultural implements. Wood serves as excellent fuelwood with high calorific value.

Medicinal value

Bark and leaves possess antimicrobial, anti-inflammatory, and astringent properties. It is used in traditional medicine to treat fever, constipation, and digestive disorders.

Fodder and green manure

Leaves serve as fodder for goats and cattle during dry seasons. Litter contributes organic matter and enhances soil fertility.

Role in agroforestry and sustainable land use

Tamarind fits well in various agroforestry models such as: Agri-horticultural systems (with legumes, cereals), Silvi-pastoral systems (fodder grass under canopy), Boundary and live-fence plantations. Its nitrogen-fixing potential (through rhizosphere interactions), minimal input requirement, and perennial nature enhance long-term productivity, biodiversity conservation, and carbon sequestration, aligning with climate-resilient strategies.

Socioeconomic and cultural significance

In India and Southeast Asia, tamarind is intertwined with local cuisines, traditional rituals, and rural livelihoods. Women often engage in its collection, pulp processing, and value-added products, contributing to gender-inclusive development. The tree's low maintenance and multi-utility characteristics have made it a reliable asset for smallholder farmers and tribal communities.

Challenges and future prospects

Despite its utility, tamarind remains underutilized in commercial horticulture

due to:

- Long gestation period
- Lack of improved cultivars
- Inadequate post-harvest infrastructure
- Unorganized marketing

Future interventions may include

- Genetic improvement through clonal selection and biotechnology
- Value chain development and market integration
- Promotion under agroforestry schemes

and MNREGA-linked afforestation programs

Conclusion

Tamarindus indica L. stands out as a promising multipurpose tree species with immense ecological, nutritional, and economic value. With targeted research, policy support, and farmer-level interventions, tamarind can significantly contribute to sustainable livelihoods, land rehabilitation, and climate change mitigation in tropical and subtropical regions.

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Fire in the Pines (*Pinus roxburghii*): Survival and change

Yamini Sharma and Karan Sharma
Genetics and Tree Improvement Division
ICFRE- Himalayan Forest Research Institute, Shimla, Himachal Pradesh, India
Email: yamisharma1996@gmail.com

Forest fires are an annual reality in the chir pine (*Pinus roxburghii*) forests. During the dry summer months, large tracts of pine-dominated forests are affected by fires of varying intensity. Although forest fires are often considered purely destructive, they are now recognised as important ecological forces that influence vegetation structure, biodiversity, regeneration, and soil health (Brown et al., 2011).

Chir pine forests occupy extensive areas of the lower and middle Himalaya, generally between 900 and 1500 m altitude. These forests are adapted to dry climatic conditions and frequent surface fires. Mature chir pine trees possess thick, fire-resistant bark, which allows them to survive low-intensity fires (Fule et al., 2021). However, repeated burning alters forest composition by favouring fire-tolerant species while suppressing fire-sensitive broad-leaved trees (Sardinha et al., 2026).

A major contributor to frequent fires is the accumulation of dry pine needle litter on the forest floor. Pine needles decompose slowly, forming a continuous fuel bed that facilitates rapid fire spread during dry periods (Fonda, 2001).

Impact of fire on vegetation structure

Forest fires influence plant species differently across vegetation layers, resulting in noticeable changes in floristic composition.Tall tree species such as *Pinus roxburghii*, *Bombax ceiba*, *Pyrus pashia*, and *Cassia fistula* often withstand fire due to their height and protective bark, which insulates vital tissues from heat damage (Yamini, 2019). In contrast, many broad-leaved species are highly vulnerable, particularly during their early growth stages.Ban oak (*Quercus leucotrichophora*), an ecologically important species for soil conservation and moisture regulation, is especially sensitive to fire at the seedling, sapling, and pole stages. Repeated fires severely restrict its regeneration, gradually shifting forest composition towards pine-dominated stands (Yamini, 2019). Fire-resistant shrubs such as *Woodfordia fruticosa* often resprout vigorously after fire and dominate burnt areas due to their strong regenerative capacity (Kumar and Thakur, 2008; Yamini, 2019). In the herb layer, forest fires create open niches with increased light availability, encouraging rapid colonisation by opportunistic species. Unfortunately, this also favours invasive weeds such as *Parthenium hysterophorus*, which establish quickly in burnt areas and suppress native herbaceous vegetation (Yamini, 2019). Several native shrubs and herbs fail to survive repeated fires and gradually disappear from frequently burnt sites, leading to reduced habitat complexity.

Forest fires influence biodiversity in complex ways. Immediately after a fire, species evenness may increase temporarily because the dominance of a few species is reduced (Yamini, 2019). However, frequent fires generally result in reduced species richness, particularly among fire-sensitive plants.

Impact of fire on the regeneration pattern

Regeneration patterns also vary between burnt and unburnt forests. Burnt areas often show good seed germination due to reduced litter cover and improved light conditions. However, survival beyond the seedling stage is limited, as repeated fires damage young plants before they mature.

Saplings and pole-stage trees are usually more abundant in unburnt forests, where stable conditions favour long-term growth and establishment (Yamini, 2019).

Impact of fire on soil physico-chemical properties

Forest fires significantly influence soil physico-chemical properties. Ash deposition after fire can temporarily increase soil pH and enhance the availability of essential nutrients such as nitrogen, phosphorus, and potassium (Mittal et al., 2019). These changes may improve soil fertility in the short term.However, fire also reduces soil organic carbon by burning litter and organic matter. In hilly terrain, nutrient-rich ash is easily lost through surface runoff and erosion, particularly during monsoon rains, leading to long-term soil degradation (Beyer et al., 2011).

Conclusion

Forest fires are a powerful ecological force shaping the Chir pine forests. While fires may bring short-term benefits such as increased nutrient availability, their long-term impacts include reduced biodiversity, poor regeneration of broad-leaved species, and soil degradation. Understanding fire ecology and adopting integrated forest management strategies, such as fuel reduction, promotion of mixed forests, and community involvement, are essential for developing fire-resilient Himalayan forests.

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Climate-smart agroforestry is not enough: The case for heat-adaptive agroforestry

Katikala Anish[1], Mhaiskar Priya Rajendra[2], Milkuri Chiranjeeva Reddy[1], Yerrawada Naveen[1], Bheemreddyvalla Venkateshwar Reddy[1], Rohith Ravula[1] and Sachin Kumar[1]

[1] Department of Silviculture and Agroforestry, Forest College and Research Institute (FCRI), Mulugu, Telangana, India, 502279

[2] Department of Forest Ecology & Climate Science, Forest College and Research Institute (FCRI), Mulugu, Telangana, India, 502279.

E-mail: katikalaanish@gmail.com

Introduction

India's farms are changing in ways few of us expected. Summers are arriving sooner, nights are not cooling the way they used to, and heat events that once felt rare are now regular. In 2024 and 2025, India experienced prolonged, intense heat episodes that stressed crops, animals and rural livelihoods tens of thousands of suspected heat-illness cases and significant agricultural losses were recorded (Quandt *et al.*, 2023).

For decades, the global response has championed "climate-smart" agriculture and agroforestry: practices intended to increase productivity, remove carbon, and adapt to a changing climate. But heat is a specific, sometimes brutal, challenge. Heat extremes act fast, amplify drought, and damage living systems in ways that general climate-smart measures don't always prevent. This article argues for reframing agroforestry in India moving from "climate-smart" to explicitly heat-adaptive agroforestry: designs, species and policies optimized to protect farms against extreme heat today and in the coming decades.

Why climate-smart falls short on heat

Climate-smart is a broad, helpful umbrella for sustainable practices, but its breadth is also its weakness. Reviews of climate-smart agriculture show progress better varieties, water efficiency and agroecological approaches yet they also note gaps: uneven attention to local heat impacts, insufficient integration of social vulnerability (who is most hurt by heat), and a bias toward mitigation (carbon) over fast-acting resilience needs (Lou*et al.*, 2024).

Heat extremes have three properties that demand special treatment:

Immediate physiological thresholds

Plant and animal physiology have narrow temperature windows; a few days above critical temperatures can abort grain, kill pollinators, or cause livestock fatalities.

Compound stress

Heat rarely comes alone. It often co-occurs with drought and high humidity, amplifying crop water stress and disease risk. Studies of recent Indian heat events show a strong co-occurrence of drought and heat episodes (Verma *et al.*, 2025).

Spatial and temporal heterogeneity

Heat affects field differently low-lying plots, exposed ridges and urban peripheries heat up more. Solutions require fine-scale design, not one-size-fits-all prescriptions.

Climate-smart agroforestry brings many co-benefits, but it was not always designed with these heat properties in mind. If the goal is to save harvests andlives within weeks of a heat spike, we need agroforestry that prioritizes heat buffering as a central objective.

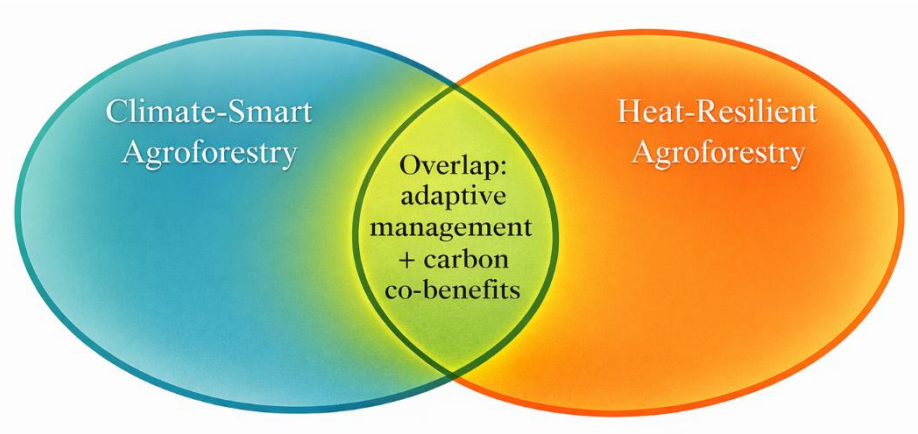

Fig 1. Climate Smart vs Heat resilient Agroforestry

What does "heat-adaptive agroforestry" mean?

Heat-adaptive agroforestry explicitly centers three outcomes:

- Immediate microclimate cooling at canopy and crop level (shade, evaporative cooling).
- Thermal refuge for fauna and people (safe shelter for livestock, cooler workspaces).
- Greater system inertia resilience to recurring extreme heat through species and soil strategies that maintain productivity and regeneration.

In practice, this means designing tree–crop systems whose primary objective is to reduce on-farm temperatures and protect vulnerable life stages (flowering, fruit set, young animals), and not only to sequester carbon or diversify incomes.

On-farm design principles

Below are practical principles and examples tailored to Indian conditions (Chaturvedi *et al.,* 2017; Nicholls*et al.,* 2026).

Layered canopy for shade and diurnal cooling

A multi-strata system tall native canopy trees, mid-story fruit trees, and shrubs create a vertical gradient of shade that cools crops and soil during the day and reduces night-time radiative heating. Species selections should emphasize fast-establishing, heat-tolerant native trees (for example: bamboo species for quick canopy, Prosopis alternatives in arid zones, and species identified by agroforestry guides for India) (Chaturvedi *et al.*, 2017).

Evaporative cooling through managed water features

Small ponds, swales and irrigated micro-wetlands act as heat sinks. Evaporation from these water bodies cools the local air, benefits pollinators, and provides emergency water for livestock during heat waves. Placement matters: situate ponds upwind of high-value crops or animal shelters (Chaturvedi *et al.*, 2017).

Soil cover and mulching for lower soil temperatures

Mulch crop residues, leaf litter, or manufactured mulches can cut daytime soil heating, reduce evaporation and protect root systems during short, intense heat spells. Over time, improved soil organic matter boosts water-holding capacity, smoothing moisture shocks when heat and drought co-occur (Chaturvedi *et al.,* 2017).

Hedgerows and windbreaks to moderate wind and radiation

Strategically planted hedgerows dampen hot, drying winds and reduce solar radiation on exposed plots. Dense shrubby rows along field edges can protect young seedlings and fruit trees during early heat spikes (Chaturvedi *et al.,* 2017).

Species selection for phenological match and heat tolerance

Choose crop and tree varieties that flower outside the peak heat window or tolerate higher temperatures during reproductive stages. For trees, prioritize species that maintain canopy cover in heat and recover quickly from heat-induced leaf shedding. ICFRE and CIFOR species lists provide locality-specific options for India (Chaturvedi *et al.*, 2017).

Mobility and refuges for livestock and people

Create shaded corridors and permanent shelters with water access for animals. For farm workers, protected work areas and cooling shelters reduce heat exposure and keep labor productive through critical seasons (Chaturvedi *et al.*, 2017).

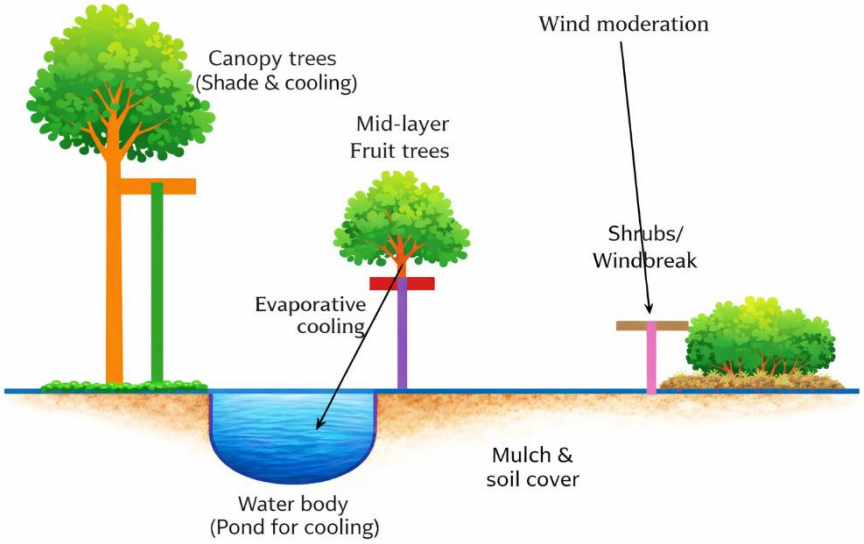

Fig 2. Heat-adaptive Agroforestry farm design

Social and institutional measures beyond plants and ponds

Heat-adaptive agroforestry is more than planting the right trees. It needs institutions and knowledge systems to work: (NDMA, 2024; Abebaw *et al.*, 2025)

Local heat-action planning for agriculture

District heat risk maps should feed into planting calendars and advisories (what to do when a heat warning is issued). CEEW and other studies have shown that many Indian districts are now at high heatwave risk planning must be local.

Extension and farmer co-design

Farmers must be involved in co-designing systems so heat measures align with labor calendars, market needs and cultural practices. Participatory trials accelerate adoption.

Incentives for rapid cooling measures

Short-term subsidies for ponds, mulches, or shade nets during emergency seasons can be cost-effective compared with replacing failed harvests.

Insurance and safety nets

Crop and livestock insurance schemes must account for heat events, not just drought or flood indices, and provide rapid disbursements when heat causes crop failures.

Table 1. Comparison between Climate-Smart Agroforestry and Heat-Adaptive (Heat-Resilient) Agroforestry

Aspect	Climate-Smart Agroforestry	Heat-Adaptive / Heat-Resilient Agroforestry
Primary focus	Long-term climate change mitigation and adaptation	Immediate and long-term adaptation to extreme heat stress
Key objective	Increase productivity, enhance	Reduce on-farm temperatures and

	carbon sequestration, and improve resilience	protect crops, livestock, and people during heat waves
Treatment of heat stress	Considered indirectly as part of overall climate variability	Addressed explicitly as a critical and urgent climatic risk
Time scale of benefits	Mostly medium- to long-term	Immediate, short-term, and long-term
System design emphasis	Tree–crop integration for sustainability and diversification	Microclimate regulation through shade, cooling, and thermal buffering
Canopy structure	Trees integrated based on productivity and land use	Multi-layered canopies designed specifically for shade and cooling
Role of water bodies	Often optional or secondary	Central component for evaporative cooling and thermal moderation
Soil management	Soil fertility and carbon enhancement	Soil temperature reduction, moisture conservation, and root protection
Species selection	Multipurpose and economically valuable species	Heat-tolerant, fast-growing, and phenologically suitable species
Livestock considerations	Secondary or indirect benefits	Explicit provision of shaded shelters and thermal refuges
Human well-being	Limited focus on occupational heat stress	Direct reduction of heat stress for farm workers
Response to heat waves	Limited capacity to buffer sudden extreme events	Designed to function as frontline defense during heat extremes
Policy alignment	Climate-smart agriculture and mitigation policies	Heat action plans, disaster risk reduction, and adaptation policies
Overall suitability under extreme heat	Partially effective	Highly effective and context-specific for Indian conditions

Policy levers and research needs

Heat-adaptive agroforestry requires policy moves in three areas: (Verma *et al.*, 2025)

Research to fill the evidence gap

While agroforestry buffers climate extremes in general, we need targeted trials measuring how specific designs reduce canopy and canopy-adjacent temperatures, protect flowering, and sustain yields during heat events. Land-surface studies of recent Indian heat events show the complex interactions of drought and heat research should model and test interventions at farm scale.

Seed and sapling supply chains

Fast, reliable access to appropriate saplings (heat-tolerant natives, multipurpose species) is essential. Nurseries and public tree distribution programs should diversify beyond a handful of species and include farmers in species choice.

Integration into national heat action and agricultural plans

Heat action plans exist for cities and public health in some states; agriculture must be explicitly included in all district/state heat strategies, with agroforestry measures listed as actionable adaptation steps. Reports from governmental and expert bodies in 2024–25 underline the urgency: heat is already affecting public health and agriculture, and many districts face high heat risk.

Economic sense not just a feel-good add-on

A heat-adaptive system is an investment with multiple returns: protected yields,

diversified incomes (fruit, timber, and fodder), reduced irrigation needs over time, and lower livestock mortality. When short-term losses from heat events are large and evidence shows they can be even modest investments in ponds, mulch and shade can be cost-effective. Pilot projects and payment schemes (e.g., agroforestry-linked payments for ecosystem services) can help farmers adopt faster.

Quick, actionable checklist for farmers

For practitioners, a short checklist can translate principles into action:

- Plant a mix of canopy + mid-story + shrubby hedgerows within 1–3 years.
- Create or restore small ponds in strategic locations.
- Use mulches on all high-value plots before peak heat season.
- Schedule planting/flowering windows to avoid predicted peak heat (local advisories).
- Set up shaded livestock shelters with water and ventilation.
- Participate in local trials and share observations.

Conclusion

Agroforestry has been widely promoted as a climate-smart approach for sustainable agriculture, offering benefits such as carbon sequestration, biodiversity conservation, and livelihood diversification. However, under India's rapidly intensifying heat extremes, climate-smart agroforestry alone is no longer sufficient. Heat stress now represents the most immediate and damaging climatic threat to crops, livestock, farm workers, and rural livelihoods. Heat-adaptive agroforestry provides a necessary shift by explicitly prioritizing temperature regulation, microclimate buffering, and thermal protection. Through layered tree canopies, water bodies, windbreaks, mulching, and heat-tolerant species, these systems actively reduce on-farm temperatures and protect critical growth stages during heat waves. Beyond ecological benefits, heat-resilient designs enhance social resilience by reducing occupational heat stress and stabilizing farm productivity.Reframing agroforestry through a heat-resilience lens enables a proactive response to climate change. Integrated into local heat action plans and agricultural policies, heat-adaptive agroforestry can serve as a practical, scalable, and future-ready strategy for Indian agriculture in an era of extreme heat.

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The role of medicinal herbs

Anchal Sharma[1] and I.B. Maurya[2]
[1]Department. of Wildlife Management
[2]College of Horticulture & Forestry, Jhalawar
College of Horticulture and Forestry, Jhalawar (Agriculture University, Kota)

Herbs have a special significance in human life since ancient times. Whether it's treating physical ailments or achieving mental peace, herbs have proven their usefulness in every era. Despite the development of modern science, the importance of natural medicine and medicinal plants remains undiminished. Herbs play a major role in the Ayurvedic, Unani, and Siddha systems of medicine. This article explains the role of medicinal herbs, their uses, benefits, and their place in modern medicine.

Historical Importance of Herbs

Herbs have been used in India, since the Vedic period. Texts like the Rigveda, Atharvaveda, and Charaka Samhita mention hundreds of medicinal plants. At that time, people lived in harmony with nature and relied on plants for the treatment of their ailments. Herbs were not only helpful in treating illnesses, but were also important in preventing them and boosting the body's immunity.

Key medicinal herbs and their properties

India is home to a variety of herbs with exceptional medicinal properties. Some key herbs and their benefits are listed below:

Turmeric (*Curcuma longa*)

Benefits

Anti-inflammatory, antioxidant, joint pain relief.

How it works

Contains a compound called curcumin, which reduces inflammation and fights oxidative stress.

Use

For arthritis, digestion, and immunity

How to take

Mix with food, in tea, or as a supplement with black pepper (for best absorption).

Ginger (*Zingiber officinale*)

Benefits

Aids digestion, relieves nausea, anti-inflammatory

How it works

Contains an active compound called gingerol, which is rich in medicinal properties.

Use

It is used for indigestion, morning sickness, cold symptoms.

How to take

Fresh or dried, mixed into tea, soup, or smoothies

Ashwagandha (*Withania somnifera*)

Benefits

A powerful adaptogen, reduces stress and anxiety, increases energy

How it works

Balances cortisol levels and supports the adrenal glands.

Use

For fatigue, anxiety, and weakened immunity.

How to take

As a powder in milk or in capsules.

Peppermint (*Mentha piperita*)

Benefits

Aids digestion, pain reliever, and antibacterial

How it works: Contains menthol, which soothes muscles and reduces discomfort.

Use

For IBS, headaches, and colds.

How to take

As a tea, essential oil, or mixed into food

Tulsi (*Ocimum sanctum*)

Benefits

Boosts immunity, reduces stress, supports respiratory health

How it works

Acts as a natural adaptogen and antibacterial.

Use

For coughs, colds, and anxiety.

How to take

Boiled as a tea, mixed into food, or as a supplement

Echinacea (E*chinacea angustifolia*)

Benefits

Strengthens the immune system, prevents colds

How it works

Stimulates the immune response and may reduce the severity of colds.

Use

For the early stages of the flu, seasonal infections

How to take

As a tincture, tea, or capsule

Neem (*Azadirachta indica*)

Benefits

Neem is called nature's natural antibiotic. It helps purify the blood, relieve skin diseases, and detoxify the body.

How it works

Neem contains active compounds like azadirachtin, nimbin, and quercetin. These substances inhibit the growth of harmful microbes, reduce inflammation, and support the body's natural defense system.

Use

Used in skin care, dental care, and traditional medicine**,** **e**ffective in treating infections, wounds, and skin disorders

How to take

- Neem leaves: Chewed fresh (2–3 leaves daily)
- Neem powder: ½ teaspoon with warm water once daily
- Neem juice: 10–20 ml on an empty stomach
- Neem oil: For external use only (skin and hair)

Giloy (*Tinospora cordifolia*)

Giloy is also known as Amrita.

Benefits

Enhances immunity and fights infections, reduces fever and helps in recovery, improves digestion and metabolism, helps control diabetes

How it works

Giloy contains bioactive compounds like alkaloids, glycosides, and polysaccharides that strengthen immune response, reduce inflammation, and detoxify the body.

Use

Widely used in Ayurveda as an immunity booster**,** helpful in chronic fever, allergies, and respiratory issues**.**

How to take

- Giloy juice: 15–30 ml with lukewarm water daily
- Giloy powder: ½–1 teaspoon once or twice a day
- Giloy tablets: As prescribed by an Ayurvedic practitioner
- Giloy decoction (kadha): Boil stem pieces in water and drink

Role in mental health

Problems like mental stress, anxiety, and insomnia are increasing rapidly in modern lifestyles. Herbs offer natural and safe solutions to these problems. Herbs like Brahmi, Shankhapushpi and Ashwagandha help calm the mind, increase concentration, and improve sleep. Regular

consumption can improve mental health without any side effects.

Boosting Immunity

The global pandemic of COVID-19 has proven how important it is to maintain a strong immune system. In Ayurveda, herbs are used to strengthen the immune system. Giloy, Amla, Tulsi, and Ashwagandha are some of the herbs that provide the body with the power to fight diseases.

Use of herbs in modern medicine

Presently, pharmaceutical companies are also recognizing the properties of herbs. Many modern medicines are based on natural ingredients. Scientific research has proven that many herbs possess antibiotic, antiviral, anti-inflammatory, and antioxidant properties. Their use helps reduce side effects in modern medicine.

Use in Home Remedies

Herbs have been used in Indian homes for generations. Grandmothers' remedies often provide simple and effective solutions to household ailments. For example basil and ginger decoction for coughs, celery for stomach aches, mint oil for headaches, or turmeric for wounds may be used. This knowledge has been passed down from generation to generation.

Promoting a natural lifestyle

The use of herbs is not limited to healing the body; it represents a holistic lifestyle. When a person lives in harmony with nature, their physical and mental health automatically improves. The integration of yoga, pranayama, a sattvic diet, and herbs creates a holistic and balanced lifestyle.

Natural distribution of medicinal plants growing in and around PCIM&H, Ghaziabad

Deepthi Koppala, Jitendra Pal Singh, Mukesh Kumar and Jayanthy A
Pharmacopoeia Commission for Indian Medicine and Homeopathy
Kamla Nehru Nagar, Ghaziabad

Abstract
Commonly, many unwanted herbs and shrubs grow in a particular location often competing with desired plants for resources like water, nutrients, and light. They can be invasive, spreading quickly and taking over gardens, crops, or natural areas. We consider such plants as weeds. If we try to recognize their identity, it is revealed that they are not silly weeds, instead they are valuable medicinal plants as they possess medicinal properties due to the presence of active phytochemicals in them.The rich biodiversity of our region has blessed us with a treasure trove of medicinal plants, used for centuries to treat various ailments and promote overall well-being. From traditional folk remedies to modern pharmaceuticals, these plants have played a vital role in the healthcare practices of local communities. Present study aims to explore the common medicinal plants found in and around the campus of Pharmacopoeia Commission for Indian Medicine & Homeopathy, Ghaziabad, highlighting their unique properties, uses, and benefits. By documenting these plants and their significance, we hope to preserve traditional knowledge and promote the sustainable use of these valuable resources for future generations.

Keywords: Biodiversity, Conservation, Herbarium, Medicinal uses and Weed

Introduction

Pharmacopoeia Commission for Indian Medicine & Homeopathy (PCIM&H) is a subordinate office under Ministry of Ayush, situated at Kamla Nehru Nagar, Ghaziabad, covers around 8.3 acres of garden area with enormous number of herbs, shrubs, climbers, trees including both terrestrial and aquatic forms. A weed is described as any plant growing in a location where it is not wanted. This encompasses not only invasive or exotic species, but also native and cultivated crops when they occur outside of intended areas. So, any plant that becomes a nuisance due to its presence in an undesired location may be classified as a weed. Weeds can cause significant negative effects by competing with commercially cultivated crops for essential resources such as nutrients, water, and sunlight. As a result, they can reduce crop yields (Klingman *et al.*, 1975). These weeds also possess characteristics such as rapid growth, prolific reproduction, and strong competitive abilities.

While weeds are often considered detrimental due to their negative impact on agricultural productivity, it is important to recognize that many weed species also hold significant medicinal value. Historically, various weeds have been used in traditional medicine to treat a wide range of ailments. Numerous researchers such as Majid *et al.*, 2012, Bandyopadhyay *et al.*, 2014, have documented the medicinal uses of different plant species for the treatment of various diseases. However, people often lack awareness about these plants, which may appear as no use for mankind. These weeds may belong to different families like Amaranthaceae, Asteraceae, Brassicaceae, Caryophyllaceae, Convolvulaceae, Cucurbitaceae,
Cyperaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Malvaceae, Oxalidaceae, Poaceae, Polygonaceae, Scrophulariaceae, Solanaceae, Verbenaceae. The present paper provides the information about some of the weed plants and their medicinal uses found in and around PCIM&H, Ghaziabad,

Uttar Pradesh. It will be highly beneficial for researchers and the local people in updating their knowledge and finding out medicinal uses of these plants.

Geographical location of PCIM&H

PCIM&H is located at the coordinates: latitude 28.692609° and longitude 77.460348°. The weeds growing in and around the campus of PCIM&H were recorded in the year 2023-24by conducting frequent field visits. Plant identification was conducted through a review of relevant literature, including regional floras and botanical references specific to Ghaziabad, and by comparison with authenticated herbarium specimens. Additionally, digital photographs of the weeds growing on the campus were taken to aid in confirming their identity. Medicinal properties and the uses of the weeds growing in the campus were studied and recorded with the help of literature available.

Medicinal plants and their uses

It was found that, certain area of the campus is covered with wild herbal flora which includes several plants with medicinal uses. The campus is eco-friendly with rich flora of trees, shrubs, herbs, grasses and aquatic plants. A total of 45 weed species has been identified in the campus and reported to have medicinal uses. The weeds recorded are naturally grown in the campus. Around 45 weed species, having remarkable medicinal importance were reported in the Table 1. The photographs of all the weed plants were given in 'Fig1'. These medicinal weeds belong to 23 plant families altogether. Among these, Asteraceae was the highest contributor (13 %) followed by Euphorbiaceae (11 %).

Also, the present study revealed that many of the herbal weed members grow naturally in the campus area in different seasons. Some exotic weeds like *Ecliptaprostrata*, *Oxalis corniculata* and *Phyllanthus amarus*are also luxuriously present in the campus, which have enormous medicinal value (Table 1). Hence much attention is needed for their in-situ conservation in natural habitat.

Table 1: List of available Common Medicinal Plants with their medicinal uses

S. N.	Botanical name	Vernacular name	Family	Part used	Uses
1.	*Abutilon indicum* (L.) Sweet.	Malvaceae	Indian mallow	Whole plant	Root and bark - aphrodisiac, anti-diabetic, nervine tonics, and diuretic. Seeds - urinary disorders, laxative. Leaves - applied topically to boils and ulcers. (Raja and Kailasam, 2015)
2.	*Acalypha indica* L.	Euphorbiaceae	Kuppi	Whole plant	Insect bites, headaches, epilepsy, ear aches and as an expectorant (Isman, 2000)
3.	*Achyranthes aspera* L.	Amaranthaceae	Chirchita	Whole plant	Antipyretic and cardiovascular agent

					(Sutar *et al.*, 2008)
4.	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Alligator weed	Aerial part	Treatment for diarrhoea, dysentery, anaemia, blood conditions, fever, post-natal depression, wounds, and to boost milk production. (Rattanathongkom *et al.*, 2018)
5.	*Alternanthera sessilis* (L.) R.Br.ex DC.	Amaranthaceae	Sessile joyweed	Whole plant	Treat cuts, wounds, skin diseases, an antidote for snake bites and scorpion stings. (Merish *et al.*, 2014)
6..	*Amaranthus viridis* L.	Amaranthaceae	Green amaranth	Whole plant	Labor pains; reduce fever, urinary and respiratory issues, venereal diseases, ulcers, rheumatism and asthma. (Reyad-ul-Ferdous *et al.*, 2015)
7.	*Anagallis arvensis* L.	Primulaceae	Scarlet pimpernel	Whole plant	Wound healing, skin infections, diuretic, antifungal, expectorant, and anti-inflammatory properties. (López *et al.*, 2011)
8.	*Argemone mexicana* L.	Papaveraceae	Mexican poppy	Root, latex and seed	Dropsy, jaundice, skin diseases, and eye conditions, blood circulation, anti-venom properties and its latex is used for conjunctivitis. (Sharma *et al*., 2012)
9.	*Boerhaavia diffusa* L.	Polygonaceae	Punarnava	Root	Diuretic/nephrological system, jaundice, wound healing (Thirumalaiv *et al.*, 2010; Prachi *et al.*, 2009)
10.	*Calotropis procera* (Ait.) R. Br.	Asclepiadaceae	Swallow wort	Stem bark, root bark, leaf	Asthma, cold, cough, piles, ulcers, diarrhoea, heart diseases, leprosy, rheumatism and diseases of skin, spleen, liver and abdomen. (Verma *et al.*, 2010)
11.	*Chenopodium album* L.	Chenopodiaceae	Bathua	Whole plant	Treat disorders of the blood, heart, spleen, bile.

					(Yao *et al.*,2010)
12.	*Chloris virgata* Sw.	Poaceae	Feather finger grass	Whole plant	Anti-oxidant properties. (Kumari *et al.*, 2024)
13.	*Cissampelos pareira* L.	Menispermaceae	Velvet Leaf	Root	Abdominal pain, inflammation, indigestion, wounds, snakebites, and various infections, blood purifier, malaria, pneumonia, and birth control. (Sudhakaran, 2012)
14.	*Coccinia indica* Wight &Arn.	Cucurbitaceae	Ivy Gourd	Leaves and fruits	Anti-oxidant properties (Venkateswaran and Pari, 2003).
15.	*Convolvulus prostrates* Forssk.	Convolvulaceae	Bindweed or Shankhpushpi	Whole plant	Boosting memory and intellect, antianxiety, and anthelmintic properties, bronchitis, epilepsy, teething in infants, and improving appetite and complexion. (Bhowmik *et al.*, 2012; Balkrishna *et al.*, 2020)
16.	*Coronopus didymus* (L.) Sm.	Brassicaceae	Swine-cress	Leaf	Cough bruises, arthritis, ulcers, cancer, and urinary issues. Relieves pain, fever, and inflammation. (Busnardo *et al.*, 2010)
17.	*Cuscuta reflexa* Roxb.	Convolvulaceae	Amarbel	Seed	Treatment in jaundice, gout and hair development promotor (Khan and Widunbiliu, 2022)
18.	*Cynodon dactylon* (L.) Pers.	Poaceae	Bermuda grass	Whole plant	Anti-diabetic, antimicrobial, anti-inflammatory, diuretic, and Antioxidant properties. (Parihar and Sharma, 2021)
19.	*Cyperus rotundus* L.	Cyperaceae	Nut grass	Rhizome	Stomach issues, inflammation, diarrhoea, menstrual disorders, and infections. (Dang *et al.*,2011)
20.	*Eclipta prostrata* L.	Asteraceae	Bhringaraj	Whole plant	High blood pressure, heart disease, diabetes,

					skin and respiratory issues, digestive disorders, and wounds. (Khan and Khan, 2008)
21.	*Euphorbia hirta* L.	Euphorbiaceae	Asthma Weed	Whole plant	Bronchial and respiratory diseases (Kumar *et al.*, 2010)
22.	*Euphorbia prostrata* W. Ait.	Euphorbicaeae	Dudhi	Whole plant	Skin diseases and asthma. (Sharma *et al.*, 2012)
23.	*Evolvulus alsinoides*L.	Convolvulaceae	Vishnukranta	Whole plant	Treatment of neurodegenerative diseases, asthma and amnesia Boost memory and improve intellect (Sethiya *et al.*, 2009)
24.	*Heliotropium indicum* L.	Boraginaceae	Indian heliotrope	Whole plant	Skin diseases, poison bites, Stomach ache and nervous disorders. (Muthu *et al.*, 2006)
25.	*Lactuca saligna* L.	Asteraceae	Willowleaf lettuce	Whole plant	Antioxidant and antibacterial properties. (Bouymajane *et al.*, 2024)
26.	*Lantana camara* L.	Verbenaceae	Lantana	Whole plant	Leaves- antitumoral, antibacterial, antihypertensive agent Root- malaria, rheumatism, and skin rashes (Barreto *et al.*, 2010; Kalyani *et al.*, 2011)
27.	*Malva sylverstris* L.	Malvaceae	Common mallow	Leaves and flowers	Inflammatory diseases of mucous mem branes, cystitis, and diarrhoea (Mousavi *et al.*, 2021)
28.	*Melilotus officinalis* L.	Fabaceae	Yellow sweet clover	Flowering tops	Anti-aging, pains and aches, anti-malarial properties. (Adams *et al.*, 2009)
29.	*Mimosa pudica* L.	Fabaceae	Touch-me-not	Whole plant	High blood pressure, psoriasis cure and wound-healing activities. (Paul *et al.*, 2010 Ignacimuthu *et al.*, 2008)
30	*Oxalis corniculata*	Oxalidaceae	creeping	Whole	Convulsion and piles,

.	L.		woodsorrel	plant	scorpion sting, stop bleeding from wounds (Li *et al*., 2006; Hebbar *et al*., 2004)
31.	*Parthenium hysterophorous* L.	Asteraceae	congress weed or gajarghans	Whole plant	Anti-inflammatory and anti-microbial properties (Kaur *et al*., 2021)
32.	Phyllanthus amarus *Schumach. & Thonn.*	Euphorbicaeae	Bhui Amala	Root, stem and leaves	Kidney, urinary bladder and intestinal infections, diabetes, and hepatitis (Jantan *et al.*, 2019)
33.	*Pluchealanceolata* Oliver & Hiem.	Asteraceae	rasna	Leaf	Antipyretic,analgesic,laxative, nervinetonic and uterine relaxant (Jadhav Bhutani, 2005)
34.	*Polygoniumaviculare*L.	Polygonaceae	Knotweed	Whole plant	Dysentery and haemorrhoids. (Robu *et al.*, 2008)
35.	*Portulaca oleracea* L.	Portulacaceae	Khurfa	Whole plant	Wound-healing properties (Rashed *et al.*, 2003)
36.	*Ricinus communis* L.	Euphorbiaceae	Arandi	Seed, leaf, root	Insecticidal and anti-cancer properties (Shobha *et al.*, 2019; Hussein *et al.*, 2016)
37.	*Rumexmaritimus* L.	Polygonaceae	Golden Dock	Leaves, seed	Mild constipation, Skin problems, Diarrhoea, Piles, Bleeding of the lungs, Sores, Ulcers, Wounds, Cancer, Gastric disturbance, Dermatitis. (Hossain *et al*., 2015)
38.	*Scopariadulcis* L.	Scrophulariaceae	Sweet broomweed	Leaves	Fever, kidney stones, diabetes, jaundice, stomach problems, skin disease, and piles. (Jeeva and Femila, 2012; Bhuyan and Baishya, 2013)
39.	*Sidaacuta*Burm.f.	Malvaceae	Sida	Leaves, roots	Leaf-abdominal pain, haemorrhoids, vomiting and gastric disorders. Root- breathing problems and cough (Silja *et al*, 2008)
40.	*Sida rhombifolia* L.	Malvaceae	Bala	Root	Anti-oxidant activity (Dhalwal *et al.*, 2007)
41	*Solanum nigrum* L.	Solanaceae	Black	Whole	Hepatitis, fever, ulcers

.			nightshade	plant	(Mandal *et al.*,2023)
42.	*Solanum virginianum*L.	Solanaceae	Yellow-fruit nightshade	Whole plant	Asthma, chest pain, leucoderma, scorpion bite, and sterility in women, toothache (Rane *et al.*, 2014)
43.	*Sonchus oleraceus* L.	Asteraceae	Sow Thistle	Root, stem and leaves	Gastric spasm, hepatitis, infections, inflammation, headaches, general pain, rheumatism. (Agra *et al.*, 2008)
44.	*Tribulus terrestris* L.	Zygophyllaceae	Gokhru	Whole plant	Sterility, sexual problems, metabolism disorders. (Kamenov *et al.*, 2017)
45.	*Vernonia cinerea* Lees.	Asteraceae	Sahadevi	Whole plant	Abdominal pain, diarrhoea, asthma, bronchitis (Sen *et al.*, 2011; Sinhababu and Banerjee, 2013)


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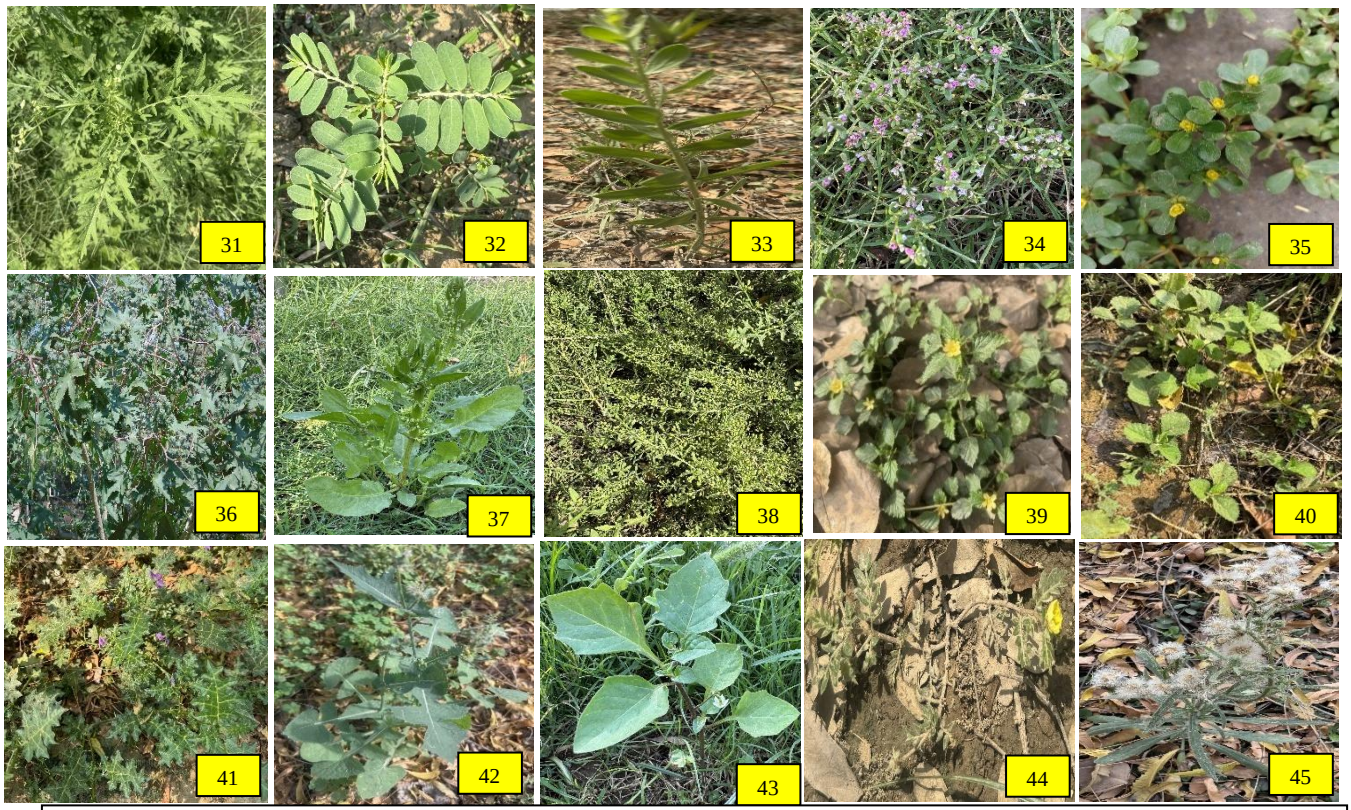

Fig. 1. Photographs of few selected plants grow as weed and used as medicine in the campus of PCIM&H
1) *Abutilon indicum* (L.) Sweet. 2) *Acalypha indica* L. 3) *Achryanthes aspera* L. 4) *Alternanthera philoxeroides* (Mart.) Griseb. 5) *Alternanthera sessilis* (L.) R.Br.ex DC. 6) *Amaranthus viridis* L. 7) *Anagallis arvensis* L. 8) *Argemone mexicana* L. 9) *Boerhaavia diffusa* L. 10) *Calotropis procera* (Ait.) R. Br.11**)** *Chenopodium album* L. 12) *Chloris virgata* Sw. 13) *Cissampelos pareira* L. 14) *Coccinia indica* Wight & Arn. 15) *Convolvulus prostratus* Forssk. 16) *Coronopus didymus* (L.) Sm. 17) *Cuscuta reflexa* Roxb. 18) *Cynodon dactylon* (L.) Pers. 19) *Cyperus rotundus* L. 20) *Eclipta prostrata* L. 21) *Euphorbia hirta* L. 22) *Euphorbia prostrata* W. Ait. 23) *Evolvulus alsinoides* L. 24) *Heliotropium indicum* L. 25) *Lactuca saligna* L. 26) *Lantana camara* L. 27) *Malva sylverstris* L. 28) *Melilotus officinalis* L. 29) *Mimosa pudica* L. 30) *Oxalis corniculata* L. 31) *Parthenium hysterophorous* L. 32) *Phyllanthus amarus* Schumach. & Thonn. 33) *Pluchea lanceolata* Oliver & Hiem. 34) *Polygonium aviculare* L. 35) *Portulaca oleracea* L. 36) *Ricinus communis* L. 37) *Rumex maritimus* L. 38) *Scoparia dulcis* L. 39) *Sida acuta* Burm.f. 40) *Sida rhombifolia* L.41) *Solanum nigrum* L. 42) *Solanum virginianum* L. 43) *Sonchus oleraceus* L. 44) *Tribulus terrestris* L. 45) *Vernonia cinerea* Lees.

of various weed species, many of these plants are routinely removed as unwanted vegetation which will lead to the depletion and then extinction of this population from a particular area. Additionally, developmental activities have often led to habitat destruction, significantly impacting plant diversity and contributing to the ongoing loss of biodiversity. In this context, conserving biodiversity has become a global priority. Educational and research institutions have a crucial role to play, especially in educating students about the importance of biodiversity conservation. This study emphasizes that many commonly found weeds in our environment possess medicinal properties.

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Standardization and quality control issues in herbal non-timber forest products (NTFPs)

Manorath Sen[1], Ajit Kumar Mourya[2], Sharat Kothari[1] and Atahar Perwez[1]
[1]ICFRE- Arid Forest Research Institute
Jodhpur, Rajasthan
[2]ICFRE – Tropical Forest Research Institute
Jabalpur, Madhya Pradesh
Email- msen@icfre.org

Introduction

Herbal non-timber forest products (NTFPs) play a vital role in India's traditional healthcare systems, forest-based livelihoods, and emerging bio-economy. Medicinal plants, gums, resins, bark, roots, leaves, seeds, and other plant parts collected from forests have been used for centuries in Ayurveda, Siddha, Unani, and diverse folk traditions. In recent years, global demand for herbal medicines, nutraceuticals, cosmetics, and wellness products has grown rapidly, bringing new economic opportunities for forest-dependent communities.

However, this growing demand has also highlighted serious concerns related to standardization and quality control. Unlike synthetic drugs, herbal NTFPs are natural biological materials whose quality varies widely depending on species, habitat, harvesting practices, and post-harvest handling. The absence of uniform quality standards often results in inconsistent efficacy, safety risks, and reduced market credibility. Addressing these issues is essential to ensure consumer safety, strengthen traditional medicine systems, and support sustainable forest-based livelihoods.

Importance of standardization in herbal NTFPs

Standardization refers to establishing consistent parameters for the identity, purity, strength, and safety of herbal raw materials and products. In the context of herbal NTFPs, it ensures that plant materials used in formulations deliver predictable therapeutic benefits and meet regulatory requirements. Quality control complements standardization by monitoring contamination, adulteration, and degradation during collection, processing, and storage.

For forest-based products, standardization is not merely a laboratory exercise. It has direct implications for income generation, conservation, and market access. High-quality standardized raw materials fetch better prices, reduce rejection in supply chains, and improve the reputation of forest-derived products in national and international markets.

Sources of variability in herbal NTFPs

Genetic and species diversity

Medicinal plants often show significant genetic variation, even within the same species. In many cases, multiple species are traded under a single local or common name, leading to confusion and inconsistency. This species substitution is one of the primary causes of variable quality in herbal NTFPs.

Environmental and ecological factors

Soil type, rainfall, temperature, altitude, and sunlight strongly influence the synthesis of secondary metabolites in plants. As a result, the same plant species collected from different regions may differ considerably in chemical composition and medicinal value.

Seasonal and harvesting variations

The concentration of bioactive compounds changes with plant age and season. Harvesting plant parts at inappropriate stages can significantly reduce potency. Unscientific harvesting methods, such as uprooting entire plants or excessive bark removal, further affect both quality and sustainability.

Fig 1: Unscientific harvesting and seasonal variation significantly influence the quality and sustainability of herbal NTFPs.

Fig 2**:** *Improper drying and storage practices are a major cause of quality deterioration in herbal raw materials.*

Major quality control issues in herbal NTFPs

Misidentification and adulteration

Misidentification of plant species is a widespread problem in herbal NTFPs. Collectors often rely on visual similarity or local names, leading to substitution with incorrect species. In longer supply chains, intentional adulteration with inferior or cheaper materials is also common. These practices reduce therapeutic efficacy and may pose health risks.

Contamination and safety concerns

Herbal NTFPs are susceptible to contamination by soil, dust, microbes, and environmental pollutants. Improper drying and storage encourage fungal growth, resulting in aflatoxin contamination. In some areas, heavy metals and pesticide residues further compromise product safety, creating barriers to quality certification and export.

Poor post-harvest handling

Traditional post-harvest practices such as drying on bare ground, storage in humid conditions, and lack of proper packaging lead to deterioration of herbal raw materials. Loss of volatile and heat-sensitive compounds during drying significantly reduces medicinal value and shelf life.

Challenges in standardization of herbal NTFPs

Standardization of herbal NTFPs is challenging due to the complex chemical nature of plant materials. Unlike synthetic drugs, herbal products contain multiple active compounds that act synergistically, making it difficult to define a single quality marker. Additionally, quality testing infrastructure is often located far from forest areas, limiting access for primary collectors. Fragmented supply chains and limited awareness among stakeholders further complicate quality assurance efforts.

Scientific approaches to standardization and quality control

Standardization begins with proper botanical authentication using morphological characteristics, herbarium references, and, where possible, molecular tools. Physico-chemical parameters such as moisture content, ash values, and extractive values provide baseline quality indicators. Advanced phytochemical profiling techniques create chemical fingerprints that ensure authenticity and consistency. Microbial load and toxicity testing are essential to ensure compliance with safety standards.

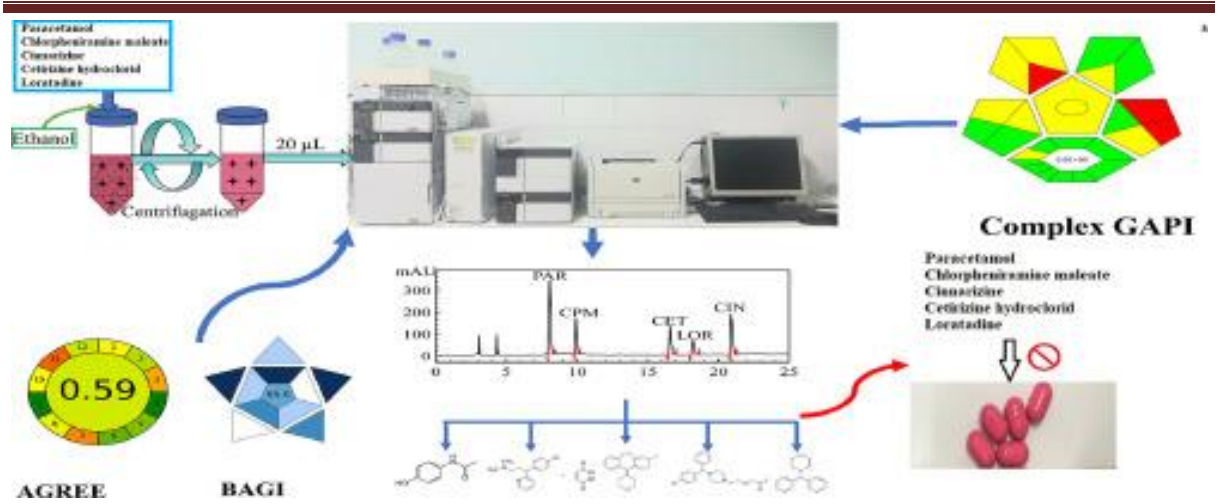

Fig 3: Laboratory-based quality control and phytochemical profiling help ensure the safety and efficacy of herbal NTFPs.

Role of post-harvest management

Improved post-harvest management is one of the most effective ways to enhance quality. Scientific drying methods, hygienic storage, grading, and primary processing at the collection site significantly reduces losses and contamination. Training forest communities in simple post-harvest technologies can greatly improve both quality and income.

Institutional and policy support

Forest departments, research institutions, and development agencies play a crucial role in strengthening quality assurance systems. Developing harvesting protocols, standard operating procedures, and decentralized processing facilities can bridge the gap between forest collection and market requirements. Certification and traceability systems further enhance transparency and consumer trust.

Quality control, conservation, and livelihoods

Quality-oriented NTFP management promotes sustainable harvesting by rewarding better practices with higher returns. This creates a positive cycle where improved quality leads to better prices, reduced overexploitation, and long-term conservation of forest resources.

Conclusion

Standardization and quality control are no longer optional components in the management of herbal non-timber forest products; they are fundamental requirements for ensuring the credibility, safety, and sustainability of this sector. As demand for herbal medicines, nutraceuticals, and natural health products continues to rise, the consequences of poor-quality raw materials become increasingly significant. Inconsistent efficacy, contamination, adulteration, and lack of traceability not only threaten consumer health but also undermine the reputation of traditional medical systems and restrict access to regulated markets.

From a forestry perspective, weak quality control often results in overexploitation and destructive harvesting practices. When market systems reward quantity rather than quality, forest resources are subjected to excessive pressure, leading to depletion of valuable medicinal plant species. Conversely, a quality-driven approach encourages sustainable harvesting, proper post-harvest handling, and long-term stewardship of forest ecosystems. By linking higher returns with better quality, standardization creates incentives for conservation while strengthening forest-based livelihoods.The successful implementation of standardization requires

coordinated efforts across multiple stakeholders. Forest-dependent communities must be empowered through training in species identification, sustainable harvesting, and scientific post-harvest practices. Research institutions and regulatory bodies need to develop practical, region-specific standards that respect traditional knowledge while incorporating modern scientific validation. Equally important is the establishment of decentralized processing and testing facilities near forest areas, which can bridge the gap between primary collectors and market requirements.

In the long run, integrating standardization and quality control into herbal NTFP management has the potential to transform the sector from an informal, extraction-based system into a resilient, value-driven bioeconomy. Such a transition will not only enhance the global competitiveness of Indian herbal products but also ensure that forest resources are utilized responsibly and equitably. By prioritizing quality, India can safeguard its rich medicinal plant heritage while promoting sustainable development, public health security, and inclusive growth in forest-dependent regions.

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The magic shrub: *Carissa spinarum*

Nikhil Pathania[1] and Sakshi[2]
[1]Department of Botany
Sardar Patel University, Mandi (H.P.)
[2]Department of Forest Products
Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan (H.P.)
E-mail: nikhilpathania4u@gmail.com, sakshipathania884@gmail.com

Introduction

Carissa spinarum L. belongs to the family Apocynaceae. The plant is known as 'Wild Karanda' or 'bushplum' and is an underutilized wild fruit closely related to *Carissa carandas*. *Carissa spinarum* is also called as "Magic Shrub" in some of the African countries, as it is considered as a source of treatment for various diseases and ailments. *Carissa spinarum* is a small spinous evergreen erect thorny shrub.

Part used: Fruit, Root, Seed, Leave, Flower

Distribution

In India, this shrub occurs wild and is commonly found in semi-arid regions, particularly in the districts of Kangra, Hamirpur, Bilaspur, Una, Mandi, Solan and Sirmaur of Himachal Pradesh. Beyond India, it is widely distributed across tropical regions of Asia, Africaand Australia.

Morphology

- The plant is a thorny shrub with forked branches, attaining a height of about 2–3 m. Its wood is very hard, and the bark varies from light brown to green. The thorns, measuring nearly 3.2 cm in length, are brown to greenish at the base and gradually turn deep brown toward the tip.
- The leaves are ovate and leathery, approximately 4.5 cm long and 2.5 cm wide, with reticulate pinnate venation and entire margins. They are borne on a short petiole about 3 mm long and exude white latex when plucked from the stem.
- The flowers are white, pleasantly fragrant, short-stalked, bisexual, and complete. The fruit is an ovoid berry measuring about 5–12 mm in length and nearly 6 mm in diameter, it is green when unripe and turns shiny black upon full maturity.

Nutritional profile

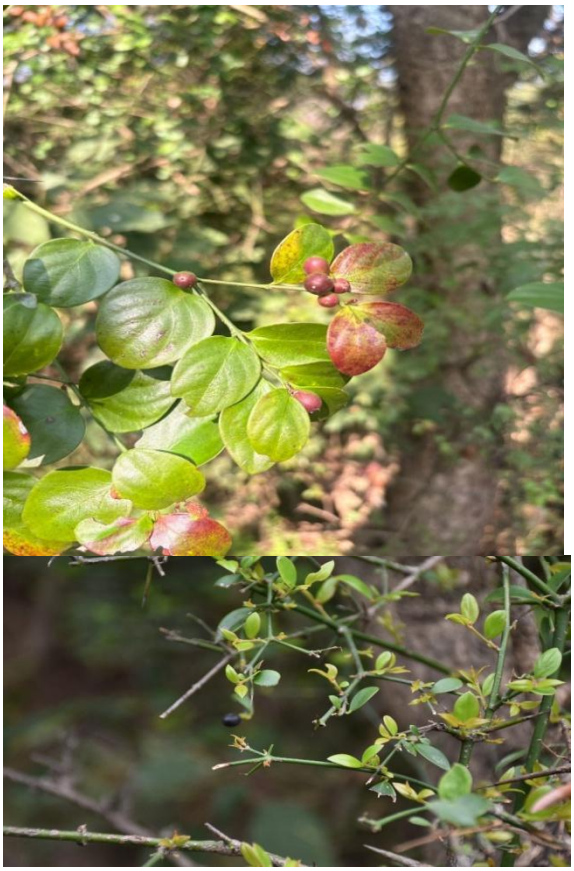
The nutritional profile per 100 g shows that the sample contains 64.00% moisture and 12.20 g of carbohydrates, indicating a high-water content with moderate energy contribution. It is very low in fat (0.13 g) and protein (0.04 g). The ash content is 1.62 g, reflecting the total mineral matter present. Among minerals, potassium (0.50 g) is present in the highest amount, followed by phosphorus (0.06 g). Calcium and magnesium are each present at 0.05 g, while iron is found in a small quantity (0.01 g) per 100 g.

Medicinal Importance of *Carissa spinarum*

The root leaves and fruits of *Carissa spinarum* possess a wide range of medicinal properties beneficial to both

humans and animals. Various parts of the plant are traditionally used for their antimicrobial effects and in the treatment of chest ailments, parasitic infections, and malaria. Extracts of the plant have been reported to be effective against stomach ache, diarrhea, and dysentery, as well as for stopping post-partum bleeding, healing ulcers, relieving muscle cramps, and cleansing worm-infested wounds in animals. Experimental studies indicate that root extracts promote significant wound healing by enhancing wound contraction and epithelialization.

Traditionally, *Carissa spinarum* has also been used in the management of rabies, typhoid fever, syphilis, herpes simplex virus (HSV-I and HSV-II) infections, gonorrhoea, hepatitis, measles, chickenpox, and polio. Additional therapeutic uses include the treatment of fever, skin disorders, cataracts, anaemia, constipation, gastric ulcers, asthma, myalgia, infertility, hypertension, and kidney-related ailments. The plant is further recognized for its anticonvulsant, anticancer, antidiabetic, and anti-rheumatic properties. Studies have also demonstrated its diuretic, anti-inflammatory, hypolipidemic, analgesic, and hepatoprotective activities. Moreover, *Carissa spinarum* is used to manage sexual asthenia in males, serves as an



antidote and repellent for snakebites, and is employed in the treatment of chronic pain and joint inflammation.

***Carissa spinarum* L.**

Unique value

A paste made from crushed roots is used as a fly repellent, while a decoction of the roots is used to treat epilepsy.

The resurgence of Alexandrine Parakeets: A tale of triumph in Jhalawar

Anchal Sharma[1] and I.B.Maurya[2]
[1]Department of Wildlife Management
[2]College of Horticulture and Forestry
Jhalawar- 326023 (Raj.)
E-mail: *Anchal@aukota.org*)

In the heart of Rajasthan lies a hidden gem - Jhalawar, a region swarming with vibrant culture and rich history. Recently, this land witnesses an unexpected revival, with the glorious return of the magnificent Alexandrine Parakeets. These splendid birds, also known as Gagroni parrot, owe their name to the majestic Gagron Fort of Jhalawar, a UNESCO World Heritage Site. For decades, they flourished amidst the fort's fruit-laden trees and nestled within its ancient walls.

Once feared to have vanished from Jhalawar entirely, the Alexandrine Parakeet, renowned for its ability to mimic human speech, now marks its triumphant return. A remarkable avian renaissance is underway, with recent expeditions confirming the presence of this rare species within the forests of Jhalawar along with rose-ringed parakeet (Fig-1). On the bank of the Aahu River, amidst the lush foliage of *Azadirachta indica*, *Prosopis juliflora* etc trees and the surrounding orange and guava orchards, approximately 20 individuals - both males and females - were sighted on February 3rd and 12th, 2024 (Fig-2 Location: 24^0 63′50 N 76^0 05′50 E). An individual with a length of 20 inches and a tail nearly a foot long, adorned with captivating red markings, and boasting a weight twice that of other parrot species, the male Alexandrine Parakeet dons a prominent red collar around its neck, further enhancing its magnetism.

One of the most captivating behaviors exhibited during the sighting by these parakeets was their courtship rituals (Fig-3). During the mating season, which typically occurs in the early months of the year, male Alexander Parakeets put on a dazzling display to attract potential mates. With vibrant plumage adorned in shades of green and red, the males flit and flutter through the canopy, emitting melodious calls and performing intricate aerial maneuvers. These displays serve not only to impress the females but also to establish dominance within their social groups. The courtship rituals of Alexandrine Parakeets are not merely a spectacle for onlookers; they are essential for maintaining the genetic diversity and population stability of these birds. By selecting healthy and genetically robust mates, they ensure the continuation of their species for generations to come.

Historically, the Alexandrine Parakeets, scientifically known as *Psittaculaeupatria*, graced the skies of Jhalawar in significant numbers. However, due to habitat loss, illegal trapping, and the pressures of urbanization, their population dwindled precariously over the years. By the turn of the century, sightings of these majestic birds became increasingly rare, once on the brink of local extinction, it is protected under Schedule 1 (B) of the Wildlife Protection Act (WPA) 1972. The species that was listed with IUCN in 2012 as least concerned has over a year moved to 'Near Threatened' status in the Red list of the International Union for Conservation of Nature (IUCN) in 2013 and in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These parrots were caught by poachers for their great demand as domestic pets since they imitate human voices perfectly and also due to their bigger size.

As poaching for the pet trade intensified, these once-familiar avian denizens all but disappeared from Gagraon Fort and the wider Jhalawar district. A 2020 wildlife survey conducted by the forest authorities revealed a distressing absence of the Gagroni Parrot, signaling a dire plight.

Fig-1: Group of *Alaxendrine parakeet* on Neem tree

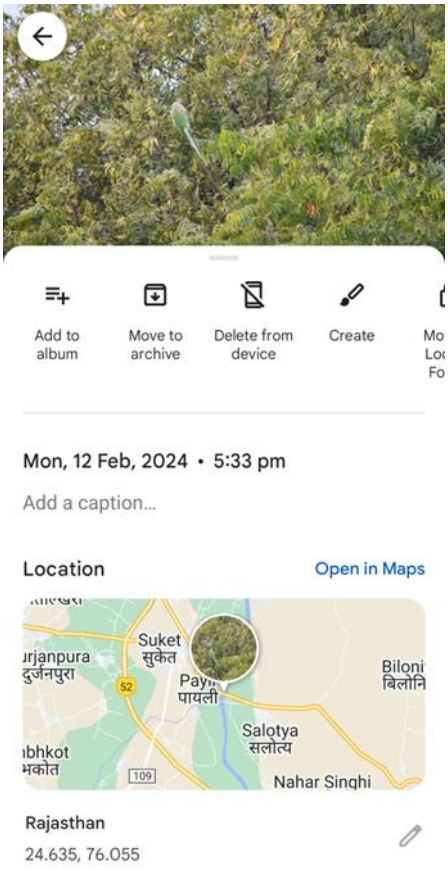


Fig-2: Sighting location of *Alaxendrine parakeet*

Fig-3: Courtship behaviour shown bymale and female *Alaxendrine parakeet*

Yet, against all odds, these charismatic birds, named after the legendary conqueror Alexander the Great, are now staging a remarkable comeback. Their presence not only adds glory to the region but also serves as a testimony to the power of conservation efforts and the resilience of nature. By working together to protect and restore their habitats, we can ensure that these magnificent birds, and countless other species, thrive for years to come.

So, the next time you find yourself in the attractive landscapes of Jhalawar, keep an eye out for the vibrant hues and melodious calls of the Alexandrine Parakeets, as they soar through the skies, symbolizing hope, resilience, and the enduring beauty of nature.

PCIM&H infrastructure- A blend of modern facilities and therapeutic thematic gardens

Deepthi Koppala[1], Jitendra Pal Singh[1], Lalit Tiwari[1], Nitin Rai[1], Jayanthy A[1] and Raman Mohan Singh[1]
[1]Pharmacopoeia Commission for Indian Medicine and Homeopathy
PLIM Campus, Kamala Nehru Nagar, Post, Raispur, Ghaziabad, Uttar Pradesh 201002

Abstract
Pharmacopoeia Commission for Indian Medicine and Homeopathy, located in Ghaziabad, is a prominent institute dedicated to educationand sustainable practices in herbal sciences. Its primary mandate is to establish pharmacopoeial standards for the pharmacopoeias and formularies of 'Indian Medicine' and 'Homeopathy'. Along with, this Institute is also equipped with modern facilities such as greenhouse and polyhouse for plant cultivation, a vermicompost unit for organic waste management, interactive kiosks, QR code access, and thematic gardens. These facilities allow students, trainees, and visitors to explore and learn about various medicinal plants. The institute also promotes environmental awareness through initiatives like Miyawaki forest plantations and themed gardens, which help increase biodiversity and create green, eco-friendly spaces. By combining traditional knowledge with modern technology, PCIM & H aims to provide an inspiring, educational, and sustainable environment for everyone who visits.

Keywords: Pharmacopoeial species, medicinal plants, thematic display.

Introduction

Medicinal plants have been the foundation of traditional healthcare methods for thousands of years, and many cultures throughout the world still rely on plant-based medicines for everyday medical needs.In both developed and emerging countries, the demand for herbal and natural health products has increased due to advancements in plant science. 70–80% of people worldwide are thought to still use medicinal plants as their first line of therapy (Singh, 2002; WHO, 2002). With over 2,000 species found in various ecosystems, India is particularly renowned for its abundance of therapeutic herbs and spices. Systems like Ayurveda, Unani, and Siddha have a lot of potential in the nation (Prakash & Gupta, 2005).

The Pharmacopoeia Commission for Indian Medicine and Homoeopathy (PCIM&H)**,** Ghaziabad, a subordinate office under the Ministry of Ayush, Government of India**,** maintains a National Herbal garden for Pharmacopoeial species in 36,500 sq. ft. area which spread in 3 separate pockets (Pocket 1, 2 and 3) and houses more than 350 species of medicinal plants. The objective of maintaining medicinal plants garden in Pharmacopoeia commission for Indian medicine & Homoeopathy is the conservation and cultivation of medicinal plants used in Ayurveda, Siddha, Unani and Homoeopathy (ASU&H) systems of medicine the produce of which is used to laying down quality standards of ASU&H drugs to check the adulteration and substitution. Garden also serves the information regarding the proper taxonomical and morphological identification of genuine medicinal plants used in the various system of medicine.

PCIMH developed a greenhouse, a hi-tech polyhouse, and a vermicomposting unit in Pocket-2, and carried out Miyawaki plantation in Pocket-3. Also, in pocket -2 of Herbal garden area a remarkable Medicinal Thematic Garden has been developed over an expansive area of 12,000 square meter.This garden serves as a living repository and educational platform for the plants used in the Ayurveda, Siddha, Unani, and Homoeopathy (ASU&H) systems of medicine and also other scholars visit

Commission from India and abroad. However, the primary mission of PCIM&H is to develop pharmacopoeias and formularies and to function as a Central Drugs Laboratory for Indian medicine and homoeopathy. As a part of this mandate, the Medicinal Thematic Garden acts as a functional extension of its work by demonstrating the pharmacological and ecological relevance of medicinal plants used in classical formulations.The garden not only preserves biodiversity but also promotes community awareness about India's flora.

Green house

A greenhouse (measuring 80 sq.m (10 m × 8 m), equipped with a misting facility, in the garden area of Pocket-2) is being actively maintained for the propagation of nursery plants, to maintain plants under shaded or controlled conditions before transferring them to open field environments, especially after collecting them during survey tours. This structure provides a shade and controlled environment for the healthy growth of various plant species.

Polyhouse

A 150 sq.m (10 m × 15 m) polyhouse equipped with temperature and humidity control was developed in the Pocket-2 campus of PCIM & H for growing and maintaining exotic plants used in Ayurveda, Unani, Siddha, and Homoeopathic systems of medicine, along with other rare species. To support the cultivation of plants requiring high-altitude conditions, a cold-room facility (10 × 10 ft) capable of maintaining temperatures of 15 °C and 5 °C was also established as part of the polyhouse. Several exotic species such as ***Crocus sativus***, ***Bergenia ciliata***, ***Cedrus deodara*** and others were maintained in the polyhouse.

Green house

Poly house

A total of 12 thematic gardens namely Trikatu, Triphala, Tulsi garden, Nakshatra vatika, Rashi vatika, Chatursheeri, Dashmoola vatika, Panchavalkala, Navagraha vatika, Panchakola, Aquatic Garden and Aroma Garden were established at PCIM&H. Each thematic garden is built around a classical Ayurvedic or astrological concept. These gardens are interconnected with walking paths, facilitating seamless exploration. Each plant is also tagged with a QR code-enabled nameplate, providing access to the plant's botanical name, common, other regional names, medicinal uses and parts used.

Various themes of Herbal Garden

Nakshatra vatika

Nakshatravatika is a traditional Indian concept where specific plant species are grown according to the 27 Nakshatras (constellations) of Vedic astrology. Each Nakshatra is associated with one particular tree or plant that is believed to have spiritual, medicinal, and ecological significance. This has also reference in Rajanikantu (….), the classical literature. The constellation wise medicinal plants for

a nakshatravatika are *Strychnosnux-vomica* (for Aswini nakshatra) , *Phyllanthus emblica (for* Bharani nakshatra), *Ficus racemosa* (for Kritika nakshatra), *Syzygium cumini* (for Rohini nakshatra), *Acacia catechu* (for Mrigasrisham nakshatra), *Aquilaria agallocha* (for Ardra nakshatra), *Bambusa bambos* (for Punarvasu nakshatra), *Ficus religiosa* (for Pushyam nakshatra), *Mesuaferrea* (for Ashlesha nakshatra), *Ficus benghalensis* (for Magha nakshatra), *Butea monosperma* (for Poorvaphalguni nakshatra), *Prosopis cineraria* (for Uttaraphalguni nakshatra), *Spondias pinnata* (for Hasta nakshatra), *Aegle marmelos* (for Chitra nakshatra), *Terminalia arjuna* (for Swati nakshatra), *Limoniaacidissima* (for Vishakam nakshatra), *Mimusopselengi* (for Anuradha nakshatra), *Bombax ceiba* (for Jyeshta nakshatra), *Canarium strictum* (for Moolam nakshatra), *Saracaasoca* (for Poorvashada nakshatra), *Artocarpus hetero phyllus* (for Uthrashada nakshatra), *Calotropis procera* (for Shravana nakshatra), *Moringa oleifera* (for Dhanibatha nakshatra), *Anthocephaluscadamba*(for Satahisa nakshatra), *Azadirachtaindica*(for Phoorvabadrapada nakshatra), *Mangifera indica* (for Uttarabadrapada nakshatra), *Madhuca longifolia* (for Revati nakshatra)

Navagraha vatika

In Vedic astrology, the Navagrahas, or nine planets namely, Sun, Moon, Mars, Mercury, Jupiter, Venus, and Saturn (visible planets) and Rahu and Ketu (shadow planets) influence an individual's destiny, and their negative effects can be mitigated by planting and worshipping specific associated plants. For example, *Achyranthes aspera* isassociated with Mercury, *Ficus racemosa* for Venus, *Butea monosperma* for Moon, *Ficus religiosa* for Jupiter, *Calotropis gigantea* for Sun, *Acacia catechu* for Mars, *Cynodondactylon* for Ketu, *Prosopis cineraria* for Saturn, *Desmostachyabipinnata for* Rahu. A ***Navagraha Vatika*** (Nine Planets Garden) promotes physical, mental, and spiritual well-being. These sacred trees also hold significant medicinal, religious, aesthetic, and cultural value.

Rashivatika

Astrology links each zodiac sign to a specific plant believed to align with an individual's energy. Planting and worshipping the plant associated with one's zodiac sign is thought to attract positivity, healing, and prosperity. For example, *Pterocarpus santalinus* for zodiac sign Aries, *Alstonia scholaris* for Tauras, *Artocarpus heterophyllus* for Gemini, *Butea monosperma* for Cancer, *Ziziphus jujube* for Leo, *Mangifera indica* for Virgo, *Mimusopselengi* for Libra, *Acacia catechu* for Scorpio, *Ficus religiosa* for Sagittarius, *Dalbergia latifolia* for Capricon, *Prosopis*

*cineraria*for Aquarius, *Ficusbenghalensis* for Pisces.

Triphala Garden

The word Triphala literally means three fruits. In Ayurveda, triphala is a technical term signifying mixture of dried fruit rind of three fruits - Amla, Baheda and Harad.

Terminalia chebula

Emblica officinalis

Terminalia bellerica

Trikatu Garden

Trikatu means the mixture of three pungents. The word has been derived from Sanskrit term tri: three; katu: pungents. It consists of dried fruits of made of Pippali (long pepper), Shunthi (dry ginger), and Maricha (black pepper). In Ayurveda, it is used to stimulate digestion and metabolism.

Piper nigrum

Piper longum

Zingiber officinalis

Dashamoola Garden

Dashamoola is the Sanskrit name for a group of 10 medicinal plants, classified as proving beneficial in cases of Asthma and difficult respiration. The name is derived from the words 'Dasha' means ten and 'moola' means root. These plants are traditionally divided into two groups: the *BrihatPanchamoola*, which includes the larger tree species—Bilva (*Aegle marmelos*), Agnimantha (*Premnaser ratifolia*), Shyonaka (*Oroxylum indicum*), Patala (*Stereo spermum suaveolens*) and Gambhari (*Gmelina arborea*)and the *Laghu Panchamoola*, which comprises the smaller herbs and shrubs - Shalaparni (*Desmodiumgangeticum*), Prishniparni (*Urariapicta*), Brihati (*Solanum indicum*), Kantakari (*Solanum xanthocarpum*), and Gokshura (*Tribulus terrestris*).

Tulsi garden

Thetulsigarden showcases the rich diversity of the *Ocimum* genus, highlighting the cultural and medicinalof Tulsi in traditional systems.In this garden, five important species of Tulsi are cultivated: *Ocimum sanctum* (Krishna/Shyama Tulsi), known for its strong aroma and high medicinal value; *Ocimumbasilicum* (Sweet Basil), valued for its culinary and aromatic uses; *Ocimumkilimandscharicum* (Kilimanjaro Tulsi), rich in camphor and widely used in essential oil extraction; *Ocimumgratissimum* (Junglitulsi), recognised for its clove-like fragrance and

antimicrobial properties; and *Ocimumcanum* (Holy Basil), known for its mild aroma and traditional healing uses.

Chatursheeri

A Chatursheeri Garden is a thematic plantation that features four important species of the *Ficus* genus, traditionally grouped together for their ecological, cultural, and medicinal significance. This garden includes *Ficusbenghalensis* (Banyan), *Ficusreligiosa* (Peepal), *Ficusracemosa* (Gular), and *Ficuslacor* (Pilkan). A Chatursheerigarden helps in conserving these valuable *Ficus* species and provides a space for educating visitors about their botanical characteristics, cultural importance, and therapeutic uses.

Panchavalkala garden

Panchavalkala Garden is a specialized herbal garden that highlights the five important bark-yielding tree species which includes Vata (*Ficusbenghalensis*), Udumbara (*Ficusracemosa*), Ashwatha (*Ficusreligiosa*), Plaksha (*Ficuslacor*), and Parisha (*Thespesia populnea*).

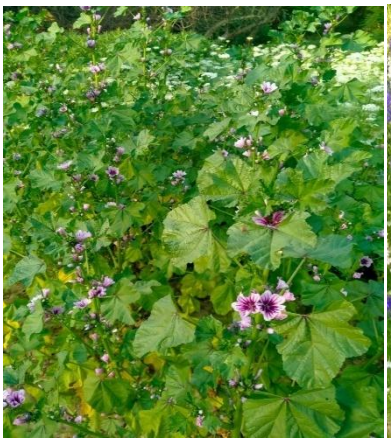
Panchakola Garden

Panchakola is one of the most popular formulations in Ayurveda, which is used as general health tonic. It is composed of five major indigenous plant materials *i.e.*, Pippali (*Piper longum*), Pippalimula (root of *Piper longum*), Chavya (*Piper chaba*), Chitraka (*Plumbago zeylanica*), and Shunthi (*Zingiberofficinale* – dried ginger).

Aquatic garden

Under the aquatic garden, plants such as *Nelumbo nucifera*, *Nymphaea* spp., *Trapanatans* and others were maintained in the garden areas of Pocket-2 and Pocket-3.

Delphinium sps



Malva sylvestris

Echinacea paradoxa

Aroma garden

An aroma garden is a specially designed garden that features plants known for theirfragrances and essential oil content. These gardens are developed to provide a sensory experience through natural aromas and to conserve aromatic and medicinal plant species. In the aroma garden, a variety of aromatic and medicinal plants were maintained, including ***Rosa damascena***, ***Mentha arvensis***, ***Jasminum officinale***, ***Magnolia champaka***, and other important species.

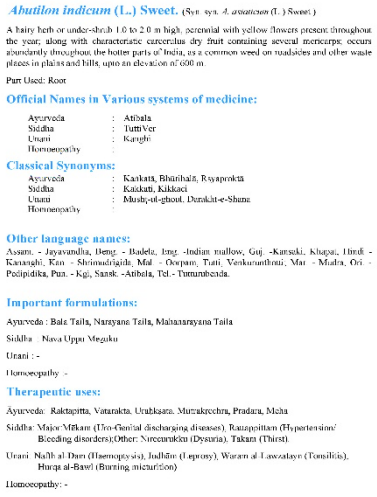
Awareness of medicinal plants through digital technology:

To make this valuable plant collection more accessible in the digital age, each plant has a name board (with accepted hindi name, botanical name and family) are displayed with QR codes scanning of which anybody get the details of the plant such as:

- Botanical synonyms (if any)
- Names in various systems of medicine

- Part used
- Therapeutic uses of each part in each systems of medicine
- Important formulations with the part in each system of medicine.

This helps visitors learn more and supports research and awareness. Also, touchscreen kiosks are also available for students, trainees, and visitors. They can use these to learn about the different plant species in the Herbal Garden.A total of 350 QR codes were created and installed throughout the garden.



***Abutilon indicum* (L.) Sweet.** (Syn. syn. *A. avicennae* (L.) Sweet.)

A hairy herb or under-shrub 1.0 to 2.0 m high, perennial with yellow flowers present throughout the year; along with characteristic carcerulus dry fruit containing several mericarps; occurs abundantly throughout the hotter parts of India, as a common weed on roadsides and other waste places in plains and hills, upto an elevation of 600 m.

Part Used: Root

Official Names in Various systems of medicine:

Ayurveda	:	Atibala
Siddha	:	TuttiVer
Unani	:	Kanghi
Homoeopathy	:	

Classical Synonyms:

Ayurveda	:	Kankata, Bhūribalā, Rsyaprokta
Siddha	:	Kaikati, Kilikaci
Unani	:	Mushj-ut-ghoul, Darakht-e-Shina
Homoeopathy	:	

Other language names:

Assam. - Jayavandha, Beng. - Badela, Eng. -Indian mallow, Guj. -Kansuki, Khapat, Hindi - Kanaughi, Kan - Shrimudrigidi, Mal - Oorpam, Tuti, Venkurunthini, Mar - Mudra, Ori - Podipidika, Pun. - Kgi, Sansk. -Atibala, Tel.- Tumrubenda.

Important formulations:

Ayurveda : Bala Taila, Narayana Taila, Mahanarayana Taila

Siddha : Nava Uppu Mezuku

Unani : -

Homoeopathy : -

Therapeutic uses:

Ayurveda: Raktapitta, Vatarakta, Urubkasra, Mutrakrechra, Pradara, Meha

Siddha: Major Mthum (Uro-Genital discharging diseases), Ratzapittan (Hypertension/ Bleeding disorders);Other: Nirecurukkri (Dysuria), Takam (Thirst).

Unani: Nafth al Dam (Haemoptysis), Judhām (Leprosy), Waram al Lawzalaye (Tonsilitis), Harqa al-Bawl (Burning micturition)

Homoeopathy: -

Plant details available via QR code on the name board

Group photo point

Vermicompost unit

Vermicompost unit

A vermicompost unit has been set up in Pocket 2 of the facility with dimensions of 4m x3m x 1.2m, with a vermiwash collection facility, providing ample space to produce compost using earthworms. This unit is constructed to convert organic waste (fallen leaves and grass collected from the garden) into compost.

Miyawaki plantation

A Miyawaki forest plantation was established in the Pocket 3 area, covering around 340 square meters, with diverse species such as *Syzygium cumini*, *Punica granatum*, *Bauhinia variegata*, *Annona*

squamosa, *Aegle marmelos*, *Ficus benjamina*, *Bombax ceiba*, *Terminalia arjuna*, *Pongamia pinnata*, *Lawsonia inermis*, *Asparagus racemosus*, and *Aloe vera*. The purpose of this plantation is to restore green cover, promote biodiversity, and create a sustainable ecosystem. Its uses include improving soil quality, reducing urban heat, providing a habitat for wildlife, and offering green spaces for education, recreation, and environmental awareness.

Miyawaki forest plantation

Vertical garden

A vertical garden facility was constructed in Pocket II, featuring a backdrop of the PCIM&H board with a length of 8 meters and a width of 2.6 meters. The structure also includes a grouting system with three steps of brick masonry work, providing stability and support for the vertical garden. This innovative garden feature contributes to enhancing the aesthetic appeal of the area.In addition; eight vertical garden structures were installed in both the building areas of Pocket I and Pocket II of PCIM&H. Each structure stands at a height of 3 meters and a width of 2 meters.To ensure the plants remain healthy and properly hydrated, a drip irrigation system was installed for the vertical garden. This system ensures efficient water delivery directly to the plant roots, minimizing water wastage and promoting better plant growth.

Installation of touch screen-based Kiosk units

Two interactive Kiosk with touch screen were installed at the entrance of each building of Pocket -1 & Pocket -2 of PCIM&H.All facility data developed at PCIM&H is being entered into this interactive kiosk for the benefit of students, trainees, and other visitors. Users can interact with the kiosk to access comprehensive information about the Herbal Garden, including the number of species, detailed information on each species, and access to the virtual library of raw drugs and the raw drug repository. Visitors can also explore the virtual herbarium and view the photo gallery, all through the touchscreen interface of this kiosk.

Conclusion

The future vision for establishing thematic gardens, green house, poly house and other facilities is to create simple, educational, and eco-friendly spaces where people can easily learn about different groups of useful plants. These gardens will help protect important species, support research, and inspire communities to value nature and traditional knowledge.

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Agroforestry Potential of *Moringa oleifera* Lam. for sustainable farming systems

Thounaojam Bidya Chanu[1] and Vishwajeet Sharma[2]
[1] ICAR-Indian Institute of Soil and Water Conservation, Dehradun, Uttarakhand
[2]Indian Council of Forestry Research and Education, Dehradun, Uttarakhand
E-mail: bidiachanu@gmail.com

Abstract
Moringa oleifera Lam., commonly known as drumstick or horseradish tree, is a fast-growing, drought-tolerant multipurpose tree native to the Indian subcontinent. Owing to its exceptional nutritional value, medicinal properties and ecological adaptability, Moringa has gained global recognition as a "miracle tree." This article explores the agroforestry potential of *M. oleifera*, emphasizing its role in food and nutritional security, soil improvement, climate change mitigation and livelihood enhancement. The adaptability of the speciesto marginal and degraded lands, high biomass production and multifunctional uses make it a promising future-smart tree for sustainable agroforestry systems, particularly in South Asia and other undernourished regions.

Keywords: Moringa, agroforestry, nutritional, food security.

Introduction

Agroforestry, the intentional integration of trees with crops and/or livestock, is increasingly promoted as a sustainable landuse system capable of enhancing productivity, resilience and environmental stability. Among the tree species suitable for agroforestry, *Moringa oleifera* Lam. stands out due to its rapid growth, minimal input requirements and multiple ecological and socioeconomic benefits.The tree fulfills all the basic prerequisites required to serve as a component of an agroforestry system.

M. oleifera is widely cultivated across tropical and subtropical regions of Asia, Africa, Latin America and the Caribbean. Almost all parts of the tree—leaves, pods, flowers, seeds, bark and roots—are edible or have medicinal, industrial or agricultural value. In many developing countries, Moringa contributes significantly to household nutrition, livestock feeding and supplementary income. Despite its wide utility, Moringa remains underutilized in organized agroforestry systems, particularly in South Asia, where food insecurity, malnutrition and climate risks persist.

Origin, taxonomy and distribution

Moringa tree has much more diversity in species, which includes thirteen known species in the genus Moringa of family Moringaceae. Among all species, *M. oleifera* is the most widely cultivated due to its superior adaptability and broader utility.The species is indigenous to the north-western regions of India, Pakistan, Nepal and Bangladesh. The species is present in Asia, Africa, North America, Central America, theCaribbean, South America and Oceania.Today, *M. oleifera* is naturalized across tropical and subtropical regions worldwide owing to its ecological adaptability and ease of propagation.

Botanical and morphological characteristics

Moringa oleifera is a small to medium-sized deciduous tree, typically reaching 8–12 m in height with a trunk diameter of about 45–60 cm. The tree has a deep taproot system with spreading lateral roots, contributing to drought resistance and soil stabilization. Leaves are large, tripinnate, and rich green; flowers are fragrant, creamy-white and bisexual; fruits are elongated pods (drumsticks) containing winged seeds rich in oil.

The species is fast-growing and capable of producing substantial biomass within a

short period, making it highly suitable for biomass-based agroforestry systems.

Ecological requirements and cultivation

Moringa oleifera thrives in tropical and subtropical climates, performing best at temperatures between 25–35°C, but tolerating extremes up to 48°C and mild frost. It grows well in areas receiving annual rainfall between 250 and 1,500 mm and adapts to altitudes up to 1,200–2,000 m.

The species tolerates a wide range of soil conditions, often prefers neutral to slightly acidic soil (pH 6.3 to 7.0) but favors well-drained sandy loam or slightly calcareous soils. Waterlogging is detrimental, whereas drought conditions are well tolerated once the plant is established. Moringa only requires a few amounts of water, it can be grown by using rainwater. Moringa is particularly suitable for dry regions as it is a heat loving plant.

Propagation is achieved through seeds or cuttings, with seeds showing high germination rates (≈85%). The ease of establishment and low maintenance requirements make Moringa suitable for marginal and degraded lands.Moringa is grown primarily for its leaves, pods and kernal, which are used to produce oil and purify water. Season, variety, fertilizationand irrigation can all affect the output. Warm climates, dry conditions, the use of additional fertilizers and irrigation all boost moringa yields.

Agroforestry Applications of *Moringa oleifera*

Alley Cropping and Intercropping

Moringa can be incorporated into agroforestry systems to improve soil fertility, offer shade and supportbiodiversity. By providing a varied source of income and lowering the hazards connected with monoculture farming, intercropping moringa with other crops can increase overall farm production and resilience. Moringa is widely used in alley cropping systems due to its light canopy and compatibility with annual crops. Regular pruning supplies nutrient-rich biomass enhances soil fertility and reduces dependence on chemical fertilizers.

Soil Improvement and erosion control

Moringa leaves are rich in nitrogen and micronutrients, contributing to rapid nutrient cycling when used as green manure or mulch. Leaf litter decomposition releases nutrients quickly, improve soil organic matter and enhances moisture retention. In agroforestry systems, their deep root systems help reduce soil erosion and also help stabilize degraded landscapes.

Livestock fodder

Moringa leaves contain high crude protein (20–30%), essential amino acids, minerals and vitamins, making them an excellent supplementary fodder for cattle, sheep, goats, poultry and fish. Inclusion of Moringa in livestock diets has been shown to improve growth, milk yield and feed efficiency.

Nutritional and medicinal importance

Moringa leaves, seeds and pods are an important dietary source since they are full of important nutrients. Among the most nutrient-dense plant foods are Moringa leaves, which are rich in minerals (calcium, magnesium, iron, potassium, and zinc), vitamins (A, C, E and B complex) and antioxidants. Moringa fruits (pods) are rich in potassium, high in fiber, low in calories and a great source of vitamin C.The World Health Organization has recommended Moringa as a dietary supplement to combat malnutrition.

Like spinach, the fresh leaves can be used in a variety of recipes such as soups, stews andsalads. They can be added to scrambled eggs, rice dishes and curries after being boiled or sautéed. A powder made from dried and crushed moringa leaves can be used as a dietary supplement. The nutritious content of smoothies, sauces, soups and baked goods can be increased by adding this powder. Herbal tea, which

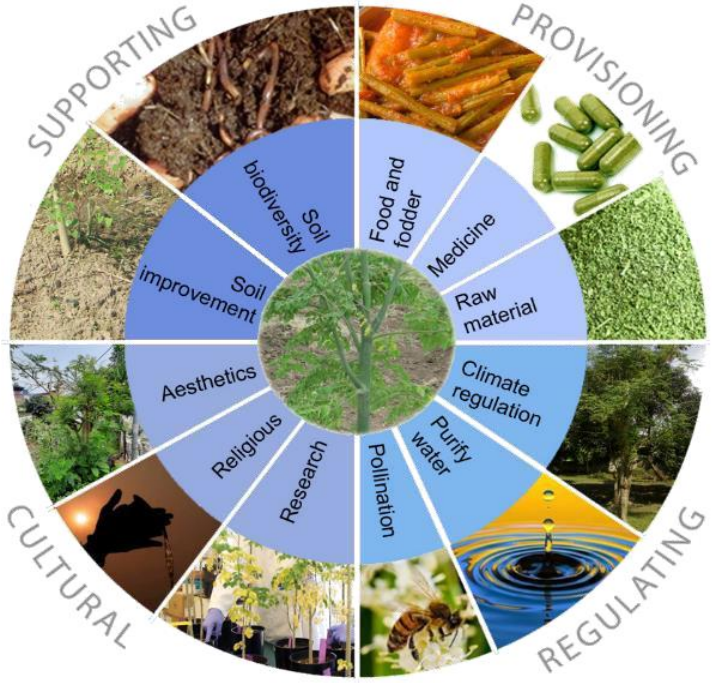
is well-liked for its antioxidant qualities, is also made from dried Moringa leaves. Known as "drumsticks," Moringa fruits are long, thin pods that are frequently eaten, particularly in South Asian cooking.

Medicinally, Moringa exhibits antioxidant, anti-inflammatory, antimicrobial, antidiabetic and cardioprotective properties. Extracts from different plant parts are used in traditional medicine to treat anemia, digestive disorders, infections and inflammatory conditions.

Table: Nutritional values (per 100 g) of fresh leaves, dried leaves and leaf powder of *Moringa oleifera* Lam. (Fuglie, 2001; Moyo*et al.*, 2011).

Nutrients	Fresh leaves	Dried leaves	Leaf powder
Calories (cal)	92	329	205
Crude protein (g)	6.7	29.4	27.1
Fat (g)	1.7	5.2	2.3
Carbohydrate (g)	12.5	41.2	38.2
Fiber (g)	0.9	12.5	19.2
Calcium (mg)	440	2,185	2003
Potassium (mg)	259	1,236	1,324
Iron (mg)	0.85	25.6	28.2
Magnesium (mg)	42	448	368
Phosphorus (mg)	70	252	204
Copper (mg)	0.07	0.49	0.57
Sulfur (mg)	–	–	870
Vitamin A (mg)	1.28	3.63	16.3
Vitamin B1 (mg)	0.06	2.02	2.64
Vitamin B2 (mg)	0.05	21.3	20.5
Vitamin B3 (mg)	0.8	7.6	8.2
Vitamin C (mg)	220	15.8	17.3
Vitamin E (mg)	448	10.8	113

Moringa trees provide the ecosystem services as shown in the figure (Ranjitkar and Sujakhu 2021)



Climate change mitigation and adaptation

Moringa oleifera contributes to climate change mitigation through high biomass production and carbon sequestration. Studies indicate that Moringa absorbs significantly more CO_2 than many conventional tree species. Its drought tolerance, deep rooting system and ability to grow under harsh conditions make it a resilient species for climate-adaptive agroforestry systems.Additionally, feeding Moringa to ruminants has been shown to reduce methane emissions, contributing to mitigation of greenhouse gases from livestock systems.

Socio economic and livelihood benefits

Moringa-based agroforestry systems provide multiple income streams through the sale of leaves, pods, seeds, oil and value-added products such as leaf powder and cosmetics. Several studies report high benefit–cost ratios and profitability from Moringa intercropping systems.For smallholders, especially in tribal and marginal areas, Moringa enhances food security, generates employment during lean seasons and supports household nutrition.

Conclusion

Moringa oleifera is a highly promising agroforestry species due to its multifunctionality, resilience to climate stress and wide-ranging nutritional, medicinal and environmental benefits. Integrating Moringa into agroforestry systems can significantly enhance soil fertility, livestock productivity, carbon sequestration and rural livelihoods. Promoting Moringa-based agroforestry on marginal and degraded lands can contribute to sustainable agriculture, climate resilience and improved food and nutritional security. Future research should focus on system optimization, value chain development and region-specific agroforestry models.

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P.O.RFRC,MandlaRoad
Jabalpur–482021,M.P.India
Phone:91-761-2840484
Fax:91-761-2840484
E-mail:vansangyan_tfri@icfre.gov.in,vansangyan@gmail.com
Visitusat:http://tfri.icfre.orgorhttp://tfri.icfre.gov.in