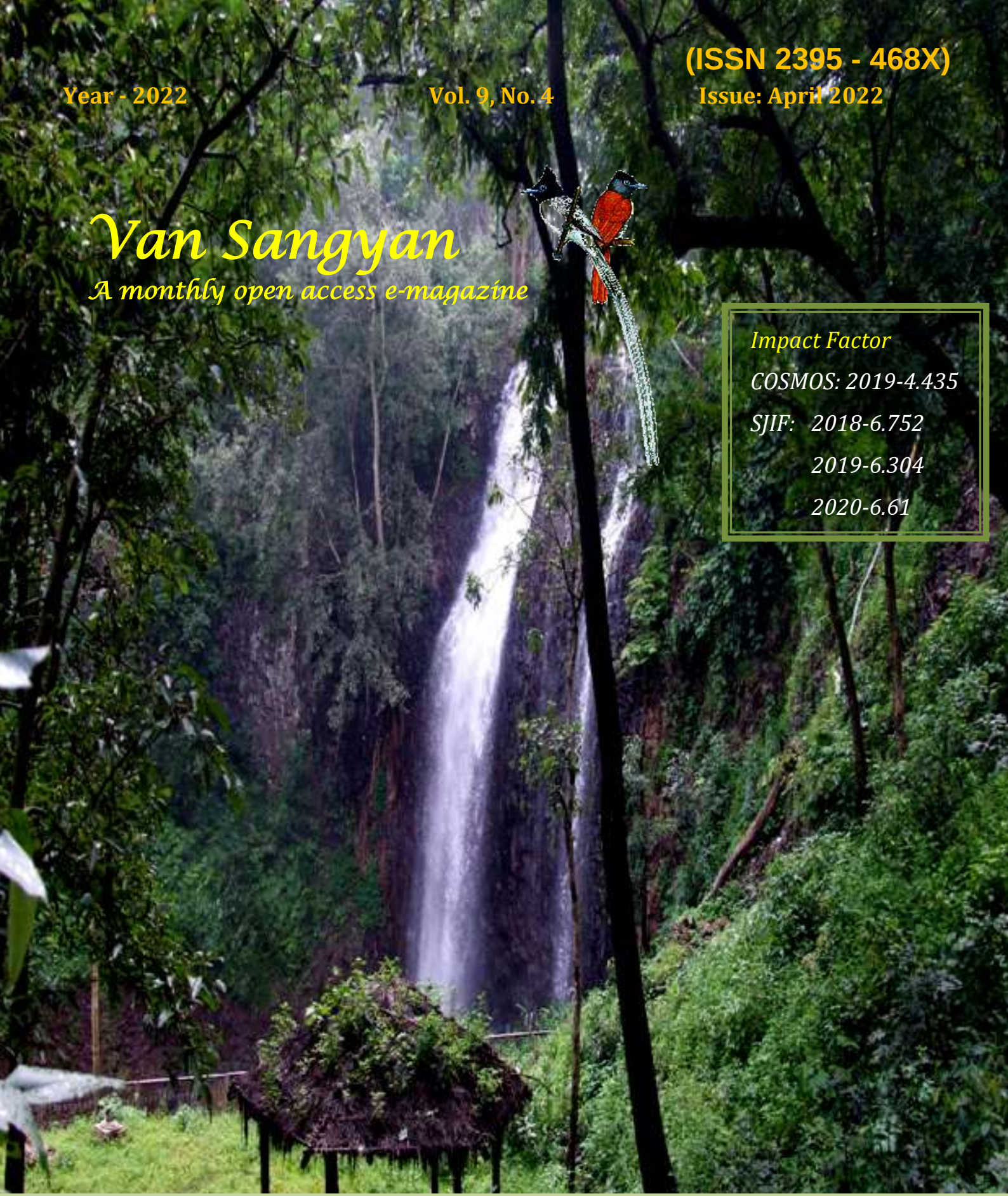
(ISSN 2395 - 468X)
Year - 2022 Vol. 9, No. 4 Issue: April 2022

Van Sangyan

A monthly open access e-magazine



Impact Factor

COSMOS: 2019-4.435

SJIF: 2018-6.752

2019-6.304

2020-6.61

Indexed in:

COSMOS Foundation (Germany)

International Inst. of Org. Res. (Australia)

IIJIF

Tropical Forest Research Institute
(Indian Council of Forestry Research and Education)
Ministry of Environment, Forests and Climate Change (MoEFCC)
PO RFRC, Mandla Road, Jabalpur – 482021, India

Van Sangyan

Note to Authors:

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

by e-mail to vansangyan_tfri@icfre.org

or, through post to The Editor, Van Sangyan,
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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
Photo credit: Dr. N. Roychoudhury and Dr. Rajesh Kumar Mishra, TFRI, Jabalpur (M.P.)

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From the Editor's desk

Agroforestry has significant potential to provide employment to rural and urban population through production, industrial application and value addition ventures. Current estimates show that about 65 % of the country's timber requirement is met from the trees grown on farms. Agroforestry also generates significant employment opportunities. It is also recognized that agroforestry is perhaps the only alternative tomeeting the target of increasing forest or tree cover to 33 per cent from the present level of less than 25 per cent, as envisaged in the National Forest Policy (1988). A major role for agroforestry is emerging in the domain of environmental services. Agroforestry is known to have the potential to mitigate the climate change effects through microclimate moderation and natural resources conservation in the short run and through carbon sequestration in the long run. Agroforestry species are known to sequester as much carbon in below ground biomass as the primary forests, and far greater than the crop and grass systems.

Agroforestry systems offer means to address to a significant extent the present challenges of food, nutrition, energy, employment and environmental security. However, appropriate research interventions, adequate investment, suitable extension strategies, incentives to agroforestry practitioners, enabling legal and regulatory environment, marketing of agroforestry produce, post-harvest processing, development of new products.

Given the fact that land-holding size is shrinking, tree farming combined with agriculture is perhaps the only way forward to optimize the farm productivity and thus, enhancing livelihood opportunities of small farmers, landless and the women. Agroforestry interventions can be a potent instrument to help achieve the 4 percent sustained growth in agriculture. In short, trees on farm or agroforestry are uniquely place for achieving multiple objectives, especially the food, nutrition, employment, health and environmental security. It is contended that an ever-green revolution is unlikely without a major groundswell of growing trees on farms.

Agroforestry can become an important tool to build resilience of farmers and rural people against threats of climate change and natural calamities. This can also help in greening the rural employment and rural development opportunities by providing agroforestry tree produce based economic opportunities. Emphasis needs to be on raising fast growing trees / bushes / grasses on marginal and degraded farmlands keeping in view their uses for meeting various energy requirements for making profitable agroforestry practices. This is of particular significance for meeting various energy needs of agroforestry itself, such as for irrigation, motive power, farm machines and processing industry. Therefore, it should be considered in conjunction with making of the provisions for financial incentives, especially for setting up of various renewable energy systems / devices.

In line with the above this issue of Van Sangyan contains an article on Agroforestry certification process of wood-based industries in India. There are also useful articles viz. Forests for livelihood security, Insect hotels: A mode of conservation of beneficial insects, Assessment of soil erosion – physical, empirical and remote sensing methods, Termite damage and their control in forest nurseries and young plantations, First report of rare insect pest Xylotrechus smei (Cerambycidae: Cerambycinae: Clytini) attacking redsanders plantations in Telangana and Dinumma placens -A major insect pest of Albizia species in nursery stage.

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

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Agroforestry certification process of wood-based industries in India

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Introduction

The word 'agroforestry' is now commonly used in reference to a land use strategy that includes the deliberate insertion of trees and woody perennials into the production system(Wilson & Lovell, 2016). Agroforestry practises have risen in popularity in recent years as a potential solution to the various issues of sustainable food production in a resource-constrained environment, as well as the restoration of tree cover, particularly in tropical areas (Steffan-Dewenter et al., 2007; Rueda et al., 2014). Agroforestry systems are based on the idea of integrating agriculture into tree-covered systems to increase productivity while also delivering some of the services and goods that are typically associated with forests. While agroforestry systems cannot completely replace natural forests in terms of diversity and richness, they can help to restore some forest-derived ecosystem services and commodities (Obeng & Aguilar, 2015; Perfecto et al., 2005). While agroforestry systems have long been recognised as significant interventions for the protection of tree-covered habitat and farm resilience, particularly in tropical regions, there have been few coordinated initiatives to promote agroforestry across global supply chains. Growing consumer awareness of the environmental impact of consumption patterns has resulted in the rapid creation of a sustainable food business. In this environment, sustainability certification has emerged as one of the most important tools for regulating the production and distribution of sustainable foods. While various voluntary sustainability guidelines have arisen in recent years to encourage biodiversity conservation and tree cover protection in agricultural production systems, the landscape remains fragmented and displays multiple methods in the absence of a clear formulation of certification principles (Potts et al., 2014). Sustainability certification schemes have evolved in recent years in response to growing consumer awareness of social and environmental difficulties along global supply chains, as well as growing worries about the detrimental environmental effects of unsustainable farming and forestry methods.

Certification: An overview

The words certification, eco-certification, and eco-labelling are all used to describe the process of confirming the sustainability of production or business processes in relation to a given standard and then attaching a label to differentiate complying items in the marketplace. However, certification is only one part of a larger system of sustainability requirements, and it is best understood in context. Standards systems are voluntary processes that allow producers and businesses to certify compliance with environmental, social, ethical, and other standards. There are three main components in most systems(Steering Committee 2012): (1) The standard establishes a set of social and environmental best practises for a particular industry, crop(s), or product (s). It also defines compliance criteria (e.g., compliance indicators and a score system) as well as directions for implementation. Every few years, standards are updated to integrate new knowledge in order to increase efficacy. (2) The compliance verification process consists of a set of methods that ensure that items labelled as sustainable meet the standards of the relevant standard. Auditors evaluate social and environmental practises and/or performance at the production-unit level (e.g., farms) using on-site inspection, interviews, farm records, and other corroborating evidence. Independent, third-party accreditation agencies are usually in charge of overseeing the audit process' integrity. Traceability systems (chains of custody) follow certified products from the point of origin to the point of sale to verify that only certified products are marketed as certified. Certification is usually given at the level of a producer group or cooperative for crops farmed by smallholders (such as coffee and cacao). The organisation is in charge of ensuring that all of its members follow the sustainability guidelines, and such compliance is verified by external auditors, usually by visiting a sample of member farms. (3) Consumers can distinguish sustainable items through sustainability labels (eco-labels) or other forms of communication. While most standards systems have their own labels, certified products are not necessarily labelled as such at the consumer level, but business-to-business transactions can still be distinguished. Eco-labels have proliferated in a number of sectors in recent years, as anyone involved in day-to-day shopping can confirm. Sustainability certification schemes have evolved in recent years in response to growing consumer awareness of social and environmental difficulties along global supply chains, as well as growing worries about the detrimental environmental effects of unsustainable farming and forestry methods. This is always a possibility, especially when smallholder agroforests are near National Parks or logging concessionsto change market systems by introducing certification as a voluntary approach to remedy significant gaps in global environmental governance (Steering Committee 2012). Certification has achieved significant and expanding market penetration for key tropical crops in recent years, in accordance with these aspirations. One possible demand driver is consumer recognition of certification, which has reached mainstream levels in developed country markets. For timber products, including those from smallholder forests,

the FSC standard has been used on about 30 million ha around the world. Third-party certification agencies handle the majority of sustainability certification (and, in certain circumstances, claim verification). The practise of third-party certification occurs when neither the producer (first party) nor the person in charge of setting the standard (second party) is responsible for confirming the claims. (Vellema et al., 2015). To become an authorised certification body, third-party auditors must be properly accredited. It certifies the entity's ability to conduct conformity assessments and verify the producer's adherence to a certain sustainability standard(Millard, 2011). While third-party certification remains the dominant paradigm for certification processes, self-assessment and first-party evaluation are becoming more important as tools for lowering certification costs and facilitating the implementation of sustainability standards.

Fig 1. Pre-requisites of certification procedure

Types of certification systems

To give consumers with assurances, a variety of certification processes are used. **Forest management certification**, which certifies that timber or NTFP products come from well-managed forests or plantations that meet the criteria of economic viability, social fairness, and environmental soundness; **organic certification and other 'environmentally-friendly production'** certification schemes, which certify that products have been obtained without the use of chemicals in a way that protects soils and ecosystems; and **agroforestry certification,** either from existing programs such as forest garden certification, or through the creation of a specific label for products from high-biodiversity agroforestry systems.

Necessity of certification:

The certification of production systemsoffers various benefits to producers ranging from improved access to markets to more reliable sales partnerships, premium prices or a minimum price guarantee. It can also facilitate access to improved knowledge and skillsets around good farming practices and business skills, as well as improved institutional and administrative capacity, all of which benefit farm productivity and profitability while also filling critical policy and administrative gaps. (Fenger et al., 2017; Tscharntke et al., 2015). However, if sustainable agricultural techniques are not appropriately compensated for, certification systems can operate as market entry barriers, particularly for farmers with low resources, and can impose additional financial strain on producers (Bray & Neilson, 2017). Traceability systems are an important aspect of sustainability certification because they describe the system in place that allows a certified product to be tracked back to its source.

Challenges in certification

Landscape processes including biological interconnection, watershed functions, and other ecosystem services may be hampered by heterogeneity (Holzschuh et al., 2008). Many certification standards are global in character, with a basic generic standard that may struggle to account for the widely diverse conditions under which crops are grown across the tropics. While some standards include instructions for local adaptation, they rarely cover all aspects of the standard.

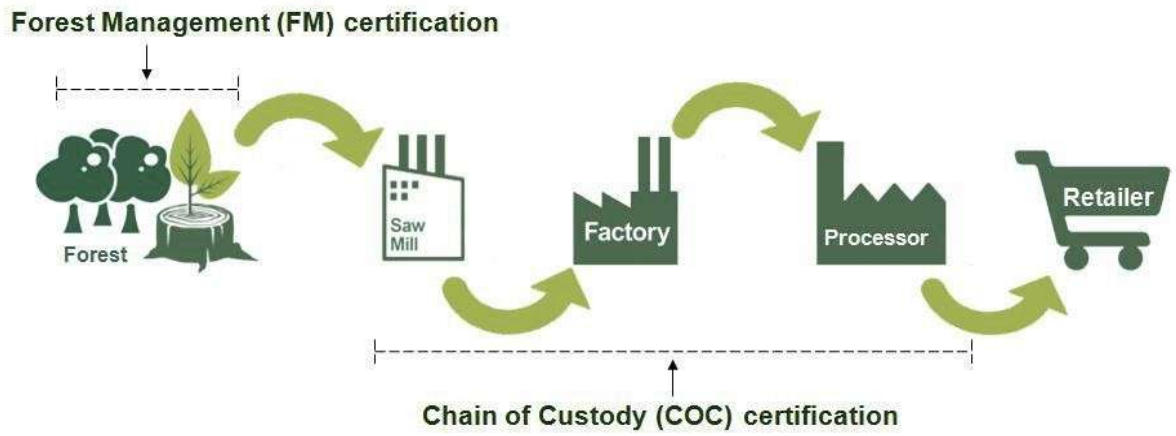

Fig 2. TypesofAgroforestryCertification

Benefits of Agroforestry Certification (Muthoo, M. K. 2012)

- **Principle 1: Compliance with laws**
  - The organization shall comply with all applicable laws, regulations and nationally-ratified international treaties, conventions and agreements.
- **Principle 2: Workers rights and employment conditions**
  - The organization shall maintain or enhance the social and economic wellbeing of workers.
- **Principle 3: Indigenous peoples`rights**
  - The organization shall identify and uphold indigenous peoples' legal and customary rights of ownership,use and management of land, territories and resources affected by management activities.
- **Principle 4: Community relations**
  - The organization shall contribute to maintaining or enhancing the social and economic wellbeing of local communities.
- **Principle 5: Benefits from the forests**
  - The organization shall efficiently manage the range of multiple products and services of the management unit to maintain or enhance long term economic viability and the range of environmental and social benefits.
- **Principle 6: Environmental values and impacts**
  - The organization shall maintain, conserve and/or restore ecosystem services and environmental values of the management unit, and shall avoid, repair or mitigate negative environmental impacts.
- **Principle 7: Management planning**
  - The organization shall have a management plan consistent with its policies and objectives and proportionate to scale, intensity and risks of its management activities. The management plan shall be implemented and kept up to date based on monitoring information in order to promote adaptive management. The associated planning and procedural documentation shall be sufficient to guide staff, inform affected stakeholders and interested stakeholders and to justify management decisions.
- **Principle 8: Monitoring and assessment**
  - The organization shall demonstrate that, progress towards achieving the management objectives, the impacts of management activities and the condition of the Management Unit, are monitored and evaluated proportionate to the scale, intensity and risk of management activities, in order to implement adaptive management.
- **Principle 9: High conservation values**
  - The organization shall maintain and/or enhance the High Conservation Values in the Management Unit through applying the precautionary approach.
- **Principle 10: Implementation of management activities**
  - Management activities conducted by or for the organization for the Management Unit shall be selected and implemented consistent with he organization's economic, environmental and social policies and objectives and in compliance with the principles and criteria collectively.

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Forests for livelihood security

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Forest ecosystems play an important role in ecological sustainability, economic development and livelihood security of people at local as well as global level. Forests direct neighbourhood and worldwide atmosphere, improve climate occasions, control the hydrological cycle, ensure watersheds and their vegetation, water streams and soils.

Forests are the most important renewable sources to the people. It is estimated that around 2.4 billion people in the world are dependent on the forests for their daily livelihood requirements such as food, water, fuel wood, round wood and many other materials which is a subsistence source. Globally, 200 million indigenous communities are almost fully dependent on forests and about 350 million people who live adjacent to dense forests depend on them for subsistence and income.

In India, the total tree cover of the country accounts for 80.69million hectares which represents 24.62% of the total geographical area of the country. After agriculture, the forest sector is India's second largest land use system. About 300 million tribal and other local people rely on the forest for their survival and livelihood in distant forest periphery settlements, and about 70% of India's rural population uses fuelwood to meet their home energy demands. Forests are the principal source of livelihood and monetary revenue for roughly 100 million of them, who rely on fuelwood, non-timber forest products (NTFP), and construction materials. Forests provide food for more than half of India's 70 million tribal people, the poorest people in the country.

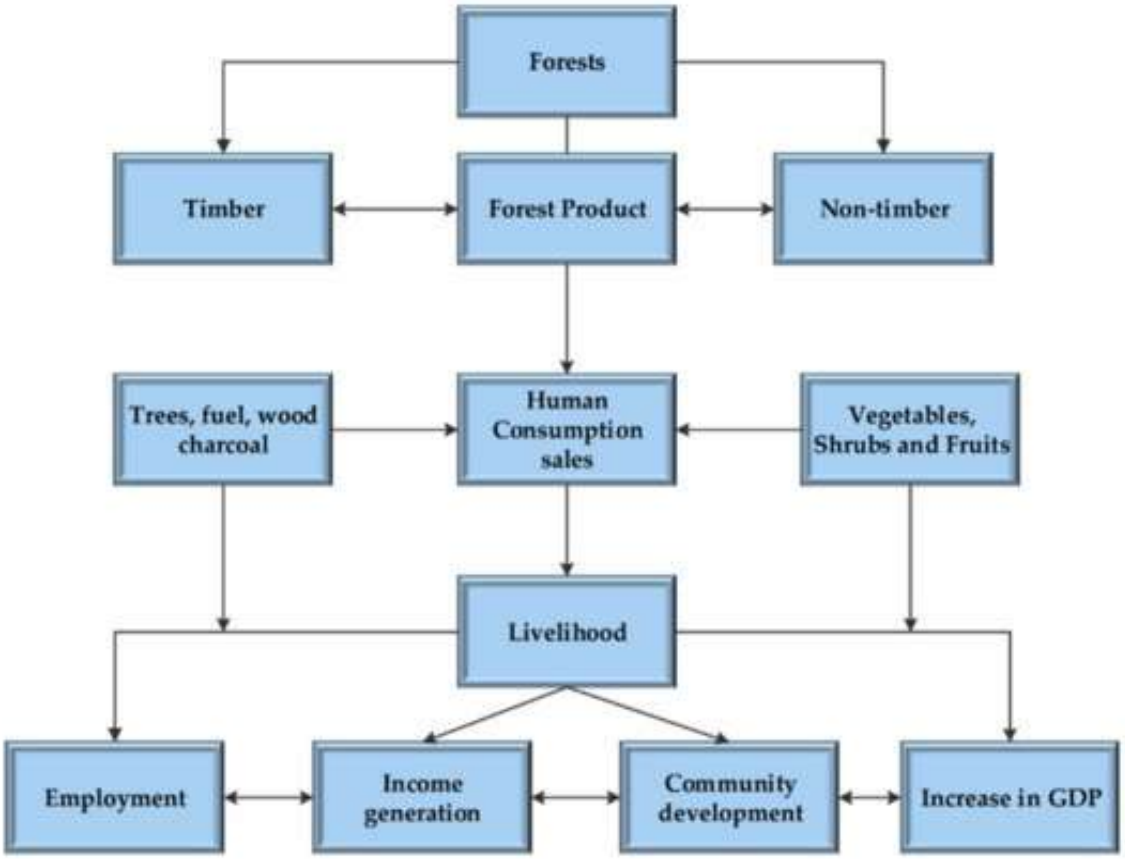
Forest management approaches have always tried to develop and understand the protective and productive features of natural forests. Prioritization was given to biological, technical, and macroeconomic factors. The major area of focus is about the way in which, forests, wood loots and trees can contribute to livelihood of people in particular and human welfare in general. The role of people in resource management and their livelihood issues were relegated for a longer period. It is in the recent times only their role and needs has been recognised. The forest services are diverse and forest uses are categorized into various categories. It is emphasizing that forest has more than economic value. Human activities are already impairing the flow of ecosystem services from the forests on a large scale.

The loss of forest cover has given negative effect on human life such as loss of livelihood and the source of livelihood like agricultureand livestock is depending on the forest.

Importance of Forests in the livelihood security:

Forests provide a multitude opportunity of livelihoods for people in the form of direct employment, self-employment and secondary employment. Size of agriculture

land, selling of forest products, tourism activities, community support, quality of labour available at household level, skills of family members, physical fitness to do hard work, and access to common property resources are some of the assets, activities, and capabilities that provide livelihood status to rural people. Rural youths work in agriculture, jhum cultivation, business, and other wage jobs are now working in



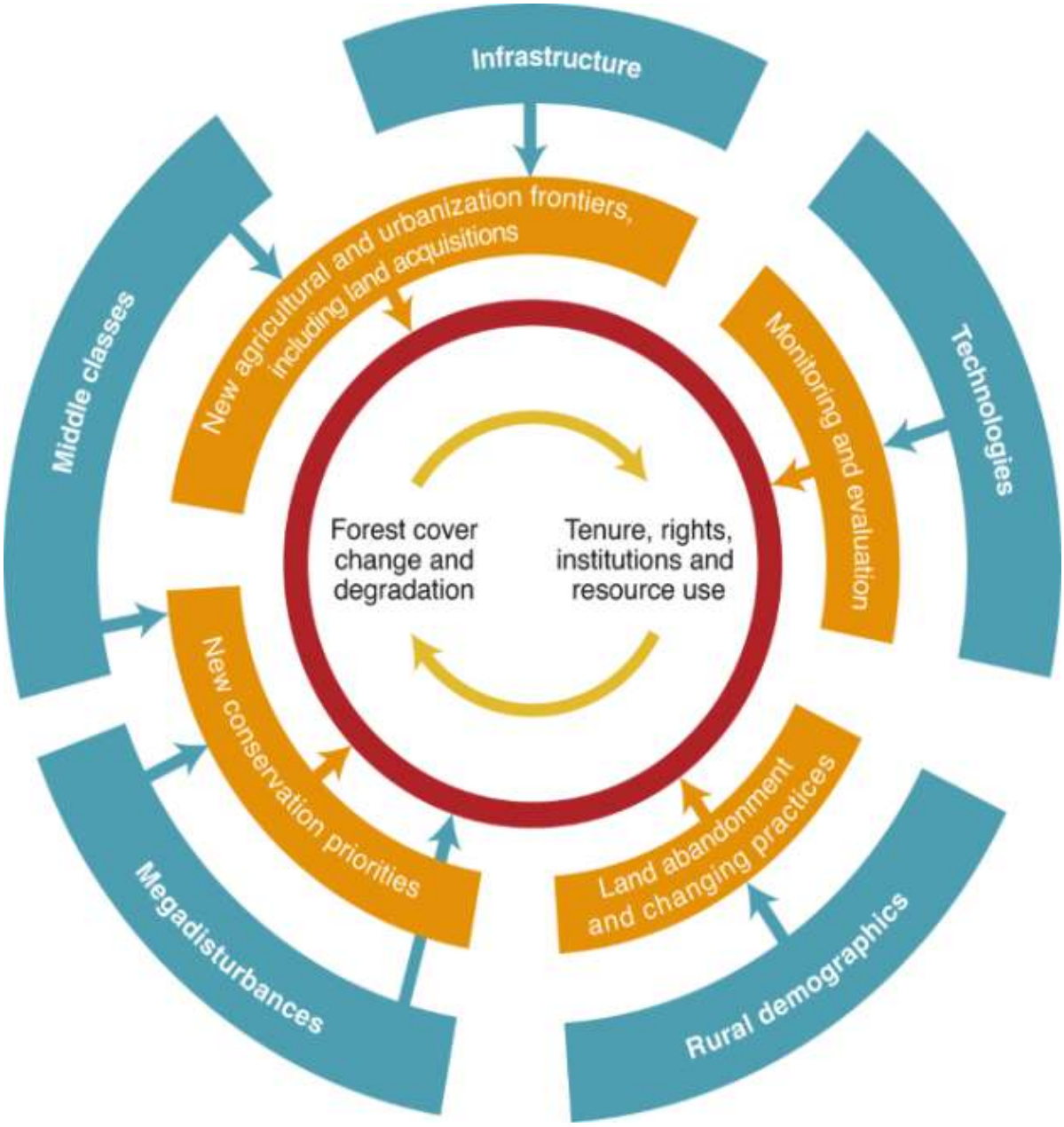
(Source: Saif Ullah et. al., 2021)

the park's tourism business and development. The directemployment is provided by the forest department and other departments (ruraldevelopment, agriculture and co-operatives) in the form of managerial, technical, research, planning and executive jobs. The first step in this aspect is the initiation of the Joint Forest Management in1972. This is mainly due to the realisation that the management of forests will become cumbersome unless there is people's participation. It catered the basic requirements of fuelwood, fodder, minor forest produce and construction timber of the rural poor assuring them good income. Infact, the stake holders were offered an equity-based stake in protection and development of the forests.

The self-employment is created to localpeople through the sale of fuel wood and fodder, lopping and grass cutting, forest-basedhandicrafts and cottage industries, etc. The application of local skills and village-leveltechnology in wood based and small-scale forest-based enterprises provide secondaryemployment and livelihood opportunities for

people.The income from sale of theforest products for households living in and around forest constitutes 40 to 60 per cent oftheir total income Over50 per cent of forest revenue and 70 per cent of export income are collected from nontimberforest produces.

Although illegal, the gathering of firewood for market sale is widespread in many sections of the country's forested regions and provides a living for 11% of the population. According to the Food and Agriculture Organization, forests



(Source: Forest-linked livelihoods in a globalized world, Nature)

contribute to food access by providing jobs and monetary revenue to households and individuals, allowing them to buy food and support their livelihood. Forest-dependent households' economic access to food and other commodities is primarily based on income generated from the forest sector.

Livelihood significance of NTFPs

NTFPs benefit people's livelihoods on two levels. The first is their role in supporting households in coping with adversity represented as abrupt changes in the economic, social, or biophysical contexts in which they exist and function. Rural households frequently turn to NTFPs during such times to help them get through what they consider to be a temporary setback. This can take three different forms:

1. NTFP types or species not commonly utilised by that household, such as timber poles acquired from the environment for building purposes rather than commercial poles or cement blocks.
2. Increased consumption (relative or absolute) of things that are already a part of their way of life. Typically, this entails exchanging gathered commodities for purchased ones, such as increased usage of wild spinaches or a reduction in paraffin consumption in favour of fuelwood.
3. Temporary selling of NTFPs on local and regional marketplaces, including within communities and among neighbours.

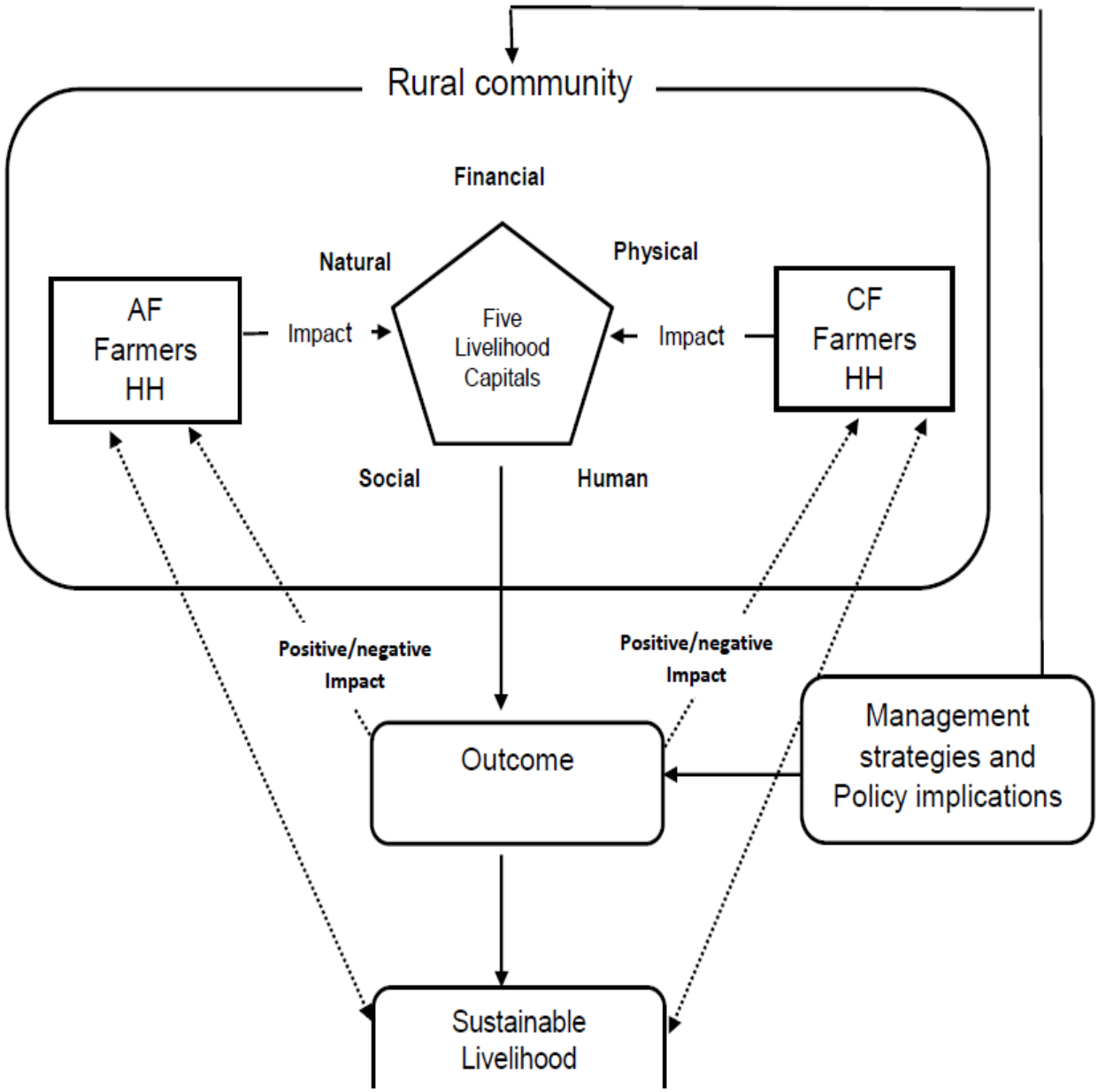
In times of adversity, the NTFPs often provide as an essential source of income. The percentage of NTFPs collected by communities for the purpose of supporting their subsistence needs varies by state, ranging from 5.4 to 55 percent across the country. According to research by the Government of India, NTFPs trading, which includes the gathering and processing of economically significant NTFP species, created at least 35 million man-days of employment. According to studies, NTFPs play a significant role in the livelihoods of forest-dependent people, many of whom have few non-agricultural income options (MOEF, 2006). The NTFP industry accounts for about 55 percent of forestry jobs. While NTFP collecting provides a significant source of money and employment for forest dwellers, it also has a multi-faceted economic impact due to downstream processing and distribution. However, tenure security, lack of processing skills and narrow market access are the limiting factors restraining the generation of greater benefits from these resources.

Livelihood significance of agroforestry

The impact on livelihood is one of the major contributions made by agroforestry to the economy. This can be seen in terms of income, and in the generation of employment opportunities.Agroforestry in India contributes to the Indian Council of Agricultural Research's target of increasing forest cover from 23 percent to 33 percent of land area.

According to the Report of the Task Force on Greening India for Livelihood Security and Sustainable Development (Planning Commission 2001), agroforestry systems should be managed on 10 million ha of irrigated land and 18 million ha of rain-fed land. The Third Assessment Report on Climate Change (McCarthy et al. 2001) of the International Panel on Climate Change (IPCC) recognised the potential of agroforestry for addressing multiple problems and providing a variety of

economic, environmental, and socioeconomic benefits.The average carbon sequestration capacity of agroforestry in India is estimated to be 25 tC ha-1 over 96 million ha. Biomass productivity is a significant determinant of regional variation. Agroforestry systems also enable underprivileged people to improve their living conditions by providing economic and environmental security.There is potential for employment under-improved agroforestry systems, amounting to 943 million person-days annually from 25.4 million ha., Dhyani et al. (2003). Maximum employment opportunity is seen to be in tree-borne oil seeds, followed by silvipasture. Dhyani and Sharda & Sharma (2005) have estimated that the potential of agroforestry for rural development and employment generation amounts to 5.763 million person-days yr-1 in the Himalayas alone. Non-timber forest products have long been recognised as valuable resources for long-term livelihood and ecosystem protection. Agroforestry has enormous job-creation potential in India. The highest potential is in the cultivation of tree-borne oil seeds, followed by silvipasture systems.



(Source: Ahmed et. al., 2021)

Challenges and emerging issues

On account of their potential role in livelihood and poverty alleviation, NTFPs have gained new attention in international debates that make it urgent for governments to put in place pro-poor reforms in the forest sector to protect and enhance the livelihood benefits those forests provide to the poor. If this is to be realized, local communities will get more secure rights if they are to be involved in managing and protecting large areas of forests globally. There is sudden and high commercial demand, a more involved regulatory framework is also necessary, including permits, quotas, taxes and restrictions on trade. Governments will need to approach NTFP regulation in ways that reflect the financial, ecological and social costs and benefits of such actions.

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Insect hotels: A mode of conservation of beneficial insects

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Introduction

According to a recent research from the USDA's Natural Resources Conservation Service, animal pollinators assist three-quarters of the world's blooming plants and around 35% of the world's food crops reproduce, with over 3,500 species of native bees helping to enhance agricultural production. According to some estimates, animal pollinators such as bees, butterflies and moths, birds, bats, beetles, and other insects are responsible for one out of every three bites of food we consume. The decrease of helpful fauna caused changes in other beneficial insects. As a result, the conservation of beneficial insects is critical. Many ways, such as insectaries, beetle banks, hibernaculum, insectary plant, and nest boxes, are important, but a fresh notion of insect hotel has just emerged.They can come in a number of forms and sizes depending on the purpose or bug to which they are targeted. Most include many portions that provide insects with nesting facilities – especially during the winter – as well as shelter or refuge for a variety of insects. One of their functions is to provide a home for pollinators. Aside from insect hotels, more flowers can be planted. Anise, stonecrop, monarda, catnip, queens, and loosestrife herb are some examples of natural bee diets. It is not required to have a bee hive with an insect hotel. With the present concern of honey bee colony extinction, you may utilise an insect hotel as a backup for pollination, which native bees can do well. Some native bee species pollinate specific plants. Panurgus (*Panurgus calcaratus* or *Panurgus banksianus*) is an example of a pollinator that only pollinates hawkweeds (*Hieracium caespitosum*).

Fig 1. Insect hotels across different parts of world

Why an insect hotel?

In colder regions, an insect hotel serves as a hibernation site for insects, whereas in warmer temperatures, it serves as a breeding site. One advantage of a hibernating site is that all of the insects will be in your garden when spring arrives. In warm areas, the hotel serves as a spot for insects to breed and find a dry place during the wet season. Insect variety is stimulated by providing an ideal home for insects in the garden, orchard, or food forest. The effect of diversity is an enhancement in the garden's ecological equilibrium. A hotel is an indirect exterminator as well. Lice and mites are destroyed by insects such as lacewings, hoverflies, ladybugs, beetles, and earwigs.Attracting insects and native solitary bees is an essential part of the hotel. Each climate has its own native bee species. Native bees are not comparable to honey bees in many ways; they have diverse behaviour and come in a variety of forms and colours. The Mason Bee *(Osmia rufa*), for example, prefers to nest in cavities in walls, plant stems, and dead wood, which we supply in the insect hotel. Native bees have the benefit of not stinging in most circumstances. Most native bees do not produce honey. Other insect larvae are also destroyed by solitary bees. More pollination in your garden is ensured by providing adequate habitat for native bees.

Insect hotels attract beneficial insects

Beneficial insects contribute to biodiversity, which is the foundation of the world's ecological balance. An insect hotel in your yard will attract these helpful insects, providing them with a place to reproduce and hibernate for the winter. Increasing ecological production through encouraging biodiversity in the garden. Placing an insect motel in your yard improves the likelihood that beneficial insects will come spontaneously. These man-made structures, also known as bug hotels, bug boxes, and bug houses, provide several advantages. In addition to being attractive, they assist to compensate for the increasing loss of natural ecosystems. Although redesigned and carefully groomed gardens might be lovely, they frequently lack the natural habitats required to attract beneficial insects and promote biodiversity. Insect hotels provide excellent bug real estate - the correct sorts of environments to attract these helpful insects, boost their numbers, and minimise the need for pesticides, since these bugs

provide biological pest management. A balanced ecosystem provides numerous benefits not just for the individual garden, but for the environment as a whole. In addition to offering ecological protection, insect hotels can also aid in biological control through conservation and augmentation of existing natural enemies.

Benefits of insect hotels

1. Compensate for the growing loss of natural environments
2. Encourage beneficial organisms to aid with pest control.
3. Enhance biodiversity and ecological balance in the garden.
4. Provide an opportunity for children to learn about how well-balanced ecosystems work.
5. Organic Pest Control

Pesticides are reduced or eliminated when beneficial insects and pollinators are welcomed into your garden. Certain nonselective insecticides also harm beneficial insects.

How to build an insect hotel

An insect hotel does not have a conventional design. It is simply created from accessible materials, preferably recycled and natural materials, mostly from natural constructions made of wood logs, pallets, bamboo, reeds, stones, tiles, and clay in a variety of forms and sizes. Drilling holes of various diameters, from 3 to 10 mm, in a tiny oblique angle by confining moisture and employing holes of varied depths for biodiversity conservation may also be done. It is critical to add a rain-proof roof to keep the wood and reeds dry, especially because bees are looking for dry locations. Furthermore, the hardwood logs used in the creation of insect hotels must be free of any additional chemical treatments, as the usage of chemicals repels insects. Hotels can be adorned with old rusted metal pieces such as tins, old tools, wheels, and so on. Some native bees, such as Andrena and Sphecidae, dig their nests out of sand or clay. This insect habit preference may be used to build insect hotels by combining clay with sand to attract these bees. Fill old tin cans or stone plant pots with clay and set them between the logs. Because bamboo and wood are perishable in nature, a stone foundation may be a superior option.

Conclusion

Insects such as solitary bees and solitary wasps utilise insect hotels as nesting locations. Other insects' hotels are expressly constructed to allow the insects to hibernate, with ladybirds and, possibly, butterflies being significant examples. Due to their role in encouraging insect pollination, insect hotels are popular among gardeners and fruit and vegetable growers that will enhance agro-ecosystem biodiversity and sustainance. Some intricately crafted insect hotels may be attractions in their own right and are increasingly being spotted in pub gardens and other tourist destinations.

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Assessment of soil erosion – Physical, empirical and remote sensing methods

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Soil erosion causes adverse agronomic, ecological, environmental and economic effects not only on agricultural lands, but also on terrestrial ecosystems, siltation of reservoirs, and degradation of forest, pasture and rangelands. Soil erosion reduces soil fertility, crop production and biodiversity, alters water quality and increases risks of global climate change and food insecurity. Soil is eroding at faster rate than it is being formed and thus more attention is needed.

Soil erosion is the process involving detachment and subsequent transport of soil particles by raindrop impact. There are two agents of soil erosion *i.e.* wind and water, each loss significant amount of soil and reduces its productivity and quality. Overpopulation, harsh climatic conditions, overexploitation and unwise use of soil resources, deforestation, etc., resulting in soil-food-population imbalance, have rendered most of the tropical and subtropical ecosystems extremely vulnerable to soil erosion and erosion induced land degradation.

Soil erosion is a primary cause of land degradation and responsible for 84% of degraded acreage (Blanco et al., 2010). Land degradation is the rate of adverse changes in soil qualities (such as nutrient status, soil depth, concentration of salts etc), resulting in decline in productive capacity of land due to processes induced mainly by human intervention (UNEP, 1992). In India during 2015-16, Land degradation is estimated to be occurred on 91.20 million hectares of land (27.77% of total geographical area), including 50.99 M ha from water erosion, 3.04 M ha from acidification, 1.82 M ha from water logging, 14.27 M ha from wind erosion, 6.46 M ha from salinization/alkalization (Sreenivas et al., 2021). During 2015-16, 5.90 million hectares of land was degraded in Madhya Pradesh (Sreenivas et al., 2021). Various factors responsible for land degradation includes over exploitation of land, soil erosion, climate change, population pressure, unplanned urbanisation.

Types of soil erosion

Water Erosion

Erosion by water is the most serious degradation problem in the Indian context. Sreenivas et al. (2021) reported that during 2015-16, 5.63 M ha land in Madhya Pradesh was degraded due to water erosion. Major types of water erosion are observed in India i.e., Splash erosion, Sheet erosion, Rill erosion, Gully erosion, Stream bank erosion, Seashore erosion and Slip (landslide erosion). They may occur singly or in combination. The most spectacular water erosion is observed in the form of gullies and ravine formations.

Wind Erosion:

The removal of natural vegetative cover resulting from excessive grazing and the extension of agriculture to marginal areas, etc., are the major human-induced factors leading to accelerated wind erosion. The area affected by wind erosion during 2015-16 was 14.27 M ha of India. There are three types of wind erosion viz., Saltation, Suspension and Surface creep.

Factors influencing soil erosion

- Amount and intensity of rainfall
- Wind velocity
- Topography/ slope of the land
- Physical and chemical properties of soil
- Ground cover, its nature and extent
- Intensive agriculture
- Over grazing
- Deforestation
- Climate change

Methods for estimation of soil erosion

Assessment of soil erosion and mapping of erosion-prone areas provide knowledge for soil conservation and watershed management (Sharma et al. 2012). Thus, the need is not merely to quantify the erosion rates, but such results of erosion assessment can be important in decision making and supportive in policy formulation for sustaining the environment as a whole coupled with the land productivity.

Several models were developed for estimating the amount of soil erosion

Physical Models (Bhattarai and Dutta, 2007)

- Water erosion prediction project (WEPP)
- Areal non point source watershed environment response simulation (ANSWERS)
- limburg Soil erosion model (LISEM)
- European Soil erosion model (EUROSEM)
- Soil and water assessment tool (SWAT) synthesizing individual components and requires detailed database for all components

Empirical Models

- Universe soil loss equation (USLE)
- Modified Universe soil loss equation (MUSLE)
- Revised Universe soil loss equation (RUSLE)

Universe soil loss equation (USLE)

- Given by Wischmeier and Smith (1978)
- Designed to predict average annual soil loss caused by sheet and rill erosion on single slope. This erosion model was created for use in selected cropping and management systems.
- It is also applicable to non-agricultural conditions/construction sites.
- The USLE for estimating average annual soil erosion is

$$A = R*K*L*S*C*P$$

A = Average annual soil loss in tones per acre

R = Rainfall erosivity index

K = Soil erodibility factor

L = Topographic factor

S = Slope factor

C= Cropping factor

P = Conservation practice factor

Modified Universe soil loss equation (MUSLE)

- It was given by Williams and Berndt and Smith (1975)

- This is developed to estimate sediment yield for individual storms. Replacing the rainfall factor in the USLE with a runoff factor.
- The MUSLE equation is

$$Sy = a\ (Q^1 qp)\ b\ K\ L\ S\ C\ P$$

Where,

Sy = Sediment yield (ton)

a, b = location coefficients

Q^1 = volume of runoff (m^3)

qp = peak flow rate (m^3/sec)

Revised Universe soil loss equation (RUSLE)

- Given by Renard et al (1997)
- This is revised version of USLE model, same empirical principles
- This model enables prediction of an average annual rate of soil erosion for a site of interest for any number of scenarios involving erosion control practices
- Soil loss is estimated within the raster/grid GIS
- It can also be applied under tropical climates with better accuracy

USLE & MUSLE models were criticized for their potentiality in prediction of spatial distribution of soil erosion. RUSLE, the revised version of USLE not only provides an estimation of soil loss at the plot scale, but also it represents the spatial distribution of soil erosion in an area. The combined use of geospatial technique and RUSLE model has been widely used for its simplicity and applicability over larger areas with better accuracy and low cost.

Remote sensing and GIS

Use of Remote Sensing and Geographic Information System (GIS) are very helpful in assessment of soil erosion studies as it allows consideration of spatial variability in soil, land use/land cover, elevation/slope etc (Sharma et al. 2011). GIS-USLE integration is often used to obtain quick and useful information regarding soil loss (Fistikoglu and Harmancioglu, 2002). The flow chart for estimation of annual rate of soil erosion using Revised Universe soil loss equation and remote sensing and GIS is represented in figure.

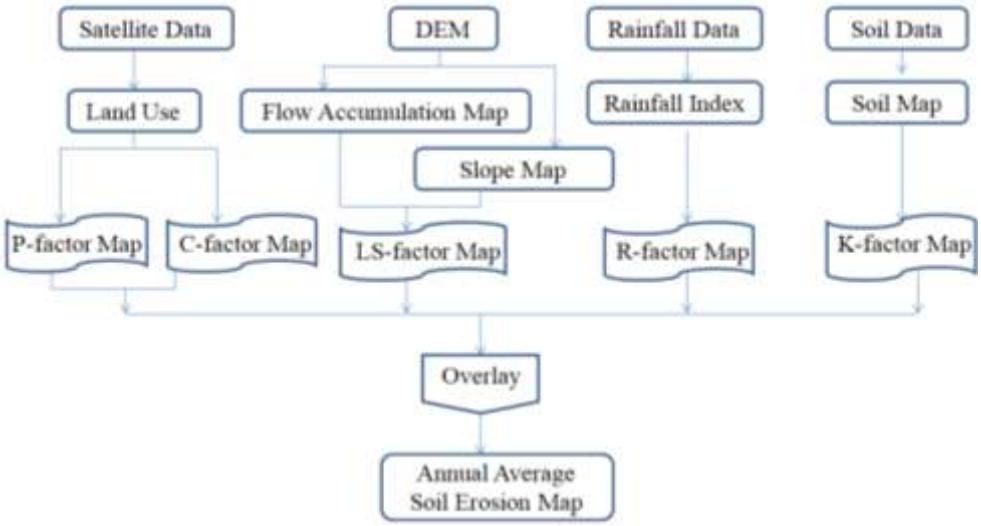

Fig 1: Flow chart for estimation of annual rate of soil erosion using RUSLE and Remote sensing and GIS

Conclusion

Soil erosion is a global problem, but its magnitude is region specific. Water and wind erosion are the primary agents that cause soil-erosion induced degradation. Deforestation, over grazing, intensive cultivation, mismanagement of cultivated soils and urbanization are the main causes of soil erosion. Using conventional methods to assess soil erosion risk is expensive and time consuming. Using geographic information systems (GIS) to integrate existing soil erosion models, field data, and data provided by remote sensing technologies may prove valuable to future studies.

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Termite damage and their control in forest nurseries and young plantations

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Introduction

The role of Forest nurseries are of immense importance as they provide the desired planting stock and keepour Nation's forest lands productive. Factors influencing the quantity and quality of nursery seedlings ultimatelyinfluence our future timber supply. The termites are the major insect pest that negatively affect the quality andquantity of nursery grown seedlings.In the well managed nurseries, the problem of termite damage is negligible, but at times, it becomes a serious problem, resulting in mortality of nursery plants. The critical period during which most termite damage occurs is 4 - 6 months after planting. The damage becomes prominent during scarcity of water. In nurseries usually, termite attack is noticed only when the seedlings are weak due to some earlier infestation or infection or scarcity of water. The mortality of the plants occurs as a combined action of more than one factor, and the termites only hasten the death of the plant.

In the growing trees, the termites attack only the outer dead bark and are mostly restricted to the dead portions. The worker termites eat away thin layers of the bark surface. The attack usually under earthen galleries which covers the bark and under which workers and soldiers travel to and from the ground connection leading to sometimes to tree branches or inside the trunk through wood scars of branches and freedom heart wood. Such type of damage causes hollowness in the large trees. However, by and large, damage is limited to a part of the tree. As a rule, it is only in weak trees that the subterranean termites extend their operations to sapwood.

Termitaria (House of termite)

Worker **Soldier** **Swarmer** **Queen**

Castes of termite

Nature of damage

(a) Most termite damage young plantations immediately after planting up to one year, is by and large, a primary causal factor. Here, the tap root is ring barked after feeding on secondary hosts, which is completely eaten up followed by wilting and drooping of tender leaves, and ultimate death of the seedlings or young plants. The attacked plant can be easily pulled out from the ground or falls down automatically in due damage. This is a most common cause of mortality during the first year of planting.

(b) When the seedlings or young plants become debilitated due to drought, fungal pathogens or other unfavourable factors, especially during summer months, the seedlings or the transplants are vulnerable to termite attack. This is considered as a secondary cause responsible for the mortality. In such cases, the young plants exhibit evidence of damage partially by other factors and partially by root injury caused by termites.

***Eucalyptus* seedlings damaged by termites**

Mortality of *Gmelina* seedlings due to termite attack

Mud galleries on outer surface of tree

Management of termites

Control of termites in the forest nurseries

Treatment of nursery beds

For protection of nursery beds, it must be treated before the seeds are sown. Spray 0.2% water suspension of Chlorpyriphos at the rate of five litres per sq. meter area. The insecticide is sprayed in the nursery beds few days before sowing. For preparation of the insecticidal solution, add 1 litre of chlorpyriphos 20EC in 125 litres of water and mix it thoroughly with a stick. Drench the nursery bed of 12m x 1.2m size with 125 litres of the chloripyriphos solution using the sprinkler or common fountain bucket.

Control of termites after the attack has been noticed (Post planting treatment)

Pre-planting treatment is always recommended as it is more effective and economical. In the areas where the termite infestations are severe, post planting treatment do not field good results and by the time termite attack is noticed it is too late to save the affected seedlings. However, after inspection of the planting area, dead plants are removed and replaced with healthy seedlings. Make a few holes about 10-15 cm deep around each seedling and pour half litre of 0.3% of chlorpyriphos.

Termites attacking standing trees (bark feeding termites)

In the plantations or roadside avenue trees, standing trees in the agro-forestry plantations, it is a common sight to see the muddy plasters or the eastern galleries all over the lower portion of the stem.

Termite control in young plantations

In areas of high termite activity, where the damage is very extensive and is likely to affect the growth, chemical treatment may be carried out as follows:

Soil treatment

One to two litre of insecticidal conclusion of 0.2% Chlorpyriphos may be applied by digging a trench encircling the base of the tree.

Bark treatment

To prevent the termite attack on the bark or the outer portion of the tree trunk, brush painting with 0.2% Chlorpyriphos or may be done after scrapping off the earthen plaster or galleries after treatment at the base of the tree.

Control of termite mounds

Mounds are permanent abodes of these species where they multiply and become a continuous source of termite attack to the plantations. Complete destruction of a mound colony is quickly and economically achieved by making a few holes in the mound and pouring solution of the insecticide by means of a bucket and a large mouthed funnel. It takes about a week for the complete killing of the entire mound colony. Another most effective method is by poisoning the mounds with Aluminium Phosphoric tablets. Two to four tablets should be placed in 1 meter mound and close all the openings with wet mud. The termites will die due to fumigant action (Mound poisoning).

The average annual productivity of wood per ha. in India has been worked out at 0.7 cubic meter which is much less than the world average of 2.1 cubic meter. The average potential productivity of Indian forests has been estimated at 6 cubic meters per ha. per annum. Concerted efforts are made to raise large-scaleplantations to bridge this gap between the potential and realized productivity.

First report of rare insect pest *Xylotrechus smei* (Cerambycidae: Cerambycinae: Clytini) attacking redsanders plantations in Telangana

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Pterocarpus santalinus, with the common names red sanders, red saunders, Yerra Chandanam, Chenchandanam, redsandalwood, Rakta Chandana, and saunderswood, is a species of *Pterocarpus* endemic to the southern Eastern Ghats mountain range of South India. This tree is valued for the rich red colour of its wood. The wood is traditionally considered not aromatic. However, in recent years there has been a marked uptick in the use of red sandalwood as a component of incense, especially in the west. The tree is not to be confused with the aromatic *Santalum* sandal wood trees that grow natively in South India.. Apart from some abiotic factors such as fire, wind, storms, and climate change, there are many biotic factors like insects and diseases, which can have a devastating impact on the forest landscape. Man-made forests in general and particularly trees are susceptible to pests and diseases. Red sanders, a species with high timber value, is also affected; however the information on disease and pests is scanty.

P. santalinus is most commonly known as red sandal wood, but it also has other common names in several languages. *Pterocarpus* is derived from the Greek words *pteron* (wing) and *karpos* (fruit), referring to the winged pod, while *santalinus* originates from the Latin *sandal* and *inus* (meaning similar to), i.e., a plant with characteristics similar to Indian sandalwood, *Santalum album* L. (Botanical Survey of India 2012). Like African or Nepalese sandalwood and Indian sandalwood, *P. santalinus* is also prized for its hard, dark-purple, bitter heartwood. In India, the natural range of *P. santalinus* used to be a very restricted area of 15,540 km^2 in the southeast. Currently, *P. santalinus* is found exclusively in a well-defined forest tract of Andhra Pradesh in Southern India.

The colour and fragrance of *P. santalinus* heartwood are derived from santalins while the pleasant aroma is caused by the presence of terpenoids (Kumar *et al*. 1974). A dye prepared from the heartwood of *P. santalinus* is used as a stain in light microscopy (Banerjee and Mukherjee 1981; Sen Gupta and Mukherjee 1981), as a coloring agent in pharmaceutical preparations, in food, leather and textile industries (Ankalaiah *et al*. 2017), and as a textile dye (Gulrajani *et al*. 2002). The medicinal properties of *P. santalinus* have been extensively reviewed elsewhere (Navada and Vittal 2014; Azamthulla *et al*. 2015) and will not be covered in this review. However, multiple uses ethnomedicinal uses and phytochemistry

have been provided as supplementary tables to offer a more rounded appreciation of this tree in the context of this review. Natural Resources has placed the species in 'Endangered' category, up listing from its earlier 'Near Threatened' category (Ahmedullah, 2021). The species is listed in Appendix II of CITES which restricts international trade of its wood and wood products from natural sources (Pattanaik, 2019). In general, this species is inherently resistant to insects, fungi and marine borers. Even in nurseries and plantations, redsanders will not encounter any serious effects of pests. Insects that were reported to infest red sanders prior to harvest include *Eotetranychus sexmaculatus*, species of Planococcus, leaf-eating caterpillars, Pyralid caterpillars and white grubs. However, their effects on red sanders were subtle (Umalatha & Anuradha, 2019).

Cerambycidae is one of the economically and ecologically important species-rich families of beetles (Coleoptera) with over 35,000 described species The number of wood-boring cerambycid beetles in the tropics is very large. (Kariyanna *et al*., 2017 & Lawrence, 2014). *Xylotrechus smei* (Castelnau & Gory, 1841) belongs to the subfamily Cerambycinae and tribe Clytini that contains small to large, elongate beetles with reniform eyes, pronotum without lateral margin, notosternal suture rarely complete, usually indistinct and empodium usually small or indistinct (Monné et al., 2017). Several well established alien species belong to the tribe Clytini and the genus *Xylotrechus* with majority of them originating from Asia (Hanceanu et al., 2021).

In India, *Xylotrechus* is represented by 19 species (Kariyanna *et al*., 2017a). Among these, *X. stebbingi* Gahan, 1906 that originated in Northern India, is regarded as notorious pest for invading several Mediterranean and European countries through imported wood. (Braud et al., 2002; Sama & Cocquempo, 1995). Similar to *X. stebbingi*, yet another polyphagous species of this genus is *X. smei*. *X. smei* was originally described from India and it morphologically resembles *X. stebbingi* (Laporte & Gory, 1841; Sama, 2006; Vitali, 2004).

Recently, *X. smei* is reported in several ports of entry in France and US (Roques *et al.*, 2017; Wu et al., 2017). Though widely distributed in India and reported so far from Himachal Pradesh, Kashmir, Uttar Pradesh, Madhya Pradesh and West Bengal, the major hot spots of *X. smei* are the Deccan and the North Eastern regions of India. More than 40 trees were reported as hosts of his pest among which *Morus alba* and *Morus indica* are the most preferred ones in the hot spot areas (Kariyanna *et al*., 2017; Kariyanna *et al*., 2019). Discrepancies that revolved around identification of *X. stebbingi* that was introduced into the western Palaearctic as *X. smei* was recently clarified by Sama (2006). However, it was based on the characters found in prothorax and elytra. Furthermore, information about this pest that appeared as part of faunistic studies from India (Mitra *et al*., 2015; Mitra *et al*., 2017) in the last decade concentrated mainly on the patterns and characters of the surface. However, no attempt was made to describe the details of terminal abdominal segments and genitalia, including their measurements that are inevitable for the authentic identification of this pest as well as in differentiating the male and female. The current study was

undertaken to investigate the possible cause of dying red sander trees in a red sander plantation in Telangana, India and reports the association of *X. smei* with the dying trees. This also provided us an opportunity to report the first detailed description of terminal abdominal segments and genitalia of both sexes of *X. smei* adults along with additional supplementary characters and measurements of grubs and pupae with illustrations for authentic identification of this polyphagous pest.

The severe infestation of *Xylotrechus smei*, Cerambycidae: Cerambycinae: Clytini) wood boring Cerambycid beetle is reported from redsanders plantations in three locations Nimmalgudu, Badradri district, Marlapadu, Vensoor Mandal, and Vishwanadhapuram, kallur Mandal, Khamum district of Telangana, India. Earlier, the occurrence of *Xanthotrechus species* on *P. marsupium* was reported. However, this is the first report of *Xanthotrechus smei* on redsanders.

The grubs (larvae) bore into the host stem and forms tunnel inside the shoot. The shoot becomes prone to breakage. Young plants usually die due to pest infestation while the older ones become unhealthy.

The female beetle, after fertilization, laid eggs in October – November in the cracks and crevices of the primary branches of the host trunk. Ovipositor continues for 20-28 days during which a female lay about 100 eggs. After about 10 day's caterpillars hatches out from the eggs. The caterpillar, initially feed on soft bark of the host but later on the bores through the woody tissues, eating the plant tissues and making multidimensional tunnels. The caterpillars remain inside the tunnel formed in the host tissues for about 10 months and attain a length of 1.5 cm, with a broad head and tapering abdomen. Before pupation caterpillar forms an exit hole and pupate near the whole opening. Pupation period lasts for about 30 days after which adult beetle emerge out. Maximum emergence occurs during April – May or October – December. Only one generation is completed in a year.

In conclusion, the present study reports the infestation of red sanders by *X. smei* for the first time from Telangana, India. Considering the importance of red sanders and severity of *X. smei* on red sanders, control measures are needed for effective management of this pest from both economic and conservation point of view. However, to our knowledge, this is the first report of ***Xanthotrechus*** on redsanders. Instant control measures were provided to farmers for immediate control of this pest.

Remove and destroy dead and severely affected branches of the tree.

Remove alterate host, Mulbery, cotton and other host.

Swab Coal tar+Kerosene@1:2or Carbaryl 50 WP 20 g/l (basal portion of the trunk 2mt above ground level

Apply cabofuron 3G 5g per hole and plug with mud

Apply chloropyriphos 6 ml with lime to trunk or Wrap up the green cloth to trunk to tree trunk to avoid egg laying.

Spray Chloropyriphos 6 ml/l or Spinsad 0.25 ml/l

Fig: 1.larval infestation on wood by wood borer in Redsanders in Telangana (India)

Fig: 2. Eggs and adults (*X. smei*) of wood borer on Redsanders in Telangana (India)

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Red List of Threatened Species: *Pterocarpus santalinus*, IUCN

Appendices I, II and III, CITES

Dinumma placens -A major insect pest of *Albizia* species in nursery stage

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Abstract

Albizia lebbek (Linn.) Benth. and *Albizia procera* (Roxb.) Benth. (family Fabaceae) are commonly known as black siris and white siris respectively and found almost all over the country. Both the species are fast growing and economically important tree species with nitrogen fixing ability. Their cultivations are threatened by a variety of insect pests in nursery and plantations. The present article deals with the pest profile of *Dinumma placens* Walker (Lepidoptera : Noctuidae), which is a major insect pest of *A. lebbek* and *A. procera* in nursery stage.

Key words: *Albizia lebbek*, *Albizia procera*, *Dinumma placens*, nursery insect pest.

Introduction

Albizia Durazz (family Fabaceae) is a genus of more than 160 species of mostly fast-growing are known to occur in tropical and sub-tropical regions of Asia, Africa, America and Australia. They are commonly called sirises. Of these, about 16 species are indigenous to Indian sub-continent (Anon, 1983). The most popular species of these are *A. lebbek* (Linn.)

Benth. and *A. procera* (Roxb.) Benth., commonly called as black siris and white siris respectively and found almost all over the country. Both the species are typical inhabitants of the deciduous types of forests and yield valuable timber. Being fast growing and economically important tree species with nitrogen fixing ability, *A. lebbek* and *A. procera* are widely accepted in plantation programme for agroforestry, social and community forestry (Anon, 1988, 1994).

Both *A. lebbeck* and *A. procera* are always threatened by a good number of insect pests. The perusal of entomological literature reveals that the total number of insect species associated with living plants of *A. lebbek* and *A. procera* are 27 (12 species of defoliators, 7 species of sap-suckers, 6 species of seed-feeders and 2 species of stem-borers) and 33 (23 species of defoliators, 5 species of seed-feeders, 3 species of stem-borers and 2 species of sap-suckers) respectively (Beeson, 1941; Bhasin and Roonwal, 1954; Browne, 1968; Roychoudhury and Sambath, 1998; Roychoudhury, 2002; Roychoudhury and Joshi, 2006; Roychoudhury and Mishra, 2022). Besides these, Roychoudhury et al. (2009) have recorded *Dinumma placens* Walker (Lepidoptera: Noctuidae) feeding on seedlings of *A. lebbek* and *A. procera* for the first time, which is a new addition of insect pest to both the host plants. The present article deals with the pest profile of defoliator, *D. placens* which is a major insect pest of *A. lebbek* and *A. procera* in nursery stage.

Pest profile

Dinumma placens Walker (Lepidoptera : Noctuidae)

D. placens is a moth, first described by Francis Walker in 1858. It is found in the Indian sub-region, Sri Lanka, Thailand, China, Taiwan and Japan (https: //en. wikipedia. org/ wiki/ Dinumma_ placens). According to Hampson (1894), the habitat of *D. placens* is Nilgiris, Sri Lanka and Rangoon.

Field observations of Roychoudhury et al. (2009) reveal that moths lay eggs on tender leaves. Early instars feed on young leaves, whereas later instars prefer mature leaves and consume the entire leaflets except midrib. The larvae of this defoliator are semiloopers, elongated, about 15-20 mm in length and 2-3 mm in breadth when full grown, pale green to dark green in colour with two lateral white lines in between dorsal and ventral side. Pre-pupae are dark green in colour. Pupae are dark brown, obtect and naked. It was observed that pupation occurred in leaf litter or soil and pupal period varied from 6-10 days. The moth of this species has been described by Hampson (1894). The male moth of this species was recognized by the distinguishing characters : head and thorax purplish black, abdomen fuscous with dorsal tufts black, fore wing reddish brown suffused with purplish black, a black basal patch, waved ante- and postmedial lines, the latter angled beyond cell, the area between them black, with a deeper black spot at end of cell, a subapical black and whitish spot on outer margin, with fine blue streaks across it, a similar spot but with no whitish above outer angle and hind wing fuscous. The female moth showed antemedial and outer areas of fore wing redder. The moths were nocturnal, medium sized and wing expense varied from 26-28 and 29-32 mm respectively for male and female moths (Fig.1).

Fig.1. Adult moth of *Dinumma placens*

It has been observed that *D. placens* starts appearing with the onset of rain and cause severe damage to nursery seedlings of both *A. lebbek* and *A. procera* during the rainy season of the year (July-October) (Roychoudhury et al., 2009). The percentage incidence of this insect has been noticed to be 14-20% and 15-22% for *A. lebbek* and *A. procera* respectively. As a whole, *D. placens* is a major insect defoliator of *A. lebbek* and *A. procera* in nursery stage.

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Published by:

Tropical Forest Research Institute
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