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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

Bamboos based agroforestry can play an important role in enhancing productivity, sustainability and resource conservation. Many of the useful bamboo species can occupy the same ecological niche as trees and are well suited for agroforestry. Bamboos have many advantages over trees such as, relatively short time span from planting to harvest, versatility of use, ability to provide building materials and edible products for many years or even decades. Hence, there are large scale efforts to promote bamboos under agroforestry system.

Bamboos require four to five years to yield first harvest, if grown from offsets, which is much earlier than any other woody species. If raised from seedlings, first harvest is obtained after seven years. This initial period can be sustainably utilized for raising intercrops and enhancing sustainability and income of the growers. Under agroforestry system, quantity and quality of bamboos are expected to be higher as compared with monoculture and unmanaged plantations. The scope of bamboo in agroforestry is very wide because of the uncertain weather conditions and increasing cost of labour. Bamboos, if properly managed, can be grown in agrisilviculture, silvipastoral, agrisilvipastoral and agrisilvihorticultural system.

In line with the above this issue of Van Sangyan contains an article on Bamboo based agroforestry system for maintaining ecosystem and sustainability in India. There are also useful articles viz. Silvopasture: A sustainable farming system for a changing world, नीम से बोएँ आत्मनिर्भरता के बीज - नीम आधारित कृषि वानिकी, Miyawaki method of recreating native forests, Role of agroforestry in organic farming, Buchnania lanzan Spreng (Chironji): A potential wild fruit tree of central India, Proclivity on multipurpose trees for promoting bund plantations in south-east Rajasthan, अर्नीबिया यूक्रोमा (रतनजोत): एक गंभीर लुप्तप्राय औषधीय पौधा, Management of flyash through forestry interventions and Climate calamity and the wild: Book review

I hope that readers would find maximum information in this issue relevant and valuable to the sustainable management of forests. Van Sangyan welcomes articles, views and queries on various such issues in the field of forest science.

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Bamboo based agroforestry system for maintaining ecosystem and sustainability in India

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Introduction

Bamboo, the most fascinating and diverse group of plant known to mankind belong to the family 'grass' or sub family Bambuseae of the family Poaceae (Gramineae) (Singh et al., 2012). Bamboo grows in at least 37 million ha worldwide and covers about 1% of the global forest area (Lobovikov et al., 2007).As per FAO report 2007, there are about 1,200 species of Bambooin 90 genera across the world. India has About 125 indigenous and 11 exotic species of bamboo from 23 genera. It is abundantly found deciduous and semi-evergreen forest of northern and southern India. Total bamboo bearing area of the country has been estimated to be 15.0 million of the county geographical area (ISFR, 2021).Versatility group of bamboo plants linked closer with the culture of tropical Asia. It is a present of nature that has empowered people to draw a variety of benefits. For livelihood sustainability bamboo has been an important source of income for millions of rural people in India.Because of its wider essential uses, it is described as "friend of people", "green gold", "green gasoline", "Poor man timber" and "the cradle to coffin timber" (Singh Ombir et al., 2008). As bamboo harvesting is a continuous process, old clumps are removed new once regenerate and process will continue. Bamboo based agroforestry system produced bamboo stock, leaf biomass as well as sustainable crop.

What is bamboo based agroforestry?

Before we go ahead towards Bamboo-based agroforestry we must understand about Agroforestry. Agroforestry is a land use system that integrates trees, crops and animals in a way that is scientifically, sound, ecologically desirable, practically feasible, and socially acceptable to the farmers (Nair et al., 1979). The Bamboo-based agroforestry is the integration of Bamboo plant with other agriculture crop along with livestock production to obtain ecological and economics benefits. It can develop in the form of homegardens, block plantation, windbreaks on the boundary of agriculture field, in poultry/dairy farm and in plain and wetland near the ponds.

(A) **(B)**

Fig 1 (A-B): Bamboo plantation in Arboretum BUAT, Banda.

How bamboo based agroforestry save the ecosystem?

Firstly, as we look towards, agriculture crop specially cash crop fertilizer is required to the crop from seeding to the germination stages where as Bamboo requires no chemical to proliferate. In India crop like Cotton and some other agriculture crop depletes the nutrient from the soils, Bamboo sequest the nitrogen and the cultivation of Bamboo does not surplus the chemical to the environment.Secondly, in traditional agroforestry system once the agriculture crop mature it will clear cut harvest and at that time the nutrients are washed away by rainfall, the erosion will occur on the top layer of the soil. The bamboo-based agroforestry protects the land from harsh wind.The Bamboo stumps are blazed to provide fertilizer and their roots persist in land after harvesting clumps check the soil erosion and assist to preserve nutrient for the next crop. Along with them their leaf-litter and fine root decomposition emphasize the soil organic matter. Due to its fine and extensive root system and fast-growing ability it will help in rehabilitationof degraded and waste. In Allahabad, India INBAR support a bamboo project which lend a hand to rise 15 meters water table with in 10 years and return a destroy brick mining area prone to frequent dust storms, to productive Agri land.

Thirdly, according to INBAR report 2018, Due to world fastest growth rate, giant woody bamboo is considered effective Carbon dioxide absorber. However, 100 to 400 tonnes of carbon sequest per hectare.Showing similar amount of carbon stores to tree plantation. Whereas carbon also stored in products made with Bamboo as well as charcoal. Despite of the facts that carbon emission reduction by product is presently not contemplated an mechanism approved under the Paris Agreement For Climate Change, this outlook is especially pertinent where bamboo products are used and further in future in corporate and embrace the reduction protocols for Greenhouse Gas.

Sustainability through bamboo based agroforestry

Bamboo the most assailable NTFPs of the world -give continuous fodder for the livestock, continuous timber for the household or building purpose and continuous income in term of macro/micro scale bamboo industries and Handicraft items (Adhikari, N.2008). As we compare

the bamboo from timber, bamboo is twice or at least twice as timber. Its tensile strength is tenacious than steal (source: unsustainable magazine). However, Bamboo cultivation empowered the women potential as it is light in weight and their linear splitting make it flexible due to these reasons it is easy to carry way bulk mass across various massive distance.The Self Help Group were specially promoted by GOI under Bamboo Mission to generate skill among women regarding bamboo cultivation and uses. Under sustainable development goal the Handicraft likes Basket, small furniture, flowerpot, wooden jewellery; bamboo-based kitchen material is an alternative source of income. During the leaning period it reduces the risk associated with collecting timber for fuelwood and creating new dynamic of employment for the women in India.

Today bamboo is an alternative of different materials and trends toward more eco-friendly product i.e. Bamboo toothbrush, cooling straws, food plates, flooring mats. Despite bamboo associate with jute and paper are used as bag and covering the entire India market as a excellent replacement of plastic polythene.

Major Challenges

- Poor ability of planting material is one of the major problems while cultivation of bamboos from seeds.
- Lack of conservation awareness among the tribal and rural people.
- Deterioration of important genetic sources of economic important species due to over- exploitation.
- Lack of mechanization and skilled people in harvesting and propagation.
- Insufficient warehouse/storage/depot infrastructure after bamboo harvesting.
- Generally, bamboo-based agroforestry system lacks effective and efficient land tenure system.
- Lack of intensified research in bamboo agroforestry system.

Conclusion

Bamboo is primarily a perennial grass with woody clums from rhizomes and the fastest growth plant on earth recorded as approximately 121cm in 24 hrs. Bamboos have the dense surface root, huge connection network of rhizomes which form a mat like structure and help to prevent the seepage of soil water and furnish a high quality of protection during sheet and gully erosion for soil conservation. It is recommended as a suitable for the ecological restoration and reclamation of degraded land and introduced for the treatment of landslides and soil liquification.In India where livestock is the major livelihood option, bamboo- based agroforestry system is a quite unique opportunity to the farmer. Globally, India is second largest producer of bamboo than China and only 4%of the bamboo products were captured in global market. Due to which in India greater benefit of Bamboo Agroforestry system. If we invest more in Bamboo agroforestry system definitely it hitches up potential of India.Whereas more intensive research, investment and up scaling is recommended in India for Bamboo.

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Silvopasture: A sustainable farming system for a changing world

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Introduction

Silvopasture is an agroforestry system that combines trees, pasture, and livestock in a mutually beneficial way. In silvopasture, trees are intentionally grown in pastures to provide shade, forage, and wood products for livestock, while also sequestering carbon, reducing erosion, and enhancing biodiversity. This system has gained popularity in recent years as a sustainable farming practice that offers economic, environmental, and social benefits.

Need for Silvopastoral system in Indian sub-continent

There is a growing need for silvopastoral systems in the Indian subcontinent due to a range of environmental, economic, and social factors. Firstly, the subcontinent faces significant challenges in terms of land degradation, deforestation, and soil erosion, which impact the productivity and sustainability of agriculture and livestock systems. Silvopastoral systems can help to restore degraded lands and improve soil fertility, as trees and shrubs help to prevent erosion and improve water retention, while also providing fodder and other benefits. Secondly, the demand for livestock products in the subcontinent is expected to grow rapidly in the coming years, driven by population growth, rising incomes, and changing diets. This presents an opportunity for livestock producers, but also raises concerns about the environmental and social impacts of intensifying livestock production. Silvopastoral systems can provide a more sustainable and resilient approach to livestock production, by reducing the reliance on external inputs, improving the nutritional value of forage, and enhancing the resilience of livestock to climatic shocks. Thirdly, the subcontinent is home to a rich diversity of traditional agroforestry and pastoral systems, which provide important ecosystem services, cultural values, and livelihood opportunities for local communities. However, these systems are under threat from a range of drivers, including land-use change, land fragmentation, and climate change. Supporting and scaling up silvopastoral systems can help to maintain and enhance the sustainability and resilience of these traditional systems.

Overall, silvopastoral systems have the potential to provide multiple benefits in the Indian subcontinent, including improving soil and water quality, increasing livestock productivity and resilience, and enhancing biodiversity and cultural values. However, the adoption and scaling up of these systems will require supportive policies, investments, and partnerships across multiple sectors and actors.

Benefits of silvopasture system:

Climate Mitigation

Trees in silvopasture sequester carbon, reducing greenhouse gas emissions and

helping mitigate climate change. According to studies, silvopasture systems can sequester 30-40 tons of carbon per hectare over 20 years.

Increased productivity

Trees in silvopasture can provide additional income streams for farmers by producing wood, fruits, nuts, and medicinal plants. Moreover, the shade from trees reduces heat stress in livestock, allowing them to graze for longer periods and increase weight gain.

Erosion control

Tree roots stabilize soil and reduce erosion, which improves water quality and reduces sedimentation in waterways. This also helps preserve the pasture's topsoil and prevent soil degradation, reducing the need for costly inputs like fertilizers.

Biodiversity conservation

The combination of trees and pasture provides habitat for wildlife, which can increase biodiversity and support ecological resilience. Moreover, silvopasture systems can act as corridors for wildlife movement between forest fragments, contributing to habitat connectivity.

Implementation of silvopasture system

Implementing silvopasture requires careful planning and management. Farmers must choose the right tree species, spacing, and management practices, depending on the soil, climate, and livestock species. To create the system, the first step is to plant the trees, either by direct seeding or transplanting. Then, livestock can be introduced to the pasture, and the farmer must manage grazing and pruning to optimize productivity and ecosystem health. Silvopasture systems can be implemented on existing pastures or as new projects. However, transitioning to a silvopasture system requires a long-term vision and planning, and the assistance of technical experts and funding agencies.

Important silvipasture systems of world

Silvopasture systems are found in many parts of the world, and there are several important examples. Here are a few:

Montado in Portugal and Spain

Montado is a silvopastoral system found in the Iberian Peninsula that combines cork oak trees with livestock grazing. The cork oak trees are managed to produce cork, while also providing shade and forage for animals. Montado has cultural and economic significance, as well as environmental benefits, such as carbon sequestration and biodiversity conservation.

Alley cropping in Latin America and Africa

Alley cropping is a silvopastoral system that combines rows of trees with annual or perennial crops. The trees are managed to produce wood and other products, while also providing shade and shelter for livestock. This system has been used in several countries, including Mexico, Costa Rica, and Nigeria.

Silvopastoral systems in the United States

In the US, there are several examples of silvopastoral systems, including managed grazing systems in the western rangelands, and agroforestry practices in the southeastern US. These systems combine trees with livestock and/or crops, and provide economic and environmental benefits.

Dehesa in Spain

Dehesa is a silvopastoral system that combines holm oak trees with livestock

grazing. The trees are managed to produce acorns, which are an important food source for pigs, and the grazing animals help maintain the understory vegetation. Dehesa has cultural and environmental value, as well as economic benefits, such as the production of high-quality ham.

These are just a few examples of silvopasture systems found around the world. Each system is unique and adapted to the local context, and they all share the goal of integrating trees, pasture, and livestock in a mutually beneficial way.

Silvipastoral system in India

Silvopastoral systems are also present in India, and there are several examples of such systems that are being used by farmers and landowners. Some of the important silvopastoral systems in India are:

Nari Shamba

Nari Shamba is a traditional silvopastoral system used in the Northeastern states of India, particularly in Meghalaya. It involves the cultivation of betel nut palms in association with other crops such as paddy, maize, and vegetables, and livestock rearing. The betel nut palms provide shade and betel nut products, while the other crops provide food and income. This system has been used for centuries by the indigenous Khasi community.

Silvipasture Systems in Rangelands

Silvipasture systems are also being used in the rangelands of India, particularly in the semi-arid and arid regions. In these systems, trees are planted in pastures to provide shade, fodder, and other products for livestock. The trees also help in soil conservation, water retention, and carbon sequestration. This system is being promoted by several NGOs and government agencies in India.

These are just a few examples of silvopastoral systems in India. These systems are important for sustaining agriculture and livestock production, conserving biodiversity, and mitigating the impacts of climate change.

Criteria for trees and grasses in silvipastoral system

The selection of trees and grasses in silvopastoral systems should be based on several criteria, including:

Adaptability

Trees and grasses should be adapted to the local climatic and soil conditions. They should be able to tolerate drought, flooding, and other environmental stresses, and should have a good growth rate.

Nutritive value

Trees and grasses should have a high nutritional value for livestock. They should be palatable and digestible, and should provide adequate protein, energy, and minerals for the animals.

Compatibility

Trees and grasses should be compatible with each other. The trees should not shade out the grasses, and the grasses should not compete with the trees for water and nutrients.

Multipurpose use

Trees and grasses should have multiple uses, such as timber, fuelwood, fodder, and non-timber forest products. This will enhance the economic value of the system and increase its resilience.

Resistance to pests and diseases

Trees and grasses should be resistant to pests and diseases, or have a low susceptibility to them. This will reduce the need for pesticides and other chemicals, and minimize the risk of crop failure.

Environmental benefits

Trees and grasses should have environmental benefits, such as soil conservation, water retention, carbon sequestration, and biodiversity conservation. These benefits will enhance the ecological sustainability of the system.

Overall, the selection of trees and grasses in a silvopastoral system should be based on a balance between the needs of the livestock, the economic and environmental benefits of the system, and the adaptability of the species to the local conditions.

Opportunity for silvipastoral systems in India

Silvopastoral systems have significant potential in India, and there are several opportunities for their adoption and expansion. Some of the key opportunities include:

Livestock production

India has a large livestock population, and silvopastoral systems can provide a sustainable and efficient way to produce fodder for them. These systems can also help to improve the health and productivity of livestock, reduce their environmental impact, and increase their economic value.

Climate change mitigation

Silvopastoral systems can help to mitigate the impacts of climate change by sequestering carbon in the soil and in the biomass of trees and grasses. They can also help to reduce greenhouse gas emissions from livestock production by improving the efficiency of nutrient use and reducing the need for synthetic fertilizers.

Soil and water conservation

Silvopastoral systems can help to conserve soil and water resources by reducing erosion and runoff, increasing infiltration, and improving soil quality. They can also help to recharge groundwater and reduce the risk of droughts and floods.

Biodiversity conservation

Silvopastoral systems can provide habitat for a wide range of flora and fauna, including birds, insects, and other wildlife. They can also help to conserve and restore degraded landscapes, and promote agroecological resilience.

Economic benefits

Silvopastoral systems can provide a range of economic benefits, such as timber, fuelwood, non-timber forest products and ecotourism. They can also generate employment opportunities and enhance the livelihoods of farmers and rural communities.

Overall, silvopastoral systems have great potential to contribute to the sustainable development of India, and there are many opportunities for their adoption and expansion. However, their success will depend on effective policies, incentives, and technical support, as well as on the participation and engagement of stakeholders across the public and private sectors.

Suitable trees and grasses for silvopastoral system in Indian Sub-continent

The choice of suitable trees and grasses for silvopastoral systems may vary depending on the specific climate, soil type, and livestock preferences. However, here are some examples of trees and grasses that are commonly used in silvopastoral systems:

S. No.	Tree Species	Particular
1	*Acacia nilotica*	*Acacia nilotica* is a fast-growing and drought-tolerant tree that provides high-quality forage for livestock. It is also a good source of fuel wood, timber, and non-timber forest products.
2	*Leucaena leucocephala*	Leucaena is a leguminous tree that fixes nitrogen in the soil and provides high-protein forage for livestock. It is also used for fuel wood, timber, and other purposes and highly palatable for cattle and other livestock such as poultry and fishery.
3	*Ficus Spp*	Ficus is a multipurpose tree that provides fodder, timber, and other products. It is also used for shade and soil conservation.
4	*Albizzia lebbeck*	It is also a fast growing multipurpose tree species known for its good nutritive fodder value as well as good timber and pulpwood characteristics.
Grasses		
1	Napier grass	Napier grass is a high-yielding and drought-tolerant grass that provides high-quality forage for livestock. It is also used for soil conservation and as a bio fuel feedstock.
2	Guinea grass	Guinea grass is a perennial grass that provides good-quality forage for livestock. It is also used for soil conservation and as a biomass feedstock.
3	Stylo	Stylo is a leguminous grass that fixes nitrogen in the soil and provides high-protein forage for livestock. It is also used for soil improvement and erosion control.

Overall, the selection of suitable trees and grasses for a silvopastoral system should take into account the specific environmental conditions, livestock preferences, and economic and ecological objectives of the system.

Successful silvopastoral system in India: A case study

Silvipastoral system in Kangayam

Kangayam, located in the southern Indian state of Tamil Nadu, is a region where silvopastoral systems are commonly practiced. The region is known for its indigenous cattle breed, the Kangayam breed, which is well-suited to grazing in forested landscapes.

In Kangayam, silvopastoral systems are typically based on a combination of trees, shrubs, and grasses that provide food and shelter for the cattle. Some of the common tree species used in these systems includes *Acacia* and *Leucaena*, which provide high-quality forage and also help to fix nitrogen in the soil. Other tree species like Neem, Karanj, and Imli are also used in silvopastoral systems for their shade, fodder, and medicinal properties.

The grasses used in Kangayam's silvopastoral systems include species like stylo, guinea grass and Napier grass, which provide high-quality forage for the cattle. In addition, leguminous shrubs such as *Sesbania*, *Gliricidia*, and *Calliandra* are also planted as they add to the forage availability and soil fertility.

Silvopastoral systems in Kangayam have several benefits, including improved

livestock health and productivity, enhanced soil fertility and water retention, and increased biodiversity. They also provide multiple sources of income for farmers, including livestock sales, timber, fuel wood, and non-timber forest products. Furthermore, silvopastoral systems in Kangayam help to maintain the cultural and ecological heritage of the region by promoting traditional land use practices.

However, despite the many benefits of silvopastoral systems, there are also challenges, such as limited technical knowledge and access to quality seeds and planting materials. Therefore, there is a need for greater investment in research, extension, and capacity building to support the adoption and scaling up of silvopastoral systems in Kangayam and other regions of India.

Conclusion

Silvopasture systems offer a promising way to meet the challenges of sustainable agriculture, especially in the context of climate change and biodiversity loss. Farmers and consumers alike can benefit from these systems, which provide economic, environmental, and social benefits. By investing in silvopasture systems, we can support a more sustainable and resilient food system, while also contributing to global efforts to mitigate climate change and conserve biodiversity.

नीम से बोएँ आत्मनिर्भरता के बीज - नीम आधारित कृषि वानिकी

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नीम अपने धार्मिक , औषधीय, सजावटी और बहुआयामी मूल्यों के साथ एक अनूठा पेड़ है। संयुक्त राष्ट्र नीम को 21 वीं सदी का पेड़ घोषित किया है। भारत में नीम व्यापक अनुकूलन एवं विभिन्न पारिस्थितिक और पर्यावरणीय लाभों के साथ ग्रामीण और शहरी परिदृश्य में अच्छी तरह से वितरित है। लेकिन कृषि भूमि पर ब्लॉक, पट्टी या सीमा रोपण के रूप में इसका प्रचार सीमित है। बहुउद्देश्यीय नीम का पेड़ दुनिया भर में स्थायी कृषि प्रणालियों में अपार क्षमता रखता है। यहाँ तक कि नीम सूखाग्रस्त और खराब वातावरणीय एव भौगोलिक परिस्थितियों में भी किसान कोउच्चतम लाभ देने में सक्षम है।

नीम भारत में उत्पन्न होने वाले अद्भुत वृक्षों में से एक है। प्राचीन काल से , नीम विभिन्न पारिस्थितिक और पर्या वरणीय लाभों के साथ औषधीय , जैव उर्वरक, जैव-कीटनाशक, तिलहन और मवेशी चारा जैसे बहु- आयामी उपयोगों के कारण भारत में एक उल्लेखनीय परंपरागत स्वदेशी वृक्ष प्रजाति रही है । पुराने भारतीय साहित्य अर्थात अथर्व वेद , उपनिषद, अमरकोष,घर्यसूत्र, आयुर्वेद आदि में नीम के पेड़ का उल्लेख सर्व रोग निवारिणी के रूप में किया गया है , जिसका अर्थ है सभी रोगों को ठीक करने वाली दवा। नीम के पेड़ की सबसे अच्छी बात है, इसको व्यापक अनुकूलन, उष्णकटिबंधीय से उपोष्णकटिबंधीय क्षेत्रों में , अर्ध-शुष्क से आर्द्र उष्णकटिबंधीय क्षेत्रों तक उगाया जाता है। आज हमारे देश में 120 मि. है. भूमि बंजर है जो खेती योग्य नहीं है ऐ सी भूमि में नीम आधारित कृषिवानिकी अपनाई जा सकती है।

नीम को सभी प्रकार की भूमि में आसानी से उगाया जा सकता है । नीम में सूखा की स्थिति सहन करने हेतु अत्यधिक प्रतिरोधी क्षमता होती है । किसान नीम के पौ धों का रोपण अपने खेतों में सघन रोपण या कृषि भूमि पर औषधीय पौधों की खेती करने से अतिरिक्त आर्थिक लाभ मिल सकता है। विभिन्न अनुसन्धानों में यह भी पाया गया कि नीम को फसल के साथ समायोजित करने पर इससे मिट्टी की उर्वरता में वृद्धि होती है । वर्तमान में सरकार प्राकृतिक खेती बढ़ावा दे रही है । जिसमें नीम से बने उत्पाद जैसे जीवामृत, घनामृत, नीमास्त्र एवं नीम लेपित यूरिया महत्वपूर्ण हैं। नीम का तेल, नीम के बीज की खली और नीम से बने कीटनाशक कृषि क्षेत्र में विशेष रूप से जैविक एवं प्राकर्तिक खेती में उपयोग किए जाते हैं। सयुंक्त राष्ट्र ने इसे 21 वीं सदी का पेड़ घोषित किया है। इसके साथ ही नीम को देश की कृषिवानिकी में भी शामिल किया गया है । साथ ही भारत सरकार ने 1 नवम्बर

2021 को नीम लेपित यूरिया का क्रय विक्रय का नियम लागू कर दिया है जिसके अर्न्तगत 100 प्रतिशत नीम लेपित यूरिया किसानों को उपलब्ध कराई जाएगी। इस नियम से भारत में नीम के तेल का कृषि में शानदार महत्व बढ़ गया है। किसी रासायनिक अवरोधक की जगह यूरिया पर जैविक नीम के तेल का उपयोग बहुत ही लाभदायक है, जिसके प्रयोग से यूरिया से नत्रजन मुक्त होने की दर को कम करके 10 प्रतिशत तक दक्षता का बढ़ाना है। साथ ही मिट्टी एवं जल को प्रदूषित होने से बचाया जा सकता है और फसल उत्पादन में भी वृद्धि होती है । राष्ट्रीय स्तर पर नीम लेपित यूरिया के उपयोग करने में 2-3 मिलयन टन यूरिया की कम खपत आंकी की गई है, जिसका मूल्य 572 से 857 मिलियन अमरीकी डॉलर है ।

नीम आधारित कृषिवानिकी

राष्ट्रीय स्तर पर नीम का ट्रेड यूरिया की आपूर्ति बनाए रह ने के लिए पर्याप्त नीम के तेल की उपलब्धता सुनिश्चित हो, जिसके लिए वर्तमान समय में नीम वृक्षा रोपण को प्रोत्साहन दिया जा रहा है। किसान नीम के पौधों का रोपण अपने खेतों की मेड़ पर , कृषिवानिकी या सामुदायिक वानिकी के रूप में कर सकते हैं साथ ही नीम के पौधों के बीच अनुपयुक्त भूमि में दलहनी - मटर, चना, मसूर, मूंग, अरहर तिलहनी - तिल, सरसों, सोयाबीन, मूंगफली एवं सब्जियां-मटर, गोभी, टमाटर, मिर्ची एवं औषधीय पौधे- एलोवेरा , तुलसी, अश्वगंधा, शतावरी, सर्पगंधा की खेती करने से अतिरिक्त आर्थिक लाभ मिल सकता है । नीम की पत्तियों के गिरने से एवं सड़ने से मिट्टी की उर्वरता में भी वृद्धि होती है । नीम के पौधों को 3 x 3 मीटर (1111 पेड़/ हे.), 4 x 4 मीटर (625 पेड़/है.) और 5 x 6 मी. (333 पेड़/ हे.) की दूरी पर लगाया जा सकता है। समान्यतः 100 नीम के पौधे लगाने का खर्चा लगभग 8000 से 10000 रु. तक आ जाता है जिसमें भूमि की जुताई, गड्ढा खुदवाई, खाद एवं पौधों की लागत शामिल है।

उत्पादन एवं आर्थिक लाभ

एक सामान्य नीम का पेड़ आमतौर पर 5-6 साल के बाद फल देना शुरू कर देता है । एक पूर्ण विकसित नीम का पेड़ एक मौसम में 30-40 किलो फल देता है। वर्तमान में नीम के नीबोली की खरीद दर 15 रूपये प्रति किलो ग्राम है । एक पेड़ से प्रति मौसम वर्ष 300-600 रुपये तक कमा सकते हैं । एक पेड़ 10 साल में पूरी तरह से उत्पादक बन जाता है, जोकि 11-25 साल में औसतन 90 किग्रा तक पहुँच जाता है एवं सौ साल तक औसतन 50-130 किलो/वर्ष तक फल देता है। बीजों के अलावा नीम से इमारती एवं पलाऊ लकड़ी का भी उत्पादन प्राप्त किया जा सकता है। इसकी इसकी ऊँचाई पाँच वर्ष में 4 मीटर एवं 10 वर्ष में 10 मीटर तक बढ़ जाता है । 15 वर्ष का पेड़ लगभग 400 किग्रा. लकड़ी का उत्पादन कर सकता है । विभिन्न वैज्ञानिक शोधों द्वारा पता चला है कि नीम की पत्तियाँ छोटे मवेशी जैसे भेड़, बकरी बड़े चाव से खाते हैं। एक परिपक्व पेड़ से लगभग प्रतिवर्ष 350 किलोग्राम पत्तियां प्राप्त हो सकतीं हैं। कृषि वानिकी का लाभ-लागत अनुपात 1 9:56 है जो कि यह दर्शाता है कि एक रुपये के निवेश पर 18.56 रूपये का शुद्ध आर्थिक लाभ कमाया जा सकता है।

नीम की व्यावसायिक सफलता के लिए अच्छी गुणवत्ता वाले नीम के बीजों की समय पर पर्याप्त

आपूर्ति महत्वपूर्ण है, अतः नीम के बीज और पत्तियों का संग्रह ग्रामीण परिवा रों विशेषकर ग्रामीण महिला ओं के लिए पूरक रोजगार और अतिरिक्त आय का महत्वपूर्ण साधन हो सकता है।

सारणी-1: नीम का औसत फल उत्पादन एवं आर्थिक लाभ

नीम की औसत उम्र (वर्ष)	औसत फलोत्पादन (किलो/ वृक्ष)	कृषिवानिकी (5 x6) मीटर अंतर्गत औसत फलोत्पादन (किलो/वर्ष)	मेड़ों पर लगे नीम से आर्थिक लाभ (प्रति 100 वृक्ष)
3-5	6	1860	27900 रु.
6-10	20	6200	93000 रु.
11-15	98	30380	455700 रु.
16-20	132	40920	613800 रु.
21-25	113	35030	525450 रु.

निष्कर्ष

अतः व्यावसायिक रूप से सुलभ कीटनाश कों और उर्वरकों के साथ सह-संबद्ध होने पर नीम आधारित वस्तुएं अद्भुत होती हैं, साथ ही नीम आधारित कृषिवानिकी अपनाकर पारम्परिक खेती की तुलना में किसान अधिक मुनाफा प्राप्त कर आर्थिक आत्म निर्भरता प्राप्त कर सकता है।

हरी नीबोली

परिपक्व नीबोली

नीम बीज

नीम बीज में आकृति भिन्नता

नीम आधारित कृषि वानिकी

नीम आधारित कृषि वानिकी में मसूर अंतर-फसल

Miyawaki method of recreating native forests

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Introduction

Forests are the vast ecosystem on the earth being home to innumerable floral and faunal species. Since ages, they have been playing an important role in maintaining the ecological balance on the earth. However, as the time passed on, mindset of humans got shifted to commercialization and started to exploit the forests. Since 1990, world has lost 420 Mha of forest at an annual decline rate of 10 Mha. At present world has around 4.06 billion ha of forest area which is equivalent to 31% of total land area (FAO, 2020) and India has 24.62% of total forest area (ISFR, 2021). Thus, there is an urgent need for the restoration of the forests. Akira Miyawaki, a Japanese Botanist developed a method in which thick and dense forests can be developed very rapidly using native species and this methodology is named as "Miyawaki Method of Afforestation". Miyawaki method of planting became successful in mitigating the effects of tsunamis, typhoons, heat waves, etc. in Japan and soon got spread to various nations across the world. It created a sensation in the field of afforestation of the cities by converting the backyards into micro-forests.

Salient features of a miyawaki forest

- With the help of this method, a forest can be established in approximately 25 to 30 years compared to that of natural process which will take around 200 years.
- Large number of species can be planted within a small area thus ensuring a mimic of natural forest and is 100% native.
- Rate of growth of trees in a Miyawaki forest is 10X faster than natural means thus creating 30X denser plantation compared to traditional ones.
- In the initial three years, weeding and watering should be done after which it becomes self-manageable.
- Saplings are planted so dense usually 2-3 plants with in one sq.m such that they compete with each other for sunlight and grow taller.
- There is no need of adding any extra fertilizers or manure as their leaves, branches, twigs etc fall, decompose and add organic matter to the soil.
- Trees in a Miyawaki forest absorb 30X more carbon dioxide compared to monocultures.
- A Miyawaki forest plays a very crucial role in ameliorating micro-climate and sustaining biodiversity of the location in which it is established.

Fig.1: A two year old Miyawaki forest established inside the Punjab Agricultural University campus, Ludhiana.

Steps involved in establishing a Miyawaki forest

1. In the initial step, it is necessary to determine soilquality along with the natural vegetation of the area, so as to determine which type of vegetation it can sustain.
2. After determination of the soil quality,plough the soil preferably up to 1m to break the clods and add manure, cocopeat so that the time taken by the natural process of soil evolution gets reduced
3. After soil preparation, get the site ready by putting fence around the plot, making a way so as to water the plants, remove weeds etc.
4. The next step involves the planting of the native tree species preferably 80cm high. This ensures their adaptation more quickly compared to other non-native species.
5. Plant the trees preferably in a layered format where in shrubs are planted in first row followed by small trees and then followed by big trees.
6. Stacking is necessary for the saplings right after planting so as to avoid dropping and bending,
7. For the initial 3 years, regular weeding and watering should be done so that trees get well established after which there is no need of any maintenance, they become self-sustainable and grow very rapidly
8. Thus within a short span of time a dense forest is created which will ensure clean and healthy environment along with supporting many life forms.

Criticisms faced by Miyawaki method of afforestation

Though Miyawaki method of planting ensures many benefits it has been facing a lot of criticism due to some of the reasons such as – the cost of preparing the soil and land is very high, also large of saplings are needed which willincrease the investment in developing a Miyawaki forest. This method is not suitable in the hilly areas with heavy rainfall and areas which face heavy wind flow because it will cause the uprooting of the saplings in the initial years. Another criticism faced by the Miyawaki forest is that the yield from the forest is very low because the entire pressure on the trees is towards growing in height as they receive very low light due to dense planting which makes them grow rapid in height instead of girth. In India, this method has gained rapid importance only in the recent times, thus we still don't know what will be its long-term benefits.

Conclusion and suggestions

Miyawaki method of afforestation is one of the good initiatives to create a natural forest within a small area ensuring a sustainable environment. This type of forests should be planted more in the metropolitan cities like Hyderabad, New Delhi, Mumbai, Bangalore etc. where there is heavy pollution. Government should provide some incentives to establish these kinds of forests. Very less research has happened over this topic thus focus of the researchers should be shifted towards this so that the drawbacks could be eliminated and thus ensuring a green and clean environment.

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Role of agroforestry in organic farming

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Introduction

Ever since the Green revolution happened across the world, agriculture sawed its peak in terms of production. It introduced the usage of fertilizers, herbicides, pesticides, hybrid seeds etc. so as to meet the demands of the increasing population. This led to the practice of present-day agriculture also known as conventional agriculture. Though this practice was able to fulfil the hunger crisis across the world, it led to unsustainability and raised many concerns like that of food security, environmental pollution, climate change, increase in the green-house gases, global warming, soil erosion etc. In conventional agriculture, focus is mostly on a specialised crop / monoculture by increasing the efficiency of inputs like fertilizers etc without changing the structure and functions of the whole system so as to obtain increased yields. In order to tackle this issue, there came a new concept of agriculture into practice *i.e.*, Organic farming. Although organic farmingcan able to solve some of the constraints arose due to conventional farming but it is unable to eradicate it completely. Thus, agroforestry can be a very good option so as to increase the yields in a sustainable manner without causing any hampering to the basic structure of farming.

Organic farming

Organic farming came into limelight as an alternative to the conventional agriculture. According to Scofield (1986) organic farming doesn't simply means using of living materials, but it focuses on the concept of `wholeness'. Even though organic farming constitutes for about only 1% of global agricultural land and less than 5% of the sales, it represents one of the fastest growing sectors in the field of agriculture across the globe. According to the modern definition given by Lampkin: "the aim of organic farming is to create integrated, humane, environmentally and economically sustainable production systems, which maximise reliance on farm-derived renewable resources and the management of ecological and biological processes and interactions, so as to provide acceptable levels of crop, livestock and human nutrition, protection from pests and disease and an appropriate return to the human and other resources". Organic farming prohibits the usage of synthetically produced pesticides and fertilizers, antibiotics in livestock feed etc. It emphasises on practices like crop rotation, cover cropping or mulching so as to improve soil quality. Weeds are removed by means of mechanic ways rather than following chemical methodology. Due to all these practices, higher biodiversity sustains than in conventional farming including insects,

pests, soil biota, and even large birds and mammals. Due to higher water holding capacity in the crops grown through organic farming, their yield hasn't shown any decline during drought days compared to that of crops grown by conventional farming which showed reduction in yield.

Criticisms faced by organic farming

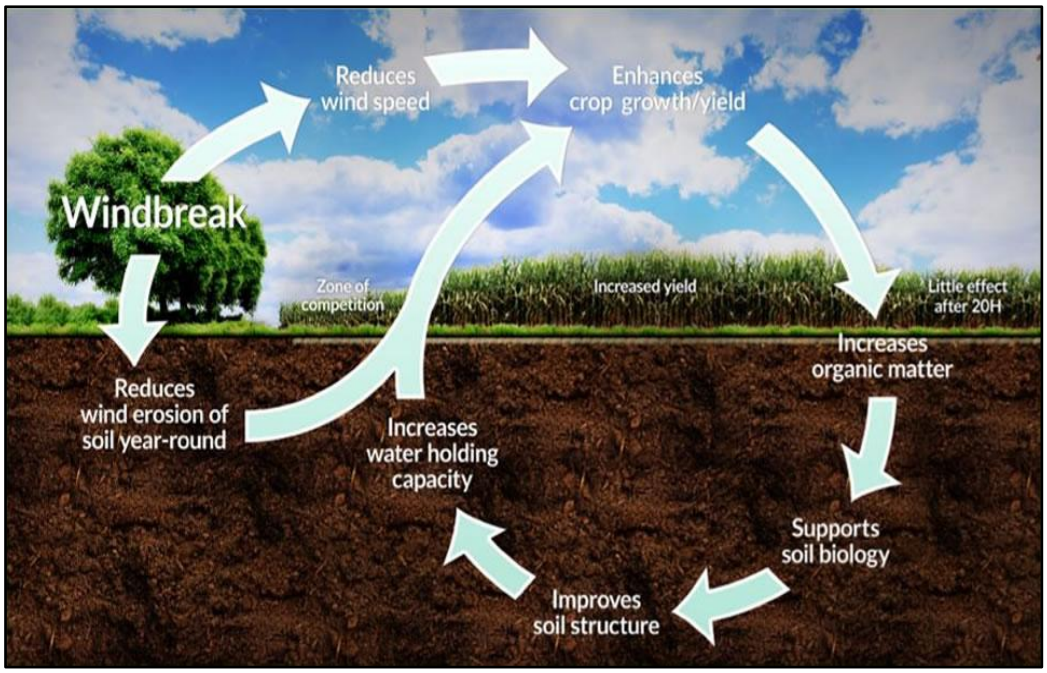
- Despite of several advantages obtained from organic farming it showed many of the negative consequences. One of the major criticisms faced by organic farming is its lower yield compared to conventional farming. On an average, 20% to 25% reduction of yield was observed in organic farming (Kirchmann*et al*, 2009).
- In order to produce same yield as compared to conventional agriculture it requires more land to grow crops which in turn leads to more destruction of forests. Even though it is thought that organic farming is carried out in a sustainable manner it uses the same basic methodology as conventional farming.
- The issue of nitrogen leaching is not eradicated completely in organic farming. Even some studies showed that there was increase in the levels of nitrogen in the groundwater near the crops grown by organic farming. During the initial sowing of the cropfarmers undertake the practice of tillage in both the methodologies whether it is in conventional farming or it is organic farming. Though tillage helps in better water seepage into the ground as well the root growth, it causes the problem of soil erosion, lowering of biological activity in the soil etc (Amundson *et al*, 2015).
- In order to tackle this issue the concept of zero tillage was adopted in organic farming. However it is not majorly practiced by the below margin farmers as it hasn't shown any impact in the increase in the yield of the crop. When the emission of green house gases per unit area basis was studied it showed less emission from the organic farms however when the yield gap in organic farming is taken into account, emissions per unit of output were higher in organic farms compared to conventional agriculture.

Advantages of integrating organic farming with agroforestry

- Agroforestry is one such approach where in trees are combined with crops or livestock. It is an age-old practice of cultivating trees on farm lands. In some of the tropical countries, crops of coffee and cocoa are cultivated in organic manner and are grown along with trees as these crops require shade to grow. Organic farming in many of the developed nations is usually getting monocultured and thus agroforestry will play a very important role in the crop diversification and intensification of agro-ecological relationships.
- Integrating agroforestry with organic agriculture will help to reduce the yield gap, as there will be a year-round supply of goods

from trees as well as crops. Trees growing on the farm lands will become a source of fodder for the livestock and add nutrients to the soil. They play an important role in binding the soil particles, thus reducing the risk of soil erosion and leaching of the nutrients.

- Agroforestry also protect the crops from the extreme climatic conditions. They become the life line for the farmers of the harsh climatic regions. Windbreaks and shelterwood agroforestry systems act as a strong barrier towards high-speed winds, hot air etc. Livestock also gets protection from the trees during the period of scorching heat.
- The leaves of the trees growing on the farm lands can be used as mulch for the organic crops which will protect them from excessive evapotranspiration and also add nutrients to the soil. Agroforestry is also thought to improve the product quality of the organic crops. For e.g., protein content in wheat (Lin *et al*, 2001).
- Planting of Nitrogen fixing trees on the hedges while growing organic crops in the alleys cater the nitrogen requirement of these crops thus, reducing the dependency on the chemical fertilizers. Trees also help in fixation of the soil organic carbon, nitrogen, phosphorous and many other nutrients along with improving many of the soil characteristics like soil porosity, acidic nature of the soils etc.
- Agroforestry can serve as natural controller for some of the crop pests, as trees harbour many birds, insects etc which will feed on these pests thus reducing their impact on the crops yield. E.g.: Trees harbour many of the birds like owls, eagles etc which will feed on the rodents destroying the crops.
- Organic farming paves a way for the new employment generation as it requires additional labour to take care of the crop growth. This will lead the farmers to additional investment which will be compensated by the agroforestry. Practising agroforestry will also provide aesthetic and recreational benefits to the farmers and also play an important role in preserving the local culture.
- Thus, integrating agroforestry with organic farming will pave a way for the development in the field of organic agriculture and increasing sustainability.



Source: https://www.fs.usda.gov/nac/topics/soil-health.php

Challengesof integrating organic farming with agroforestry

Though there have been found many advantages of integrating trees with organic crops still it is not practised in a wide manner. There have been many constraints regarding this issue such as high expenses for initial establishment, requirement of land agricultural lands, skilled and trained labour, lack of research etc.

Conclusion

It is sure that growing trees along with organic crops will ensure sustainability along with improving the quality of the yield. Thus, modern agroforestry systems should be developed which will ensure environmental benefits along with improving the economic status of the farmers.

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Buchnania lanzan Spreng (Chironji): A potential wild fruit tree of central India

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Introduction

Minor forest products have been a source of livelihood for millions of forest dwellers in India and other developing countries. The seeds of *Buchanania lanzan* tree species are of great commercial value to the tribal people of rural India. Francis Hamilton first reported *Buchanania lanzan* (Chironji) in 1798 as a member of the Anacardiacae family. It has different common names depending on the region: Charoli (Gujarat), Piyal (Assam), Achar, Chawar, Cuddapah almond (Bengali), Charu (Oriya) and Char (Telugu). The seeds of this tree species are commercially very useful to the rural tribal people all over India. *Buhanania lanzan* is a medium-sized, drought-tolerant, needs moderate light and does well in thickets, but is very sensitive to frost. Chironji is an economically important, endangered, non-nationalized secondary forest product that is widely distributed in the forests of the central regions of India and is an excellent candidate for agroforestry and social forestry. Local communities harvest the fruit during the hot summer months, when other agricultural activities are disrupted and nuts are sold at local markets for a living. Apart from being an important source of life for the tribal people, indigenous traditional knowledge indicates that all parts of the chironji plant are used to treat various ailments. Kernels are reported to contain approximately 52% oil, which is considered an excellent substitute for olive and almond oils (Kumar *et al*., 2014). Nuts are also a key ingredient in the delicious local desserts 'chironjikibarfi' and 'chironji ki kheer'.

Origin and distribution

Chironji is thought to originate from the Indian sub-continent and is found in India, Bangladesh Nepal, Myanmar, Thailand, Sri Lanka, Australia and the Pacific islands (Zeven and de Wet, 1982). In India it is sparsely distributed from the foot hills of outer Himalaya to an altitude of 1200m and extending through states of Madhya Pradesh, Bihar, Uttar Pradesh, Orissa, Andhra Pradesh, Chhattisgarh, Jharkhand, Gujarat, Rajasthan, Maharashtra and to Tamil Nadu and Kerala in south (Sharma, 2012).

Description

Chironji is a medium-sized tree reaching 15 m in height. The trunk is straight and cylindrical, with felted branches. This tree is mostly evergreen, with short leafless periods during the hot summer months (Luna, 2005). It is easily identifiable by its dark gray crocodile bark with red flames. The leaves are alternate, simple, thick, elliptic and obtuse or rounded at the base.

In cone-shaped panicles, the greenish-white flowers bloom from January to March, and the fruits ripen from April to June. The fruit changes its color from green to red as it ripens and eventually black. The fruits are small, drupes, ovoid or globose, about 1.25 cm long.

PC: Gauri Rawale @CAFRI, Jhansi

Soil and climate

Chironji is very hardy and drought tolerant tree that grows well in rocky and dry sloppy areas. It prefers tropical to subtropical climate and maximum shade temperature varies between 37.5^{o}C to 50^{o}C, while minimum for 0^{o}c to 12.5^{o}C in natural habitat. The annual rainfall in its region may vary from 750 to 2180mm. Also it avoids damp site but occupy hardy clayey soils. It does not prefer damp and water logged sites.

Propagation

- This plant can be propagated through seeds which are collected in the month of April to June. It lose seed viability with time and having somewhat irregular good seed years. Freshly collected seeds are reported to give 85% germination which progressively decreases with the passage of time (Luna, 2005).
- Mechanical scarification *i.e* damaging the hard endocarp before sowing helps to improves germination percent. Generally germination starts within a week and completes in 30 days.
- It is a slow growing species. Also it possesses exogenous dormancy due to hard seed coat. Ajith *et al*., 2018 reported that scarification with GA_3 200mg for 12hrs helps to breaks dormancy in stored seeds of *B. lanzan* and improves the germination upto 90% per cent.
- It is important to consider the sowing time and depth of sowing because it affects the germination behavior and growth of chironji. Best germination was recorded

when seeds are sown in March at 1cm depth compared to seeds sown in November and December. However, some researcher recommended for surface sowing or at 0.50 cm sowing depth for early and better seed germination under nursery.

- Singh and Singh (2014), concluded that bud sprout (68.00%) and graft success (66.66%), were noted highest in July for the softwood grafting of chironji. Irrespective of scion and rootstock, maximum accumulation of nitrogen and carbohydrate contents was recorded in March. Softwood grafting in July may be adopted for multiplication of elite chironji genotypes.

Harvesting and yield

- Harvesting starts from April and June and generally finished within 15-20 days and fruits are generally harvested green *i.e.* before ripening.
- Trees are lopped for rapid and maximum collection and seed collection should be done from second to third week of May for quality seed collection with respect to fruit weight, kernel weight, germination percent and chemical content i.e. oil, protein and sugar contents.
- Prasad, (1989) reported about 300 to 1200 quintals of chironji seed are collected from Madhya Pradesh annually. On an average a tree produces about 40–50 kg fresh fruits, which come down to 8–10 kg on drying, yielding 1.0–1.5 kg of finished produce per tree (Sharma 2012).

Conservation

*B. lanzan*is included in the Red Data Book published by the International Union for Conservation of Nature and Natural Resources (IUCN) as it is a vulnerable medicinal plant. The species is facing severe genetic erosion as a result of activities related to afforestation in tribal inhabited areas. In most of the central Indian states, it declares a non-nationalized NTFP and it is free for harvesting. Local inhabitants take advantage of and diminish the trees. Things went worst as collectors are not bothering about the cultivation. Many workers reported that indiscriminate harvesting; cutting branches to the rampant collection of seeds and lopped trees attract the infestation of insect pests which adversely affect the growth and productivity.

Conclusion

The above mentioned facts reveal that the species have a good economic potential. Although, regeneration is poor due to unscientific exploitation of seeds but vegetative propagation could be a viable means of reproduction. Conservation of Chironji has emerged as a big issue amongst conversationalists and environmentalists in India. The species listed in the vulnerable group of the Red data book of IUCN. As Chironji is a highly nutritious seed having potential industrial and domestic uses therefore, conservation approaches for this valuable species should be cultivation-oriented.

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Proclivity on multipurpose trees for promoting bund plantations in south-east Rajasthan

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Introduction

Enormous tract of existing agricultural field bunds in north-western part of India is a potential opportunity to develop bund planting or agroforestry system. The inconsistency in climatic changes coupled with very high weather pattern changes further aggravates the problem and makes farming uneconomical. In such situations, less water and nutrient demanding technologies hold a good promise to sustain the productivity and provide alternative source of income to the farmers. Natural vegetation of the dry land and ravine land are very poor, *Prosopis juliflora* major species composition of tropical thorn forest in the entire ravine watershed (Singh *et al.*, 2015). Agroforestry, social forestry, community forestry, village forestry and farm forestry are all in terms used to describe tree growing that is undertaken mainly outside the gazetted/ notified forest areas. Trees Outside Forests (TOFs) are the main source of tree based fuel, food, fodder, fibre, etc. The quality and quantity of benefits expected from TOFs mainly depends on choice of species, seedling quality and their field management. The diverse edaphic-climatic condition of India offers the scope for planting a variety of multipurpose tree species. For example, market changes may persuade farmers, who previously grew trees for fodder and fuel, to cut their trees for sale as round wood for construction material. Forests have three main functions: 1) Economic (timber production) 2) Environmental (soil protection, landscape, biodiversity, and water quality protection and enhancement) 3) Social (recreation, employment and rural development) Each of these functions must be taken into consideration in the planning and management of a forest, in keeping with the principles and aims of sustainable forest management. Agroforestry is a land use system in which trees are grown in association with agricultural crops, shrubs, pastures or livestock. The integration of trees and shrubs in the land use system can be either a spatial arrangement or in a time sequence. Sometimes the phrase woody perennials are used instead of trees and shrubs. Of course woody perennials include all tree and shrubs with a lifespan of more than a year, but they also cover bamboos and palms. Small and marginal land farmers have been growing trees for different purposes in resource poor region. Certainly, all trees provide shade and protection from soil erosion. In this sense, all trees can be said to have at least two purposes. These may include soil conservation, shade, fuel wood, timber, fibre, fodder, food or medicine.

Demand of fodder and fuelwood requirement in semi-arid regions

The majority of the people belonging to small farmers and animal rearing is there major livelihood generation activity especially goat, buffalo, camel. The present source of fuelwood is insufficient to meet the fuel needs. What is more disturbing is due to lack of fuel, cowdung is dried and used for fuel purpose and otherwise it would have been a source of manure to the agricultural fields. The absence of fodder and shortage of fuel is further deteriorates ravine belts. Dry land silvi-pasture system by planting of multipurpose fodder yielding trees and suitable grasses like *Cenchrus cillaris, C.setigerus, Chrysopogan fulvus, Dicanthium annulatum and Hetropogan contortus etc*. The abandoned gully encroached lands is possible to adopt some fast growing economic species like bamboo and babul with effective moisture conservation measures (Kala et al., 2021c). Biofencing around the field also essential to protect agricultural field from domestic and wild animals like wild boar, Porcupine, Nilgai etc.

A transect survey and personal observation were conducted to know and understand the ecological indication and distribution of tree diversity in ravine region. The repeated field surveys were conducted in the randomly delineated sample plots of each stratum (ie. 10 m x 10 m for trees, 5m x5m for shrubs, 1m x1m for herbs) to document the tree diversity. Observations were made on the habit features and habitats of each tree species in the field. Indigenous MPTs species are universally recognised as a natural gift and play significant role in environmental rehabilitation because of their exultant survival and high adaptation to local conditions. Despite this, very little information's available about suitable MPTS and their silviculture techniques for ravine land afforestation. The present study attempted to explore the suitability of MPTs in the semi-arid regions of Rajasthan. The field survey was conducted through PRA method on representative random blocks and recorded the ranking of multipurpose trees based on phyto-sociological benefits (Table-1). Keeping this in view a comprehensive ready reckoner for MPTs has been prepared for dryland agroforestry systems and resource conservation in semi-arid regions.

Multipurpose fodder trees can be used in two or more ways

Farmers can grow multipurpose trees in various combinations with other crops, as in agroforestry, in block plantations of trees or in naturally regenerating tree farms. Farmers facing changing conditions in their environment or market can also change the way they manage a tree. Selection of region specific MPTs is a primary step for establishment quality plantation and their management.

Selection of MPTs using following selection criteria

- **Easily establishment:** require minimum labour for planting and maintenance.
- **Fast growing nature:** benefits become available to the farm family as soon as possible.
- **Good re-sprouting/ coppicing power:** hedgerows continue to grow regularly after pruning.
- **Nitrogen fixing legume:** leguminous (nitrogen-fixing) species can contribute to crop nutrition.

- **Good quality and palatable fodder**: provide more green manure and acceptable fodder.
- **Long and deep root system:** nutrients and water are drawn from lower soil layers.
- **Easy to propagate through seed or clones:** generally, growing hedgerows from seed requires less labour than vegetative propagation.
- **Adaptable to close spacing:** alley cropping / hedgrows require dense planting.

Preference ranking of MPTs by selected village farmers

The major challenge in dryland or ravine area planting is *Prosopis juliflora* infestation which is not preferred by the habitants due to various reasons. Human and livestock by providing good quality fuel and fodder in sufficient quantity generate income apart from environmental benefits were discussed and farmers preference based on different attributes were gauged during PRA exercise. Therefore, primary priority of the farmers and inhabitants our study area is to replace *Prosopis juliflora* with valuable MPTs. Attributes considered for listing the farmers' preference for agro forestry tree species are fodder, fuel, shade or protection, timber and its market value. Overall, farmers preferred multipurpose tree species were listed here (Ref: Table-1 and Photo: 1). Those are *Pongamia pinnata, Inga dulce, Acacia nilotica, Dendrocalamus strictus* and *Prosopis cineraria* were the most favourite agro forestry tree species.

Table- 1: Farmer's preference on adopting Fodder Trees through PRAs in selected villages

Common Name	Scientific Name	Farmers preference attributes*					Total	Priority rank
		Shade	Fuel	Fodder	Timber	Other marketable products		
Kachnaar	*Bauhinia racemosa*	7	8	6	6	6	33	III
Jungle jalebee	*Inga dulce*	7	7	8	7	8	37	I
Bamboo	*Dendrocalamus strictus*	8	4	8	6	9	35	II
Neem	*Azadirachta indica*	8	6	6	6	8	28	V
Gular	*Ficus racemosa*	6	5	6	4	4	25	VIII
Ardu	*Ailanthus excelsa*	5	5	9	2	6	27	VI
Senna Siamea	*Cassia siamea*	5	5	7	2	2	21	VII
Karanj	*Pongammia*	7	8	2	8	6	31	IV

	pinnata							

Identified list of multi-purpose tree species for semi-arid regions

Studies have indicated that the choice of species under agroforestry landuse varies significantly from place to place, as it is based on the consideration of economical, silvicultural, ecological and local needs. Accordingly a shortlist prepared and complete silviculture techniques briefed for most suitable MPTs for ravine land cultivation and rehabilitation. In this system, the multipurpose tree species are raised and managed on farm bunds for their ability to produce not only wood but also leaves and or fruits that are suitable for fodder and food purpose (Kala et al., 2021b). The following models of agroforestry system with identified MPT species as the most commonly grown and preferred species for semi-arid ravine agro- ecological regions of India (Photo.1 & Fig.1), those species are *Albizia lebbeck, Azadirachta indica, Pongamia pinnata, Acacia nilotica, Inga dulce, Leucaena leucochephala, Bauhinia racemosa, Bamboos, Hardwickia binnata, Cassia siamea, Prosopis cineraria etc.,*

An understanding of their silvicultural characteristics is required, before they can be promoted. Some of the species attributes that are considered critical for considerations under agroforestry are as follows, Fast growing with high photosynthetic ability, Multipurpose utility, Coppicing ability, Adapted to local environment, Biodiversity value, Easy to regenerate, Economically valuable to local people, Ecologically well suited. Based on the observation of performance and utility, local communities have knowledge and preference for some of the local species. However, the promotion of such species is restricted due to difficulty in regenerating and establishing them. Hence, there is a need for silviculture techniques about these species for adaptation and cultivation by the local communities. The recommended silvicultural practices can be easily followed and adopted by preferred farmers for promotion tree farming through ravine land agroforestry, farm forestry and Social forestry.

Photo.1 Identified Multipurpose Trees Species (MPTs) - suitable to bund planting

Initiation Har Med per Ped programme and international Year of plantation activity in TSP & SCSP Model Villages of Bundi District in Rajasthan

Tree species are common to most farming systems providing an element of stability to the system in areas of highly variable rainfall in ravine region. For this system to survive, efficient rain-water conservation and utilization is the essential task. Depending on agro climatic conditions the number of trees per hectare and the selection of fruit and forestry species may vary. Apart from fruit tree and forestry species with high growth rates or strong wood were preferred, for example *Azadirachta indica*, *Pongamia pinnata*, *Inga dulce*, *Ailanthus excelsa*, *Ficus racemosa and Cassia siamea* are some of the favoured species (Kala et al, 2021a). The area would be systematically treated with field bunds across the slope. The

trench cum bund created help to retain *in situ* soil and moisture. This also would promote good tree growth of various species planted on the bunds. Recent years, awareness creation, distribution of planting material for promotion of Har Med per Ped programme and International Year of Plantation Activity in TSP & SCSP model villages of Bundi district in Rajasthan were also initiated and explained benefits bund planting among the farmers preferably women farmers on world soil day (Photo.2). Most recommended and preferable row espacement for bunding planting is 6m x 6m to 10m x 10m. Those MPTs comprise of species such as Acacia, Karanj, Neem, Bauhinia, Manila tamarind, Dalbergia, Cassia, Albizia etc. Approximately 400 to 600 plants per hectare can be accommodated on boundaries and bunds. These plants are regularly pruned to avoid shading and to obtain biomass for mulching and fertilizing. The twigs pruned also provide enough fuel wood to meet the firewood requirement of the local community. They provide manure and their decoction botanical pesticides. It may be noted that usually a farmer accepts a plant only when it has multiple utilities. These live fences in addition to providing protection to the plantations also help to increase bio-diversity in the area and produce substantial quantities of biomass. This biomass obtained by pruning the fencing regularly which helps in increasing soil moisture retention capacity and increased fertility.

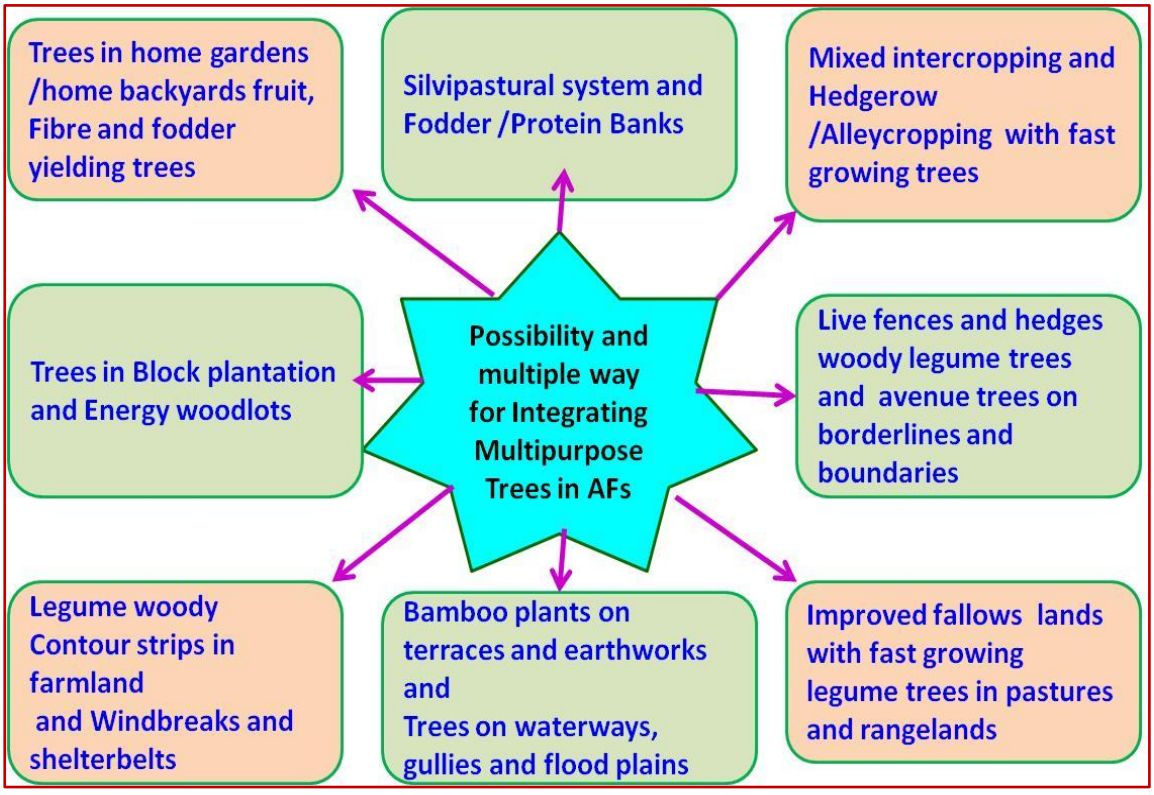

Fig.1. Sustainable way to rehabilitate ravine land farming systems with suitable MPTs

Photo.2. **Awareness creation and Distribution of MPTs with Low –Cost Tree Guard for Promotion of Har Med Per Med programme in TSP –SCSP (Watershed) Villages of Bundi District in Rajasthan**

Important intangible and intangible benefits MPTS involved in agroforestry systems

The products and services derived from multipurpose trees and shrubs are manifold but they can be summarized simply as follows:

Tangible Benefits	Intangible Benefits
↓ Wood - fencing or building poles saw timber, veneers, paper, chipboard Bark -raw and processed for various uses ↓ Energy from firewood, charcoal, liquid and gaseous fuels and feeds stocks ↓ NTFPs like resins, oils, paints, varnishes, Pharmaceuticals ↓ Leaf material - thatch, fibre, fodder, leaf oils, fruit and flower - drinks, medicines, honey, dyes, food ↓ Root material - fuel wood, chemical extractives, dyes ↓ Employment generation especially for the landless labours ↓ Additional income generation ↓ Reduce import mechanisms ↓ Risk reduction through multiple outputs ↓ Labour saving in some situations	↓ Climatic moderation (macro- and micro-) ↓ Soil stabilization and Soil improvement ↓ Water-flow moderation and Improving downstream environments ↓ Wildlife habitats, Aesthetic value, Amenity and tourism ↓ Pest and weed control ↓ Use or rehabilitation of degraded land ↓ Public awareness and education ↓ Rehabilitation of abandoned and degraded land, increasing production ↓ Improved human and animal nutrition and health.

Summary

These vast tracts of existing ravine lands in north-western part of India have potential environment threat to nearby productive lands due to over exploitation and mismanagement. The inclement weather conditions also coupled with very high summer temperature further aggravates the problem and makes crop farming uneconomical. In such situations, less water and nutrient demanding agriculture and forestry technologies hold a good promise to sustain the productivity and provide alternative source of income to the farmers. Animal husbandry is the major livelihood generating activities for small and marginal farmers in ravine region of India. But, absence of sufficient fodder and shortage of fuelwood is also further deteriorates ravine belts. So, utilizing these kind ravine wastelands is an important mandate for increasing fodder and fuel availability (Photo.3). The existing information on the suitable trees species for non-arable or wasteland rehabilitation in the country is sketchy, fragmented and lies scattered with various research institutes across the country, whereas the existing information have compiled, it is a comprehensive ready reckoner for ravine

land farmers and other beneficiaries too. Accordingly a shortlist of species identified and complete silviculture techniques were briefed out for undertaking ravine land cultivation and rehabilitation. The following MPTs were highly preferred by farmers in semi-arid ravine agro- ecological regions viz., *Albizia lebbeck, Azadirachta indica, Pongamia pinnata, Inga dulce, Bauhinia racemosa, Dendrocalamus strictus, Hardwickia binnata, Cassia siamea, Ficus racemosa etc.* These multipurpose tree species could be easily included and raised as boundary planting on farm bunds / black planting/ agroforestry plantation. Through tree farming and material processing, are well suited to this region due to twin concerns of livelihood enhancement and environmental protection - the key components for developing these resource poor lands using Multi-Purpose Trees.

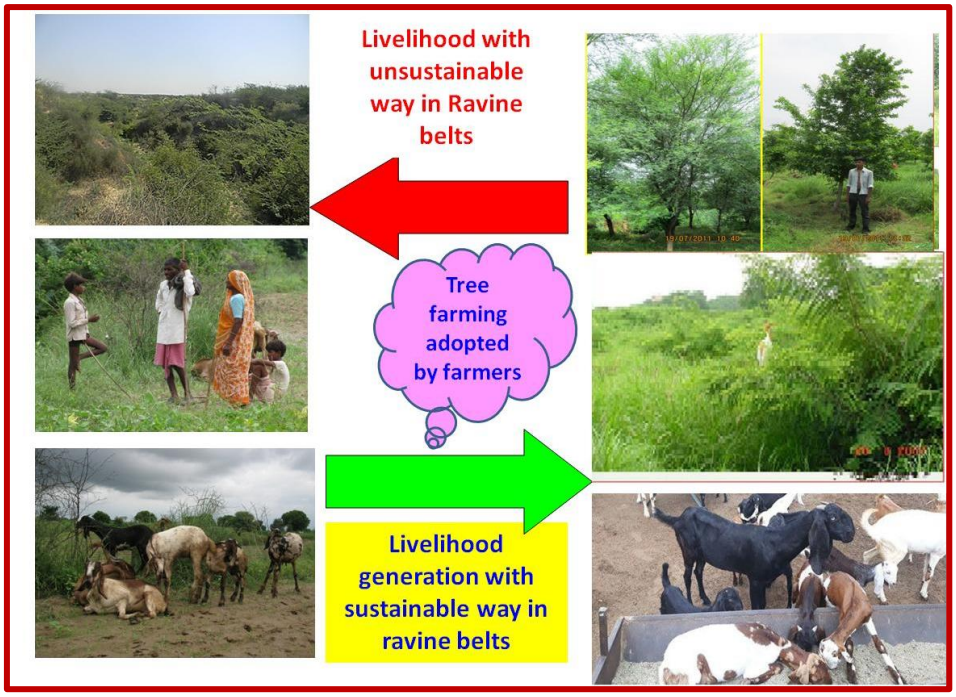

Photo.3. Integration of MPTs – An inevitable approach tree fodder production in dryland Agroforestry systems

Therefore, the use and promotion of MPTs in bunding planting for watershed management, soil and water conservation, rehabilitation of degraded land could be possible approach to catering the local people needs in sustained way. Adaptation of Multipurpose trees and tree based material processing are well suited to this region to meet twin concerns ie., livelihood enhancement and environmental protection – which are key components for sustainable land management. Hence, through an effective organized massive cultivation of these MPTs in integrated watershed management programme with community participation could helpful to

increase the green cover and establish rural industries that provide optimum livelihood development to the local community.

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अर्नीबीया यूक्रोमा (रतनजोत): एक गंभीर लुप्तप्राय औषधीय पौधा

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भूमिका

आधुनिक विज्ञान में जबरदस्त प्रगति के बावजूद, विभिन्न रोगों के इलाज के लिए पारंपरिक, उपचारात्मक प्रणालियों के उपयोग के बारे में दुनिया भर में जागरूकता है। यह अनुमान है कि अविकसित देशों में 80 प्रतिशत आबादी अभी भी प्राथमिक स्वास्थ्य देखभाल के लिए पारंपरिक पौधों पर आधारित दवाओं के उपयोग पर निर्भर है। भारतीय हिमालयी क्षेत्र, औषधीय पौधों की प्रजातियों का एक विविध भण्डार है जो मानव उपयोग के लिए प्राकृतिक उत्पादों के स्रोत के रूप में काम करता है। हिमालयी क्षेत्र प्राचीन काल से भारत में उपयोग किए जाने वाले औषधीय पौधों के आधे से अधिक का योगदान देता है। ये पौधों की प्रजातियां, उनके अंधाधुंध उपयोग, हर्बल उद्योगों में बढ़ती मांग और अवैज्ञानिक कटाई के कारण, अपने प्राकृतिक आवास से लगातार कम हो रही हैं और कई विलुप्त होने के कगार पर हैं । इसका एक उत्कृष्ट उदाहरण रतनजोत है जोकि एक व्यावसायिक रूप से मूल्यवान पर गंभीर रूप से लुप्तप्राय पौधा है। रतनजोत, उप अल्पाइन क्षेत्र में बेतुला, रोडोडेंड्रोन, ओक और देवदार के पेड़ों के बीच ज्यादातर छायांकित क्षेत्रों में उगता है, जबकि अल्पाइन क्षेत्र में, रतनजोत खुले धूप वाले स्थानों में उगता हैं।

आर्नेबिया यूक्रोमा, को सामान्यतः रतनजोत के नाम से जाना जाता है। सन 1998 के दौरान, इसे लुप्तप्राय पौधों की श्रेणी में शामिल किया गया था। हालांकि, औषधीय गुणों के कारण, रतनजोत के पौधों का अत्यधिक दोहन किया गया है जिसके कारण इसे अब नवीनतम इंटरनेशनल यूनियन फॉर कनजर्वेशन ऑफ नेचर (आइ यू सी एन) वर्गीकरण के अनुसार हिमाचल प्रदेश के गंभीर रूप से लुप्तप्राय पौधों की सूची में शामिल किया गया है। जीनस *अर्नीबिया* की कुल पाँच प्रजातियों में से तीन हिमाचल प्रदेश के लाहौल और स्पीति क्षेत्र में पाई जाती हैं। इनमें से केवल *अर्नीबिया यूक्रोमा* (चित्र 1) जोकि स्थानीय भाषा में डिमोक या खामेद के नाम से जाना जाता है, का उपयोग बड़े पैमाने पर व्यावसायिक रूप से किया जाता है। यह पौधा रेतीली (अच्छी तरह से जल निकासी वाली) और पोषक तत्वों की कमी वाली मिट्टी में शानदार उत्पति दिखाता है लेकिन छाया वाले क्षेत्रों में इसकी उत्पति ना के बराबर होती है। यह एक बारामासी रूटस्टॉक है जिसका नया तना पिछले वर्ष के आधारीय गुच्छे से बढ़ता है, ऊपरी पत्तियां छोटी और चौड़ी होती हैं जबकि निचली पत्तियां का पुष्पक्रम लांसोलेट और एकूट होता हैं। फूल गुलाबी या बैंगनी रंग के होते हैं जो उपरीय पुष्पक्रम पर पैदा होते हैं। कांटेदार पत्तियों की उपस्थिति, इस पौधे को चराई से

बचाती है, इसलिए कठोर जलवायु परिस्थितियों वाले क्षेत्रों में भी यह पौधा अच्छी तरह से पनपता है। यह पौधा जुलाई से सितंबर के महीने के दौरान 3,200 से 4,500 मीटर तक की ऊंचाई तथा फूलों वाली पहाड़ियों की ढलानों पर प्राकृतिक रूप से उगता है। यह पौधा यकृत और हृदय नाड़ियों पर कार्य करते हुए ठंडे गुण प्रदर्शित करता है। विभिन्न उद्देश्यों के लिए इसकी जड़ों की अवैज्ञानिक कटाई आमतौर पर इसके निवास स्थान के नुकसान और कम जनसंख्या घनत्व के लिए जिम्मेदार होती है, इसलिए भविष्य में पुनर्जनन के लिए मुख्य बाधाओं के रूप में काम करती है। इस पौधे की आबादी को इसके प्राकृतिक आवास में कम करने में मवेशी चराई को भी एक प्रमुख योगदानकर्ता के रूप में पहचाना गया है।

पैदाइश और वितरण

रतनजोत भारत के हिमाचल प्रदेश राज्य के अल्पाइन और उप अल्पाइन क्षेत्रों (ग्रेट हिमालयन नेशनल पार्क, पिन वैली, चंबा, लाहौल और स्पीति, रोहतांग, किन्नौर घाटी); जम्मू और कश्मीर (कुर्रम घाटी, देवसाई, मकरा, कगन घाटी, बेदोरी, अलियाबाद, पीर पंजाल) ओर उत्तराखंड (हर-की-दून, हिमटोली, केदारनाथ, माना, फूलों की घाटी, गोरसन, द्रोणागिरी, मलारी, कुमाऊँ, गढ़वाल) में उगता है जबकि नेपाल में यह खुली ढलानों और झाड़ियों के बीच में पनपता है।

इसके अलावा यह उत्तरी अफ्रीका, तुर्की और ईरान के उत्तरी प्रांतों में विशेष रूप से पर्वतीय क्षेत्रों में भी पाया जाता है। रतनजोत की यह प्रजाति अन्य वन्य प्रजातियों जैसेकि *क्रेपिस फ्लेक्सुओसा, कैरगाना ब्रेविफोलिया, ग्लूकोमा निवेली, एस्ट्रैगलस कैंडोलीनस, कॉसिनिया थॉमसन, ड्रेकोसेफालस नूतन, पॉलीगोनम प्लेबियम, सिसर मैक्रोफिला, रोजा वेबियाना, सेलिनम टेन्यूफोलियम, एफेड्रा जेरार्डियाना, हिपोफे टिबेटाना, हेराकलियम थॉमसोनी, आर्टेमिसिया मैरिटिमा, रिब्स ओरिएंटलिस,* और *कैपरिस स्पिनोसा* के साथ पनपती है।

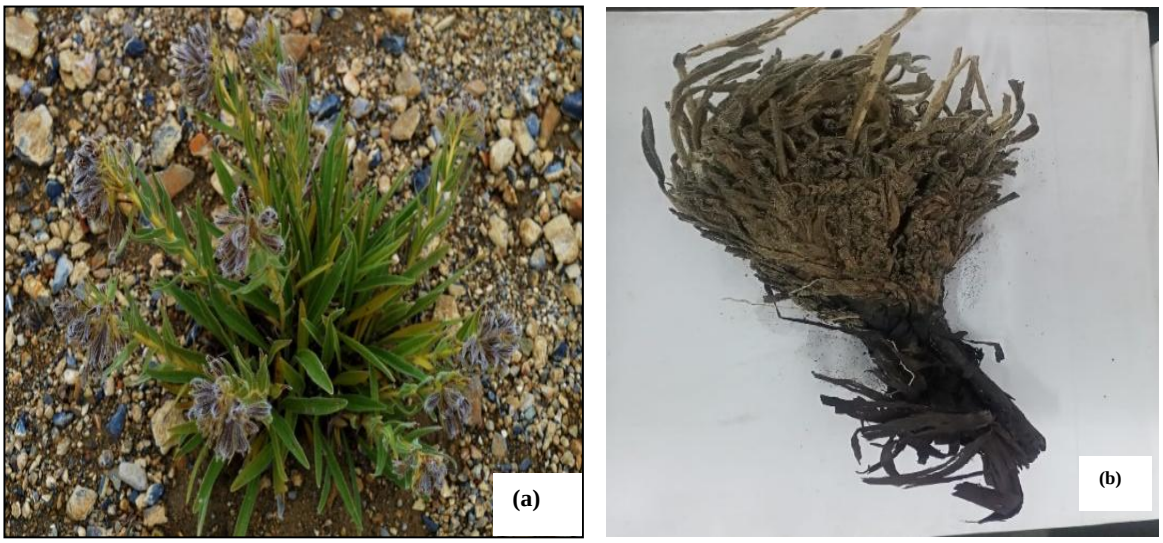
औषधीय महत्व

रतनजोत एक ऐसा औषधीय पौधा है जिसकी जड़ का उपयोग आंखों के विकारों, कटने और घावों, दांतों के दर्द और कान के दर्द के इलाज के लिए किया जाता है। यह यकृत और हृदय नलिकाओं पर कार्य करता है । यह रक्त के प्रवाह को नियंत्रित करता है और खसरा, सूजन और घावों से जुड़े विषाक्त पदार्थों को बेअसर करने में भी सक्षम है। इसके अलावा, इसका उपयोग मेनोरेजिया के इलाज के लिए किया जाता है। रतनजोत की जड़ का चूर्ण फेफड़ों की समस्या और खांसी के इलाज में भी सहायक होता है।

इसके अतिरिक्त, जलने और अन्य त्वचा संबन्धित रोगों को ठीक करने के लिए भी इसकी जड़ों का उपयोग किया जाता है। इसके अलावा यह प्यालों के डिज़ाइनिंग ओर कपड़ों की रंगाई के लिए भी उपयोग में लाया जाता है । कई क्षेत्रों में लोग इसे अलग-अलग प्रकार के पाक व्यंजन बनाते समय एक प्राकृतिक रंग के रूप में भी प्रयोग करते हैं। इसके अलावा रतनजोत के पूरे पौधे को जब मिट्टी के साथ मिलाया जाता है तो यह मिट्टी की उर्वरता में वृद्धि करने में भी सहायक माना गया है । रतनजोत औषधीय पौधे की जड़ें लाल नेफ्थोक्विनोन वर्णक से भरपूर होती हैं जिसके

कारण इस पौधे को एंटी-माइक्रोबियल, एंटी-इंफ्लेमेटरी, एंटी-ट्यूमर, और गर्भनिरोधक गुणों का एक अच्छा स्रोत माना गया है।

रतनजोत, इसके जैवसकरीय घटक, और कच्चे अर्क को कई जैविक प्रभावों से भी जोड़ा गया है जिसके कारण इनमें मौजूद विभिन्न मेटाबोलाइट्स जैसेकि शिकोनीन , अल्कैनिन, नेफ्थोक्विनोन, शिकोमेटाबोलिन एच, मेरोटरपेनॉइड, एपॉक्सीअर्नेबिनोल, और आइसो-हेक्सिल-नैफ्थोपुरपुरिन आदि को माना गया है। रतनजोत के शिकोनीन तथा अन्य द्वितीयक मेटाबोलाइटस को एंटीवायरल, एंटीफंगल, जीवाणुरोधी एंटीकैंसर, और प्लेटलेट एकत्रीकरण आदि गतिविधियों के लिए जिम्मेदार माना गया है। रतनजोत पौधे और उसके मूल परिवेश में पाए जाने वाले सूक्ष्मजीवों के बीच के जटिल मेलजोल, इस पौधे की द्वितीयक मेटाबोलाइट्स को स्रावित करने और असंगत पारिस्थितिक स्थितियों को सहन करने की अद्वितीय क्षमता का कारण माना जाता है।



चित्र 1: (a) *अर्नीबीया यूक्रोमा* (रतनजोत) का पौधा (b) *अर्नीबीया यूक्रोमा* की जड़

निष्कर्ष

विकारों की एक विस्तृत श्रृंखला को ठीक करने की उनकी व्यापक क्षमता और उनके कम या कोई दुष्प्रभाव नहीं होने के कारण औषधीय पौधों की मांग दिन-ब-दिन बढ़ती जा रही है। प्रागैतिहासिक काल से स्वदेशी चिकित्सा में विभिन्न प्रकार के विकारों के इलाज के लिए उपयोग की जाने वाली सबसे महत्वपूर्ण हर्बल दवाओं में से एक **"रतनजोत"** की मानवजनित गतिविधियों और अवैज्ञानिक कटाई के परिणामस्वरूप इस अत्यधिक मूल्यवान पौधों की प्रजातियों को इसके प्राकृतिक आवास से हटा दिया गया है। साथ ही इसे गंभीर रूप से लुप्तप्राय औषधीय पौधों की प्रजातियों की श्रेणी में रखा गया है। प्राकृतिक रूप से पाए जाने वाले पिगमेंट जैसे शिकोनीन, डीऑक्सीशिकोनिन, ββ-डाइमिथाइलैक्रिलशिकोनिन, और इसकी जड़ों में एल्केनिन इसके उपचारात्मक प्रभावों के लिए जिम्मेदार हैं। हर्बल दवा की मांगों को पूरा करने के लिए कंपनियों और स्थानीय लोगों के लिए, इस पौधे की प्रजाति की औषधीय प्रमुखता और

गंभीर रूप से लुप्तप्राय स्थिति को ध्यान में रखते हुए इसका संरक्षण और प्रचार करना और भी उचित हो जाता है।

Management of flyash through forestry interventions

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Human race has come a long way evolving, inventing, shaping and refining into today's modern way of living. Electricity serves as the major fuel in revolutionizing the needs of this modern world. It has ubiquitously become basic necessity running our homes, offices, industries and even modes of transport. Electrical power has demonstrated pivotal role in origination of fields including entertainment, medical surgeries, information technologies, robotics andmany others without which a mere imagination of long happy and healthy life is far fetched.

The need for electricity is endless and its humongous production is done either conventionally through Thermal, Hydro, Nuclear power or with Wind, Solar andother renewable sources. According to MInist, In India, about 75% of the total power generation is achieved through coal based thermal power plants currently having installed capacity of over 2 lakhs Megawatt. Use of inferior lignite coal in this production process generates 266 Metric Ton of fly ash as residue each year (Yadav et al., 2022). Occurring as fine amorphous particles of few to 100 microns, fly ash is a ferro-alumina silicate mineral with major matrix elements like silicon, aluminium, iron constituting significant amounts of both major nutrients (that is K, P, Ca, Mg, S) and micro nutrients (like Cu, Zn, Mn, Fe, Mo, B) (Yadav, 2023).

Around 92.41 percent of the generated fly ashis utilized in manufacturing of cement, building products, waste land development, construction of roads/ highways/ flyovers/ dams, reclamation of low-lying areas, back filling and stowing of mines, etc (Ministry of Power, 2021). But the unutilized fly ash is discharged to accumulate in ash lagoons of power plants. The light weighted amorphous ash particles travel long distances, sometimes up to few kilometres. This fugitive dust emission from flyash lagoons causes serious problems in and around thermal power plants by inducing chronic pulmonary diseases and other health issues in local people. At times, horizontal seepage of underground water from the ash lagoons also creates water logging condition in the adjacent agricultural fields. Seepage of water from ash lagoons induces contamination and pollution of adjoining land and water bodies affecting agriculture productivity. Wherein coal being the mainstay of power generation not only threatens the sustainable development but also raises many environmental and health issues. Hence management of fly ashis the major concern of coal-based electricity production in the country.

Tropical Forest Research Institute, Jabalpur has been working dedicatedly for over a decade with various thermal power plants of the country to provide solutionfor different problems associated with

management of flyash in their power plants.

In one such associated study severe problem of fugitive dust emission from flyash lagoons was reported at Shri Singaji Thermal Power Plant (SSTPP), Khandwa (M.P.) causing turmoil in the lives of local people and farmers.Team of scientists and researchers from TFRI, Jabalpur conducted detailed vegetation survey in the surrounding forest and non-forest areas of ash lagoons to screen native dominant species suitable for plantation. Thereafter, plantation of the identified species of grasses, shrubs and trees was conducted on the ash lagoons by adopting proper cultivation and plantation techniques. This resulted in biological reclamation of fly ash lagoons within a short span of a year while controlling fugitive dust emission and horizontal seepage of water in agricultural fields from the lagoons.

Construction of fly ash dyke model was also proposed as long-term solution in the study. The proposed model will act as a physical barrier for mitigating the impact of high wind velocity, which will restrict emission of fly ash particles to long distances.

In another ash management study at NTPC, Dadri which has the country's first of its kind dry ash disposal system. This ash mound is spread over 375 acres and envisages disposing ash for 40 years of operation of the thermal plant. Plantation of about 1.25 lakh seedlings of 40 forestry and horticultural species stabilizes the ash mound. TFRI recommended plantation of tree species (preferably nitrogen fixing) having higher growth and natural regeneration capacity for the stabilization of ash mound. However, it was also recommended to monitor and restrict their growth into converting weeds in long term particularly Su-babul.

In yet another study, fly ash from NTPC Korba (CG) was used to conduct pot culture experiments in TFRI nursery, Jabalpur. Twenty tree species were grown in polybags consisting mixture of fly ash, cow dung manure and soil (1:1:1) collected from site. The plants were watered, weeded and hoed at regular intervals. On the basis of growth performance like height, girth and biomass of the plants, a number ofspecies were screened for plantation on fly ash dumps/dykes/mounds: like Safed siris, Babul, Karanj, Eucalyptus and Prosopis. Few grasses were also screened for initial stabilisation of flyash dykes.

The plantation model proposed and raised at NTPC Korba has become a success in the region. The selected species are now being replicated in restoration programmes of other thermal power plants in Chhattisgarh.

Besides this Tropical Forest Research Institute, Jabalpur is also associated in providing technical guidance in establishing flyash utilisation Park usingforestry interventionsfor ADANI Power Ltd. at Gondia, Maharashtra and resolving assigned NGT cases related to the management of flyash. These interventions ensureclean forestry-based solutions to the coal-based thermal power plants for management of flyash over longer run.

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Climate calamity and the wild: Book review

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This book has written by Professor Ranjan Chakrabarti, former Vice-Chancellor of Vidyasagar University and currently Professor of History, Jadavpur University, Kolkata, published by Primus Books, New Delhi, June, 2022 which entitled *Climate Calamity and the Wild: An Environmental History of the Bengal Delta, c. 1737-1947*.The book under review offers a climatic and environmental history of the deltic plains of Bengal. This book tackles historical issues in ecological, biological, and cultural terms, turning away from conventional ideological and political approaches. Current volume examines how the delta's political economy, production, crop pattern, inland and overseas trade and demographic pattern were transformed by shifts in climate, forests, river system and hydrology. The present book involves an exploration, of the complex dynamics of the interaction of human societies with the rich history of natural disasters such as super cyclone, thunderstorms and floods resulting in the loss of life, property, livelihood patterns, human settlements and wild life as well as major shifts in the history of colonial Bengal. The author focused and aims to break the silence in the history writing of colonial Bengal relating to the climatic and environmental significance of the Bengal delta.Professor Ranjan Chakrabarti is one of the doyens of the Environmental and ecologicalhistory of South Asia.This volume is very helpful not only for the history students, professors, and researchersbut also for the general readers.

Present book under review is divided into two parts,part one focused on climate calamity and part two deals with the ordering the wild.Each parts contains three different chaptersand the introduction and conclusion.In theintroduction section of the book mainly focused on historiography of environmental history along with the references. The opening chapter, 'Climate, Monsoon, and Water: The Bengal Delta' deals how the unique climate of the delta makes it one of the most water rich areas of the world. Every year huge amounts of river and rainwater pass through the delta on their way to the Bay of Bengal. A natural disaster like flooding large areas and depositing fertile alluvium. The monsoon of Bengal regulates the political ecology and hydrology of the delta in more ways then one. It controls and reminder the flow and overflow of rivers the intensity of floods, the character of overflow irrigation and the wildlife, vegetation and ecology of this particular location. The second chapter 'Rivers of Bengal Delta' focused on how the Bengal delta occupies a unique position among the larger deltas of the world for its varied complex river and water resource management systems. In some way the history of Bengal is essentially a history of rivers. The Bengal has a distinct

environmental and ecological identity because of its large water resource management system and unique geo cultural identity. The third chapter called 'Cyclones in the Bengal Coast: A Case Study of the Cyclone of 1737 discussed on the earliest recorded calamities in the coastal Bengal and reveals that tropical cyclones in the sate are marked by the violent rain and occasional tidal waves leading to flooding of low swampy lands. Incredible storms in coastal zones also result in great loss of life, human settlements, and wildlife. Finally a negative impact on the agriculture and the local economy become a barrier for the communication of human settlements in the particular location.

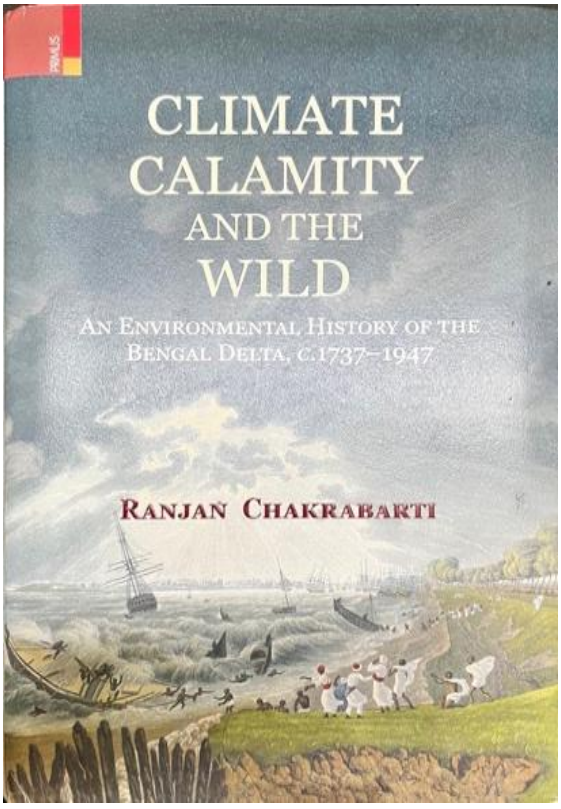
Part two begins with the chapter entitled 'Ordering the forest or the *Jungle'* discussed about the colonial strategy of ordering the wild animals and argues that natural world had always evoked a special interest among the Europeans in colonial India particularly in Bengal. Natural history has always featured quite prominently in the wrings of the Europeans. In the nineteenth century the natural world under the colonial possessions become increasingly subject to scientific scrutiny by the environmentalists.Ideas of landscape far from being peripheral to the exercise of power constituted a central and integrating elements in the wider framework of the colonial knowledge and was a critical themes in the larger colonising procedure.In the fifth chapter called 'Rifle and Romance in the Jungle: The Imperial Hunt or*Shilkar'*concentrate in the history of hunting in the colonial Bengal. This chapter is very significant for those who are seriously interested in history of forestry in India. This employs hunting or certain aspects of Wildlife in Bengal to comprehend the varied complexities within the scientific debate over the wildlife, conservation and forest resource management of the environment and the ecology. The sixth or the final chapter of the book titled 'Human-Tiger Conflict in the Forest of Bengal: A Case Study of the Sundarbans' focuses on how the human-tiger conflict become the major issue in the Sundarbans during the colonial period. This chapter of the book is also helpful for the understanding of the Project Tiger that was launched in the post-colonial period in India. In the conclusion, the author probe into the climate, calamity and the wild of the Bengal delta has brought out a plethora of interesting interactions between early colonial investigators and the subject populations in the other. Finally the book end with the series of bibliography included primary and secondary sources related to the environmental history of India.

In the end, we should refer to some of the minor limitations of this outstanding work which are expected to be modified in the next editions. First of all, there are few maps used in this book are not clear. The map of Eastern Bengal, Assam and Bhutan by J.G Barthlomew and the highlighting Bakerganj in the Dacca division are not clear. Secondly the title of the book is *Climate Calamity and the Wild: An Environmental History of the Bengal Delta, c. 1737-1947*, but if we observe carefully, the book claims to be about the environmental history of entire Bengal, but it actually an environmental history centric on South Bengal. This book is silent about

the environmental history of North Bengal during the given period. Overall the book appears is an exercise in environmental and climatic of the Bengal delta with the issue relating to wether and the climate as its central theme. The present book under review showed how the Bengal Delta's unique climate and topography led to frequent changes or shifts in the courses of rivers leading to the creation of new channels and the dissolution of already established human settlements.

Ranjan Chakrabarti

Climate Calamity and the Wild: An Environmental History of the Bengal Delta,c. 1737-1947,New Delhi, Primus Books, 2022,Hardcover, RS. 1295, ISBN: 9789355724618, Page. 269.



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