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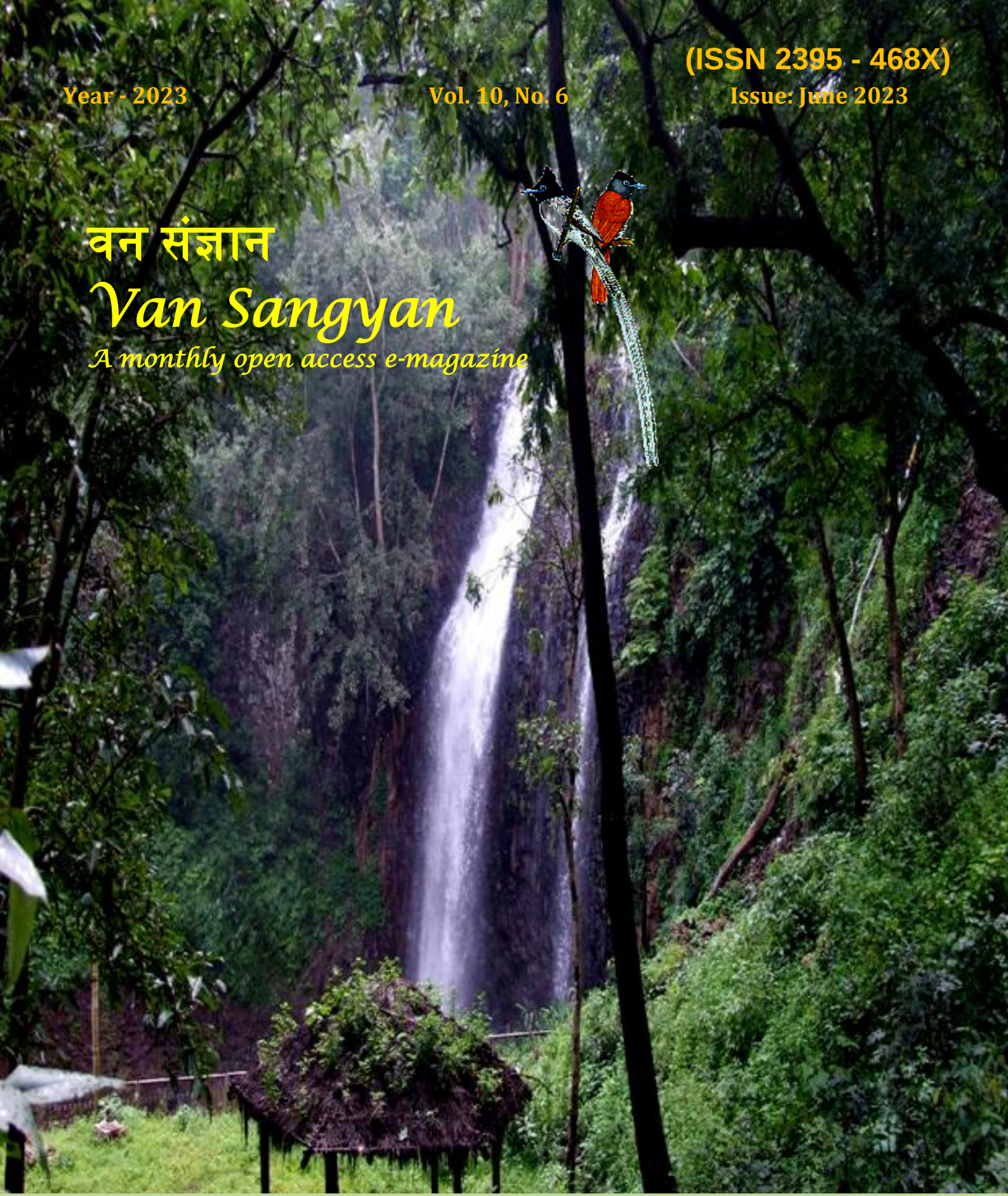

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Van Sangyan

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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or, through post to The Editor, Van Sangyan,
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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

The building and construction sector is one of the major contributors of emission of greenhouse gas and it is responsible for nearly 36 % of global energy consumption. It has become important to mitigate the environmental impacts associated with this industry which also include utilization of alternatives to reduce the carbon footprints of the building projects throughout the globe. Renewable materials, such as wood and wood based products as an alternative building material can help us in achieving sustainability goals and mitigate climate change. Wood se- questers carbon dioxide at a rate of 1 to 1.2 tons/m3 of wood, and has a relatively low manufacturing carbon footprint compared to other materials. In fact, wood is the only material that can remove carbon from the atmosphere for the lifetime of its usage. When sustainably-sourced, mass timber can be harvested and replenished with fewer lasting environmental impacts.New engineering technologies and modern building techniques have advanced the capabilities of mass timber construction, particularly in mid and high-rise construction. Cross-laminated timber and glue-laminated timber are two engineered wood production methods have enabled significant vertical growth in mass timber construction.

First article in this issue presents an overview of mass timber products and their advantages in terms of the environment, economy, and society. Followed by this, other artciles includesAgroforestry in cold-deserts, Significance of potting mixture in successful establishment of nursery, Canopy management in fruit crops, Harnessing the power of rhizobium for bioremediation, Understanding LiFE movement, Vulnerability of forest ecosystem to climate change, नारायणपुर का साप्ताहिक बाजार: भोजन योग्य वन्य व कम प्रचलित वनस्पतियों का अनूठा संग्रहण, and चार बीज: गरीबो का बादाम .

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 observations 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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An insight into the sustainability of mass timber products

Priyank Maithani[1*], Shakti Singh Chauhan[2], Anil Kumar Sethy[3]

[1]Institute of Wood Science and Technology, Bangalore, India
[2]Scientist –G, Institute of Wood Science and Technology, Bangalore, India
[3]Scientist –E, Institute of Wood Science and Technology, Bangalore, India
E-mail: pmaith.2010@gmail.com

Abstract

In the construction sector, the sustainability of mass timber products has gained importance. An overview of mass timber products and their advantages in terms of the environment, economy, and society is given in this chapter. Some of the environmental advantages mentioned include carbon sequestration and the decrease of greenhouse gas emissions. Construction cost reductions, employment growth in the forestry and construction sectors, and local material sourcing are only a few of the economic advantages. and a vision for sustainable mass timber products in the building sector round up the chapter.

Keywords: mass timber, sustainability, construction, environmental benefits, economic benefits, social benefits, challenges, strategies, case studies.

Introduction

The buildings constructed in last 60 years are characterised by huge consumption of energy and natural resources. This consumption of natural resources, the production of significant amount of waste, the pollution of water and air are largest undesirable effects related to the construction and building industry. Currently, the construction energy utilizes annually an average of 40% of resources such as raw material, energy and water. It also produces about 40% of solid waste Improved tenant comfort and indoor air quality, greater civic pride, and good effects on mental health and well-being are just a few of the social advantages. However, the chapter also emphasizes the drawbacks and restrictions of mass timber items, such as worries about fire safety and the scarcity of certified sustainably sourced wood. The advancement of fire safety technology and laws, along with strategies for encouraging sustainable forest management practices, life cycle thinking, and circular economy ideas, are also covered. A review of the main ideas and pollution. In this context, it is essential for the building sector to turn in to sustainable dimension. Due to such approaches, there is development of cultural models based on environmental sustainability, involving all sectors of human activity and evidently the construction and building sector. The trend in construction activities has been shifting towards ensuring the preservation, protection, and improvement of the environment. This is being achieved through the adoption of materials, production processes, and management techniques that prioritize biocompatibility, energy efficiency, and sustainable economic practices.

The building and construction sector is one of the major contributors of emission of

greenhouse gas and it is responsible for nearly 36 % of global energy consumption (IEA, 2022). It has become very important to mitigate the environmental impacts associated with building and construction industries which also include utilization of alternatives to reduce the carbon footprints of the building projects throughout the globe. The sustainable material like wood and wood based products as an alternative building material can help us in achieving sustainability goals and mitigate climate change since wood as a material have a lower carbon footprints than their non-wood counterparts such as masonry, concrete, steel etc. Additionally, trees also help in carbon sequestration and promoting wood based material can keep carbon stored away from the material throughout their lifetimes (Churkina et al. 2020, Lippke et al. 2011).The construction and building industries have become a major target for reduction of environmental impacts as it amounts to 1/3rd of the global final energy and contributes around 15% of the direct CO2 emissions (IEA, 2022).With increasing population and urban migration, the energy demand for construction sector and associated emissions continue to grow, especially in developing countries (IPCC, 2014). It is estimated that around 70 % of the world's population will live in urban regions by 2050 (UNEP 2017), which will result in increasing demand for housing and infrastructure. To achieve the carbon neutrality by 2050, all the new buildings and 20 % of the present building stock are expected to be zero carbon by 2030 (IEA, 2022).

According to a study it was reported that in 2015, 7GtCO2e have been emitted from the construction of building and infrastructure, with 4 GtCO2e was attributed to material usage only (UNEP, 2019). As awareness for sustainability is increasing day by day, the buildings are becoming more energy efficient; people are getting more aware about the environmental impact of construction materials (D'Amic et al, 2021). One efficient method to significantly reduce GHG emission from material manufacturing is by substituting energy-intensive material such as concrete and steel with bamboo, wood and other plant fibres in building construction (N. Heeren et al., 2015). This approach has led to 17 % increase in utilization of wood which resulted in 20 % reduction in carbon emission from building materials (Buchanan &Levine, 1999). This again promoted the development of wood based industries and helped in mitigating climate change.

The concept of sustainable development was first established by G.H. Brundtland at a meeting of the World Commission on Environment and Development in the Brundtland Report, Our Common Future. Poverty in the southern hemisphere and unsustainable production and consumption practises in the northern hemisphere were recognised as the primary worldwide environmental challenges by the study. To solve these difficulties, a concept known as sustainable development was devised to blend development and environmental concerns. The notion of sustainable development sought to balance economic progress, social well-being, natural resource conservation, and environmental preservation while preserving future generations' capacity to satisfy their own

requirements. To do this, it is critical to follow ethical standards and moral responsibilities, such as protecting current resources and preserving the planet's natural balance. The present issue for the construction industry is to use environmentally friendly materials and techniques that serve the social and economic purposes of the building while also being ecologically benign. Addressing these difficulties requires a fundamental shift in design idea to allow for better cohabitation with ecological and social systems, since environmental problems are caused by poor design of entrepreneurial, social, economic, and political systems.

In recent years, sustainability has become a concept, with an increased emphasis on striking a balance between environmental, social, and economic factors. Sustainability has been applied to a variety of sectors, including building, where it plays an important role in moulding the future of our built environment.The construction sector is a major user of natural resources. As a result, there is an urgent need to create sustainable practises and materials that help lessen construction's environmental effect.Mass timber is one potential material that has received a lot of attention in recent years. Cross-laminated timber (CLT), glued laminated timber (glulam), and nail-laminated timber (NLT) are engineered wood products that provide a sustainable alternative to standard building materials such as concrete and steel.

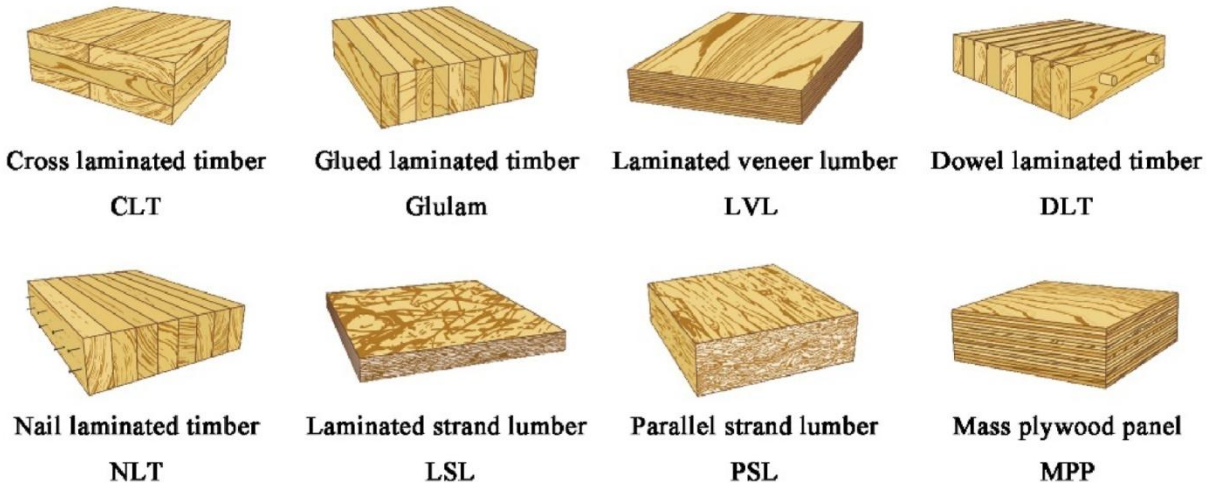

Figure 1: Different types of mass timber products (Duan, 2022).

Because trees absorb carbon dioxide (CO2) as they develop, mass timber products provide a number of environmental advantages, including minimal carbon emissions during production. Furthermore, mass timber products may store carbon throughout their lifetime, assisting in the reduction of CO2 levels in the environment. Mass timber has a lower embodied energy than conventional materials, which means less energy is needed during manufacture. It also has a better insulation value, which decreases the amount of energy needed to

heat and cool buildings.There are also major social and economic advantages to mass timber. The usage and production of mass timber benefits local economies and produces employment in rural regions. Mass timber products are extremely simple to work with, which reduces construction time and costs, and they have a distinct look that appeals to architects, designers, and building owners.

While mass timber offers great promise as a sustainable construction material, there are several issues that must be addressed. Concerns about fire safety, the availability of certified lumber, and a lack of regulatory frameworks are among them.This article will investigate the long-term viability of mass timber products, including the environmental, social, and economic advantages as well as the problems connected with their manufacture and usage. It will also look at the present situation of the mass timber business, such as production capacity and availability, as well as the regulatory frameworks in various areas. Furthermore, this paper will look at how mass timber may revolutionise the building sector and contribute to a more sustainable future.

Construction

Because of its availability, ease of handling, renewability, and unique properties for furniture, structural usage, and temporary buildings, wood has been used as a building material for millennia. Despite major advances in wood technology and engineering, wood's supremacy has fallen since the nineteenth century, especially in nations where reinforced concrete and steel have monopolised the market. This decrease is linked to a variety of cultural, economic, and environmental issues such as natural degradability, combustibility, shape and size constraints, and a general mistrust of a natural material with intrinsic faults that impair mechanical performance. In comparison to other building materials, wood is more vulnerable to degradative or destructive biological modifications, as opposed to temperature changes or exposure to chemicals and gases, which may impact other materials. The mechanical strength of wood is also affected by environmental hygrometric conditions. Furthermore, wood is prone to fungal and insect assaults and is flammable, which has led to its poor reputation as a building material and declining usage.

Recently, there has been shift towards the utilization of wood as a structural material, especially in nations where it has was previously ignored or less preferred. This is due to development of engineered wood products which combines the inherent properties of wood as a natural resource with the uniformity, dependability and high performance of the manufactured material. Engineered wood products are subject to stringent quality control and standardization procedures, making it a reliable building material.

Wood is a material with good mechanical strength in both tension and compression, so it can be used to make elements prone to bending, such as beams, compressed like pillars, and stretched like tie rods, without the need to combine it with other materials, as opposed to concrete and masonry.Wood is a material with a high strength-to-weight ratio comparable to steel, as well as compressive strength comparable to reinforced concrete.

Lightness is a key attribute in terms of both strength and cost-effectiveness. In terms of strength, the lower mass of wood constructions, for example, compared to masonry, makes them less susceptible to seismic forces. In terms of cost-effectiveness, the choice of a light material ensures ease of manufacture, handling, and transportation, as well as a reduction in the cost of supporting or foundation structures. Furthermore, the option of dry building provides for quick execution, adaptability, and a high degree of prefabrication.Because of its poor conductivity, high heat inertia, and inherent hygroscopicity, wood adds to environmental comfort. Natural materials like wood and cork are already pleasant at ambient temperature, but stone and cement are only viewed as comfortable at higher surface temperatures.Last but not least, the use of wood fits well with current trends of eco-compatible and sustainable building since it has a low environmental effect on all levels because it is recyclable, renewable, biodegradable, and devoid of hazardous materials.

Climatic protection encompasses all measures to resist and mitigate the impacts of global warming, including reacting to documented climatic changes and more frequent catastrophic events. The carbon cycle is the movement of carbon through the geosphere, hydrosphere, biosphere, and atmosphere. Human activities now produce more CO2 emissions than can be naturally absorbed by oceans and ecosystems, resulting in increasing greenhouse gas emissions and a rise in global temperatures. There are two ways to climate protection: lowering emissions and developing carbon reserves. Wood is a material that can accommodate both (Hildebrand et al., 2017 &Ramage et al., 2017). Through photosynthesis, trees store huge quantities of CO2, and 1 m3 of wood stores around 1 tonne of CO2 throughout its existence, even when turned into a completed product. Using wood in construction has two benefits: it replaces more polluting building materials and it regenerates trees, which may remove CO2 from the environment. Wood usage also provides economic and social sustainability advantages, such as reduced transportation energy consumption, the creation of local job possibilities, and the expansion of the wood market for forest conservation. Using lumber in construction may also cut costs, enhance structural timber demand, and generate jobs in forest care, sawmill production, prefabrication workshops, and specialised assembly firms, lowering unemployment and revitalising economically poor places.

Economic benefits

Mass timber products have various economic advantages that make them an appealing alternative to standard building materials. In this part, we will go through the economic advantages of mass timber products in depth.One of the most significant economic advantages of mass timber products is the cost reductions they provide in building. When compared to typical building materials, the use of mass timber products may dramatically lower construction costs since they need less work and time to install. Prefabricated mass timber items are made offsite under controlled circumstances and then delivered to the building site for assembly. This decreases construction time and on-site labour, resulting in considerable cost

savings. Furthermore, mass timber products may be made to be lightweight, minimising the requirement for heavy equipment during construction and therefore further lowering costs.

The usage of mass timber products creates jobs in the forestry and building sectors as well. The manufacturing of bulk wood products requires skilled work, resulting in job possibilities in the forestry sector. Foresters are in charge of maintaining and harvesting the forests that provide the raw materials for mass timber products. Furthermore, mass timber product manufacture need highly qualified professionals such as designers, engineers, and technicians who operate in factories to construct prefabricated components. Carpenters, electricians, and other skilled tradespeople are also employed as a result of the installation of mass timber products on building sites.

Another economic advantage of mass timber products is the ability to source materials locally. The availability of sustainably managed forests is required for the manufacture of mass timber products. As a result, the usage of mass timber products fosters the development of the forestry sector, which helps rural areas' economic prosperity. Furthermore, purchasing materials locally decreases transportation expenses, which lessens the environmental effect of construction while also contributing to the local economy.

Social benefits

The use of mass timber products in building provides a number of social advantages that contribute to the overall sustainability of the built environment. These advantages include greater tenant comfort and indoor air quality, increased community participation and pride, and a favourable influence on mental health and well-being.

Improved indoor air quality is one of the key benefits of adopting bulk wood products. Natural wood is used to make mass timber goods, which do not release dangerous chemicals into the environment like synthetic construction materials like plastics and composite wood products. As a consequence, buildings made with mass timber products have much lower levels of volatile organic compounds (VOCs) and other contaminants in the interior air. This is especially critical in places where people spend a lot of time, such as schools, offices, and residential structures.

The usage of mass timber products may contribute to greater occupant comfort in addition to enhancing indoor air quality. The inherent capacity of mass timber products to manage temperature and humidity levels may eliminate the requirement for mechanical heating and cooling systems. This not only saves energy and decreases greenhouse gas emissions, but it also makes the interior climate more pleasant for building inhabitants.

Increased community participation and pride is another social advantage of mass timber products. Mass timber structures are often considered as symbols of innovation, sustainability, and development, and may become community icons. Furthermore, using local wood in the construction of mass timber structures may generate a feeling of connectedness to the surrounding environment as well as a sense of community ownership and responsibility.

Finally, mass timber products have been demonstrated to improve mental health and well-being. Natural materials, such as wood, have been demonstrated in studies to alleviate stress and enhance general mood and cognitive performance. Biophilic design features, such as the utilisation of natural light, plants, and views of the surrounding environment, that are often included into mass timber structures, have been demonstrated to have a good influence on mental health and well-being.

Strategies for ensuring sustainability of mass timber products

Although using mass timber products in construction has many benefits for the environment and the economy, it is crucial to maintain their long-term viability via appropriate management and ethical practices. To ensure the long-term survival of timber products, a range of procedures may be used.

To ensure a steady supply of wood over the long term, it is essential to promote sustainable forest management practices. Sustainable forest management must strike a balance between its economic, environmental, and social aspects. This entails protecting water resources, preserving the diversity and health of forest ecosystems, and securing the livelihoods of those that rely on the forest for their subsistence. Sustainable forest management techniques may help to maintain a consistent supply of wood for the mass timber industry while minimizing unfavourable effects on the environment and local communities.

Using life cycle thinking and circular economy concepts is another way to ensure the sustainability of mass timber products. In order to minimize negative environmental effects, life cycle thinking involves examining a product's whole life cycle, from raw material extraction through disposal. The circular economy advocates creating products and processes that promote recycling, reuse, and resource efficiency. Applying these ideas to mass timber items can help us minimize waste, lessen the impact on the environment, and build a more sustainable and circular economy.The long-term profitability of mass timber products may also be ensured by encouraging ethical sourcing and certification schemes. Making sure that timber is purchased legally and sustainably is part of responsible sourcing. The Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) are two certification programs that provide a framework for guaranteeing that timber is sourced from responsibly managed forests. Promoting the use of certified wood in mass-produced items may help to advance sustainable methods of managing forests and ensure that the wood used in these products comes from legal sources.

The development of fire safety laws and technology is also essential to ensuring the long-term survival of mass timber goods. Mass timber construction must take fire safety into account, and new fire safety technologies and regulations may help to ensure the sustainability and safety of mass timber products. While advancements in fire safety technologies may help to boost the use of mass timber products in construction while ensuring that they are safe and sustainable, building rules and regulations, for example, may limit the use of mass timber products in construction.

A combination of strategies that support sustainable forest management practices, implement life cycle thinking and circular economy principles, promote responsible sourcing and certification programs, and advance fire safety technologies and regulations are required to ensure the long-term viability of mass timber products. These steps might help to maximize the benefits of mass timber products for the environment, economy, and society while mitigating their detrimental effects on the environment and local communities.

Case studies

As an alternative to conventional building materials like concrete and steel, mass timber construction is becoming more and more popular globally. It is a viable and ecologically responsible choice that offers several advantages, such as less carbon emissions, increased interior air quality, and sped-up construction. The insights learnt from these projects may help guide future designs and building methods. Several sustainable mass timber projects have been completed all around the globe.

The T3 (wood, Technology, and Transit) building in Minneapolis, Minnesota, is one of the most well-known sustainable mass timber constructions. 2016 saw the completion of the seven-story structure, which was built of cross-laminated timber (CLT) and glulam beams. With elements like a green roof, an energy-efficient HVAC system, and the use of locally produced materials, the project was planned to be as environmentally friendly as possible. The T3 building has won several accolades for its sustainability, including the Council on Tall Buildings and Urban Habitat's (CTBUH) 2017 Best Tall Building Award for the Americas.

The Brock Commons Tallwood House at the University of British Columbia in Vancouver, Canada, is another noteworthy sustainable mass timber building. With 18 stories and a mix of CLT and glulam beams, the building is one of the highest wood structures in the world and was completed in 2017. Using wood from sustainably managed forests, reducing material waste, and maximizing the building's energy efficiency allowed the project to meet its aim of being carbon neutral. The Canadian Green Building Council's 2017 Green Building Award was given to the project in recognition of its sustainability.

Another noteworthy sustainable mass timber project in Europe is the HoHo Wien building in Vienna, Austria. Using a mix of CLT and glulam beams, the 24-story skyscraper, which was finished in 2019, is the highest wood building in the world. With elements like an energy-efficient HVAC system, green roofs, and the usage of renewable energy sources, the project was planned with sustainability in mind. Numerous sustainability grading systems, including as LEED Platinum and the Austrian Sustainable Building Council, have granted the HoHo Wien building its seal of approval.

These case studies show that sustainable mass timber construction is possible and can be done at many sizes, from little projects to tall skyscrapers. However, there are certain best practices and lessons to be used in mass timber building in order to attain sustainability.The promotion of sustainable forest management techniques is a crucial best practice. To maintain long-term forest health and biodiversity, sustainable forest management include

ethical wood resource collection. To stop deforestation and encourage forest conservation, it is crucial to make sure that the wood used in mass timber construction comes from sustainably managed forests.

The T3 building in Minneapolis, Minnesota, USA (Brownell, 2016)

The Brock Commons Tallwood House, Canada (Brock Commons)

Figure 2: Mass timber buildings

The use of circular economy and life cycle concepts is another excellent practice. Life cycle thinking entails taking the environmental effects of a product into account at every stage of its life cycle, from the extraction of raw materials through disposal. The environmental effect of mass timber building may be lessened by putting circular economy ideas into practice and by reusing or repurposing resources.Another great practice is to support certification programs and ethical sourcing. Wood products are acquired from sustainably managed forests thanks to a number of certification programs, including the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). In mass timber building, using certified wood products may encourage sustainability and environmental responsibility.

The safety of mass timber building must also be ensured by developing fire safety technology and laws. Because mass timber items are flammable, fire safety precautions must be carefully considered. The safety of mass timber construction may be enhanced by creating and implementing new fire safety laws and regulations, which will encourage the further development of this environmentally friendly building material.

Conclusion

In conclusion, sustainable mass timber products have several advantages for the building sector in terms of the economy, the environment, and society. The use of mass timber may dramatically lower greenhouse gas emissions, enhance occupant comfort and indoor air quality, support sustainable forest management methods, and generate local employment. It is crucial to improve fire safety technologies and laws, adopt life cycle thinking and circular economy ideas, support responsible sourcing and certification programs, and advance

sustainable forest management practices to guarantee the sustainability of mass timber products.The potential of mass timber for sustainable building has been shown in several case studies conducted all over the globe. These projects have taught us the value of thorough planning, stakeholder cooperation, and close attention to detail throughout construction. Future-looking sustainable mass timber products might transform the building sector by providing a low-carbon substitute for conventional building materials. The construction industry may produce environmentally friendly, energy-efficient structures while minimizing its environmental effect with the ongoing development of novel mass timber products and technology.

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Inights into telangana forests

Rohith Ravula, Milkuri Chiranjeeva Reddy and Mhaiskar Priya Rajendra

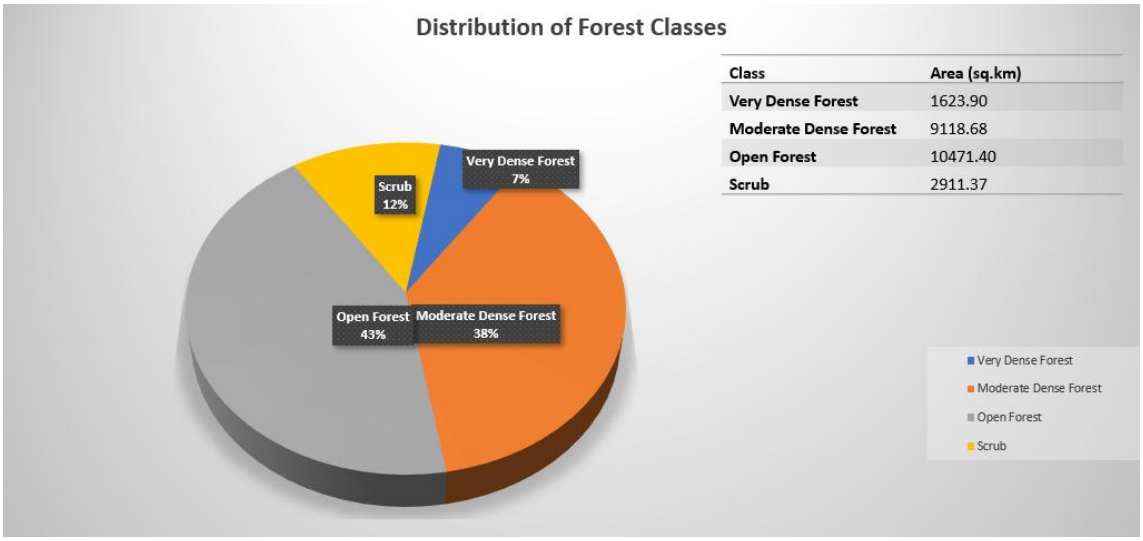
Forest College and Research Institute
Mulugu, Siddipet, Telangana
E-mail: ravularohith2021@gmail.com

Introduction

Telangana was established as a geographical and political entity on June 2, 2014, as the 29th and youngest state in the Union of India and lies in between $15^0$50' N to $19^0$55' N latitude and $77^0$14' E to $81^0$19' E longitude. Telangana state has a total geographical area of 1,12,077 square kilometres, of which the forest area accounts for approximately 24.07 % of the total geographic area (ISFR, 2021). Telangana has a diverse flora and fauna, with over 2939 plant species, 365 bird species, 103 mammal species, 28 reptile species, and 21 amphibian species, in addition to a large number of invertebrate species (State Forest Administration Report, 2019). Important endangered species found in the state include the tiger, leopard, Indian gaur, four-horned antelope, blackbuck, and marsh crocodile.The state also has dense Teak Forest along the banks of the Godavari River from Nizamabad to Adilabad, Karimnagar, Warangal, and Khammam. These forests are home to a variety of deciduous trees, including *Terminalia tomentosa*, *Pterocarpus marsupium*, *Dalbergia latifolia*, *Hardwickia binata*, Bamboo, and Teak.

Forest Cover

The distribution of Telangana state forest class wise is follows:



(ISFR, 2021)

The very dense forest was found in the former Khammam district (730.06 square kilometres), followed by the former Mahbubnagar district (336.32 square kilometres). The former Adilabad district had the most moderate dense forest with 3244.05 square kilometres, followed by the former Khammam district with 2292.84 square kilometres. With 2349.12 square kilometres, the former Adilabad district has the most open forests. With 708.64 square kilometres, the scrub jungle was most abundant in the former Nalgonda district.

Forest Cover outside recorded forest area

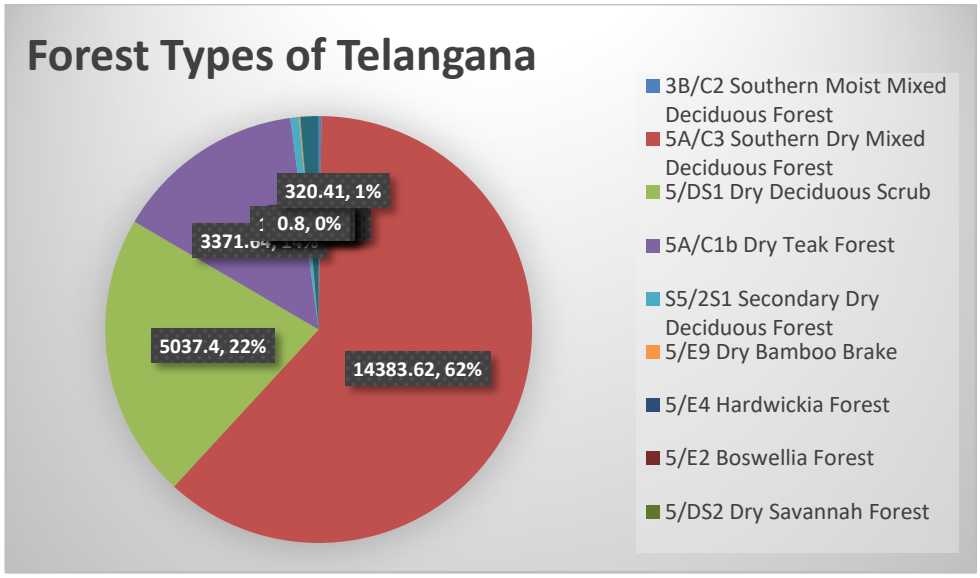
Outside of the recorded forest area (or green wash), there is about 2518 square kilometres of forest cover. The very dense forest covers approximately 73 square kilometres (2.90 %), the moderate dense forest covers 468 square kilometres (18.59 %), and the open forest covers approximately 1977 square kilometres (78.51 %)(ISFR, 2021).

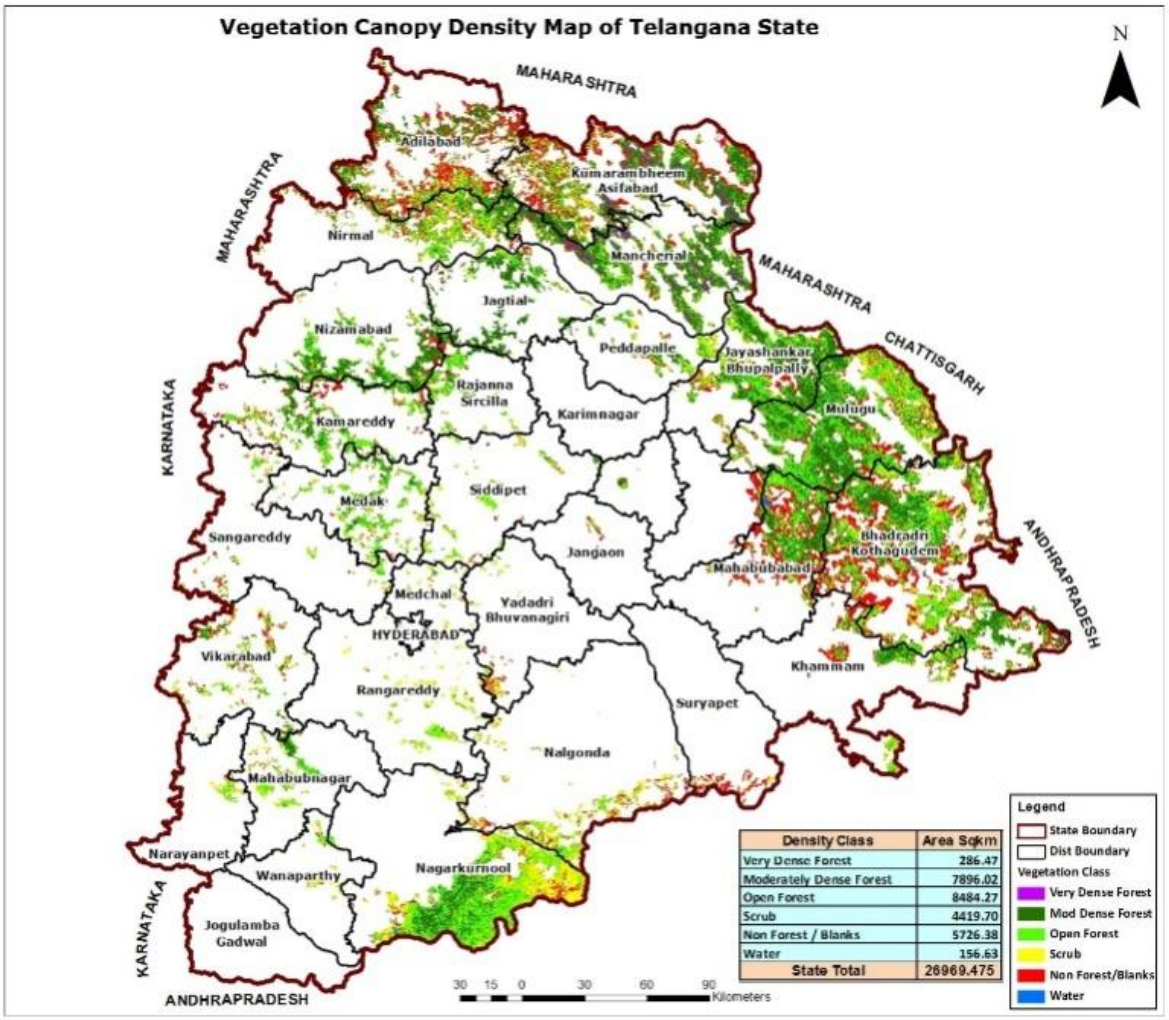
Forest Type Classification

The area under different forest types of Telangana as per Champion & Seth classification (1968) are tabulated as below:

Sl. No.	Forest Types	Area (sq. kms.)	% Of Forest area
1.	3B/C2 Southern Moist Mixed Deciduous Forest	49.23	0.20
2.	5A/C3 Southern Dry Mixed Deciduous Forest	14383.62	59.18
3.	5/DS1 Dry Deciduous Scrub	5037.40	20.72
4.	5A/C1b Dry Teak Forest	3371.64	13.87
5.	S5/2S1 Secondary Dry Deciduous Forest	151.94	0.63
6.	5/E9 Dry Bamboo Brake	16.30	0.07
7.	5/E4 Hardwickia Forest	0.47	00
8.	5/E2 Boswellia Forest	0.77	00
9.	5/DS2 Dry Savannah Forest	5.04	0.02
10.	6A/C1 Southern Thorn Scrub	0.80	00
11.	6A/C1 Southern Thorn Forest	320.41	1.32

(ISFR, 2021)

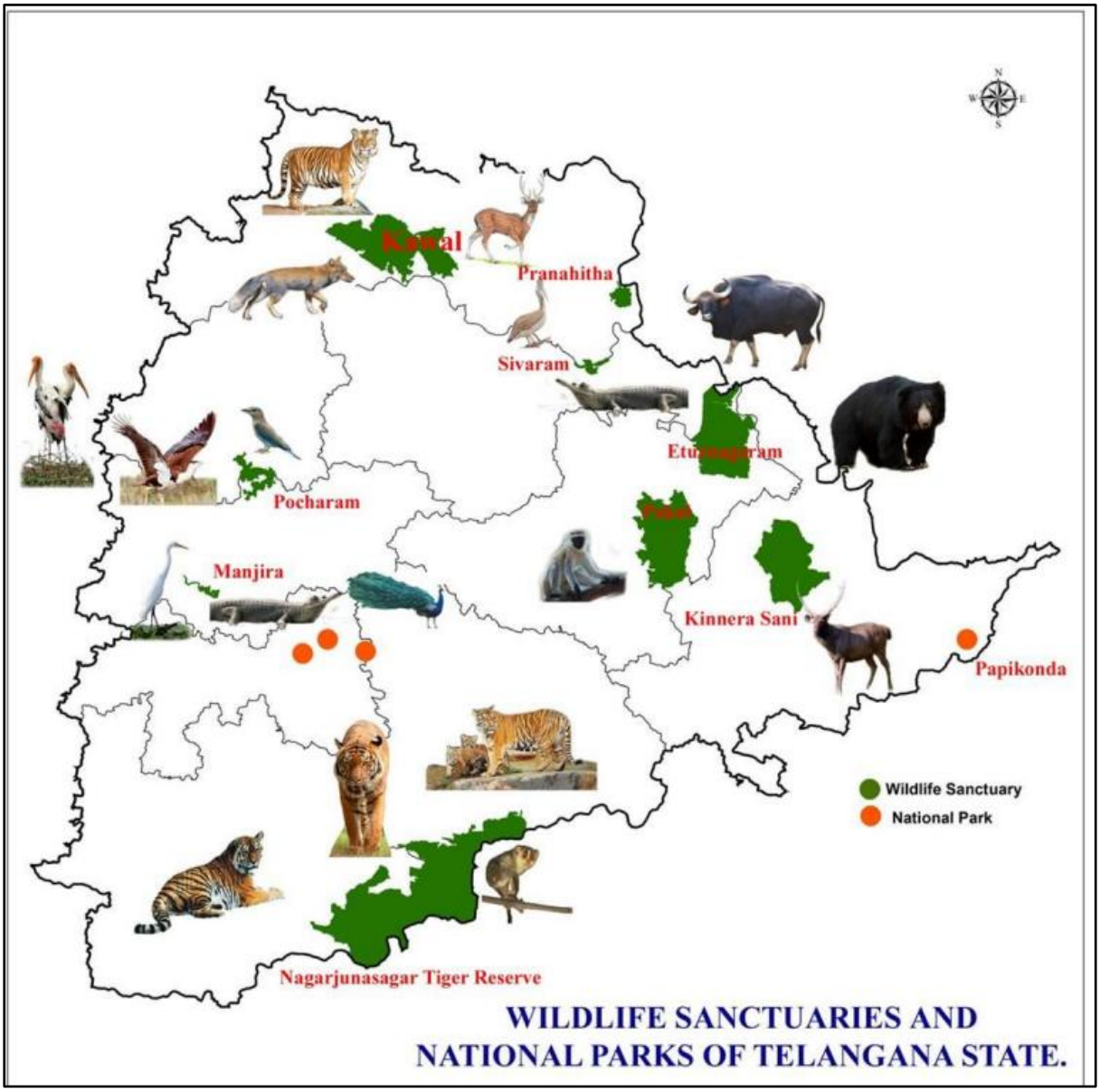




Vegetation Density Map of Telangana State

Protected Areas of Telangana

Telangana has seven wildlife sanctuaries, three national parks and two tiger reserves, Kawal Tiger Reserve and Amrabad Tiger Reservecovering 5693 square kilometres (21.16 percent of the forest area). Furthermore, Telangana state has two zoological parks and four deer parks for ex-situ wildlife conservation.



Sl.No.	Protected Areas	District (Erstwhile)	Area (sq.kms.)
1.	Kawal Tiger Reserve	Adilabad	1015.44
2.	Amarabad Tiger Reserve	Mahabubnagar	2611.39
3.	Kasu Brahmananda Reddy National Park	Hyderabad	1.42
4.	Mrugavani National Park	Rangareddy	3.60

5.	Mahavir Harina Vanasthali National Park	Rangareddy	14.59
6.	Pranahita Wildlife Sanctuary	Adilabad	136.02
7.	Siwaram Wildlife Sanctuary	Adilabad	29.81
8.	Eturnagaram Wildlife Sanctuary	Warangal	803
9.	Pakhal Wildlife Sanctuary	Warangal	860.2
10.	Kinnerasani Wildlife Sanctuary	Khammam	635.4
11.	Pocharam Wildlife Sanctuary	Medak	129.84
12.	Manjeera Wildlife Sanctuary	Medak	20

(http://forests.telangana.gov.in/)

Tree Cover and TOF

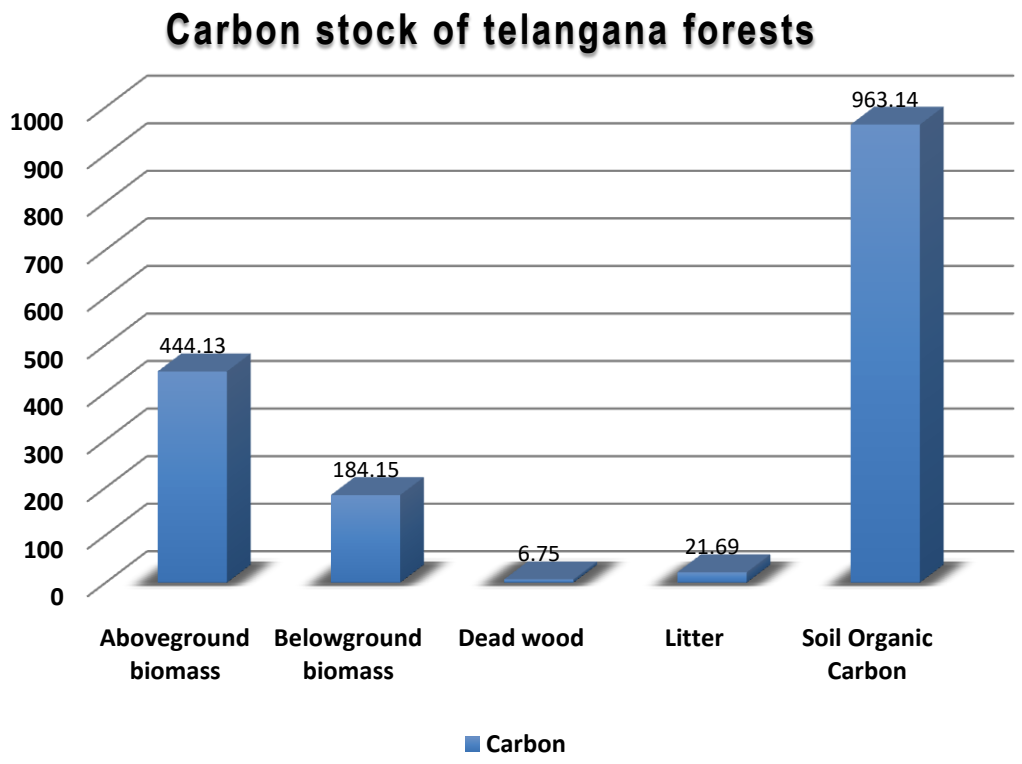
According to ISFR 2021, Telangana has a tree cover of approximately 2848 square kilometres, an increase of 334 square kilometres from ISFR 2019. Outside of the notified forests, the forest cover is approximately 2518 square kilometres, and the total extent of TOF is 5366 square kilometres. The top tree species of TOF in Telangana state are *Mangifera indica* and *Azadirachta indica* (ISFR, 2021)

Carbon stocks

The total carbon stocks of Telangana state forests and TOF are approximately 161.98 million tonnes, accounting for approximately 2.25 percent of the country's total forest carbon stock.

Sl. No	Carbon pools	Carbon (Lakhtonnes)
1.	Aboveground biomass	444.13
2.	Belowground biomass	184.15
3.	Dead wood	6.75
4.	Litter	21.69
5.	Soil Organic Carbon	963.14
	Total	1619.86

(ISFR, 2021)



Telangana State Forest Development Corporation Limited

The Telangana State Forest Development Corporation Limited is incorporated on 14.05.2015, under the Companies Act.2013 and also a Trust under the India Income Tax 1961.The organisation is established for raising man-made forests so as to meet the domestic and industrial needs of forest produce and reclothe the degraded forest areas and bring them under productive use (http://tsfdc.telangana.gov.in/).

The objectives of the corporation are as follows:

- ✓ To raise industrial plantations like Eucalyptus, Bamboo etc., to meet the raw material requirement of the wood-based industries in the state.
    - Contributing in protection of the environment and increased forest land productivity.
    - Providing gainful employment to the local tribals and rural people.
    - To provide consultancy in raising plantations of various species.

The objectives have been re-defined:

- Improving the quality and productivity of the degraded forests and plantations.
- Adoption of Watershed Approach.
- Adoption of latest gains in Bio-technology for improved productivity.
- To provide gainful employment to the local people.
- Capacity building.
- Implementation of Eco - Tourism Projects.

The plantation raised by the TSFDC is as follows:

a. Eucalyptus – 229459.67 Ha.

b. Bamboo – 6237.82 Ha.
c. Cashew nut – 105 Ha.
d. Teak – 215.86 Ha.
e. Others – 67.50 Ha.

Threatened taxa of plants

The threatened plant taxa of Telangana are as follows:

1. *Albizia thompsonii*
2. *Alysicarpus mahabubnagarensis*
3. *Andrographis beddomei*
4. *Arthraxon depressus*
5. *Arthraxon lanceolatus var. echinatus*
6. *Brachystelma nallamalayanum*
7. *Ceropegia bulbosa var. lushii*
8. *Ceropegia pusilla*
9. *Chlorophytum laxum*
10. *Chlorophytum tuberosum*
11. *Crotalaria triquetra*
12. *Crotalaria willdenowiana*
13. *Curcuma inodora*
14. *Cyathocline manilaliana*
15. *Dimeria orissae*
16. *Eriolaena lushingtonii*
17. *Habenaria panigrahiana*
18. *Hybanthus vatsavayae*
19. *Iseilema holei*
20. *Kavalama urens*
21. *Lipocarpha reddyi*
22. *Pimpinella heyneana*

(https://sites.google.com/site/efloraofindia/threatened/flora/telangana**)**

Sacred groves in TS

There are 65 sacred groves Telangana – 13 in Adilabad district, 6 in Hyderabad district, 4 in Karimnagar district, 3 in Khammam district, 9 in Mahbubnagar district, 4 in Medak district, 4 in Nalgonda district, ten in Ranga Reddy district, and 3 in Warangal district. Among all, Saileshwaram, Umamaheshwaram, Kaleshwaram, Keslapur are some famous sacred groves in the state of Telangana (http://www.cpreecenvis.nic.in/Database/Telangana_2194.aspx).

Important timber species of Telangana

The important timber species of Telangana forests includes:

a. Tectona grandis
b. Dalbergia latifolia
c. Dalbergia sissoo
d. Pterocarpus marsupium
e. Chloroxylon swietenia
f. Hardiwickia binata
g. Terminalia tomentosa
h. Acacia nilotica

(http://forests.telangana.gov.in/)

Important NTFP of Telangana

The important non-timber forest produces of Telangana forests are as follows:

1. *Diospyros melanoxylon*
2. *Bauhinia vahlii*
3. *Centella asiatica*
4. *Murraya koenigii*
5. *Withania somnifera*
6. *Andrographis paniculata*
7. *Limonia acidissima*
8. *Litsea glutinosa*
9. *Polyalthia cerasoides*
10. *Tamarindus indica*
11. *Sapindus indica*
12. *Phoenix sylvestris*
13. *Terminalia bellerica*
14. *Terminalia chebula*
15. *Emblica officinalis*
16. *Azadirachta indica*
17. *Strychnos nux-vomica*
18. *Catharanthus roseus*
19. *Buchanania lanzan*
20. *Semecarpus anacardium*
21. *Strychnos potatorum*
22. *Milletia pinnata*
23. *Madhuca indica*
24. *Sterculia urens*

25. *Cochlospermum religiosum*
26. *Boswellia serrata*
27. *Bombax ceiba*
28. *Anogeissus latifolia*
29. *Lannea coramandalica*
30. *Apis dorsata*
31. *Apis indica*
32. *Gymnema sylvestre*
33. *Thysanolaena maxima*
34. *Rauvolfia serpentina*
35. *Aegle marmelos*
36. *Aloe barbadensis*
37. *Hemidesmus indicus*
38. *Decalepis hamiltonii*
39. *Gymnema sylvestre*
40. *Acacia concinna*
41. *Annona squamosa*
42. *Annona reticulata*
43. *Aerva lanata*
44. *Achyranthus aspera*

(Wild edible fruits of Telangana State, 2022)

Breeding and reintroduction programmes of Telangana Forest Department

Mouse deer re-introduction program

The Telangana State Forest Department, the Central Zoo Authority (CZA), the Nehru Zoological Park (NZP), and the CSIR-Centre for Cellular and Molecular Biology (CCMB) have teamed up to carry out the first-ever planned reintroduction of the Indian spotted chevrotain (*Moschiola indica*), also known as the Indian mouse deer. The first batch of eight individuals was released into the wild in July, 2018, bringing the total number of individuals released into the wild to 72 following IUCN soft release protocol. This had been the tremendous efforts in seven years of conservation breeding of the elusive species at a dedicated facility on the grounds of NZP, Hyderabad, which saw the captive mouse deer population grow to around 232 individuals by March 2019.Release is done after several months of preparation at the newly built soft-release facility in AmrabadTiger Reserve and Kinnerasani Wildlife Sanctuary (Sandeep et al., 2019).

Vulture Conservation breeding programme

The Central Government has approved a vulture conservation breeding programme near the Nehru Zoological Park in Hyderabad. The goal of this programme, which is expected to cost Rs 15 crore, is to conserve and breed the Oriental White Backed Vulture and Long Billed Vulture species in collaboration with the Telangana Forest Department, Central Zoo Authority, Bombay Natural History Society, and the Union Ministry of Environment and Forests (MoEF).This is part of the MoEF's Action Plan for Vulture Conservation in India 2020-2025. In addition, the Ministry proposed establishing vulture rescue and rehabilitation centres in Hyderabad (http://forests.telangana.gov.in/)

Telangana Ku Haritha Haaram

Telangana Ku Haritha Haaram, a flagship programme of the Telangana Government envisages to increase the present 24% tree cover in the State to 33% of the total geographical area of the State. The thrust areas to achieve the above are two-fold; one, initiatives in notified forest areas, and the other, initiatives in areas outside the notified forest areas.

In this programme, it is proposed to plant and rejuvenate 230 crores seedlingsas follows –

- Outside Forests areas – 130 Crores (Including 10.00 Crs. in HMDA & GHMC areas.
- 100 Crores within Forest areas (20.00 Crs through plantations and 80.00 Crs through rejuvenation.
- Till now 220.7 crore saplings were planted over till now in six phases. Of 12,769 villages in the State, about 19,298 Palle Prakrithi Vanams (nature parks) and 12,755 nurseries, have been established in every village in collaboration with Panchayat Raj department

(http://harithaharam.telangana.gov.in/)

Establishment of CARES

Centre for Agroforestry Research and Extension Service is a society established at Department of Silviculture and Agroforestry, Forest College and Research Institute, Mulugu, Hyderabad vide G.O Rt.No.42 (EFS&T Department) in March, 2022 to deal with research, training, extension, consultancy and management issues in the field of Agroforestry, Forestry and other related aspects. The objectives of the society are as follows:

- Network and establish linkages with all stakeholders to augment the "production to consumption" in agroforestry.
- Promote effective collaboration among public agencies, private industries and organizations engaged in agroforestry.
- Develop suitable research and development (R&D) mechanism for agroforestry in consultation with all partners.
- Providing consultancy services and technical guidance for farming community with regard to development of successful agroforestry models.
- Promote self-reliance in raw material supply and augment associated socio-economic and environmental issues in Agroforestry.
- Advocacy in policy for promotion of agroforestry.
- Assist, collaborate and organize training programs, seminars, conferences, workshops, study tours etc to promoting agroforestry.
- Collaborate with institutions, Organizations, Associations and societies that are engaged in perusing similar objectives and goals.
- Prepare, print and publish papers, periodicals journals, books and Brouchers, and any other useful study/training material for conducting courses and to take up extension activity with an overall objective to furtherance the objectives, goals of the society.
- Receive funds from Government, Non-Government or other external agencies organizations/societies for carrying out its mandate.
- Offer fellowships, scholarships, prizes, and stipends in furtherance of the objectives of the society.

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Agroforestry in cold-deserts: General perspective

Dushyant

ICFRE- Himalayan Forest Research Institute
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
Conifer Campus, Panthaghatti, Shimla (H.P.)
PIN: 171013
Email: dushy.dushyant1976@gmail.com

Introduction

Cold-deserts are the unique highland eco-systems on this earth, characterised by a range of special features including arid environment, scanty vegetation cover, meagre precipitation, heavy snowfall, intense ultra-violet radiations, high-speed winds, extreme temperature gradients, blazing summers and frosty winters, skeletal soils with low organic matter, rare floral and faunal attributes. ainly, the cold deserts of the world are spread across the Asian continent in the northern part of China, southern Mangolia, Afghanistan, Pakistan, India and Russia. In case of India, the arid region between great central Himalayas and Tibetan plateau consisting of entire LadakhUT, Lahaul & Spiti district of Himachal Pradesh and Pooh sub-division of Kinnaur covers about 90% area of Trans-

COLD - DESERT LANDSCAPE (LADAKH UT)

Himalayan cold Desert and only 10% area occurs in Uttrakhand and Sikkim. The elevation of cold deserts varies from 2500 m - 6000 m amsl and the prevailing conditions are dry with high aridity index and annual rainfall less than150mm. Since a large chunk of population inhibiting these fragile areas depends on scarce natural resources. Consequently,the continuous utilization ofthe natural resources, compounded by the impacts of climate change has led to land degradation, increase in desertification and adverse effects on the livelihoods of local communities.

Problem context

Land is a crucial and limited natural resource and it plays key role in sustenanceof life on this planet.It provides a variety of ecosystem services such as production of food, preservation of bio-diversity, nutrient cycling, water purification, and carbon sequestration, *etc*. It takes hundreds of years to develop the thin layer of Land. The Global Land Outlook-2report of U.N.'s Convention to Combat Desertification (UNCCD) also underlines the significance of land resourceshighlighting itslarger contribution in global GDP and concomitantly warns about the imminent crisis to the humanity due to rapid degradation of land resources. Sadly, Land degradation and desertification has emerged as one of the biggest challenge of this century and this most important natural capital is under severe threat. Basically, the term land degradation means deterioration in the productivity potential of land and desertification is a process of land degradation in the dry arid regions. Broadly, this phenomenon covers all the activities and processes which hampers the ecological functioning of land resources and reduces its productivity. Multiple natural and anthropogenic factors contribute to land degradation *viz*. extreme weather conditions, excessive rainfall, soil erosion, developmental activities, population pressure, pollution, overgrazing, deforestation, glaciation, unsustainable land management practice and climate change*etc*., In Indian Context, about 32% of the land is considered degraded and the process is stillcontinuing.The latest Desertification and land degradation Atlas, prepared by Indian Space Research Organisation (ISRO) and released by Ministry of Environment, Forest and Climate Change (MoEF & CC) reveals countrywide dismal scenario of land degradation. The current status of land degradation and desertification is formidable because about 97.85 million hectares of the country has undergone land degradation and nearly 83.69 mha is under severe desertification in past few years. Albeit, land degradation are taking place across all the biomes but the climate change induced effects of land degradation/ desertification in the cold desert fragile ecosystems are exacerbating the problem and scientific studies indicate that direct and indirect desertification is on the rise in trans-Himalayan regions.The alteration of moisture regime, deglaciation, treeline shift, erratic weather situations are clear cut evidence to this effect. Resultantly, the scarce land resources are depleting due to soil erosion and barren geo-morphological features are expanding. A large chunk of population in these areas depends on scarce natural resources. Evidently, the fragile high altitude eco-

Anthropogenic Pressure on land resources in Tran-himalayan Cold desert ecosystem

systems with poor resilience power aremore vulnerable to disastrous impacts of degradation process.Moreover, the livelihood of peoples residing in these areas are also under stake. In this backdrop, Agro-forestry is a viable land use system for achieving the twin objectives of livelihood security and ecological balance.

Agro-forestry as a land use system

The national Agroforestry Policy (NAP) 2014, defines the term‘Agro-forestry’as the land use system which integrates trees and shrubs on farmlands and rural landscapes to increase productivity, profitability, diversity and ecosystem sustainability’. The World Agroforestry Centre (Nairobi, Kenya) defines agro-forestry as an ecologically based dynamic management system that provides considerable economic and environmental benefits by planting the trees in the agricultural landscape.In simpleterms, agro-forestry means practicing agriculture and forestry together on the same piece of land. Agroforestry as an important farming practice has got the potential to significantly reduce the pressure on the natural resources and improve the livelihood of the farmers as well.

Various types of agro-forestry (AF) systems are being practised in India since long. More importantly,such integrated farming practices holds more significance in the trans- Himalayan cold desert regions where growing season is limited, smallland holdings, coarse soils with poor nutrient status and low water holding capacityand adverseenvironmental conditions, Traditionally, hard-working people of these areas are practising different kinds of AF systems for meeting the diversifiedneeds of the livelihood and ecological security. The prevalent agro-forestry systems of the cold desert region have been classified among “Globally Important Agricultural Heritage Systems (GIAHS)” by the Food and Agriculture Organization (FAO).

Agro-forestry systems in colddeserts

In spite of the difficult conditions and toughterrain across the Indian tran-himalaya, there exists a range of varied agro-forestry systems, bearing testimony to innovative agriculture practices adopted by the people of the regions over and

period of time. The common existing agro-forestry systems of the cold desert areas include agri-silviculture (A-S);agri-horticulture (A-H); Agri-horti-silviculture (AHS); Agri-silvopastoral; Silvi-pastoral; Hortisilviculture; *etc*.

In agri-silviculture (A-S) type of system, various types of agriculture crops like wheat, barley, buck wheat, amaranth etc., are grown in the fields having boundary plantation of willow (*Salix* spp), poplar (*Populus* spp) and Juniper (*Juniper* spp). Willow (*Salix* spp)is lifeline ofcold arid regions because of its uses in the form of fuelwood and fodder by the people.Similarly, Junipers holds immense religious, social and ecological importance. Seabuckthorn (*Hippophae* spp), belonging to botanical family Elaeagnaceae is another important vegetation element in the Trans-himalayan cold arid areas.Theplant species can survive in the harsh environment and and capable of nitrogen fixation through its roots. The fruits (berries) of the plant contain anti-oxidant properties and can be used as fuel wood. The species is also planted as bio-fence along the sides of fields.

Salix and Poplar based Agri- forestry in Lahaul valley, H.P.

In agri-horticulture (A-H) typesystem, various fruit trees *viz.*, apple, almond and apricot are grown in combination with the agriculture crops or vegetables like potato, peas, cabbage, icebergs etc.In addition to this, agri-horti-silvi (AHS) type of system is also prevalentin which agricultural crops, fruit bearing trees and forest trees species grown together.

At some places, various types of fodder grasses are grown with thetrees species and such type of sytem is called silvi-pastoral. Kuth (*Saussureacostus*) and Manu (*Inularacemosa*), the important medicinal plant species of the cold-desert region are also cultivated in the fields having the tree species along the boundaries.

Thus, Indian trans- himlayancold desert landscape presents a mosaic of varied agro-forestry, which providesseveral goods and services in terms of food, fodder, fuel wood, timber, medicines, economic gains and improvement in the soil nutrient status and minimising the degradation of land resources, etc.


Conclusion

The cold desert ecosystem is unique as it holds immense biological, ecological, cultural and social significance. It is also true that the fragile ecological setting of cold–desert ecosystem is more vulnerable to land degradation and desertification. Simultaneously, the pressure on land andwater resources is also increasing due to climate change. Evidently, agro-forestry is a win – win strategy as it not only provides various tangible benefits, but also play a vital role in mitigating the effects of climatechange by increasing vegetation cover and enhancing carbon sequestration. It is also a viable solution to restore the degraded areas. There is a need for providing more impetus to the efforts by integration of traditional knowledge and scientific inputs. Need based improved integrated agroforestry systems with suitable combination of species should be promoted to provide maximum outputs and combat the major concerns of climate change and land degradation.

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Significance of potting mixture in successful establishment of nursery

Akoijam Benjamin Singh[1] and Kewat Sanjay Kumar[1, 2]

[1]Department of Forestry
Mizoram University, Aizawl – 796004 (Mizoram) India
[2]Department of Botany
University of Allahabad, Prayagraj – 211002 (Uttar Pradesh) India
Email: benjakoijam6@gmail.com

Potting mixture is a combination of various materials used for planting, such as soil, sand, perlite, vermiculite, peat moss, and/or compost. The mixture is created to provide the optimal conditions for plant growth, including proper drainage, aeration, and nutrient content. Potting mixtures are critical to the success of any nursery. It is the medium in which the plant grows and obtains its nutrients.They are essential in providing a suitable environment for healthy plant growth, as well as ensuring the proper nutrition, moisture retention, and aeration for plants to thrive. Without a suitable potting mix, all other efforts to grow plants in a nursery can be in vain.

The ingredients that make up a potting mixture are equally important. A good potting mixture should have the right combination of organic and inorganic components. Organic matter provides the essential nutrients, while inorganic components improve aeration and water retention. Therefore, the right proportion of organic and inorganic components can provide the ideal growth environment for the plant.

One of the significant benefits of potting mixtures is their ability to retain moisture. A good potting mix will have the right balance of organic matter, sand, and clay particles. This balance enables the mixture to hold water for longer periods, which ensures that the plants have the necessary moisture to grow. Additionally, a good potting mix will have the right drainage properties, allowing excess water to drain out while retaining enough water to promote healthy growth.

Another critical benefit of potting mixture is its ability to provide plants with the necessary nutrients. Most potting mixtures contain organic matter such as peat moss, which is rich in nutrients. The organic matter provides plants with essential minerals like nitrogen, phosphorus, and potassium, which are essential for healthy growth. Potting mixture gives plants a chance to receive an adequate amount of nutrients from the start of their life cycle, making them more robust and resistant to pests and diseases.

Additionally, potting mixtures can also provide good aeration to plants. The right balance of soil particles allows the potting mix to hold air pockets, which allows the roots to breathe. Once the roots receive the right amount of air and water, they will expand, and the plants will grow quickly. A well-aerated potting mix promotes the development of a robust root system, supporting the overall growth of the plant.

Another factor to consider when it comes to potting mixture is the pH level. Most plants require a pH range of 5.5-7.5 for

Different types of potting mixture

optimal growth. Therefore, the potting mixture should have a neutral to slightly acidic pH level to provide the ideal environment for the plant.

In conclusion, the importance of potting mixtures in the success of plant nurseries cannot be overlooked. Both amateur and professional growers need to pay attention to the type and quality of the potting mixtures they use. The right potting mixture for each plant type ensures that plants receive the necessary moisture retention, nutrition, and aeration to promote healthy growth. By providing plants with a suitable environment to grow and thrive, potting mixtures are key components to the success of any nursery.

Canopy management in fruit crops

Satyendra Verma[1], Subhash Chandra Singh[1], Priya Awasthi[2], Dharmendra Kumar Gautam[1]

[1]Department of Fruit Science
College of Horticulture,
[2]Department of Post-Harvest Management
College of Horticulture
Banda University of Agriculture and Technology
Banda, U.P. -210001
E-mail: - satyendraverma344@gmail.com

Abstract

Canopy management is a critical aspect of fruit crop cultivation that involves manipulating the growth and structure of the tree canopy to optimize light penetration, improve air circulation, and enhance fruit quality and yield. Effective canopy management practices are essential to maximize fruit production, prevent disease and pest infestations, and ensure sustainable fruit production. This article provides an overview of the importance of canopy management in fruit crop production, the different canopy management techniques, and their benefits.Fruit trees typically develop a complex and dense canopy as they grow, which can lead to shading of lower branches, reduced air circulation, and increased susceptibility to diseases and pests. To address these issues, canopy management techniques aim to improve light penetration, airflow, and fruit exposure to sunlight. One of the most effective methods of canopy management is pruning, which involves removing excess branches, twigs, and leaves to create an open and well-ventilated canopy that allows for optimal light penetration and air circulation.Another important aspect of canopy management is training, which involves shaping the tree during its early growth stages to promote optimal branching, height, and structure. This is achieved by selecting and retaining primary scaffold branches that provide a framework for the tree's growth and remove or limit the growth of competing branches.Canopy management can also involve the use of trellising systems, which provide support to the tree and allow for easier access to fruit during harvest. Trellising systems can also help to improve light penetration, air circulation, and reduce pest and disease incidence by keeping the fruit off the ground and away from potential disease vectors.Canopy management has several benefits for fruit crop production. By optimizing light penetration, canopy management can improve fruit quality, color, and flavor, increase yields, and reduce the risk of sunburn damage. Good airflow through the canopy also helps to reduce the incidence of disease and pest infestations, as it limits the build-up of moisture and reduces the likelihood of fungal growth.

Keywords: Canopy management, light penetration, maximizes fruit production etc.

Introduction

Canopy management of fruit trees is concerned with the development and maintenanceof their structure with respect to size and shape for maximum productivity and quality. The canopy in a fruit tree refers to its physical structure which includes the stem, branches, shoots and leaves. Canopy density is determined by the number and size of leaves, the structure of the stem, branches and twigs. The basic concept in canopy management of a perennial tree is to make the best use of land, climatic factors for enhanced productivity in a three-pronged approach. Tree vigor, light, temperature and humidity play important roles in fruit production and quality. Canopy management is the practice of manipulating the canopy or upper layer of leaves of a vineyard to optimize fruit yield. This includes pruning, training and trailing techniques that ensure plants receive the right amount of sunlight, ventilation and nutrients. Canopy management is essential in fruit horticulture as it plays an important role in determining the overall quality of the fruits produced.

Objective

The objective of canopy management is to create a balanced vine canopy that provides enough leaf area to support fruit development while ensuring that the grapes receive enough sunlight and airflow. This balance is crucial in regulating grape ripening, preventing disease, and optimizing grape quality and yield. By managing the vine canopy, growers can also reduce the risk of pests and diseases, minimize vine stress, and promote the efficient use of resources like water and fertilizer.

Principles

Pruning

Pruning is the process of cutting back grapevine shoots to control the number and size of clusters and maintain a balanced canopy. The objective of pruning is to achieve the optimal balance between vegetative growth and fruit production. Pruning also helps to manage the number of buds and shoots per vine, which influences the quantity and quality of fruit produced. There are two main types of pruning methods: spur pruning and cane pruning.

Training

Training involves directing the growth of grapevine shoots by attaching them to a trellis system. The objective of training is to ensure that the vines grow in a structured and manageable manner, and to facilitate the even distribution of sunlight and airflow across the canopy. Training also helps to prevent the vine from becoming too dense, which can lead to shading, reduced airflow, and increased disease pressure.

Trellising

Trellising involves supporting the grapevine shoots on a trellis system, which provides stability and facilitates the even distribution of sunlight and airflow across the canopy. The objective of trellising is to create a framework that supports the vines and ensures that they grow in a structured and manageable manner. There are several types of trellising systems, including vertical shoot positioning (VSP), Scott Henry, and Geneva Double Curtain.

Shoot thinning

Shoot thinning is the process of removing some of the shoots that emerge from the base of the vine or the cordon. The objective of shoot thinning is to reduce the

density of the canopy, promote better airflow, and ensure that the remaining shoots receive adequate sunlight and nutrients. Shoot thinning also helps to regulate the number of buds and shoots per vine, which influences the quantity and quality of fruit produced.

Leaf removal

Leaf removal is the process of removing some of the leaves from the vine canopy to expose the grape clusters to more sunlight. The objective of leaf removal is to enhance grape ripening, promote better airflow, and reduce the risk of fungal diseases like botrytis. Leaf removal is usually done in the fruit zone, where the leaves can shade the grapes and prevent them from receiving adequate sunlight.

Canopy management in mango

Canopy management in mango refers to the practice of manipulating the growth and development of the tree canopy to optimize the quantity and quality of fruit produced. Proper canopy management can improve fruit size, color, and sugar content, while also reducing disease and pest pressure.The primary objectives of canopy management in mango are to regulate tree growth, control the amount of sunlight that reaches the fruit, and promote good air circulation within the canopy. The canopy is composed of leaves, branches, and fruit, and proper management involves balancing the vegetative and reproductive growth of the tree.

One of the most important techniques used in canopy management is pruning. Pruning is typically done during the dormant season, which varies depending on the mango variety and location. Thinning out branches also helps to remove any crossing or rubbing branches which could cause injuries to the tree.Another technique used in canopy management is topping, which involves removing the terminal bud of the tree to limit its height and promote lateral branching. This helps to create a more compact tree, making it easier to manage and harvest. Topping is typically done after the tree has reached the desired height, which can vary depending on the specific cultivar and growing conditions.Canopy management also involves controlling the amount of light that reaches the fruit. Too much shade can reduce fruit quality and yield, while too much sun exposure can cause sunburn and reduce fruit quality. Shading can be done by retaining leaves at the base of the tree or by planting companion crops that provide shade. On the other hand, the use of reflective mulches under the trees can increase light exposure, resulting in improved fruit quality.

Canopy management in guava

Canopy management is a vital agricultural practice used in guava production to maintain plant health, promote fruit quality, and increase yields. Guava is a tropical and subtropical fruit tree that requires proper pruning and training to produce maximum fruit yield and quality. This technique involves manipulating the structure and density of the guava tree's canopy to create an optimal microclimate for fruit growth. This is achieved by removing excess foliage and pruning the tree to maintain a desirable size and shape. Canopy management also helps to improve air circulation and light penetration to the lower parts of the tree, which can enhance fruit development and quality.One of the key benefits of canopy management is the ability to control the tree's size and shape.

Guava trees can grow quite large and become difficult to manage if left unpruned. Regular pruning can help to keep the tree at a manageable size, making it easier to harvest fruit and maintain the overall health of the tree. Additionally, shaping the tree through pruning can help to improve its structural integrity, reducing the risk of limb breakage and other damage.Another benefit of canopy management is increased fruit production. By controlling the size and density of the canopy, the tree is better able to allocate its resources towards fruit production. This can lead to higher yields and larger, more flavorful fruit. Canopy management can also help to reduce the incidence of fruit drop and increase the uniformity of fruit size.

Canopy management in banana

Canopy management is a critical practice in banana farming that involves controlling the growth and distribution of the banana plant's leaves and stems to ensure optimal growth and fruit production. The goal of canopy management is to create an ideal balance between vegetative growth and fruit production while preventing the development of diseases and pests. In this article, we will discuss some of the key aspects of canopy management in banana farming.Firstly, it is essential to understand that banana plants are large, herbaceous perennials that grow up to 25 feet in height. This height makes it difficult for sunlight to reach the lower parts of the plant, which can cause problems such as reduced fruit production and disease susceptibility. Therefore, one of the primary goals of canopy management is to ensure that the leaves and stems are correctly distributed to allow enough sunlight to reach the lower parts of the plant.One of the most critical aspects of canopy management is pruning. Pruning involves the selective removal of leaves and stems to promote the growth of healthy, productive leaves and stems. The timing and frequency of pruning can vary depending on factors such as the variety of banana, the climate, and the growth rate of the plant. In general, banana plants should be pruned at least twice a year to remove old, damaged, or diseased leaves and stems.

Another critical aspect of canopy management is fertilization. Banana plants require regular and balanced fertilization to ensure optimal growth and fruit production. Fertilizers should be applied in a manner that supports the development of healthy leaves and stems while avoiding over-fertilization, which can lead to the development of disease and pest problems.

In addition to pruning and fertilization, irrigation and drainage are essential components of canopy management in banana farming. Banana plants require regular and adequate watering to support their growth and fruit production. However, over-watering can lead to root rot, which can be fatal to the plant. Therefore, proper irrigation management is crucial to prevent waterlogging and root rot. Additionally, good drainage is necessary to prevent the accumulation of excess water around the roots.Finally, disease and pest management are crucial components of canopy management in banana farming. Banana plants are susceptible to a wide range of diseases and pests, which can reduce fruit production and quality. Proper canopy management practices such as pruning, fertilization, and

irrigation can help prevent the development of disease and pest problems. However, if disease or pest problems do arise, timely and appropriate measures should be taken to prevent their spread.

Canopy management in pomegranate

Canopy management refers to a range of techniques that are used to optimize the growth and development of fruit trees, such as pomegranate trees. Proper canopy management is essential to ensure optimal fruit quality, yield, and tree health. In this article, we will discuss the different aspects of canopy management in pomegranate.Pruning is done to remove the damaged, dead, or diseased branches of the tree, which can negatively impact the fruit quality and yield. Pruning also helps to shape the tree canopy, which affects the amount and quality of sunlight that reaches the tree. Pomegranate trees should be pruned in winter or early spring when the tree is dormant.Training is another critical aspect of canopy management in pomegranate. Training involves shaping the tree when it is young to ensure a strong framework that will support fruit production. It is essential to train the tree to have a central leader, which is the main trunk of the tree. The central leader should be taller than the lateral branches to ensure that the tree has an open canopy that allows for good light penetration.Thinning is the process of removing some of the fruit from the tree to ensure that the remaining fruit has enough space to grow and mature. Thinning also helps to ensure that the tree does not become overloaded with fruit, which can cause the branches to break. Thinning should be done when the fruit is small, and it is essential to leave some space between the fruit that remains on the tree.

Spacing is another critical aspect of canopy management in pomegranate. Pomegranate trees should be spaced at least 12 feet apart to ensure that they have enough room to grow and develop an open canopy. An open canopy allows for good sunlight penetration, which is essential for good fruit development.Fertilization is also essential in canopy management. Pomegranate trees require a balanced fertilizer that contains nitrogen, phosphorus, and potassium. Fertilizer should be applied in the spring, after the tree has broken dormancy, and again in the fall before the tree enters dormancy.Irrigation is another critical aspect of canopy management in pomegranate. Pomegranate trees require regular watering, especially during the first few years after planting. The amount of water required depends on the soil type, climate, and stage of growth of the tree. It is important to water the tree deeply to ensure that the roots have access to enough water.

Canopy management in ber

Canopy management is a crucial aspect of Ber (Ziziphus mauritiana) cultivation that involves manipulating the growth and development of the plant canopy to optimize yield and fruit quality. The following are some of the key concepts involved in canopy management in Ber cultivation.

Pruning

Pruning is a common practice in Ber cultivation, which involves removing selected parts of the canopy to improve light penetration and air circulation.

Pruning helps in reducing the size of the tree canopy, allowing the tree to put more energy into fruit production. In Ber, pruning is generally carried out during the dormant period (winter) to avoid damaging the tree.

Training

Training is the process of directing and shaping the growth of the Ber tree during its early years to form a strong, productive framework. This is achieved by tying the young branches to stakes or trellises, removing competing branches, and shaping the tree into a desired form. Proper training of Ber trees helps in developing a strong root system, promoting good fruit set, and facilitating easy harvesting.

Thinning

Thinning is the process of removing excess fruit from the tree, which helps in reducing the load on the branches, preventing branch breakage, and improving fruit size and quality. Thinning also helps in reducing biennial bearing, where the tree produces a heavy crop in one year and little or no fruit the following year.

Practices for managing canopy density

Canopy density management involves practices aimed at reducing the density of the Ber canopy to facilitate better light penetration and air circulation. These include:

Heading back

This involves cutting back the tips of the branches to stimulate lateral growth and promote branching. This practice helps in reducing the height of the tree, promoting branching, and enhancing light penetration.

Lateral pruning

This involves removing lateral shoots growing along the main branches to reduce the density of the canopy and promote light penetration.

Thinning of the crown

This involves removing selected branches or portions of the crown to reduce the density of the canopy and promote light penetration.

Skirting

This involves removing the lower branches of the tree to promote air circulation and reduce the risk of disease.

Canopy management is an essential aspect of Ber cultivation, which helps in optimizing yield and fruit quality. Proper canopy management practices help in reducing the incidence of pest and disease, promoting good fruit set, improving fruit size and quality, and facilitating easy harvesting.

Conclusion

In conclusion, canopy management is critical for optimizing mango, banana and pomegranate, production. It involves a combination of techniques, including pruning, topping, shading, and pest and disease management, all aimed at balancing tree growth, regulating light exposure and airflow, and promoting fruit quality and yield. By pruning and shaping the canopy, farmers can improve fruit quality and yield while also reducing the risk of tree damage. Proper timing and technique are critical when implementing canopy management, and farmers should seek guidance from agricultural experts to ensure they are using the most effective practices for their particular growing conditions.

Harnessing the power of *rhizobium* for bioremediation: A sustainable approach to environmental clean-up

Vipula Vyas[1]*, Tanmaya Kumar Bhoi[1] and Sangeeta singh[1]

[1]ICFRE-Arid Forest Research Institute (ICFRE-AFRI)
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
Jodhpur, Rajasthan
E-mail:vipulavyas11@gmail.com

Abstract

Bioremediation, the use of microorganisms to degrade or detoxify environmental pollutants, has emerged as a promising and sustainable approach for environmental clean-up. Amongst the diverse group of microorganisms capable of bioremediation, *Rhizobium*, a genus of nitrogen-fixing bacteria, has shown great potential due to its unique abilities to fix atmospheric nitrogen and form symbiotic associations with leguminous plants. In this article, we explore the role of *Rhizobium* in bioremediation, including its mechanisms of action, applications, challenges and the use of *Rhizobium* in bioremediation of contaminated environments, its potential in restoring degraded soils, and its implications for sustainable environmental clean-up practices.

KeyWords: Bioremediation, *Rhizobium*, Nitrogen-fixing bacteria, Environmental clean-up

Introduction

Bioremediation, the use of living organisms to mitigate environmental pollution, has gained significant attention as a sustainable and cost-effective approach for environmental clean-up (Sangwan and Dukare, 2018). Microorganisms, including bacteria, fungi, and algae, have shown great potential in bioremediation due to their diverse metabolic capabilities and ability to degrade various pollutants, including organic and inorganic contaminants. *Rhizobium*, a genus of Gram-negative, rod-shaped bacteria, has garnered attention as a bioremediation agent due to its unique characteristics, such as nitrogen-fixing ability, symbiotic association with leguminous plants, and versatility in degrading environmental pollutants. *Rhizobium* bacteria are well-known for their ability to fix atmospheric nitrogen, converting it into a form that can be utilized by plants. This unique trait makes *Rhizobium* highly valuable in agricultural practices, where it can improve soil fertility and reduce the dependence on synthetic fertilizers. In addition, *Rhizobium* forms symbiotic associations with leguminous plants, wherein the bacteria colonize the root nodules of the host plant and provide fixed nitrogen in exchange for carbohydrates. This symbiotic relationship has been extensively studied for its role in enhancing plant growth and promoting sustainable agriculture practices.The ability of *Rhizobium* to colonize the root nodules of leguminous plants and survive in diverse environmental conditions makes it a promising candidate for bioremediation in different ecosystems.

Rhizobium and pollutant degradation

Rhizobium has been found to have the ability to degrade various environmental pollutants, including hydrocarbons, pesticides, heavy metals, and organic contaminants. One of the mechanisms by which *Rhizobium* can degrade pollutants is through its diverse enzymatic activities. For example, *Rhizobium* strains have been found to produce enzymes such as dehydrogenases, oxidases, and hydrolases, which can break down pollutants into less toxic forms (Teng et al.,2015). Additionally, *Rhizobium* can also stimulate the plant's own defense mechanisms, such as the production of enzymes and phytohormones, which can aid in the breakdown and removal of pollutants from the environment.

***Rhizobium* and plant-microbe interactions**

Another aspect of *Rhizobium*'s role in bioremediation is its ability to establish symbiotic relationships with plants, particularly leguminous plants. The symbiotic relationship between *Rhizobium* and leguminous plants is well-known for its ability to fix atmospheric nitrogen into a form that can be utilized by the plant, thereby promoting plant growth and enhancing soil fertility (Genre and Russo2016) This symbiotic relationship can also benefit bioremediation efforts, as the increased plant growth and root exudates from leguminous plants can stimulate the microbial activity in the rhizosphere, leading to enhanced degradation of pollutants. The presence of *Rhizobium* in the rhizosphere can also lead to the production of organic acids and other compounds that can solubilize and mobilize pollutants, making them more accessible for degradation.

***Rhizobium* and phytoremediation**

Phytoremediation is a form of bioremediation that involves using plants to remove pollutants from the environment. *Rhizobium* can play a crucial role in phytoremediation by promoting plant growth, enhancing nutrient uptake, and facilitating the degradation of pollutants (Jach et al.,2022). *Rhizobium* strains can be used as inoculants to establish symbiotic associations with leguminous plants, which can then be used for phytoremediation purposes. The enhanced growth and root exudation of leguminous plants, induced by *Rhizobium*, can facilitate the degradation of various pollutants, such as polycyclic aromatic hydrocarbons (PAHs), pesticides, and heavy metals, through processes like rhizodegradation, phytostabilization, and phytoextraction.

***Rhizobium* and bioaugmentation**

Bioaugmentation is a technique where microorganisms, including *Rhizobium* strains, are added to contaminated environments to enhance the degradation of pollutants. *Rhizobium* strains with specific metabolic capabilities can be selected and applied to contaminated sites to degrade pollutants, either alone or in combination with other microorganisms (Rangel et al., 2017). These strains can be engineered or naturally occurring and they can help to establish active microbial populations at the contaminated sites, leading to enhanced pollutant degradation. *Rhizobium* strains can also be used in consortia with other microorganisms to create synergistic effects for the degradation of complex pollutants or in challenging environmental conditions.

Conclusion and future prospect

Rhizobium and other nitrogen-fixing bacteria have shown great potential for bioremediation, offering a sustainable and environmentally friendly approach for environmental clean-up. The ability of *Rhizobium* to degrade pollutants, promote plant growth, and restore degraded soils makes it a promising candidate for bioremediation of contaminated sites, such as mine tailings, oil spills, and agricultural lands. The use of *Rhizobium* in bioremediation can offer several advantages, including reduced reliance on harmful chemicals, improved soil fertility, and enhanced ecosystem health. However, there are challenges associated with the use of *Rhizobium* in bioremediation, such as the need for site-specific optimization, addressing regulatory and safety concerns, and ensuring long-term sustainability of the approach. Further research and development are needed to better understand the mechanisms underlying *Rhizobium*-mediated bioremediation, optimize its performance, and address potential risks associated with the release of genetically modified *Rhizobium* strains into the environment.

The future prospects of *Rhizobium* and bioremediation are promising. Advances in genetic engineering, omics technologies, and our understanding of plant-microbe interactions can potentially lead to the development of engineered *Rhizobium* strains with improved bioremediation capabilities. Furthermore, the integration of *Rhizobium*-based bioremediation approaches with other biotechnological tools, such as phytoremediation and microbial consortia, can lead to synergistic effects and enhanced remediation outcomes.

Rhizobium-mediated bioremediation holds great promise as an eco-friendly and sustainable solution for environmental clean-up. Further research, innovation, and collaboration among scientists, policymakers, and stakeholders are needed to harness the full potential of *Rhizobium* and other nitrogen-fixing bacteria for bioremediation and contribute to a healthier and more sustainable environment.

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Understanding LiFE movement

Ajin Sekhar and M. Rajkumar

Forest Ecology and Climate Change Division
ICFRE-Tropical Forest Research Institute
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
PO. RFRC, Mandla Road, Jabalpur

Commemorating World Environment Day on June 05, 2022, Hon'ble Prime Minister of India launched a global initiative Lifestyle for the Environment (LiFE) Movement to encourage individuals across the globe to undertake simple climate-friendly actions in their daily lives or adoption of environment-conscious lifestyle in our fight against climate change.

As nature has evidently started showing signs and symptoms of global warming and climate change due to exacerbated exploitation, mindless consumerism, and irresponsible individual behaviour, time has come to revisit and transform human behaviour to a mindful and deliberate utilisation promoting environmentally conscious lifestyle. Using this idea, the LiFE movement seeks to leverage the strength of social networks to influence social norms surrounding climate.

LiFE Movement, originally introduced by India during the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow in 2021 seeks to replace current "use-and-dispose" economy by a circular economy whose principles are anchored on individual consciousness and mindful consumerism. Individuals who practice such a lifestyle on day-to-day basis will be recognised as 'Pro-Planet People' (P3). LiFE mission plans to create and nurture a global network of Pro-Planet People who will have a shared commitment to adopt and promote environmentally friendly lifestyles. As reiterated by Hon. Prime Minister of India, Mission LiFE borrows from the past, operates in the present and focuses on the future. Reduce, Reuse and Recycle are the concepts woven into our life. The Circular Economy has been an integral part of our culture and lifestyle. The LiFE movement, additionally, also seeks to leverage the strength of social networks and alliances to influence social norms surrounding environment and climate. Hence, abiding by the notion of responsible citizens, onus lies on us to practice, profess and propagate the essence advocated by LiFE Movement. Through the people of the country, and world as a whole, the mission eyes to reinforce our ecosystem through environment friendly lifestyles to render the nature self-sustainable, resilient and replenishable.

LiFE Movementfinds concrete agreement with the constitution of India as two specific provisions i.e., Article 48- A and Article 51-A (g) puts a duty respectively on the State and the citizens to protect and conserve the environment. Moreover, Indian Judiciary has explicitly propounded that the right to life under Article 21 of the Constitution contains right to have a healthy environment.

However, the challenge that lies ahead is to identify measurable and scalable climate friendly behaviour / behavioural patterns

to spearhead and sustain the movement among the people. Some of the well acknowledged eco-friendly behaviour that can be easily imbibed in our lifestyles are as follows;

1. Prefer public transport system over private vehicles. Drive and fly less, instead ride a bike and walk wherever possible. It would help drastically tone down per capita carbon footprint.
2. Use energy efficient lights and rechargeable batteries.
3. Switch off the extra lights and other appliances as and when required
4. Practice voluntary aversion of usage of plastic in daily lives. Always carry cloth bags for accessing daily needs
5. Reduce, reuse and recycle resources wherever possible
6. Safe dumping of domestic wastes into specifically earmarked dump yards only.
7. Inclusion of climate friendly food items in our daily lives. Millets over cereals, and plant based over meat-based diet wherever conceivable.
8. Turn off the taps while brushing and washing our hands.
9. Have a shower instead of bath. It would help reduce water use and subsequent loss of water
10. Let use of online / e-technologies ride over offline necessities such as bill payments, note makings and institutional functioning. It would help reduce the usage of paper, which in turn reduce deforestation.

Above all, the primary and the most significant single step to conform to the LiFE movement is to sincerely acknowledge that climate change is happening and by abandoning all qualms that 'climate change is a hoax', only to be a relatable messenger who is ready to offer positive social reinforcement of climate friendly behaviour.

An action through LiFE movement also supports the implementation of Sustainable Development Goals. The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The LiFE mission can be met within the framework of a revitalized global partnership for sustainable development. Specifically, the SDGs focused on sustainable cities andcommunities (SDG 11), responsible production and consumption (SDG 12), climate change (SDG 13), or life on land (SDG 15), and life under water (SDG 14) require that allindividuals temper their lifestyles in sync with the resources available on the planet.

SDG 12, in particular, entails decoupling economic growth and environmental degradationand demands more efficient and environmentally friendly management of resources, including improving energy efficiency, sustainable infrastructure, access to basic services,and providing green and decent jobs to ensure a better quality of life for all. The societalresponsibility towards SDG 12 goes beyond businesses, to involve individual consumers asactive participants in the process of achieving this goal.Given the global commitment to achieving the

SDGs by 2030, it is important to note thatMission LiFE contributes directly or indirectly to almost all the SDGs. Public participation ably supported by strong politicalfor protecting and conserving the environmentwill help translate the vision of LiFE into measurable impact.

Vulnerability of forest ecosystem to climate change

Saikat Banerjee, M. Rajkumar and K.S.Sengar

Forest Ecology and Climate Change Division
ICFRE-Tropical Forest Research Institute
(Indian Council of Forestry Research & Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
Jabalpur, India

Abstract

The presence, relative abundance and relative size of the various species in the forest reflect the nature of the forest ecosystem of which they are a part and thus may serve as indicators of site quality. The climate changes cause large-scale geographical shifts, changes in species composition and in extreme cases even extinction among biological communities. In the present paper the impact of climate change on the forest ecosystem has been discussed in length.

Introduction

The climate of the earth is governed by a complex interaction between solar radiation, atmosphere, ocean, hydrosphere and biosphere. Two major constituents of the earth's atmosphere are nitrogen and oxygen, which are radiatively non-participating; hence they do not have a direct impact on earth's climate. On the other hand, three minor gases viz. water vapor, CO_2 and O_3 play a dominant role in controlling the surface temperature of the earth. In the absence of these gases the earth's surface temperature would have been as low as –18^{o}C. These three minor gases increase the annual mean global surface temperature to +15^{o}C. They are able to increase the surface temperature of the earth because they do not absorb most of the solar radiation but absorb strongly the infrared radiation emitted by the earth surface. These gases trap infrared radiation from the earth in a manner similar to the glass in a greenhouse and hence are called greenhouse gases. The other greenhouse gases in the earth's atmosphere are methane, chlorofluorocarbons and nitrous oxide which also impact the global temperature.

The natural climate changes cause large-scale geographical shifts, changes in species composition and in extreme cases even extinction among biological communities. It can be inferred how the biota might respond by observing the world as it is today; by observing the present distributions of the plants and animals, which are determined in large part by temperature and moisture patterns, it is possible to hypothesize what would happen if these underlying temperature and moisture change. Changes in global temperature patterns would trigger widespread alteration in rainfall patterns, and for many species, precipitation is a more important determinant of survival.

Climate change affects the soil chemistry too. Increased CO_2 concentration may accelerate the growth of some plants at the expense of others, possibly destabilizing natural ecosystems. A rise in the sea level may inundate coastal biological communities.

One recent finding on the problem area is that, warming will be relatively greater at the higher altitudes; therefore, the species composition there will be the most affected.

The total number of species lost in the last 25 years has been estimated to be 50,000 illustrating the extent of biodiversity loss being experienced in the developing

countries. This is 1000 to 10000 times more than the rate of loss before the period of human interference of industrial revolution since 1800. It is estimated that worldwide slightly over 100 animal species and subspecies are threatened with extinction at the rate of one such endangered species per year. There are 20000 flowering plants, which are also exposed to the risk of facing extinction. Of the vascular plant species that India possesses, 237 of them are rare, 117 vulnerable, 170 endangered, 38 possibly extinct and 21 totally extinct (IPCC 2013). The dependence of organism on appropriate environment gives the understanding to the ecologists on the position of the relation between habitat destruction and modification with species loss.

The presence, relative abundance and relative size of the various species in the forest reflect the nature of the forest ecosystem of which they are a part and thus may serve as indicators of site quality. The correlation may or may not be apparent because the vegetation also reflects the effects of happenstance: plant competition; past events in the history of vegetation such as drought, fire and insect outbreaks; and many other factors in the ecological complex giving rise to the plant community. Nevertheless, site characteristics are sufficiently reflected in the vegetation to make the use of the latter a successful index of site quality in many instances. The plants themselves are used as the measure of site: they are Phytometers.

Tree species are useful indicators. They are long-lived, relatively unaffected by stand density and easily identified in all seasons of the year. Some species have such a narrow ecological amplitude that their occurrence is indicative of a particular site. Demanding hardwoods reach their best development only on moist, well-drained, protected sites rich in soil nutrients and characterized by a well-developed forest floor. Most trees, however, have wide ecological amplitude: they may occur and prosper on a wide variety of sites. Their presence is thus of little indicator value.

Understory plant species in the forest – although they are more apt to be influenced by stand density, past history and the composition of the forest than the tree species – have in many cases a more restricted ecological tolerance and may therefore be more useful as plant indicators. Under such circumstances, site classification schemes based upon indicator species in the understory have been markedly successful. They are most easily applied in regions where variations in altitude and precipitation are great and where humans have not markedly altered the original vegetation.

At a more complex level, all of the resources of vegetation description may be used in the segregation of forest site classes. It is important to note that the site variation frequently takes the form of a gradient rather than of distinct and mutually exclusive site classes. The latter are found only when a distinct break in site factors occurs, such as a break between a sandstone-derived residual soil and a limestone-derived residual soil. Otherwise, site changes tend to be gradual, and the continuum may better be described in terms of an ecological gradient. Ecologists do believe that plant indicators are an expression of the complex of the forest ecosystem rather than representing a specific effect of site quality. However, in the modern practice, the overstory dominants and physical factors of the

environment are used in conjunction with ground vegetation to classify and to map sites and estimate site quality.

In case of more complex and more disturbed forests, the vegetation to the site classification should involve an evaluation of the total vegetation, including not only the species present in all layers of the forest, but also the abundance, size and vigor of all elements of the flora.

Climate change is the global phenomenon. The impacts of global warming are sea-level rise; ice mass loss in Greenland, Antarctica, the Arctic and mountain glaciers worldwide; shifts to flower/plant blooming times etc. Burning fossil fuels produces carbon dioxide which is the main cause of human induced climate change. Forests remove and store CO_2 from the atmosphere. Deforestation means that CO_2 builds up quickly since there are no trees to absorb it. Producing cement is another contributor to climate change, causing 2% of our entire carbon dioxide emission. There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, volcanoes, ocean currents, the Earth's tilt and comets and meteorites (IPCC 2013).

Global forest cover

Forests cover nearly 1/3 of land globally that's 4.06 billion hectares, of which more than half (54 per cent) of the world's forests are in only five countries – the Russian Federation, Brazil, Canada, The United States of America and China (FAO FRA 2020) (Table 1). Most of the forests are in the low latitudes (0 to 25^0 N and S) or tropical zone (45 per cent), followed by high latitudes (50 to 75^0 N and S) or boreal zone (27 per cent) and mid latitudes (25 to 50^0 N and S) or temperate zone (16 per cent). Rest of the forest is in the sub-tropical zone. Forests are home to most (80 per cent) of Earth's terrestrial biodiversity containing high array of trees, plants, animals and microbes. Three quarters of the Earth's fresh water comes from forested watersheds. Over half of the world's population relies on forested watersheds for their drinking water, agricultural use and industries (FAO 2018).

Table 1. World forests of top five countries

Country	Area million hectares	Per cent over global
Russian Federation	815	20
Brazil	497	12
Canada	347	9
USA	310	8
China	220	5
Rest of world	1870	46

Source: FAO FRA 2020

The forest type such as tropical rain forest, tropical seasonal forest, tropical dry forest, sub-tropical forest, savanna, grasslands, evergreen dry and evergreen moist temperate forests, deciduous temperate forest, boreal forest, shrub lands and tundra type that can develop in an area is ultimately determined by climate (FAO

2020). Again in a particular regional climate, the vegetation is influenced by aspect, slope and the soil and geology. This ecological diversity (climate, topography, geology and soil) creates continental bands of broadly similar types of ecosystem (biome). Biome is a biological subdivision that reflects the ecological and physiognomic character of the vegetation. Global distribution of forest is given in Table 2.

Table 2. Global Ecological Forest

Forest Types	Forest Area (km^2)
Temperate Evergreen needle leaf forest	6,501,321
Tropical lowland evergreen broad leaf rain forest	6,489,017
Temperate deciduous broadleaf forest	2,688,989
Temperate deciduous needle leaf forest	2,624,624
Temperate sparse trees	1,939,314
Tropical deciduous / semi deciduous broad leaf forest	1,728,779
Temperate mixed broadleaf/ needle leaf forest	1,434,821
Tropical sparse trees	1,007,315
Tropical semi evergreen moist broadleaf forest	842,975
Tropical upper montane forest	475,660
Tropical lower montane forest	448,476
Tropical fresh water swamp forest	439,556
Temperate dry forest	241,265
Temperate broadleaf evergreen forest	179,606
Tropical mangrove	118,968
Temperate fresh water swamp forest	88,502
Tropical needle leaf forest	32,039
Tropical thron forest	10,071
Tropical mixed needle leaf/broad leaf forest	8,860

Source UNEP – WCMC (2009).

Importance and climatic role of Forests

Forests are of great importance to any country and mankind as a whole. They contribute significantly to the environment, economic and social well being of a developing country like India, in the view point of ecological balances, agricultural environment, and human utilization. Forests are home to a large number of tribes and provide jobs for more than 13 million people across the world. After oceans, forests are the worlds' largest store house of carbon. Forests contain 80% of the Earth's plant biomass and contain more carbon in biomass and soils than is stored in the atmosphere (Pan *et al.* 2013). Soils store about 3 times as much carbon as does terrestrial vegetation and double the amount of carbon that is floating in the atmosphere (FAO 2006). Forests provide valuable ecosystem goods and services to humanity, including contributions to the overall economy and hosting and protecting sites and landscapes

of high cultural, spiritual and recreational value (Jackson *et al.* 2005, McKinley *et al.* 2011). The forests reduce flooding and low flow events by intercepting runoff and encouraging infiltration (Thomson *et al.* 2011). They also improve water and air quality. They provide ecosystem services that are critical to human welfare. These include:

1. Absorbing harmful greenhouse gases that produce climate change. In tropical forests alone, a quarter of a trillion tones of carbon is stored in above and below ground biomass.
2. Providing clean water for drinking, bathing and other household needs.
3. Protecting watersheds and reducing or slowing the amount of erosion and chemicals that reach waterways.
4. Providing food and medicines
5. Serving as a buffer in natural disasters like flood, and rainfall.
6. Providing habitat to more than half of the worlds' land based species.
7. Intimately linked to rainfall and water availability.
8. Transporting water locally and globally. Large, continuous areas of forest drive the atmospheric circulation that brings rainfall to continental interiors, according to the so-called 'biotic pump theory". It explains that, through transpiration, forests actively create low pressure regions that draw in moist air from oceans, thereby, generating prevailing winds capable of carrying moisture and sustaining rainfall far within continents.
9. Forests influence local and global temperatures and the flow of heat. At higher latitudes, forest may warm regional and global climate.
10. Transpiration, interception, evaporation, infiltration and ground water recharge, tree cover can either store or recycle substantial amounts of water downwind, providing a positive impact on (and protection of) the local catchment, thereby moderating floods.

Climate change and forests are intrinsically linked and better forest management has key role to play in dealing with climate change.. On the one hand, changes in global climate are already stressing forests through higher mean annual temperatures altered precipitation patterns, and more frequent and extreme weather events (Allen *et al.* 2010). At the same time, forests and the wood they produce trap and store CO_2 playing a major role in mitigating climate change. To maximize the climate benefit of forests, more forest landscape must be kept intact, managed them more sustainably, and restored more of those landscapes which were lost,

Impacts of climate change

Sea levels are rising due to thermal expansion of the oceans in addition to melting of glaciers and land ice. Amounts and patterns of precipitation are changing. The total annual power of hurricanes has already increased markedly since 1975 because their average intensity and average duration have increased (IPCC 2007). Changes in temperature and precipitation patterns increase other extreme weather events, such as floods, droughts, heat waves and tornadoes in

respect of frequency, duration and intensity. Agricultural yields are also being affected. Lobell *et al.*(2008) suggest that due to climate change, southern Africa could lose more than 30% of its main crop, maize, by 2030. As a general rule, crop productivity increases where higher temperatures lead to a longer growing season (at the pole ward limits of cultivation of a particular crop), and decreases where higher temperatures increase heat stress and water shortage (at the equator-ward limits of cultivation). Equatorial and tropical regions where crop-growth is currently temperature-limited (or water limited) are therefore likely to experience the greatest reduction in productivity. Increased heat stress during extreme events can also reduce productivity in temperate regions and effects on pests and disease depend on local climatic limits. As a further effect of global warming, we can expect a range of events to occur in our natural ecosystems viz., changes in vegetation canopy mortality, plants diseases, insect infections, annual net primary productivity, shifts in species range related to altitude and latitude. Numerous organizations have highlighted the importance in developing spatially explicit understanding of the landscape changes taking place and their effects on ecosystems. Other observed changes include Arctic shrinkage, Arctic methane release, release of terrestrial carbon from permafrost region and Arctic methane release in coastal sediments. Arctic shrinkage is the decrease in the size of the Arctic region. This is a change in the regional climate as a result of global warming. Projections of sea-ice loss suggest that Arctic Ocean will likely be free of summer sea ice sometime between 2060 and 2080 (Bo *et al.* 2009). Other processes, however, such as drought-induced forest dieback, insect infestation, disease and catastrophic fire can happen quite rapidly if an ecosystem is pushed beyond critical thresholds. Climate influences many complex and interrelated physical and biological systems. Thus, predicting exactly what will happen as a result of Earth's warming is both complicated and difficult. But scientists are predicting a number of impacts during the 21st. century due to increases in greenhouse gases.

Land-use land-use change and forestry (LULUCF) is defined as 'greenhouse gas inventory sector that covers emission and removal of greenhouse gases resulting from direct human-induced land-use such as settlement and commercial uses, land-use change and forestry activities" (IPCC 2000). LULUCF has impacts on global carbon cycle and as such, these activities can add or remove carbon dioxide from the atmosphere influencing climate. The extent and type of land-use directly affect wild life habitat and thereby impacts local and global biodiversity.

The rate of build-up carbon dioxide in the atmosphere can be reduced by taking advantage of the fact that atmospheric carbon dioxide can accumulate as carbon in vegetation and soil in terrestrial ecosystem. Under the United Nations Framework Convention of Climate Change ((UNFCCC), any process, activity or mechanism which remove greenhouse gas from the atmosphere is referred to as a sink. Human activities impact terrestrial sink through LULUCF activities.

Consequently, the extent of carbon dioxide (carbon cycle) between the terrestrial biosphere system and the atmosphere altered.

Mitigation can be achieved through activities in the LULUCF sector that increases the removal of greenhouse gases from the atmosphere or decrease emission by halting the loss of carbon stocks. In his special report on climate change and LULUCF, the IPCC (2000) identified many land-related climate change mitigation options that have co-benefits for climate change adaptation.

Predicting the response of biodiversity to climate change has become an extremely active field of research. It is now widely recognized that climate change and biodiversity are interconnected. The multiple components of climate change are anticipated to affect all the levels of biodiversity, from organism to biome levels (Parmesan 2006).

Environmental conditions play a key role in defining the function and distribution of plants, in combination with other factors. Changes in long term environmental conditions that can be collectively coined climate change are known to have had enormous impacts on plant diversity patterns in the future and are seen as having significant current impacts. It is predicted that climate change will remain one of the major drivers of biodiversity patterns in the future.

The Earth has experienced a constantly changing climate in the time since plants first evolved in comparison to the present day, this history has seen Earth as cooler, drier and wetter and CO2 concentrations have been both higher and lower (Dunlop and Brown 2008). These changes have been reflected by constantly shifting vegetation.

As climate change have contrasting effect in different parts of the world, it mainly affect developing world, causing variability in precipitation, solar radiation, temperature, humidity etc. The natural climate changes cause large-scale geographical shifts, changes in species composition and in extreme cases even extinction among biological communities. It leads to increased infestation of disease, insect, pest and dispersal of weeds, which may affect food production and productivity. When the ambient factors affecting growth will become beyond the tolerance of the plant species, it will have a negative effect on their reproduction, life cycle and eventually extinction of the species from natural ecosystem.

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नारायणपुर का साप्ताहिक बाजार: भोजन योग्य वन्य व कम प्रचलित वनस्पतियों का अनूठा संग्रह

सौरभ दुबे
वन सुरक्षा प्रभाग
भा वा आ शि प - उष्णकटिबंधीय वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसन्धान एवं शिक्षा परिषद्, पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार)
जबलपुर (म.प्र.)

नारायणपुर जिला, छत्तीसगढ़ राज्य में स्थित हैं। पूर्व में यह बस्तर जिला का ही एक भाग था, परंतु बाद में इसे एक अलग जिला बनाया गया। यह अनछुयें घने वनों व शहरी भागदौड से अलग –थलग ग्रामीण इलाकों वाला आदिवासी बहुल क्षेत्र हैं। यहाँ के वन साल, तेंदु, चिरौंजी व साजा आदि वृक्षों सहित, शाकीय व कंदीय वनस्पतियों तथा लताओं और अनेक प्रकार की अकाष्ठ वनोंपज से समृद्ध हैं। इसके ग्रामीण क्षेत्र इमली और महुआ जैसे फलदार वृक्षों से सजे रहते हैं। ग्रामीण अपनी दैनिक जरुरतों के साथ ही बाजार में बेंचने के लिये अनेक प्रकार भोजन योग्य पत्तिदार वनस्पतियाँ, कंद तथा लताओं को अपने घरों के आँगन, बागीचों तथा कृषि भूमि पर लगाते हैं, साथ ही साथ आस – पास के वन क्षेत्रों से भी एकत्र करते हैं।

वनों तथा ग्रामीण क्षेत्रों से एकत्र की गयी विभिन्न प्रकार की वनस्पतियों का विक्रय नारायणपुर के साप्ताहिक बाजार में किया जाता हैं। यह बाज़ार नारायणपुर शहर के समीप ही सप्ताह में एक दिन लगता हैं। इस अनोखे बाज़ार में लोग अपनी जरुरत के अनुसार क्रय – विक्रय करते हैं। बाजार के दिन ग्रामीण इलाकों से आये हुयें अनेक प्रकार के बाँस व मिट्टी के हस्त शिल्प, तथा रंग - बिरंगी वानस्पतिक विविधता से यह क्षेत्र खिल उठता हैं।

इस साप्ताहिक बाजार में मिलने वाली कुछ कंदीय

वनस्पतियाँ

क़ोचई क़ाँदा

कोचई काँदा (*Colocasia spp.*), Araceae परिवार का सदस्य हैं। इस पौधे की पत्तियाँ, पत्र दंड व कंद खाने में प्रयोग किया जाता हैं। सामान्य

तौर पर इसके कंद का विक्रय किया जाता है।

जिसे भूनकर या सब्जी के रुप में प्रयोग किया जाता हैं।

तीखुर

तीखुर का वान्स्पतिक नाम *Curcuma angustifolia* है । यह Zingiberaceae परिवार से संबंधित इस पौधे को सफेद हल्दी के नाम भी जाना जाता हैं। सामान्य रुप से इसके कंद से स्टार्च निकालकर उसका चूर्ण (पाऊडर) बनाकर बेंचा जाता हैं। इसका सफेद रंग का स्टार्च मीठे व्यंजन बानाने के काम में लिया जाता हैं।

करु काँदा / डुकर काँदा

यह Dioscoreace परिवार की लता वाली वनस्पति हैं। इसका वानस्पतिक नाम *Dioscorea bulbifera* हैं। इसके भूमिगत कंद का रंग भूरा – काला होता हैं। वनों से एकत्र किये गये इसके कंदो को करु काँदा कहते है तथा ग्रामीणों द्वारा घरों पर लागाई लताओं को, जिसका कंद अधिक स्वादिष्ट होता हैं, डुकर काँदा कहते हैं। भूमिगत कंद तथा लताओं पर लगने वाले कंद दोनों भोजन योग्य होते हैं। ग्रामीण इसे भूनकर, उबालकर आलू की तरह प्रयोग करते हैं।

बैचाँदी काँदा

यह लता वाली वनस्पति हैं, जो Dioscoreace परिवार की सदस्य हैं। इसका वानस्पतिक नाम *Dioscorea hispida* हैं। इसके भूमिगत कंद तथा इसके स्टार्च का प्रयोग भी भोजन में किया जाता हैं।

जिमी काँदा

जिमी काँदा को सूरन काँदा के नाम से भी जाना जाता हैं। इसका वानस्पतिक नाम *Amorphophallus paeoniifolius* हैं ।

अंग्रेजी में इसे एलीफेन्ट फुट याम कहाँ जाता हैं। इसके कंद को सब्जी या अचार बनाकर उपयोग किया जाता हैं। इसके कंद को खाने मे से पहले

इमली की पत्तियों के साथ उबाला जाता हैं, जिससे इसको खाने से गले में होने वाली खुजली कम हो जाती हैं।

पत्तेदार वनस्पतियाँ

चेंच भाजी

इसका वानस्पतिक नाम *Chorchorus olitorius* हैं, जो कि Tiliaceae परिवार से संबंधित हैं। इसकी कोमल पत्तियों को पकाकर भाजी के रुप में प्रयुक्त किया जाता हैं।

कोलियार भाजी

इसका वानस्पतिक नाम *Bauhinia purpurea*

हैं। यह Caesalpiniaceae परिवार से संबंधित हैं। इसकी नर्म पत्तियाँ अधिकाश रुप से बारिश का मौसम आने से कुछ दिन पूर्व से तोड़ना शुरु कर दिया जाता हैं, क्योकि बारिश की शुरुवात होते ही इसकी पत्तियो पर इल्ली लग जातीं हैं।

कोलियार भाजी आदिवासी समुदाय में भोजन के लिये बहुत पसंद की जाती हैं।

करमोटा भाजी

करमोटा भाजी का वानस्पतिक नाम *Ipomoea aquatic* हैं। करमोटा भाजी को सामान्य भाषा में इसे पानी पालक या जल पालक कहाँ जाता हैं। यह तालाबों के किनारों पर या दलदली जमीन पर होती है। इसकी पौधे की कोमल पत्तियाँ को पकाकर खाया जाता हैं।

फलदार व अन्य वनस्पतियाँ

वन भटा

वन भटा कही जाने वाली इस प्रजाति का वानस्पतिक नाम *Solanum torvum* हैं।

इसका झाडीनुमा पौधा देखने में बैंगन (भटा) के पौधे की तरह दिखाई देता हैं, इसलिये इसे वन भटा कहा जाता हैं।

इसके मटर के दाने के समान गोलाकार फल कच्चे होने पर हरे रंग के होते हैं, तथा पकने पर पीले पड जाते हैं। कच्चे फलों को तोडकर बाज़ार मे बेचा जाता हैं। गाँवों के घरो के आँगन तथा बगिया इत्यादि में इसके पौधे लगाये जाते हैं। इसके कच्चे फलों से रसदार सब्जी बनायी जाती हैं।

आमरी

आमरी का वानस्पतिक नाम *Hibiscus sabdariffa* हैंयह Malvaceae परिवार से संबंधित हैं। इसकी पत्तियों को पकाकर भाजी के रुप में खाया जाता हैं तथा इसमें भिंडी की तरह लगने वाले छोटे लाल रंग के फल की ऊपरी परत को निकालकर या उसे सुखाकर चटनी बनाकर प्रयोग किया जाता हैं।

बाँस

देशी बाँस की नयी कल्म निकलने पर उन्हे काटकर यहाँ के बाज़ार में बेंचा जाता हैं। बाँस की नयी क्ल्म से ऊपरी रुयेदार परत हटाकर उसे भोजन के रुप में प्रयोग किया जाता हैं।

उक्त के अलावा नारायणपुर के साप्ताहिक बाजार में प्रत्येक मौसम के अनुसार होने वाली वनस्पतियाँ जैसे- महुआ फूल, चिरौंजी, चरोंटा भाजी, कटीली भाजी, मशरुम (बोडा/फुट्टू),

सीताफल तथा स्थानीय प्रजाति के केले आदि को विक्रय के लिये बाजार में लाया जाता हैं।

चार बीज:गरीबो का बादाम

योगेश पारधी, एस. सी. बिस्वास एवं नाहर सिंह मवई

भा वा आ शि प -उष्णकटिबंधीय वन अनुसंधान संस्थान

(भारतीय वानिकी अनुसन्धान एवं शिक्षा परिषद्, पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार)

जबलपुर (म.प्र.)

ई-मेल: yogeshpardhi1911@gmail.com

बुच्नानिया लंजन के बीज को चिरोंजी या चिरोली के नाम से जाना जाता है। अन्य नाम इस प्रकार है चार, चार्ली, चर्कोल, चारोली, मोराला| छत्तीसगढ़ में चिरोंजी का जामुन फल चार कहलाता है । इसके बीज की गिरी को चिरोंजी कहते है। गर्मी के दिनों में चार के फल पाक जाते है तो उन चार् पाक को खाने की लालसा कुछ ऐसे जाग उठती है जैसे जंगल के काले अंगूर मिले हो चार के मीठे फल जितने स्वादिष्ट होते है उतने ही अनमोल उसके गोल हरे बीज होते है उन बीजो को संगृहीत करने का शौक एसा होता है जैसे सफ़ेद कीमती मोती हो| इन बीजो के अन्दर की गिरी सफ़ेद मेवा होती है जब इन बीजो को स्वयं से फोड़कर चिरोंजी निकालने की कोशिश की जाती है तो आधे अधूरे चिरोंजी ही मिलती है कभी कभार साबुत चिरोंजी मिलती है मशीनरी युग में चार इन बीजो से परिष्कृत चिरोजी बाजारों में महंगे दामो में बिकती है छत्तीसगढ़ में इन बीजो का संग्रहण बड़े जातां से किया जाता है| चिरोंजी इतनी कीमती मेवा है की पुराने समय में माता पिता अपने लाल का नाम ही चिरोंजीलाल रख देते थे कोई मिठाई हो या खीर हो उसमे चिरोंजी का मिश्रण उसके स्वाद को बड़ा देता है| चिरोंजी की कहानी कुछ ऐसी होती है की इसके फायदे भी अनेको है। मीठी चीजो में खासतौर पर इस्तेमाल होने वाली चिरोंजी में कई एसे पोषक तत्व पाये जाते है जो स्वास्थ्य के लिए फायदेमंद होते है चिरोंजी में प्रोटीन की पर्याप्त मात्रा पाई जाती है इसके अलावा इसमें विटामिन सी व् बी भी पर्याप्त मात्रा में होती है।

प्राकृतिक आवास

एशिया, ऑस्ट्रेलिया, कम्बोडिया, चीन, भारत, इन्डोचीन, इंडोनेशिया, लाओस, मलेशिया म्यांमार नेपाल फिलिपिन्स थाईलैंड नेपाल वियतनाम। यह पौधा उष्णकटिबंधीय पौधा है जो 1200 मी की उचाई पर पाया जाता है यह उन छेत्रो में सबसे अच्छा बढता है जहा वार्षिक दिन का तापमान 32-42 डिग्री के भीतर होता है यह 1000-1500 m m की सीमा में औसत वार्षिक वर्षा को प्राथमिकता देता है लेकिन 750-2200 m m वर्षा को सहन करता है बुच्नानिया लंजन या बादाम एक सदाबहार पेड़ है जो लगभग 18मील लम्बा होता है | फल को ताज़ा खाया जाता या सुखाकर खाया जाता है|

चिरोंजी बीज का व्यापारिक महत्त्व और समस्याए

चिरोंजी का बहुआयामी उपयोग इसकी महत्ता को बड़ा देता है, इसकी महत्ता ही इसकी व्यापारिक मूल्य का मुख्य आधार है | चिरोंजी की बाजार में उपलब्धता बहुत ही कम है, और इसकी मांग बहुत ही ज्यादा, जब बाजार में मांग ज्यादा हो और उपलब्धता कम हो तब वस्तु का मूल्य स्वमेव ही बढ जाता है चिरोजी का बाजार में मूल्य 1000 से 1300 रूपये तक है| मध्यप्रदेश राज्य वन विकास निगम कें अनुसार चिरोंजी एक मुख्य वन उत्पाद

चिरौंजी पेड़

पुष्पक्रम

फल

चिरौंजी बीज

है ये अकास्ठ वन्य उत्पाद की श्रेणी में आने वाला एक मुख्य उत्पाद है जो वन छेत्र में रहने वाले वन्य ग्राम के लोगो का रोजगार का एक महतवपूर्ण साधन है साथ ही वन विभाग को इस से राजस्व भी प्राप्त होता है|वर्तमान में चिरोंजी के फल से गिरी को निकलने की उन्नत तकनीक नही है, उन्नत तकनीकी के आभाव में चार बीज की बहुतसारी गिरी ख़राब हो जाती है इसकी वजह से बाजार में चार की गिरी का उचित बाजार मूल्य नही मिल पाता है, वर्तमान समय में चार बीज से इसकी गिरी निकलने की उन्नत तकनीकी पर कार्य करने की आवश्यकता हैं साथ ही तकनीकी एसी हो की गिरी कम शारीरिक श्रम में आसानी से निकल आये, अभी ग्रामीण जन पारम्परिक तकनीकी सेचार बीज कोनिकालते है जिससे उनको समय भी बहुत ज्यादा लगता है और उत्पाद की गुणवत्ता में भी कमी आती है|

इन सभी समस्यायों को द्रस्तिगत रखते हुए आज हमें एसी तकनीक को उन्नत करने की आवश्यकता है जो कम समय और कम श्रम में हमें उन्नत उत्पाद प्रदान करे इसके लिए ग्रामीण जानो को तकनीकी प्रशिक्षण प्रदान करने की भी जरुरत है साथ ही चार गिरी को निकलने के लिए वन विभाग और गैर सामाजिक संगठन को प्रोत्साहित करना चाहिए| गैर सामाजिक संगठनो को सरकार आर्थिक सहायता प्रदान कर इस दिशा में प्रयास करना चाहिए और ये प्रयास होने चाहिए की चार बीज को रास्ट्रीय स्तर पर पहचान मिले और इसका निर्यात अन्तेर्रस्त्रिय स्तर पर हो जो हमें भारी मात्रा मेंडॉलर प्रदान करे और डोलर का चार बीज लाडला बन जाये, वन विभाग को यह जरुरत है की वन छेत्र में लगे चार के उन्नत वृक्षों का चयन करे और इन चयनित वृक्षों से वृहद स्तर पर बीजो का संग्रहण कर अपनी नर्सरी में प्रोपगते करे और वन भूमि में लगाओ ताकि आने वाले

समय में हमें चयनित उन्नत किस्म के चार वृक्षों से उन्नत चार बीज प्राप्त हो सके इस प्रयास को सफलतापूर्वक प्राप्त करने के लिए हमें वृहद स्तर पर अनुसन्धान कार्य करने की आवश्यकता है ताकि हमें अनुसन्धान के माध्यम से उन्नत किस्म का गैर अकास्थ वन्य उत्पाद प्राप्त हो सके जिसकी अंतर्राष्ट्रिय स्तर पर भारी मांग की पूर्ति कर सके प्राप्त सरकारी स्रोत से हमें यह ज्ञात होता है की चार बीज एक बहुमूल्य वन सम्पदा है जिसकी संरक्षण और संवेर्धन की महती आवश्यकता है। हम इस वन सम्पदा का जितना संरक्षण और संवर्धन करेंगी ये सम्पदा हमें उतनी ही लाभकारी परिणाम प्रदान करेगी अतएव हमें यह जानना अत्यंत आवश्यक हो जाता है की हम इसके महत्व को समझ कर इसे संवर्धित करे | उष्णकटिबंधीय वन अनुसन्धान संस्थान- जबलपुर, राज्य वन अनुसन्धान संस्थान-जबलपुर इस दिशा में चार पर अनुसन्धान परियोजना संचालित कर अनुकरणीय प्रयास कर रहे है। देश के अनुसन्धान संस्थान इस दिशा में भिन्न भिन्न तरह की परियोजनाओ में कार्य कर अपना योगदान दे रहे है।आशा है जल्द ही हमें आशातीत परिणाम प्राप्त हो | भविष्य में यह आवश्यकता है की पुरे मध्यप्रदेश और छत्तीसगढ़ से अच्छे व गुणवत्तापूर्ण पौधो को चयनित करके जेम्प्लास्म बैंक बनाया जाये और जर्मप्लास्म बैंक से बीज प्राप्त कर नर्सरी में संवर्धित कर चयनित वन क्षेत्रों में वृक्षारोपण किया जाय जिस से अच्छी किस्म के चिरोंजी वृक्ष की संख्या में वन क्षेत्रों में वृद्धि होगी और हमें उच्च गुणवत्तापूर्ण चिरोंजी प्राप्त होगी |

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P.O. RFRC, Mandla Road
Jabalpur – 482021, M.P. India
Phone: 91-761-2840484
Fax: 91-761-2840484
E-mail: vansangyan_tfri@icfre.gov.in, vansangyan@gmail.com
Visit us at: http://tfri.icfre.org or http://tfri.icfre.gov.in