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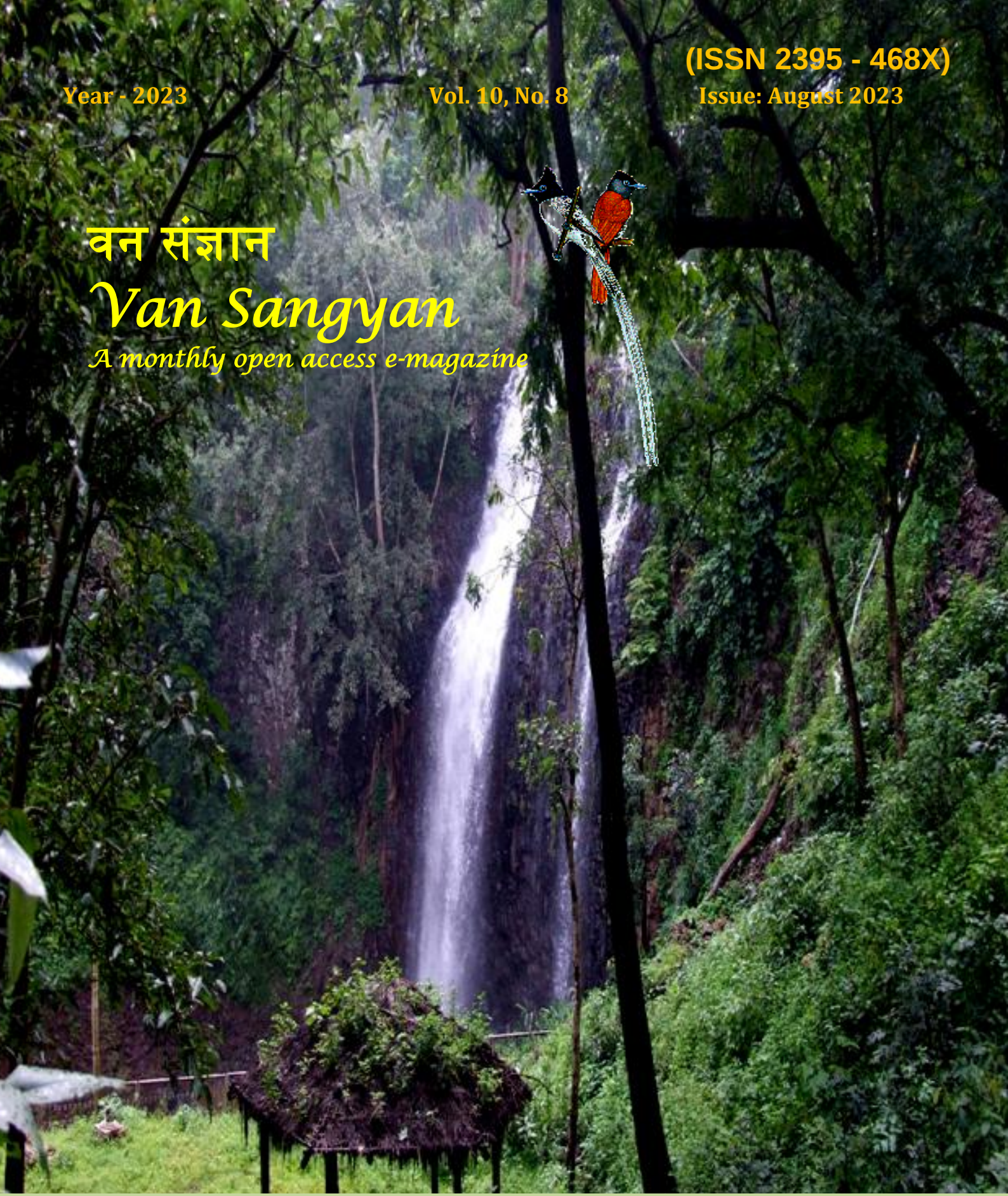

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Van Sangyan

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:

by e-mail to vansangyan_tfri@icfre.org

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

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

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve

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From the Editor's desk

Agroforestry, a land management system that integrates trees with agricultural crops and/or livestock, offers a promising alternative to traditional practices. As the world grapples with the need for sustainable resource management and biodiversity conservation, agroforestry stands out as a practical solution that promotes both economic and ecological resilience. Diversified benefits of agroforestry include enhanced productivity, livelihood diversification, carbon sequestration, soil health improvement, etc. For the popularization and effective implementation of agroforestry, work needs to done on knowledge & Training, policy support, market access. Long-term commitment from farmers and stakeholders is also essential for the success.

In line with the above this issue of Van Sangyan contains an article on Agroforestry as an alternative to forest for diversified benefits and biodiversity conservation. There are also useful articles viz., Buchnania lanzan Spreng (Chironji): A potential wild fruit tree of central India, Pongamia pinnata: An emerging tree in today's chaotic world, Green energy and Net zero emission, वन उत्पादन में बढोत्तरी एवं वनों के संरक्षण के लिए जरूरी लाख उत्पादन, An overview of an endemic tree Gluta travancorica (Chenkurinji), A brief account of the well-known avenue tree in India: Bauhina purpurea L., Preservation of forest resources: An important lifestyle for environment (LiFE) activity since time immemorial in India and RNA Interference: Next generation pest control strategy.

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 as an alternative to forest for diversified benefits and biodiversity conservation

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Introduction

What is Agroforestry?

For centuries, farmers have integrated trees in their farming systems. Agroforestry is an ancient land use practice and modern science involving the deliberate integration as well management of trees on farms and in surrounding landscapes. Agroforestry systems vary greatly in tree species producing a wide range of products and services. Agroforestry is a science that combines view points from the fields of agriculture, ecology, and rural development (Verma et al., 2023a).

Agroforestry is the production of trees and non-tree crops or animals on the same piece of land. It employs integrated concepts which make this land use management system the most self-sustaining and ecologically sound of any agricultural system (Sharma et al., 2017a). It includes integrating trees, crops and livestock in a conservative and productive manner. It can be considered more as an approach than a single finished technology. The flexibility of agroforestry approach is one of its advantages (Sharma et al., 2017b).

Objectives of agroforestry

- To increase awareness of the benefits of the integration of trees with growing crops as a part of sustainable agriculture.
- To raise awareness of the value of agroforestry in improving soil fertility and preventing erosion of soil.
- To raise awareness of the nutritional benefits of various products obtained from agroforestry.
- To gain understanding of the various benefits provided by recommended tree species.

Why agroforestry??

Agroforestry systems make maximum use of the land. Every part of the land is considered suitable for plants that are useful. Emphasis is placed on perennial, multiple purpose crops. Furthermore, systems of agroforestry are designed for beneficial interactions of the crop plants and to reduce unfavorable interactions, to reduce the risks associated with agriculture, small scale or large and to increase the sustainability of agriculture. Agroforestry practices normally help to conserve and even improve the soil. Agroforestry includes recognition of the interaction of crops, both favorable and unfavorable. The most common interaction is ‘Competition’ which may be for light, water or soil nutrients. Competition reduces the growth and yield of any crop invariably. Yet competition occurs in

Fig 1: A typical fruit-based agroforestry system in North-Western Himalayas

monocultures as well and this need not be more deleterious in agroforestry systems. Interactions may be complementary, as in the case of trees, pastures and foraging animals, where trees provide shade and/or forage and animals provide manure (Verma et al., 2021). Agroforestry systems are designed to produce a range of benefits including food, feed, fuels, fibres and usually improving soil fertility (Verma et al., 2023b). Agroforestry systems take advantage of trees for many uses, to hold the soil, to increase fertility through nitrogen fixing trees or through bringing minerals from deep in the soil and depositing them by leaf fall, to provide shade, construction materials, foods and fuel. Agroforestry may be thought as principal parts of the farm system itself which contains many other sub-systems that together define a way of life.

Anticipated outcomes of agroforestry

Communities are encouraged to regard agroforestry and tree planting as a normal activity on farmland. The building and maintenance of tree nurseries in local communities and the introduction of a variety of recommended tree species.

- Farmers are encouraged to experiment and compare various techniques for tree planting.
- People learn the value of local trees and gain confidence in their local knowledge.
- The improvement of soil fertility and conservation.
- The improvement of family nutrition.
- Fuelwood becomes more available, benefitting the local environment.

The provision of opportunities to improve small holder income (Sharma et al., 2022).

The agroforestry systems comprise the following four components-

LAND

Land is considered as the most important basic natural resource. It is a dynamic and complex combination of geology, topography, hydrology, soil, flora and fauna and influences every sphere of human activity. Different sectors including agriculture, industries, infrastructure and power projects put forth competing demand for land. Subsistence farming practices, accelerated soil and water erosion, erratic rainfall, increasing population and high density of livestock

population has all contributed to unsustainable land use that has led to degradation of this valuable resource. Agroforestry is a system to manage agricultural resource and land for the benefits of the farmer and long-term welfare of the society.

Trees

In agroforestry, particular attention is placed on multipurpose trees and perennial shrubs. The most important of the trees are legumes because of their nitrogen fixing ability. Considerable knowledge of the trees is important for incorporating them in agroforestry such as size and forms the canopy, root system, climatic adaptation of the species, adaptation to various soils and stresses and suitability for various practices (Kumar et al., 2021). Trees in an AFS can be planted in many ways viz. individual trees, scattered trees, lines of trees with crops (alley cropping), strips of trees along contour and waterways, boundary lines, living fences, windbreaks, shelterbelts, terrace planting on hill wood lots etc. The role of trees in an AFS includes-

- Source of fruits, nuts and edible leaves
- Source of non-edible materials including resin, tannin, insecticides and medicinal products
- Source of construction materials, posts, lumber and thatching
- Source of fuel
- Beautification and shade
- Soil conservation and improvement of soil fertility
- Water quality improvement
- Climate amelioration
- Carbon sequestration and climate change mitigation (Nasam et al., 2022)

Crops

Any crop plant can be used in AFS. Choice of crop plants in designing AFS should be based on those crops already produced in a particular region for home consumption, feeding animals, or that have great promise for production in the region. Choice of crops in agroforestry is based on certain values of crops viz. food crops, vegetable crops, forage crops, oil crops, cash crops and medicinal crops (Minz et al., 2021)

The crops are selected based on the following criteria:

- Crops for making money
- Crops for feeding the farmer
- Crops for good nutrition
- Crops for self sufficiency
- Crops for feeding the farm animals
- Crops for protecting the soil

Animals

Animal's viz. cow, bull, buffalo, goat, sheep, piggery, poultry and fish can be used. The choice of animal will be based on:

- Animals for making money
- Animals for feeding the farmer
- Animals for supplying labour
- Animals for non-food products
- Animals for using crop residues
- Animals for producing manure

The agroforestry strategies can be defined mainly through three main features:

1. The minimisation of risk or crop failure,
2. The optimisation of labour efficiency, and

3. The possible use of improved planting material and inputs.

Agroforestry has been in use for at least 1300 years, although tree domestications probably started much earlier. Agroforestry was brought from the realm of indigenous knowledge into the forefront of agricultural research less than four decades ago and was promoted widely as a sustainability-enhancing practice that combines the best attributes of forestry and agriculture.

Concepts of agroforestry

To be called agroforestry, a land use practice must satisfy all of the following four criteria/ four "I" words (Gold and Garrett 2009):

Intention

Combinations of trees, crops and/or animals are intentionally designed and managed as a whole unit, rather than as individual elements which may occur in close proximity but are controlled separately.

Intensive

Agroforestry practices are intensively managed to maintain their productive and protective functions, and often involve annual operations such as cultivation, fertilisation and irrigation.

Interactive

Agroforestry management seeks to actively manipulate the biological and physical interactions between tree, crop and animal components. The goal is to enhance the production of more than one harvestable component at a time, while also providing conservation benefits such as non-point source water pollution control or wildlife habitat.

Integrated

Tree, crop and/or animal components are structurally and functionally combined into a single, integrated management unit. Integration may be horizontal or vertical, and above-ground or below-ground.

Agroforestry as a science should be based on four key features: a) competition, b) complexity, c) profitability, d) sustainability.

Agroforestry for biodiversity conservation

Agroforestry is increasingly being acknowledged as an integrated land use that can directly enhance biodiversity and contribute to the conservation of landscape biodiversity. Biodiversity plays a vital role in sustaining human life and the health of our planet. Biodiversity is defined as the totality of genetic, species and ecosystem diversity that constitutes life on earth. Biodiversity which contributes immeasurably to the sustainable production of many goods and services is continued to decline at an alarming rate. Some of the important responsible factors for the current affairs of biodiversity are over exploitation of species, invasion by alien species, environmental pollution and contamination, global climate change, alteration of ecosystems and degradation and loss of habitats (Rands et al 2010).

Alarming rate of important ecosystems and species disappearance in sustaining human life and the health of our planet called for immediate action to conserve biodiversity worldwide.

Jose (2009) portrayed five major roles of agroforestry in biodiversity conservation:

1. Agroforestry provides habitat for species that can tolerate a certain level of disturbance,

2. Agroforestry helps to preserve germplasm of sensitive species,
3. Agroforestry helps to reduce the rates of conversion of natural habitat by providing a more productive, sustainable alternative to traditional agricultural systems that may involve clearing natural habitats,
4. Agroforestry provides connectivity by creating corridors between habitat remnants which may support the integrity of these remnants and the conservation of area-sensitive floral and faunal species,
5. Agroforestry helps to conserve biological diversity by providing other ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat.

Agroforestry systems by their very nature are more diverse than monocultures of crops and livestock; this increase in 'planned' biodiversity, i.e. the components chosen by the farmer, increases the 'associated' biodiversity i.e. the wild plants and animals occurring on the farm land. Role of agroforestry in conserving tropical biodiversity has been documented by the various researchers of the world. These studies demonstrate that agroforestry systems support floral and faunal assemblages that can be as species-rich, abundant and diverse as forests, but often with modified species compositions that include non-forest species (Harvey et al 2007).

Thus, in agroforestry, integration of trees and livestock on farm land increases biodiversity; this varies with land management practices, cropping pattern and arrangement of different components. These components in agroforestry introduce another kind of biodiversity in soil flora and fauna, herbivores, carnivores, decomposers, etc.

Agroforestry for aesthetics and cultural services

The visual impact of monocultures of crops or trees is unattractive for many people and in agroforestry integration of trees into agricultural landscapes can increase the diversity and attractiveness of the landscape (McAdam et al 2008). Traditional agroforestry systems such as traditional home gardens, tree-based coffee farming, grazed orchards, parkland and wood pastures are valued for their visual appeal. However, establishing modern agroforestry systems which tend to be more artificial, geometric and rigid in appearance than traditional systems causes aesthetic changes at a landscape scale, and such changes must be carefully considered in the design and location of such systems (Bell 2000).

Agroforestry is the traditional practice of cultivating trees on farm land and it is said that in many countries in the world, trees are indispensable part of their culture. People believe that forests or trees are the links between the sky and earth often symbolize links between the spiritual world of ancestors and people. The variety of cultural values and symbolic functions ascribed to the trees or forests are as numerous and diverse as the communities and cultures of the region. Tangibly and intangibly, trees or forests feature in all aspects of culture: language, history, art, religion, medicine, politics, and even social structure itself. Trees may house the

spirits of ancestors as well as those of the new born. The tree features in many myths and tales. It consistently reflects a few important symbolic images. The tree stands between heaven and earth and is associated with creation as well as the underworld ("cosmic tree"). The tree is a motherly symbol: a protector and provider who gives fruit, other foods and medicines, provides a reservoir for waterprotects against the elements and evil spirits. The tree symbolizes human productiveness. Owing to the associated cultural values trees are being introduced either on farm land or in homesteads in many tropical countries.

Thus, agroforestry can sustain human life through production of food, wood, and in addition to environmental services such as climate change mitigation, enhanced water quality and quantity and biodiversity conservation.

Conclusion

Multifunctional functioning ecosystem that has been shown to be successful in preserving and enhancing biodiversity at all scales, from the farm to the landscape, is agroforestry. Agroforestry benefits for biodiversity are explored and illustrated in this special issue, along with the methods by which agroforestry systems can support such high levels of floristic and faunal diversity. This article considerably increases the body of information on this intricate subject, which will aid in the promotion of agroforestry. They also draw attention to the demand for more thorough long-term research on agroforestry techniques globally. In order to conduct study and monitor biodiversity, long-term data sets are a crucial resource.The essays in the special issue underline the significance of agroforestry as a vital tool in conserving biodiversity in human-dominated environments, even though it is necessary to conserve biodiversity through protected areas.

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

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Introduction

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

Origin and distribution

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

Description

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

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

PC: Gauri Rawale @CAFRI, Jhansi

Soil and climate

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

Propagation

- This plant can be propagated through seeds which are collected in the month of April to June. It lose seed viability with time and having somewhat irregular good seed years. Freshly collected seeds are reported to give 85% germination which progressively decreases with the passage of time (Luna, 2005).
- Mechanical scarification *i.e* damaging the hard endocarp before sowing helps to improves germination percent. Generally germination starts within a week and completes in 30 days.
- It is a slow growing species. Also it possesses exogenous dormancy due to hard seed coat. Ajith *et al*., 2018 reported that scarification with GA_3 200 mg for 12 hrs helps to breaks dormancy in stored seeds of *B. lanzan* and improves the germination upto 90% per cent.
- It is important to consider the sowing time and depth of sowing because it affects the germination behavior and growth of chironji. Best germination was recorded when seeds are sown in March at 1cm depth compared to seeds sown in November and December. However, some researcher recommended for surface sowing or at 0.50 cm sowing depth for early and better seed germination under nursery.
- Singh and Singh (2014), concluded that bud sprout (68.00%) and graft success (66.66%), were noted highest in July for the softwood grafting of chironji. Irrespective of scion and rootstock, maximum accumulation of nitrogen and carbohydrate contents wasrecorded in March. Softwood grafting in July may be adopted for

multiplication of elite chironji genotypes.

Harvesting and yield

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

Conservation

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

Conclusion

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

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Pongamia pinnata: An emerging tree in today's chaotic world

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Introduction

One of India's richest and most brilliant trees is known as the "Pongam Tree." According to science, the tree is known as *Pongamia pinnata*. The Tamil word "pinnata," which means "Pinnate leaves," is where the name "Pongamia" originates. The tree belongs to the 'leguminosae' family. The 'Papilionaceae' subfamily belongs to it. The terms "Ponga," "Dalkaramacha," "Pongam," and "Punku" are all used to refer to this in Tamil. It is referred to as "Karanj," "Papar," or "Kanji" by its native speakers of Bengali and Hindi, respectively. English speakers refer to it as the "Karum Tree" or the "Poonga Oil Tree." It is a leguminous tree that fixes nitrogen and can tolerate drought, water logging, moderate frost, and salinity with ease. It is also able to thrive in challenging climatic and soil moisture conditions. For the treatment of many human diseases and diets, *Pongamia pinnata* has been mentioned in a variety of traditional medical systems. Alkaloids, flavonoids, tannins, hormones, glycosides, karangin, glabrin, kanugin, and other phyto constituents are among its components *Pongamia pinnata*has a long history of usage as a folk remedy, primarily in the Ayurvedic and Siddha traditions of Indian medicine. Plant extracts can be used for their anti-inflammatory, anti-nonciceptive, antioxidant, anti-diarrheal, anti-fungal, anti-hyperglycaemic, anti-lipoxidative, anti-hyperammonic, anti-plasmodial, anti-ulcer, and analgesic properties. The usefulness of P. pinnata as a source of biomedicine has recently been described, specifically as antibacterial and therapeutic agents. It has been widely used in agriculture and environmental management with insecticidal and nematicidal action. The tree is well known for its many uses as well as its potential as a biodiesel source. The seeds' typical oil content is reported to be between 28 and 34 percent, with a high concentration of polyunsaturated fatty acids. It has other uses besides being a possible biodiesel tree; the leaves are used as cattle feed, deoiled cake is used as animal feed, wood is used as fuel, and oil is used as an alternative fuel. It is a native of the Western Ghats and is primarily found in India's tidal forests. *Pongamia pinnata*, often known *as Derris indica*, is a monotypic genus that is widely distributed throughout Myanmar's rivers and beaches.

Furthermore, *Pongamia pinnata* has been recognised as a resource for agroforestry, urban landscaping, and the bioamenerification of damaged soils. As a result of the fact that climate change is a worldwide concern, understanding more about this particular species is advantageous in a variety of ways, particularly when calculating the carbon sequestration capacity and obtaining biodiesel from the tree's seeds to use as a source of input for worldwide efforts to ameliorate the issue.

"Karanj" as a folk remedy

This plant's entire life cycle has been extensively utilised in traditional medicine to treat a wide range of ailments and wounds. Since Prof. Limaye's 1925 initial investigation of this species, it has been more than 80 years. His investigation into the chemistry of *Pongamia pinnata* led to the discovery of the furanoflavonekaranjin, which has since become the emblem of this plant. *Pongamia pinnata* has been used as a crude medication to treat tumours, piles, dermatological issues, and ulcers. The root is useful for treating gonorrhoea, cleansing gums, teeth, and ulcers, as well as vaginal and skin-related disorders. This plant's many parts have historically been used to cure a variety of illnesses, such as bronchitis, whooping cough, rheumatism, diarrhoea, and leprosy. According to reports, *Pongamia pinnata* oil exhibits antibacterial efficacy against *Aspergillus niger*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. This was done using the dry weight method and the Minimum Inhibitory Concentration (MIC) determination. *Pongamia pinnata* crude leaf extract's antibacterial activity is assessed in terms of how it affects the production and behaviour of enterotoxins. Its extraction reduces cholera toxin synthesis and bacterial penetration of epithelial cells, but it has no antibacterial, anti-giardia, or anti-rotaviral properties. This suggests that *P. pinnata* extraction has effective cholera-fighting ability as well as specific anti-diarrheal action. Through in vitro research in vero cells, the antiviral capabilities of *Pongamia pinnata Linn,* used to treat clinical lesions of the skin and genitalia, were examined. At concentrations of 1 and 20 mg/ml (w/v), respectively, a crude aqueous seed extract of *Pongamia pinnata* totally prevented the growth of HSV-1 and HSV-2, demonstrating the absence of any cytopathic effect. Anti-inflammatory 70% ethanolic extract of *Pongamia pinnata* leaves has been shown to have substantial anti-inflammatory efficacy against various stages of inflammation (acute, subacute, and chronic), without having any negative effects on the gastric mucosa. Additionally, they noticed the extract had a large antipyretic effect against pyrexia caused by Brewer's yeast.

Ponagmia: a potential biofuel

Due to its high oil content, mature karanja seeds have recently garnered significant commercial relevance and are being investigated as a potential alternative fuel and energy source. Crop plants that produce oil are crucial to the expansion of the agricultural and energy industries. The polyun saturated fatty acid-rich oil seeds are a significant source of biodiesel. These organic seed oils have better physico-chemical characteristics and biodegradability than diesel fuels. Pongam is a type of such plant. Oil and antibacterial activity were analyzed from

seeds of the elite genotype of *Pongamia pinnata* by Kesari et al. The oil production from seeds that was recovered in n-Hexane was the greatest (33%). The appropriateness of *Pongamia pinnata* for use as a potential biofuel crop was determined by the physico-chemical characteristics of crude oil. According to GC-MS analysis, there were more mono unsaturated fatty acids overall (oleic acid made up 46% of seed oil) than poly-unsaturated fatty acids (33%). The investigated bacterial and fungal cultures were also inhibited by seed oil. However, it was discovered that the effectiveness of the seed oil's antimicrobial activity at four concentration levels-50%, 80%, 90%, and 100%- against certain pathogenic signs depended on the concentration. The outcomes supported the use of *Pongamia pinnata's* well-characterized elite genotype's seed oil in both medicines and diesel fuel.

"Karum": a strong phytoremediation tool

In addition to the issues caused by rising temperatures brought on by climate change, the world is also dealing with issues related to soil erosion brought on by mining and pollution. Therefore, it is essential to develop appropriate tree species-based solutions that are effective in reducing global warming, achieving detectable levels of carbon sequestration, and improving problematic soils. One such species, *Pongamia pinnata*, is capable of improving the upper environment as well as the soil. As contaminated soils are typically devoid of nutrients, the capacity to establish symbiotic relationships with soil microbes as AM and rhizobia is particularly essential. Pongamia is an excellent option for phytoremediation because of its relatively quick growth rates, high biomass output, extensive root system, capacity to grow in marginal land, and capacity to develop symbiotic interactions with soil organisms. Additionally, Pongamia's viability as a phytoremediation technique is significantly increased by the possibility of growing a biofuel crop on degraded land because it would make the crop more commercially feasible. According to some reports, pongamia has the ability to phytoremediate heavy metals from tanneries, fertiliser factories, and other sources, including arsenic (As), copper (Cu), and chromium (Cr). According to Etim (2012), phytoextraction, rhizofiltration, phytostabilization, phytovolatilization, phytodegardation and rhizodegradation are the mechanisms involved in phytoremediation. Karanj is tolerant of a wide range of soil anomalies, including extreme salinity, mild alkalinity, toxicity, water logging, and deficiency in soil fertility. Low rainfall and marginal soils are both suitable for growing the tree. However, it is advised to have the soil examined before growing Karanj in order to put a series of measures in place that will increase the crop's kernel and oil yield.

Pongam: a substantial Carbon Sequester

Pongamia pinnata, a species of deciduous tree, is one of the common trees found in the research region. Since climate change is a global issue, learning more about this particular species is beneficial in a number of ways, especially when estimating the carbon sequestration potential and extracting biodiesel from the tree's seeds to

use as a source of input for global efforts to mitigate the problem. It was discovered that the carbon sequestration potential of *Pongamia pinnata* (Karanj) was significantly higher than that of numerous other tree species during the first 10 to 15 years of its growth. It was shown that Pongamia sequestered 45 to 50 kg of carbon per tree each year, compared to 28 to 35 kg for Neem (*Azadirachta indica*), 23 to 26 kg for Mahua (*Madhuca latifolia*), and 11 to 15 kg for Tendu (*Diospyros melanoxylon*). Hence karanj is emerging as a potential tree for mitigating the effects of climate change.

Conclusion

In conclusion, the Pongam tree, scientifically known as *Pongamia pinnata*, is a remarkable tree with diverse uses and significant potential. It has been utilized for centuries in traditional medicine systems due to its medicinal properties, offering remedies for various ailments. Its extracts have demonstrated anti-inflammatory, antioxidant, antimicrobial, and antiviral activities, making it a valuable resource in healthcare. Moreover, *Pongamia pinnata* has gained attention as a potential biodiesel source, with its oil-rich seeds offering a sustainable alternative fuel option. The tree's ability to thrive in challenging environmental conditions and its remediation capabilities make it valuable for agroforestry, urban landscaping, and soil rehabilitation efforts. Additionally, *Pongamia pinnata* exhibits a substantial carbon sequestration capacity, outperforming several other tree species in the initial years of growth. This quality positions it as a valuable asset in combating climate change and mitigating its effects. Overall, the Pongam Tree stands as a prime example of nature's versatility and potential. Its combination of medicinal properties, biodiesel production potential, soil remediation capabilities, and carbon sequestration capacity make it an important player in addressing societal and environmental challenges. By harnessing the benefits of this tree, we can promote sustainable development and contribute to a greener and healthier future.

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Green energy and net zero emission

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Introduction

Green energy is a term for energy that comes from renewable sources. It is often referred to as clean, sustainable, or renewable energy. The production of green energy does not release toxic greenhouse gases into the atmosphere, meaning it causes little or no environmental impact. Some important green energy sources include power produced by solar, wind, geothermal, biogas, low-impact hydroelectricity, and certain eligible biomass sources. Net zero emission is referred to as carbon neutrality**,** which does not mean that a country would bring down its emissions to zero. Rather, it is a state in which a country's emissions are compensated by the absorption and removal of greenhouse gases from the atmosphere. Further, absorption of the emissions can be increased by creating more carbon sinks such as forests. While the removal of gases from the atmosphere requires futuristic technologies such as carbon capture and storage. More than 70 countries have promised to become Net Zero by the middle of the century i.e., by 2050. India has promised to cut its emissions to net zero by 2070 at the Conference of Parties Cop-26 summit.

Goals of green energy and net zero emission

India's renewable energy targets have steadily become more ambitious, from 175 GW by 2022 declared at Paris, to 450 GW by 2030 at the UN climate summit, and now 500 GW by 2030**,** announced at COP26. India has also announced the target of 50% installed power generation capacity from non-fossil energy sources by 2030, raising the existing target of 40%, which has already been almost achieved.

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for 'LIFE'– 'Lifestyle for Environment' as a key to combating climate change.
2. To adopt a climate-friendly and cleaner path than the one followed hitherto by others at the corresponding level of economic development.
3. To reduce the Emissions Intensity of its GDP by 45% by 2030, from the 2005 level.
4. To achieve about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of the transfer of technology and low-cost international finance including

from the Green Climate Fund (GCF).

5. To create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030.
6. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, the Himalayan region, coastal regions, and health, and disaster management.
7. To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
8. To build capacities, and create a domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies.

Initiatives taken for green energy and net zero emission

- In 2019 India announced that it would take up its installed capacity of renewable energy to 450 GW by 2030.
- The Production Linked Incentive Scheme (PLIS) is another initiative of the Government of India with respect to enhancing the manufacturing sector for the production of raw materials for renewable energy.
- The PM- KUSUM (Pradhan Mantri-Kisan Urja Suraksha evam Utthaan Mahabhiyan) aims to provide financial and water security to farmers through harnessing solar energy capacities of 25,750 MW by 2022. Solarisation of water pumps is a step in distributed power provided at the doorstep of the consumer.
- The Ministry of New and Renewable Energy on its website also hosts Akshay Urja Portal and India Renewable Idea Exchange (IRIX) Portal. It is a platform that promotes the exchange of ideas among energy conscious Indians and the Global community.

Solar Energy

India has undertaken one of the world's largest solar energy installation initiatives. Irrespective of whether it achieves the 175 GW capacities by 2022 or the 450 GW target by 2030.

Creating carbon sinks

India Cooling Action Plan (ICAP) will help address cooling requirements and reduce the cooling demand in the country. The Bureau of Energy Efficiency (BEE) and Energy Efficiency Service Limited (EESL) has taken a number of initiatives under the National Mission for Enhanced Energy Efficiency (NMEEE) to combat climate change.The Compensatory Afforestation Management and Planning Authority (CAMPA) Fund created under the Compensatory Afforestation Fund Act, 2016, has thousands of crores which will hopefully be utilised soon to compensate

for deforestation and restore the green cover comprising native species of trees.

Hydrogen Energy

India has also announced a Hydrogen Energy Mission for grey and green hydrogen.

Others are

- Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)
- Green Energy Corridor (GEC)
- National Smart Grid Mission (NSGM) and Smart Meter National Programme
- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME)
- International Solar Alliance (ISA)

Challenges in India's energy sector

- Energy Poverty and Inequality: Access to energy is a tremendous problem in India and major inequalities of access plague the country. Around 77 million households in India still use kerosene for lighting.
- The problem is even more acute in rural India where up to 44% of households lack access to electricity.
- While India has undertaken various programs and initiatives to address energy poverty, they have been faced with logistical problems and inadequate implementation locally.
- Import Dependence and Weaponization of Supply Chain: India's crude oil import bill surged 76% to USD 90.3 billion in the first half of 2022-23 and total import quantity increased by 15%.
- With its growing dependency on imported oil, India's energy security is under severe strain, and the current disrupted global supply chain due to disturbed geopolitics is compounding the problem.
- In terms of renewable energy, India is also largely dependent on foreign countries like China for solar modules.
- Backward integration in the solar value chain is absent as India has currently no capacity for manufacturing solar wafers and polysilicon, which is hindering clean energy transition.
- Climate Change Induced Energy Crisis: Climate change directly affects fuel supply, energy requirement as well as the physical resilience of current and future energy infrastructure.
- Heat waves and disturbed monsoon due to climate change are already putting existing energy generation under stress, making it even more important to reduce fossil fuel emissions.
- Women's Health at Risk: Women tend to take an active part in household activities and are at risk when long-term household energy is derived from non-clean resources such as firewood, coal, and cow dung.
- The use of non-clean energy sources increases women's risk of respiratory, cardiovascular, and psychological diseases and also increases maternal and infant mortality.

- Widening Gap Between Demand and Supply of Coal: Data from the Ministry of Coal in 2021, reveal that the gap between demand and domestic supply of coal is widening.
- Despite the availability of adequate reserves, coal extraction has been declining in the larger coal producing States.
- Owing to the rising prices and unresolved pending contractual issues with power plants is worsening the issue.
- Increasing Demand, Increasing Energy Cost: With an increasing rate of urbanisation and industrialisation, the International Energy Agency said in its World Energy Outlook report that the need for energy in India alone would rise by more than 3% annually.
- At the same time, there is a sharp increase in costs of petroleum globally.
- Ways toward energy sector
- Interlinking Women Empowerment with Green Energy: Women's empowerment and leadership in the energy sector could help accelerate the transition to a low-carbon economy by promoting clean energy.
- The "just transition"should also include a gender perspective, to guarantee equal opportunities in green jobs for both men and women in the workforce.
- Particularly in the household as responsible mothers, wives and daughters, women can also play an important role in the green energy transition in entrepreneurship and policy making.
- Diversifying Green Supply Chain: Supply chains for clean energy need to be diversified to a much larger number of countries rather than just confined to developed countries.
- In this regard, COP27's agenda of climate finance can be used as a carrier. As traditional energy sources get replaced, revenues and employment will shift from certain geographies to others and this will need to be carefully managed.
- Incentivising in Least-Cost Energy Solutions: India can encourage university-level innovations that help India pursue an economically viable clean energy transition. Thus, India's demographic dividend can also be utilised and students will be pushed more toward research and innovation than traditional education.
- For example, the Unnat Jyoti by Affordable LEDs for All (UJALA) program decreased the unit cost of LED bulbs by over 75%.
- The Ministry of Environment, Forestry and Climate Change, along with the United Nations Development Programme (UNDP), jointly launched 'In Our LiFEtime', a campaign that both urges and encourages young people between the ages of 18 to 23 years to adapt and promote sustainable lifestyles is also a good step in this direction.

- Focusing on Green Transport: There is a need to rethink and restore confidence in public transport, including the procurement of more buses, the adoption of e-buses, bus corridors and bus rapid transit systems with digitization of public transport.
- Emission norms should be tightened as well as biofuels should replace fossil fuels.
- The development of several electric freight corridors to promote electrification is also crucial to reaping the benefits of electric vehicles.
- Multisectoral Approach to Energy Transition: In India, future growth will demand resilience on multiple fronts, such as energy system design, urban development, industrial growth and internal supply-chain management, and the livelihoods of the underprivileged.
- India can gradually reduce its exposure to commodity imports and foreign supply chains through distributed energy systems and the promotion of domestic manufacturing.
- India's manufacturing prowess and technology leadership present an opportunity to leverage Make in Indiato turn India into a more self-sufficient green economy and globally competitive green energy export hub over time.
- Circular economy solutions linked with green energy should become a core feature of India's future economy.

Conclusion and suggestions

Climate change is an existential threat that has the potential to change the course of human history for the worse. Fossil fuels are the traditional energy sources that constitute the largest contributors to climate change. They account for over 75% of global greenhouse gas emissions and approximately 90% of all carbon dioxide emissions. For a better future, green energy is the key solution through which India's net zero emission target by 2070 can also be accomplished. Therefore, India should pioneer a new model of economic development that could avoid the carbon-intensive approaches that many countries have pursued in the past and provide a blueprint for other developing economies for clean energy transition. Achieving net zero by 2070 would increase annual GDP by up to 4.7% by 2036. Suggested various policies to boost renewables and electrification could make net zero possible by mid-century. Ending new coal by 2023 and transitioning from unabated coal power by 2040, would be particularly impactful for reaching net zero emissions closer to mid-century. However, they fit a general pattern of incremental progress on climate action at the global level that lacks the collective sense of urgency required to limit global warming to 1.5 degrees Celsius below pre-industrial levels. Further, whether India and the world can go with limited short-term emissions reduction and ambitious long-term climate action plans is something that remains to be seen.

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वन उत्पादन में बढोत्तरी एवं वनों के संरक्षण के लिए जरूरी लाख उत्पादन

योगेश यादवराव सुमठाणे

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लाख उद्योग का महत्व

लाख उद्योग एक ऐसा मुनाफे का उद्योग है। जो कम लागत के साथ आरम्भ किया जा सकता है। इस उद्योग के जरिये जहाँ लाखों ग्रामिण बेरोजगारों कों रोजगार के अवसर सुलभ होते है । वही पर्यावरण का भी संरक्षण होता है । लाख में अनेक प्रकार के तत्व पाए जाते है । जैसे –राल 68-90 प्रतिशत, खनिज तत्व 3-7 प्रतिशत, जल 3 प्र.श, एल्कमिन 5-10 प्र. श. आदि.

भारत में लाख उद्योग का एक लम्बा इतिहास रहा है। प्रचीन ग्रंथों जैसे महाभारत में भी लाख के भवन यानी लाक्षाग्रह का उल्लेख मिलता है , जिसका निर्माण कौरवों ने पांडवों के विनाश के लिए किया था। भारतीय प्राकृतिक राल एवं गोंद संस्थान , रांची के अनुसार विश्व भर में भारत सबसे बडा लाख उत्पादक देश है। यहॉ विश्व के कुल लाख उत्पादन का लगभग 50-60 प्र.श. उत्पादन होता है। वर्तमान में भारत में करीब 20,000 मेट्रिक टन लाख उत्पादन प्रतिवर्ष किया जा रहा हैं । लाख का उद्योग जंगल से सदे इलाकों में रहनेवाले आदिवासी लगभग 30-40 लाख लोग यह उद्योग अपनाकर अपना गुजर बसर कर रहे है। कुछ शहरों में जैसे झारखंड राज्य में आदिवासियों की संम्पूर्ण कृशि सम्बन्धी आय का लगभग 35 प्र.श. लाख उद्योग द्वारा सम्पुरित होता है।

लाख किससे मिलता है?

कुसुम (स्लीचेरा ओलियोमा) या कोसम , सैपिंतडेसी कुल के वृक्ष को "लाख वृक्ष" के नाम से भी जाना जाता है। अधिकतर वृक्ष वनों एवं ग्रामीण क्षेत्रों में महुये के वृक्ष की भाँति होता है। वृक्षों का आकार भी इसी प्रकार का होता है। फरवरी –मार्च माह में पतझड के समय नये पत्तों का रंग काफी आकर्षक एवं लगभग लाल होता है। कुसुम बीज का तेल जलाने एवं अन्य कार्यो में उपयोग किया जाता है। कुसुम वृक्षोंपर रंगीनी प्रजाति के लाख कीट का पालन नही किया जा सकता । अत : रंगीनी एवं कुसुमी लाख कीट में भेद करने के लिऐ यह एक अच्छा वृक्ष है। इस वृक्ष पर ग्रीश्म कालीन और शीतकालीन दोनों मौसम में लाख कीट को पाला जा सकता है। रंगीनी लाख कीट की तुलना में कुसुमी लाख कीट की नजदीक-नजदीक बैठते है | एंव इनकी लाख उत्पादन क्षमता रंगीनी के मुकाबले अधिक होती है। कुसुमी लाख से शीतकालीन और ग्रीश्म कालीन फसल क्रमश: जुन-जुलाई से जनवरी-फरवरी तथा जनवरी-फरवरी से जुन –जुलाई तक की होती है । सामान्य परिस्थिति में कुसुम वृक्ष पर कुसुमी कीट की उत्पादन क्षमता छ : माह की फसल में 7-8 गुनी होती है।जिसका तात्पर्य है की एक कि .ग्रा बीहन लाख लगाने से 7-8कि.ग्रा.बीहन का उत्पादन आसानी से प्राप्त किया जा सकता है। कुसुम वृक्ष आकार में काफी विशाल सामान्यता 4-6 किलो

बीहन लाख की आवश्यकता होती है। जिससे छ: माह पश्चात 30 से 45 किलो बीहन लाख प्राप्त किया जा सकता है।

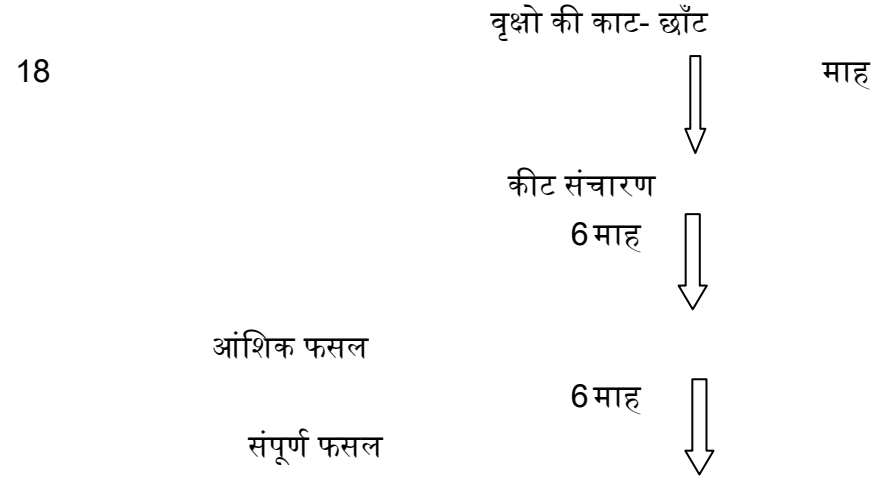
लाख किटों की संरचना एंव संचारण

वृक्षों की नर्म ट हनियों पर शिशू कीट फैलाने की प्रक्रीया ही कीट संचारण कहलाती है। इस के लिये बीहन लाख टहनियों के लगभग 6" इंच के टुकडे काट लेते है, काटते समय बीहन लाख टहनियों के ऐसे भाग जिस पर पपडी नही है , हटा देते है। बीहन की कटाई रोल कट सिकेटियर से करते है। लगभग 100 ग्राँम बीहन का बंडल को दोनों और से सुतली से बांध लेते है, बडी हूई सुतली से मोठी डाली पर इस प्रकार बाँधते है कि , इससे निकले हूये शिशू किट आगे उपलब्ध नर्म टहनियों पर पूर्ण रुप से बैठ जाये। यदि 60 मेश नायलॉन जाली के थैले (27 × 10 सेमी) उपलब्ध हो तब बीहन लाख इसमे भरकर डालियो पर बाँधना चाहिए । इससे एक तो छोटे बीहन टूकडे का भी उपयोग हो जाता है , तथा शत्रु कीटों की रोकथाम का उपाय भी होता है।

लाख विक्री हेतू तयारी

बीहन लाख से संपूर्ण लाख शिशू किट निर्गमन के पश्चात बची लाख डंडी ही फुंकी लाख कहलाती है| जैसे ही इसमें से कीट निर्गमन समाप्त हो इसे वृक्षों से उतारकर छील देना चाहीए एवं कम भी कर देना चाहीए ।

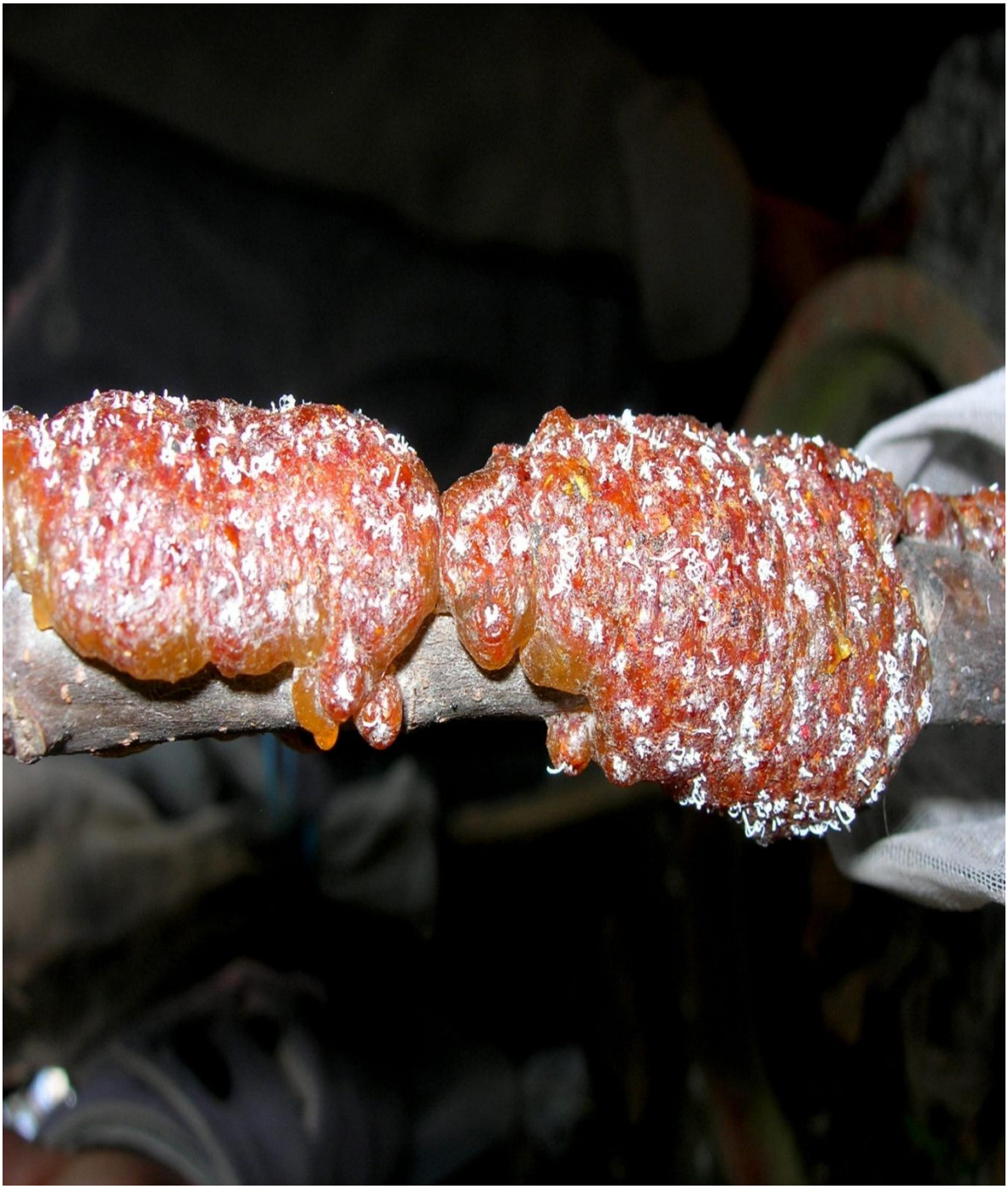
फसल कटाई के पश्चात कुसुम का वृक्ष सामान्यता १८ माह पश्चात पुन : लाख कीट संचारण हेतु तैयार होता है। अंत: फसल चक्र के क्रम को बनाये रखने के लिए पेंडों को खंड मे बाँट कर लाख उत्पादन करना ही उचीत है। प्रत्येक वृक्ष का उपयोग निम्मनविधी से करते है।



- कुल उपलब्ध वृक्षों को 4-5 खंडों में आवश्यकता नुसार बाँट ले।
- प्रत्येक खंड के वृक्षों को 6 माह के अंतराल पर काँट -छाँट करे।
- काँट –छाँट के 18 माह के पश्चात कीट संचारण करे।
- कीट संचारण के 6 माह पश्चात आंशिक फसल कटाई करे ।
- आंशिक काँट –छाँट के छ : माह पश्चात: संपूर्ण फसल काँट ले एवं इसी समय वृक्षों की काँट-छाँट भी कर दी जाए।
- खंड प्रणाली के अंतर्गत आंशिक कटाई से प्राप्त बीहन को दूसरे खंडो के वृक्ष पर चढाते रहे एवं संपूर्ण कटाई सें प्राप्त बीहन बाजार में बेच कर अपनी आय बढाये।

कुसुम का पेड़

लाख के कीड़ों द्वारा जमाई हुई लाख



कुसुम के पेड़ की कटाई छंटाई

An overview of an endemic tree *Gluta travancorica* (Chenkurinji)

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Abstract

Gluta travancorica Bedd. (Anacardiaceae (Mango family); Tirunelveli Redwood) is an extremely endemic and threatened tree species, which is of high conservation priority. The dark reddish colored heartwood of this tree is greatly exploited and used for various industrial and decorative purposes during the pre-colonial and colonial times. Though, it is one of the reasons for its threatened status, changing climatic pattern and its effects on habitat suitability takes a toll on the regeneration potential of this species in its natural habitat. This necessitates that future research must be directed at enhancing the regeneration status of this species and conservation efforts should target habitat improvement measures that ensure the survival of existing wild individuals.

Keywords: Redwood Endemic tree, Anacardiaceae, Conservation, IUCN Red Data List

Introduction

One of the evident impacts of climate change on biodiversity is the loss of endemic species in their natural habitat. About 28% of total plants and 33% of angiosperms that occur in India are endemic to the country (Chitale *et al.*, 2014). Peninsular India altogether hosts around 35% of endemic plants (Nayar, 1980).But, the loss of a species due to habitat loss and narrowing niches becomes a grave issue in several sensitive and biodiversity-rich landscapes like the Western Ghats and the Himalayas in India. As a result, many plant and tree species are considered to be endemic RET (Rare, Endangered and Threatened) species and sometimes even extinct. In this context, a species named *Gluta travancorica*, belonging to the family of Anacardiaceae is made into conservation priority in Kerala and Tamilnadu, due to its poor regeneration status and shrinking habitat (Jose and Pandurangan, 2011). It is one of the historically significant tree species of the *Gluta* genus and a testimony of continental drift (i.e. separation of peninsular India from Madagascar). Many state and national level programmes have been in progress to promote the conservation and regeneration of this species naturally. Despite this, scientific research on effective propagation methods and economic utilization is still lagging. In this article, a detailed description of this speciesis presented with its contemporary threat status and conservation efforts.

History and taxonomic description

Gluta travancorica Bedd. belongs to the genus *Gluta (L.)* of the cashew family, Anacardiaceae (Ariyarathne *et al.*, 2017). The genus also known as 'Rengas' (Stadelman, 1966), is known for its vicariance. Out of the distribution pattern of 30 species in the genus *Gluta*, only one species (i.e. *G. travancorica*) is reported in India from the Western Ghats of

Peninsular India (Van Steenis, 1978). The vicariance of this species distribution pattern is reported to be probably due to continental drift which eventually results in geographic isolation of species and narrow gene pool (Ali and Aitchison, 2008). Due to the changing environment and geography, newly isolated species like *G. travancorica*, are unable to evolve better for adaption and become locally endemic (Keast, 1971; Nayar, 1980). Studies cite that peninsular India has no record of its own endemic /primitive families. The conceptual theory by many scientists supports the fact that many plant species of peninsular India (around 35%) are the residuals of the Indian plate of Gondwana Island. *G. travancorica* is one such representative species of ancient flora representing the rich tropical SE plant community (Jose and Pandurangan, 2011). The tree is known from ancient times for its rich crimson-red colored wood also cited as blood sandalwood. It is also known by various local names like Chenkurinji, Thodappa and Shenduruni (Malayalam). It is also called as the 'Royal Tree'and found exclusively in the Shendurney Wildlife Sanctuary of the former princely State of Travancore. Several allegorical stories tell that the Maharajas of Travancore had the exclusive power to order cutting down Chenkurunji tree or its branches and violating could result in a huge fine and imprisonment.

Distribution

G.travancorica, a large evergreen tree is an endemic tree species of the Southern Western Ghats region. The tree prefers a hill forest region of elevation ranging from 300 to1100 m above MSL. It is endemic to the isolated dense evergreen, moist forest patches south of Ariyankavu Pass at Trivandrum, Kollam of Kerala and Tirunelveli regions (Kalakad-Mundanthurai Tiger Reserve) of Tamilnadu (Rajasingh, 1961; Trivedi babu,1991; Richard and Muthukumar, 2012). Ergo, it is also known as "Tirunelveli redwood". Some trees are also reported to be planted in Siruvani, Palakkad (Sasidharan, 2006). It is prominently seen in the wet evergreen forests of southern Kerala, especially at the ghats of Travancore above Papanasam and the Shendurney Wildlife Sanctuary of Agasthyamala Biosphere Reserve in Kollam is named after this tree. The tree was also widely seen in places such as Pandimala, Vilakkumaram and Rosemala of Kollam district in the pastaccording to the local forest officials.This tree usually occupies the upper storey of the west coast tropical evergreen and semi-evergreen forests canopy.

Species description

Botanical description

G.travancorica is a tall hardwood tree that grows up to 35-40 m in height and 4.5 to 5m in girth.An evergreen tree with 6-8 mm thick bark which is smooth and greyish-brown. It blazes pink with acrid, black sap exudation. Leaves are simple and alternate, crowded at the tips of branchlets and exstipulate giving a whorl appearance. Petiole is of 1-2 cm long, stout, glabrous and winged. Leaf lamina is 8-18 x 3.5-7 cm, elliptic-ovate, obovate-spathulate or spathulate, base cuneate/attenuate, apex obtuse and sometimes emarginate. Leaf margins are entire, glabrous and coriaceous (non-hairy). Lateral nerves are prominent in 13-

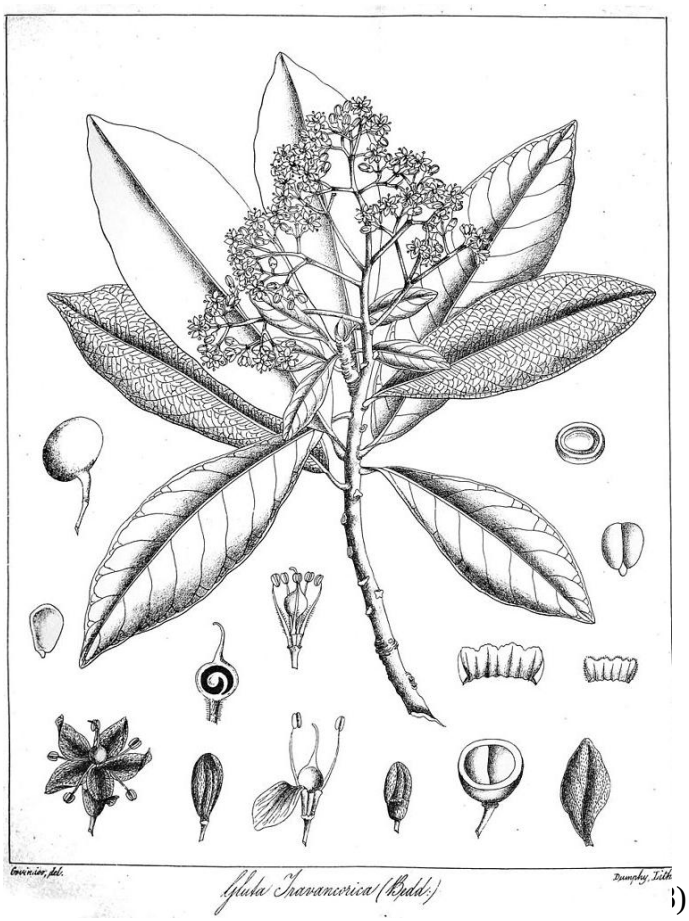
18 pairs and pinnate. The prominent secondary laterals are intercostae reticulate. Flowers are bisexual, cream-colored, 8 mm across, in axillary and terminal panicles. Calyx is deciduous, spathaceous and split irregularly. Petals are arranged 4-6, imbricate, inserted on the disc and adnate with it below, spreading in flower. Stamens are fertile and 4-6 (mostly 5) in numbers inserted onto the floral disc. Filaments are filiform and anthers dorsifixed. A single-celled superior ovary with one ovule. Style is filiform with a simple stigma. Fruitsare roundwoody warted, drupe and brown, 2.5-3.5 cm across in size, globose with thick and scurfy pericarp, rarely furrowed. Seeds are Ex-albuminous, attached to the pericarp and cotyledons are fused at the region of the embryo (Beddome, 1978; Jose and Pandurangan, 2013; Namitha and Beevy, 2020).

Phenology

The flowering and fruiting season extends from March-January due to climate change. A peak flowering was also observed in February-March with random individuals flowering in September-October (Josh and Pandurangan, 2013; Pillai and Pandalai, 2015). The fruiting period lasts for seasons with maximum fruit yield noticed in December-January and less intense fruiting from July-August. The regeneration period also spans two episodes, the summer season from February-March and the monsoon season from July-August (Jose, 2001). The seeds of *Gluta travancorica* are recalcitrant in nature and tend to lose their viability within a month under ambient conditions (Jose and Pandurangan, 2013). Even though it is a non-mangrove tree species, vivipary was first discovered in the shola niches among the individuals in the month of August, when the tree is at the stage of fruit senescence and insitu natural regeneration process is in progress. Albinism in tree seedlings was reported in regeneration exsitu (Jose and Pandurangan, 2011). Though the tree favors wind pollination, two pollinator bee species, *Apis indica Fb*. and *A. florae Fb.* were observed which are attracted to the varied flower characters like color, fragrance, nectar glands and panicles at the canopy level. Beetles and butterflies also play an important role in effective cross pollination occasionally (Jose *et al.*, 2004).

Regeneration

Fruit size was approximately 3.3-4.0 cm in dia. and 2.5-3.0 cm in length and appr. 55-65 seeds weigh per kilogram. Mature fruits are collected either from the ground or directly from trees in cloth bags. The moisture contentof the fresh seeds were high about 47%. Pre-treatments like partial or full seed coat removal (Chacko, 2009) and cold water soaking for 24 hours (Troup, 1981) enhance germination. Fresh seeds have high viability with an average of 99.7 (± 3.36) % germination. The seeds can be stored for up to 4 months with viability under normal conditions. Germination starts 18 days after sowing and lasts up to 143 days. This species can be regenerated either by direct sowing or planting out nursery raised seedlings (Dent, 1948; Joseand Pandurangan, 2013; Pillai and Pandalai, 2015).



(Source: https://www.google.com/search?q=gluta+travancorica)

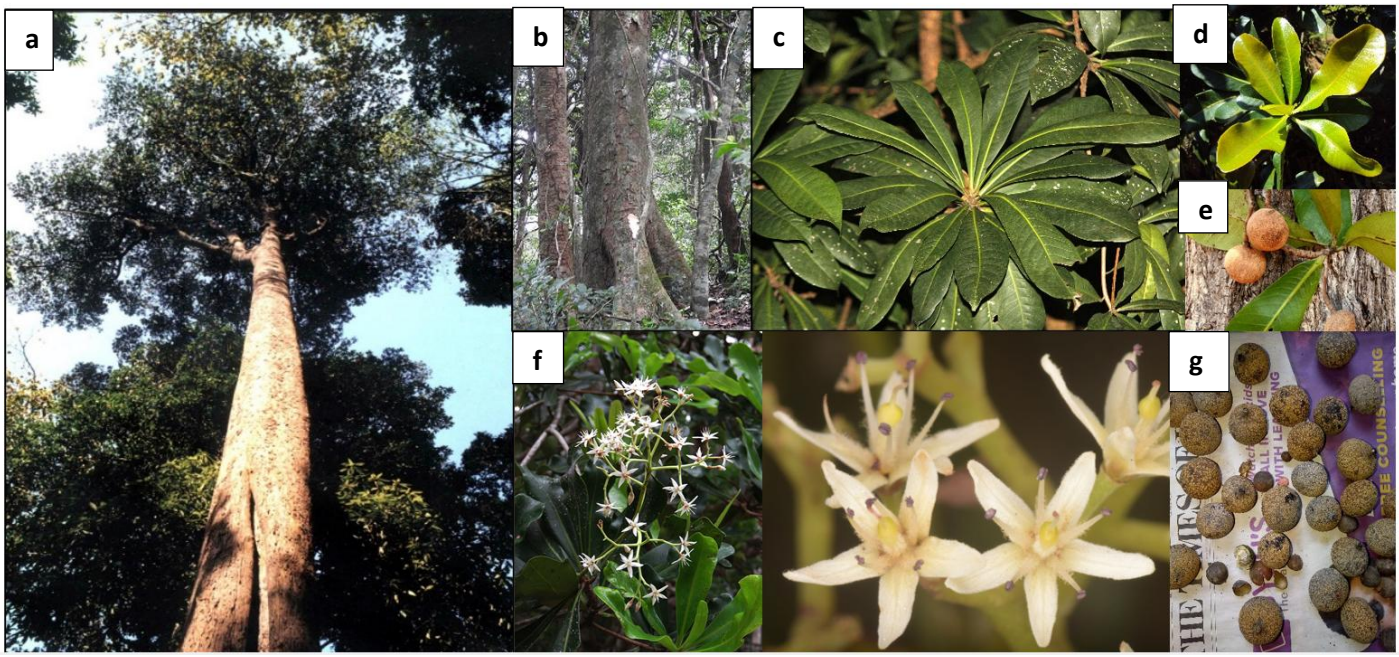


Fig. 2 a) A Large Evergreen Tree b) Trunk and Bark c) Matured Leaves d) Young Shoots e) Fruits f) Flowers g) Seeds

Uses

According to Beddome (1978), the then collector of Malabar, Mr. Athol MacGregor brought this tree to his notice as a valuable timber tree with reddish wood weighing over 40 lbs. The sapwood has a pale reddish-grey color, while the heartwood is a dark crimson. The wood is coarse-grained and exquisitely spotted with dark and light streaks of black and orange color. It has a fine grain and takes good polish well suited for furniture (Beddome, 1978). One of India's finest and most exquisite woods, with magnificent colors and patterns. Conventionally, the hard-durable wood of *G. travancorica*is in huge demand in ship building, furniture industries, carving and turnery etc. (It is also reported to have medicinal properties and is ethnically used to treat arthritis and lower blood pressure levels. This high-quality timber highly resembles 'Red Sanders' because of its pleasant reddish-colored heartwood and hence, known as 'Tirunelveli Red Wood'. It was widely used for paneling furniture and cupboards, for making musical instruments and the body of Pistol during the reign of the Travancore kings and later by the British due to its sturdiness. A resinous exudate from this wood can cause severe skin irritation. Despite this, the poisonous content of the resinous sap is volatile and will disappear gradually. So, the timber of this tree should be dried under open conditions and exposed for several years to make it free of volatiles. Precautions are needed, since the lacquered articles or furniture made from this dried timber might be toxic to susceptible persons.

Threats

G. travancorica is highly susceptible to present climate changes and shows poor regeneration status in its habitat (i.e. Shola forests). It is presented in the lower risk status of the Near Threatened category (IUCN Version 2.3, 1994). There are enough trees in the wild but most of them are unproductive in nature with poor flowering and fruiting ability and is reported with only a few young generation trees to produce viable seeds. Scientists also collected albino seedlings indicating inbreeding depression in this tree due to poor pollination in its habitat (Jose and Pandurangan, 2011). Recently, 14 species of insects are also reported as pests infesting *G. travancorica* viz. three species of moths like *Psara sp*. and *Aetholix flavibasalis Guenee* attacking foliage; a phycitid *Nephopteryx sp.* which feeds on fallen fruits; two species of beetles, *Mimela sp*. feeding on leaves and *Sternochetus sp.* (nut weevil) destroying developed nuts and a jassid bug damaging the flowers and foliage (Jose et al., 2004).

Conservation efforts

The Kerala Preservation of Trees Act 1986 completely forbids the felling of *G. travancorica* and this has reduced the illegal logging completely. This tree is found highly sensitive especially the seedlings which grow well only in certain altitudes. Ecological modeling for the conservation of *Gluta travancorica* by Namitha *et al.* (2022) is remarkable in identifying the habitat-suitability of *G. travancorica* which can be used effectively in focused reintroduction programmes. The recent afforestation efforts targeted at the species by forest department have been severely hampered and conservation measures weren't much

successful. Thus, they launched an active campaign named 'Save Chenkurinji', to be implemented in various areas coming under the Achencoil Forest Division in Kollam. As part of this campaign, the department officials have identified the area where Chenkurinji will be grown with the support of students from around 75 schools, to plant thousands of saplings in the ghat sectors of Kollam and Pathanamthitta district. Saplings will also be planted in public places apart from schools and the department has already cultivated thousands of seedlings to conserve this tree.

Conclusion

Endemic species like *G. travancorica* holds high extinction risk due to extreme climatic patterns and anthropogenic pressures in its only habitat. It is presumed that when an endemic plant species becomes extinct, it takes around 10 to 30 endemic animal species with it. The preservation of this endemic species is of major concern and insitu protection alone will not be able to revive its lost population. Exsitu conservation methods like seed bank storage, biotechnological approaches, cryopreservation etc. are some other alternatives that could support. Furthermore, there is a need to promote studies that probe into the economic utilization of *G. travancorica* like the presence of bioactive compounds in wood and applicability of advanced regeneration tools like micropropagation, tissue culture etc. that are currently unexplored and not studied. It is also reported to possess coastal adaptation due to viviparity (Namitha and Beevy, 2020) which could potentially be exploited in restoration project proposals like increasing coastal green cover. This could evoke public interest in this tree and promote the success of conservation measures.

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A brief account of the well-known avenue tree in India: *Bauhina purpurea* L.

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The practise of planting trees along roads and walkways is known as avenue plantation. The planting of avenue trees is one of the earliest concepts in the history of gardening. Emperor Asoka was the Indian pioneer king who planted shade trees in public spaces and along walkways. Since then, trees have been planted beside roads for a variety of purposes, including aesthetics, navigation, safety, etc.

The Indian avenue has both native and exotic trees, and among the many species there, *Bauhina purpurea* is one of the most widespread and well-liked. It belongs to the Fabaceae family, and it has several vernacular names such as Devakanchan, Kanjivala (Kannada), Bodanta (Telugu), Mandarai (Tamil), Chovannamandaram (Malayalam), and Kanchan (Hindi).

Basic description of the species

A small to medium-sized deciduous tree can reach heights of 4 to 10 metres quickly. It has a light grey bark, and it seems to be either mostly smooth or faintly fissured. Leaves are simple and alternate in arrangement, and flowers are large, pink, and fragrant; they may appear in axillary, terminal, or paniculate types. The large, oblong-shaped pod contains 12–18 seeds. Although it prefers moist soil, it may thrive in full sun or semi-shade.

Phenology

In the months of January through March or April, fruiting and leaf fall may occur simultaneously in Bauhinia. However, the blossoming season begins in September and lasts until about the end of February.

Propagation

The most straightforward and trustworthy technique for propagation is direct seeding. However, semi-wood cuttings are also used for propagation, but they are not that popular.

As a choice of popular avenue tree

This tree is a wonderful ornamental for avenue planting because of its small to medium size, quick growth, and fragrant blossoms.The pink blooms are a stunning sight to behold and add a vibrant splash of colour to the autumnal scene when they bloom on the trees between September and November or February. They are popular choices for specimen plantings or as border trees in avenues due to their stunning floral display.

When it is young, pruning may be necessary to help it take on a consistent shape. If not pruned, branches tend to grow low on the trunk and droop towards the ground, creating a big bush.The tree will look pleasant and tidy if it receives occasional pruning over its lifetime.

Other uses

Young leaves and blooms are used as vegetables and consumed. Bark can be

used to extract fibre and tannin, both of which have economic value. In addition to being used as fuel, wood is utilised to make agricultural tools

Pest and diseases

The tree is attacked by borers, mites, and the larvae of numerous insects. Leaf spot and leaf scorch are the two main diseases seen in the tree.

Plate 1. Bark and Plate 2. Twigs with leaves and flowers
(Source: https://indiabiodiversity.org)

Preservation of forest resources: An important lifestyle for environment (LiFE) activity since time immemorial in India

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In India, Respect for nature has been influenced by religious beliefs and indigenous practices. Even, today there exist some tribes in the remote hilly areas, whose livelihood is fully dependent on forest resources and their traditional practices conserved a large number of wild plant species for various reasons e.g. food, fiber, shelter, or medicine. There are reports which indicate that cultural and religious values are often more acceptable to the society in comparison to the legislations or regulations. In traditional landscape, the sacred areas act as de facto protected areas. However, it is felt that the religious norms and ways of nature conservation have often been neglected, misunderstood, or purposefully misrepresented with due course of time. The increasing disconnection from nature due to urbanization and exponential growth of human-induced stresses on natural ecosystems cause severe environmental degradation and loss of biodiversity. The growing interests among society in spiritual ecology, which focuses on the interrelationship between religions and environment, may help to address various environmental issues and problems within the realm of religion. Over the last two decades, an ever-increasing commitment to conservation by all the major religious traditions has been noted. This commitment has resulted in a significant increase in the number of pronouncements by religious leaders on the conservation of nature, accompanied by the growing number of religion-based environmental organizations and their active participation in specific environmental actions. This has led to a greater awareness among politicians, scientists and representatives of various international organizations of the role that religions can play in overcoming the ecological crisis.

Religion in Forest Protection

Religion being a product of feelings and beliefs, historically this instrument is used as a powerful tool for nature conservation. There are ample examples which indicate that not only plant and animal species but also water, air and land represent various gods and goddesses, apart from their materialistic uses.

The Value of Trees in Christianity

Four trees hold the most significant importance in the Bible– the Tree of Life in the Genesis, Tree of Knowledge of Good and Evil, the Tree of Life mentioned in the Revelations, and, finally, the Tree that made the cross upon which Jesus was crucified. Cedars, date palms, fig-trees, oak trees, and olive trees are most

frequently mentioned in the Bible, although other species also make an appearance.

The Value of Trees in Islam

Tree-planting is seen as a form of charity in Islam, as many others enjoy the products of the tree or its benefits across species. A saying of Prophet Mohammed that reportedly dates back to 14 centuries ago states that "If a Muslim plants a tree or sows seeds, and then a bird, or a person or an animal eats from it, it is regarded as a charitable gift for him". Ramadan, the ninth month of the Islamic calendar during which devout Muslims fast from sunrise till sunset, is also a time of charity. The spirit of Ramadan is often shared by non-Muslims, who take part in charitable events such as tree-planting, donating and sponsoring meals in solidarity with Muslim devotees.

The Value of Trees in Buddhism

The relationship between ecology and culture is a significant part of Buddhism. Scriptures say the Lord Buddha was born, enlightened, and reclaimed under the Bodhi Fig Tree, which is also referred to as the Tree of Awakening. During the time of the Buddha, many forests were revered, planted or protected; universities built in this period continue to boast of lush environments filled with massive trees planted decades ago. Across various Buddhist texts, several species of trees, from the Asoka tree to the Banyan tree, are mentioned in different contexts.

The Value of Trees in Hinduism

Just as in Buddhism, Hinduism has often positioned trees as the givers of knowledge and enlightenment. Trees are revered in Hinduism; the Rig Veda instructs not to cut down trees or uproot them as they provide protection to living beings. Scriptures have also named certain trees as 'sacred' in order to protect them from being the spoils of man. The Ashoka is one such tree, as is the Peepal tree, which has been depicted in seals dating back to the Indus Valley Civilisation. The Banyan tree is said to represent life, growth and fertility; for many others, it is also representative of the Trimurti (holy triad) formed by Lord Vishnu, Lord Shiva and Lord Brahma. Yet other trees are respected and nurtured for the tangible value they bring to everyday life. The Banana tree, for example, is an integral part of Hindu rituals because it is said to promote the welfare of a family and most parts of the plant can be used.

Table: Some important plants considered sacred because of their mention in holy books and association with different religions

S. No	Religion	Sacred plants	Relation with religion	Ref.
1	Hinduism	*Saussurea obvallata, Ocimum sanctum, Ficus religiosa, F. benghalensis, Aegle marmelos, Zanthoxylum armatum, Elaeocarpus ganitrus*	Symbol of gods and goddesses	Kala, 2006, 2010, 2017

2	Christians	*Olea europaea,Phoenix dactylifera,Ziziphus spinachristi*	Olive is symbol of peace. Date palm being a simple tree is honored as a Sunday Palm, and it is used to welcome the Jesus Christ.	Dafni et al., 2005; Kala 2017
3	Islam	*Ziziphus spinachristi, Salvadora persica, Tamarix aphylla*	Frequent mention in holy book Quran	Dafni et al., 2005, Kala, 2017
4	Buddhism	*Terminalia chebula, Ficus religiosa, F. benghalensis*	Associated with Lord Buddha	Kala, 2005, 2017
5	Jainism	*Ficus religiosa, F. benghalensis, Saraca asoka, Cedrus deodara, Terminalia bellirica*	Linked with salvation of Tirthankars (teaching gods who preach the dharma)	Jain and Kapoor, 2007, Kala 2017

Conclusions

We more and more often realize that the success of environmental initiatives depends not only on scientific and technological inventions, but also on the state of human minds. Religions have a significant and direct impact on many of these factors. Thus, the presence of religion in protecting the forests seems to be relevant and even necessary. Different traditions certainly can make different contributions to the protection of forests. An important element in shaping mindsets and lifestyles is the religious education of children and adolescents. The presence of environmental issues in religious education programs is particularly promising, because it shapes ecological lifestyles of successive generations. Today we better understand that the effectiveness of environmental projects depends on local conditions: social, cultural and religious. If we seek better protection for forest ecosystems, then appealing to religious motivation and establishing cooperation with religious leaders and faith-based environmental organizations has to become a standard approach.

Figure: Plant of *Ficus relagiosa* at TFRI, Jabalpur campus preserved because of religious belief. Same situation all around the India

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RNA Interference: Next generation pest control strategy

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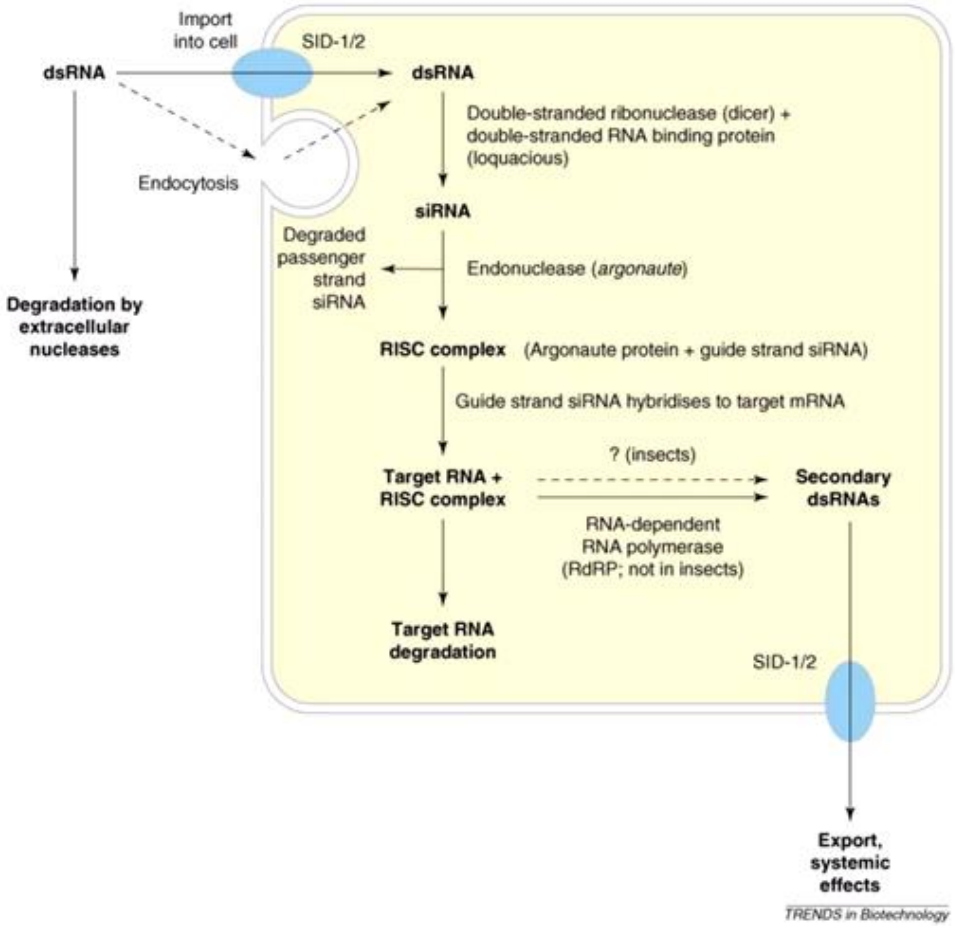
Since the discovery of "antisense-mediated silencing" of homologous genes, the basic dogma that holds that RNA is merely a passage for genetic information from DNA to proteins has been disproved and its role ingene regulation was well established (Nellen and Lichtenstein,1993). In contrast to sense or antisense RNA alone in *Caenorhabditis elegans*, Fire et al. (1998) demonstrated that double-stranded RNA (dsRNA) is the primary trigger of gene silencing. The creation of the rapidly expanding biological field known as RNA interference was made possible by this ground-breaking discovery (RNAi).

Definition

The term "RNAi" refers to the silencing of a target gene at a specific sequence. Cosuppression or post transcriptional gene silencing and quelling are two homology-dependent gene silencing mechanisms that have been discovered in plants and fungus, respectively. By targeting genes essential for pest insect's growth, development, or reproduction, RNAi could be used selectively to kill pest insects without adversely affecting non-target species (Whyard et al., 2009).

General mechanism of RNA silencing

A ribonuclease known as DICER cleaves the dsRNA into small interfering (si) RNA fragments of 20–25 base pairs. The strands of the siRNA fragments are split, resulting in the antiguide (helper) strand, which is further degraded, and the guide strand, which is complementary to the target mRNA (the RNA thatcreated the original dsRNA). The cognate mRNA is then the target of the guide strand, which is subsequently integrated into the RNA-induced silencing complex (RISC), where it forms a duplex with that RNA. The slicer activity of RISCc leaves the homologous mRNA strand that is complementary to the bound siRNA to produce additional siRNA pieces. Three control processes are triggered as a result: further mRNA cleavage, translational repression, and transcriptional repression.



Application of RNAi in the field

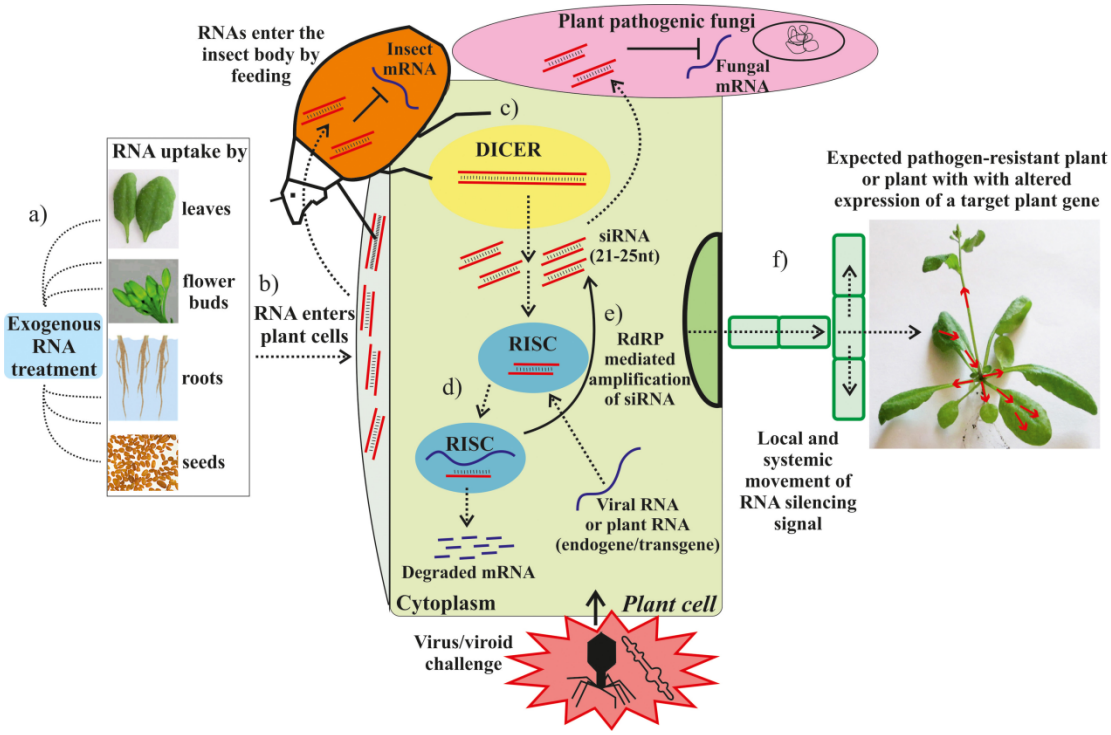
Numerous initiatives have been taken to break down these cellular and physiological obstacles in various insect species and boost the effectiveness of RNAi in insects. There are several strategies to utilize RNAi in agriculture, specifically to reduce pests or pathogens, including host-induced gene silencing (HIGS), spray-induced gene silencing (SIGS), and virus-induced gene silencing (VIGS).

HIGS requires the development of transgenic plants that express the pathogen or pest's specific dsRNA. A transgenic corn crop created by Monsanto (now Bayer Crop Science) expresses a hairpin dsRNA targeting the snf7 gene in the Western corn rootworm, *Diabrotica virgifera virgifera*, making it the first commercially available RNAi product to target an insect pest (Bolognesi et al., 2012).

VIGS is a rather innovative delivery method that is based on viruses created to produce the desired amount of dsRNA inside the pest (Kolliopoulou et al., 2017). An insect virus, for instance, may be altered to have a sequence in its genome that is identical to an insect's important gene. Direct synthesis of dsRNA molecules in the insect cells would then result from virus infection and replication.

In addition, SIGS can be employed for trunk injections and root absorption, where insects can consume dsRNA through sucking and chewing. SIGS will probably require unique formulations to boost the stability and, if possible, the RNAi efficacy in the insect, given the

limited persistence of dsRNA molecules in the environment.



Delivery methods

Basic delivery methods include oral delivery, microinjection, soaking and topical application and advance methods like nanoparticles mediated, symbiont mediated, plant mediated and liposomes mediates has been applied by many workers, which has shown promising results and difference in RNAi efficacy.

Conclusion

RNAi has a huge potential to become a successful approach for insect pest management. However, several research and ethical issues need to be addressed before this technology can be applied on a commercial level. The mode of action of RNAi in killing pests is unique and distinct with that of classical insecticides, microbes, plant-related toxins as well as Bt-related toxins which are directly harmful to pests, which has a great potential to control the resistant population. The effective application of RNAi in pest management now requires the identification of the effective gene target to be silenced which itself requires the sequencing of whole genome of different insects. A great deal with delivery of dsRNA is also faced, which require the standardization of delivery method for various insect group as its efficacy varies from insect-to-insect group.

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