(ISSN 2395 - 468X)
Year - 2022 Vol. 9, No. 8 Issue: August 2022

Van Sangyan

A monthly open access e-magazine

Impact Factor
SJIF: 2020-6.61

Indexed in:
COSMOS Foundation International Inst. of Org. Res. IIJIF

Tropical Forest Research Institute
(Indian Council of Forestry Research and Education)

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
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From the Editor's desk

When we eat fruit such as vitamin C-rich mangoes or antioxidant-packed mangosteen, we do not often realize that these delicious and highly nutritious fruits are mostly based on farmer discoveries and innovations instead of on results of long-term breeding research. Although it is widely recognized that fruits play a crucial role in a healthy and nutritious diet, investment in identifying, breeding and developing improved planting materials for fruit trees has been limited – and for good reason – as fruit tree breeding is highly challenging. The development of an improved fruit tree variety can take decades or even generations. Their conservation faces similar challenges: it is problematic as fruit seeds are recalcitrant and cannot be conserved in cold storage. Even to date, most of fruit tree crop improvement and conservation is undertaken by farmers around the world, with the public sector pitching in only in recent decades.

Asia is home to over 400 fruit tree species, and fruits like mango (Mangifera indica) and mangosteen (Garcinia mangostana) now reach customers across the globe, but that was not always the case. Many unique or highly nutritious fruit tree species remain underutilized and neglected while we continue to lose fruit tree diversity due to the dominance of introduced fruit species and changing land use patterns that result in the uprooting of diversified orchards and home gardens. In the early 2000s, countries in south, southeast and east Asia started acknowledging the incredible richness of fruit diversity they housed and recognizing the potential of fruit trees to improve local and global diets while enhancing both household income and national revenue. Fruits such as mango, mangosteen, rambutan, durian and pomelo were prioritized because of their importance in the local food cultures and to the well-being of the local populations, as sources of income, food security and a healthy and nutritionally balanced diet.

Planting the right type of trees in the right place can provide nutritious foods to improve diets sustainably while providing other valuable ecosystem services such as carbon sequestration," said Merel Jansen, the lead author from ETH Zurich and the Center of International Forestry Research. "It also can contribute to development issues related to poverty reduction, biodiversity conservation, and food security." In spite of the diversity of edible plants – there aremore than 7,000– the global food system is founded on extraordinarily low diversity. Almost half the calories consumed by humans come from only four crops: wheat, rice, sugarcane and maize. The overconsumption of these energy-rich but nutrient-poor foods – in combination with underconsumption of more nutritious foods – has contributed significantly to malnutrition, which afflicts some two billion people. Moreover, their cultivation has caused widespread losses of biodiversity and contributed to climate change. The world's hundreds of millions of smallholder farmers, who have been often pushed aside by the industrialization of food systems, have the potential to be key players in food system transformation. With the right incentives, investments and involvement, smallholder farms could scale up agroforestry systems to produce more, healthy food, while simultaneously diversifying their income sources.

Marginalized groups and women also stand to gain from tree-sourced food sources, especially when the foods are harvested from trees that are not planted but grow spontaneously or and have the potential for natural regeneration that can be managed. This is because, in part, women farmers tend to have limited access to land, credit and other assets. There are many clear opportunities to incorporate food-producing trees into landscapes. The majority of global cropland does not incorporate trees but has a high potential for doing so. Further, vast tracts of land in the tropics have been cleared for agriculture and then abandoned, and coordinated restoration efforts could include the establishment of sustainably managed agroforestry systems.

In line with the above this issue of Van Sangyan contains an article on the rich resource of nutrition and improved varieties of fruit trees in India. There are also useful articles viz. Pollen allergy due to Conocarpus: Myth or reality, Mimusops elengi: A potential medicinal tree, ग्रामीण आजीविका में आय एवं पर्यावरणस्थिरता बढ़ाने हेतु जैविक विधि द्वारा खरपतवार प्रबंधन, Bee keeping in agroforestry - A potential role for a sustainable rural livelihood, Droneochory: a novel approach to forest restoration, Ban on single-use plastic: possible alternatives and Teak Seed Orchard, Behrai, Seoni, Madhya Pradesh

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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The rich resource of nutrition and improved varieties of fruit trees in India

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Introduction

According to the Global Hunger Index 2021, India ranks 101 out of 116 countries with a score of 27.5, India has a level of hunger that is serious. It is believed that more than one-third of the world's malnourished children are in India which is not a good sign of economic progress of any country. India has failed to combat malnutrition that adversely affects the country's socio-economic progress. India is a mega-diverse country with only 2.5% of the land area, accounts for 7.8% of the recorded species of the world spread over 45,968 (11.18% of world) species of plants and 91,212 species of animals (7.43% of the world) that have been documented in its ten bio-geographic regions. The cultivation of major fruits reaches to a new height due to their large popularity. Obviously, they are good source of energy, fat and carbohydrates but somewhat they are lacking with secondary metabolites and antioxidants. The underutilized fruits have more value of nutraceuticals and are more useful in combating the nutrients related disorders in human. The rural people of tribal belts rely on these unexplored fruit crops for their nutritional and livelihood security. Since, these fruits are lesser known but due to their high medicinal potential, they are becoming popular worldwide. Fruits like aonla, ber, bael, chironzi, khejri, phalsa, pilu, karonda etc. have been shifted to cultivation and their exploitation creates a valuable livelihood option for rural households during these periods of nutritional stress caused by Covid-19 pandemic. Besides, their fresh consumption, they also have good processing potential and some of the fruits like lasoda, ker, pilu and karonda have more processing value than the fresh form. The processed products are also gaining equally importance in the market and becoming sustainable. Across India, a wide range of indigenous fruit trees are available throughout the year (Table1) for enhancement of income of farmer communities which is potential source of crop diversification and nutritional security. However, over past decades, large scale genetic loss has occurred due to urbanization of these indigenous fruit species. Climate change is another important hindrance for minimizing food production.

Reason for under exploitation of indigenous fruits:

1. Lack of importance and multiplication techniques

2. Lack of cultivation package and practices
3. Non-availability of improved varieties
4. Inadequate research on diversification of crop pattern through such species
5. No initiative by government to promote their commercial expansion
6. Lack of marketing infrastructure and value addition technologies
7. Non-preference by orchardist to establish an orchard.

Table 1: Availability of regional fruits

Fruit	Month of availability
January - February	Aonla and Ber
March - April	Ber, Mulberry, Beal, Pilu and Khirni
May - June	Chironji, Beal, Pilu, Khirni, Lasora and Mahua
July - August	Jamun, Ker and Phlasa
Sep - October	Karonda
October - November	Pomegranate, Aonla
December - January	Aonla, Ber

Nutritional and livelihood security through underutilized fruits

Indigenous fruits given the tag of 'poor man's food', and their nutritional benefits just remarked as superior in comparison to exotic fruit like apple, grape, banana and citrus etc. These fruits are an immense source of minerals and vitamins particularly vitamin C and A (Table 2). Incorporating these fruits in balanced diet can combat problems like malnutrition and other related disorders. In addition to that, these fruits are also good source of secondary metabolites which are lacking or present in small quantity in major fruits though the exploration of those are little known. If we look upon the iron availability in pilu (*Salvadora oleoides*) and chironji (*Buchanania lanzan*), it is very high (8.0 or more than 8.5 respectively) (Table 2). Likewise, karonda (*Carrissa carandus*), mahua (*Madhuca indica*) and khirni (*Manilkara hexandra*) are rich source of vitamin A which is useful for maintaining eye sight. Aonla (*Emblica officinalis*) and monkey pod (*Pithecellobium dulce*) are another important source of vitamin C whose consumption among rural population can boost immunity power a lot. Ker and chironji again good source of phosphorus and calcium which are very essential for muscle contraction, building strong bones and teeth, regulating heart beat and fluid balance etc. All indigenous fruit are good source of fibre so can their consumption can help in maintaining a healthy and happy digestive system. Since they are lesser used for fresh consumption, therefore, they also secure the livelihood of rural and tribal people by various value addition techniques. Fruits like khejri, pilu and jharber are used round the year after dehydration. Some of the fruits like ler, sangri, karonda, lasoda etc are used in the form of pickle and used widely as ayurvedic tonic. These products are not so commercial but are sold by the households in traditional local markets, haats, fairs and roasides for their earnings. In tribal pockets like Southern Rajasthan,

Odisha, Chhattisgarh etc, these are the only source of livelihood. However, standard procedure and protocol is still a challenge. But in past two decades, ICAR/SAU institution did significant work for standardization of package and practices for precision farming of such species. The popularization of these fruits is done by on farm trials, through AICRP on Arid Zone Fruits, and through various trainings and seminars. Some of the research organizations, KVKs and SAU's are working in this direction. Cultivation prospects of underutilized fruits Underutilized fruits are easy to cultivate and they are Lasoda pickle Ker 42 Indian Horticulture tolerant enough to adverse climatic and soil conditions. Fruits like ber, karonda, and custard apple can be cultivated at high soil pH (8.5 or more). They can tolerate frost and high temperature upto 48°C. They can withstand in waterlogged soils. The method of propagation is also similar to that of major fruits. Ber can be easily propagated through ring budding, lasoda through T budding, custard apple and tamarind through softwood grafting. Karonda can be easily propagated through seeds and hardwood cuttings. There is no such specific fertilizers and nutrient requirements for these crops. Indigenous genetic resource conservation strategy among the challenges of HGR, utilization and conservation of perennial species of economic importance is essential which can be done either in situ or ex situ. Emphasis needs to be given to the collection and conservation of such species in coming decades for such species.

Table 2. Proximate principles of other underutilized regional fruits species (all value as per 100 g edible portion).

Fruit	Botanical name	Energy Kcal	Protein (g)	Fat (g)	Carbohydrate (g)	Crude fibre (g)	Ca (mg)	P (mg)	Fe (mg)	Vita-A (IU)	Vita –C (mg)
Chironji	*Buchanania lanzan*	656	19-21.6	59.1	12.1	3.8	279	528	8.5	-	5.0
Ker	*Capparis decidua*	100	5.9	1.23	20.87		153.8	50.8	2.0	-	133
Karonda	*Carissa caranndus*	59.4	0.3-1.1	2.5-4.6	0.5-2.9	0.6-1.8	21	28	-	1619	9-11
lasora	*Cordia myxa*	65	1.8-2.0	1.0	12.2	0.3	40	60	- -	- -	- -
Mahua	*Madhuca indica*		1.37	1.61	22.6	- -	45	22	1.1	512	40-42
Khirni	*Manilkara*	-	0.48	2.42	27.74	-	83	17	0.9	675	15.6

	henxandra										
Monkey pod	*Pithecellobium dulce*	78.	2-3	0.4-0.5	1819	1.1-1.2	13	42	0.5	25	138
Pilu	*Salvadorao leoides*	-	6.0	2.0	76	2.0	630	167	8.0	-	2.0
Jamun	*Syzygium cumini*	62	0.7	0.1-0.3	14-16	2.9	34-94	34-78	0.9	-	44
Imli	*Tamarindus indica*	-	2-3	0.6	41-61	2.9	34-94	34-78	0.9	-	44
Ber	*Zizyphusnu malaria*	-	2.0	1.0	93	2.0	60	120	7.0	-	88

Source: Malik *et al.* 2010

Conservation strategy of indigenous resources Phalsa is a delicious fruit of arid region. Hence, it is essential to conserve the genetic diversity of Indian origin fruit species to protect and preserve for the prosperity of nation. An area which needs immediate attention is the collection, documentation, conservation and utilization for their sustained production and popularization and commercialization. To strengthen plant genetic resources of indigenous fruit and important perennial plant species, ICAR-NBPGR initiated concerted efforts to enrich their germplasm though systematic exploration and conservation through in-situ and ex-situ methods. Ex situ conservation of important perennial fruit species having economic importance consist conservation of land race, cultivated types and their wild relatives with the help of designated NAGS (National Active Germplasm site).

Strategies for the improvement and promotion of underutilized fruit crops

Regional fruit species can play a pivotal role in mitigating malnutrition problem of the country where the availability of major fruits is either low or not accessible. In recent years, the awareness toward these species has increased due to awareness campaigns by ICAR & SAU institutions or KVK and farmer's fairs demonstration or audio-video access on internet. As a result, their demand is increasing. These locally adapted species can be grown on waste lands where most of the others fruit fail to grow or cultivate. Since, these species are reservoir of minerals, vitamins and antioxidants; they can serve the purpose of achieving SDGs. But, their produce perishability is a cause of concern for research community. It has been estimated that about 15 to 25% of such produces goes Tamarind is a source of value-added products waste without reaching to consumers. Hence their value addition through SHG can boost the farmer's income at grassroots level. Several production technologies have been standardized by different institutions e.g., propagation methods (rootstock selection, grafting/ budding), plant spacing, canopy management, nutrient and water

management, crop regulation, plant protection, and post-harvest management and value addition . In addition to production, there is a need for skill development through entrepreneurships or self-help groups (SHG's) or Farmer Producer Organizations (FPO), etc. ICAR-CIPHET; CIAH, Bikaner and Godhra etc involve in organising training for popularizing these fruits and development of value added product from these species which needs to further up scale for more entrepreneurship development. Government through its various schemes like MIDH, NHB etc. is providing subsidies for the establishment of commercial orchard, ripening chamber, cold storage and packhouse. Organization of awareness camp at tehshil /block level can popularize these indigenous species, to achieve theme 'vocal for local'. In addition to above incentives to on farm diversity conservation, recognition through felicitation and monetary support to the people and societies involved in the conservation and utilization of such important indigenous underutilized fruit species need to accelerate.

Table 3: Improved varieties of regional fruit species

Fruit	Improved varieties	Institute involved for planting material supply
Bael	Goma Yashi, NB-5, NB-7, NB-9, Pant aparna, Pant Sujata, Pant Shivani, Thar divya, Thar Neelkanth	CIAH, Bikaner (Raj); NDUAT, Ayodhya (UP); GBPUAT, Pantnagar (UK)
Aonla	NA-7, NA-10, NA-6, Goma Aishwaria	CIAH, Bikaner (Raj); NDUAT, Ayodhya (UP)
Ber	Gola, Umran, Goma Krti, Katha, Seb, Thar Sevika, Thar Bhuvraj	CIAH, Bikaner (Raj)
Phlasa	Thar Pragti, CIAH-P-1	CIAH, Bikaner (Raj)
Mulberry	Thar Lohit, Thar Harit, Delhi local	CIAH, Bikaner (Raj)
Lasora	Thar Bold, Maru Samaridi, Karan	CIAH, Bikaner (Raj)
Jamun	Goma Priyanaka, Thar Kranti, CISH-J-37	CISH, Lucknow (UP); CIAH, Bikaner (Raj)
Karonda	Thar Kamal, Konkan Bold, Marugorav, Pant Manohar, Pant Sudarshan, Pant Suvarna	CIAH, Bikaner (Raj); GBPUAT, Pantnagar (UK)
Mahua	Thar Madhu	CIAH, Bikaner (Raj)
Khirrni	Thar Rituraj	CIAH, Bikaner (Raj)
Chironji	Thar Priya	CIAH, Bikaner (Raj)

Indian Horticulture Further, inclusion of course curricula about indigenous fruit species at school level will create awareness among the children. Furthermore, the use of

mass media like radio, television, newspaper and other printed and electronic media platforms can play an effective role in creating awareness about the significance of underutilized fruit crops among the growers and other stakeholders as well as consumers.

Conclusion

Indian population is growing very fast and is expected to overtake China by 2027. India stands at 101th position among 116 countries in Global Hunger Index which is a very big challenge. In many pockets, there are severe crisis for availability of quality food thus the problems like malnutrition, diabetes is arising and every second women is anemic. Feeding safe and nutritious food to this alarming growing population seems the greatest challenge to our country. India has a rich heritage of fruits due to its diverse range of climatic conditions. But, the traditional and underutilized fruits are more nutritious and healthy in terms of nutraceuticals over the major fruit crops. The underutilized fruits contain more phytochemicals including minerals, vitamins and other secondary metabolites which help in curing several chronic diseases. The consumption of these fruits has gained popularity during the COVID-19 pandemic due to their great importance in immunity boosting. Every part of India has strong diversity of underutilized fruits such as aonla (*Emblica officinalis*), bael (*Aegle marmelos (L.)*), mulberry (*Morus alba*), phalsa (*Grewia subinaequalis*), karonda (*Carissa carandus*), ker (*Caparis decidua*), pilu (*Salvadora oleoides*), khirni (*Manilkara hexandra*) and mahua (*Madhuca longifolia*) etc., which needs to be domesticated and conserved. The exploration of these fruits is rarely attempted and emphasis must be given to explore them.

Pollen allergy due to *Conocarpus*: Myth or reality

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Conocarpus erectus (Button wood) belongs to Combretaceae family. It is an evergreen multitrunked tree or shrub that can grow up to 3.5-6.0 m tall, 20 cm in diameter with spreading crown and low spreading branches. It is natively distributed in Tropical America and West Africa. This exotic tree can grow well on all terrestrial habitats and prefers tropical climate zone. Dry soils, fertile loamy soils, well-drained soils, waterlogged soils, saline soils, acidic and alkaline pH soils are all suitable for growing this tree. It can be planted singly in gardens or grown close together as informal or clipped hedge. It is also suitable as bonsai. It can be propagated by seeds or stem-cuttings. It is tolerant to drought and salt stress and therefore is suitable for coastal or beachfront planting. The tree exhibits moderate growth rate, with little maintenance. Branches tend to droop with age, and therefore requires pruning for pedestrian or vehicular clearance. It can be trained to grow with multiple or single trunk. It has no known serious pests or diseases.Wood was once an important source of firewood and charcoal and sometimes used in cabinet making. Its dark brown, fissured and scaly bark is high in tannin content and can be harvested commercially. The tree is free-flowering, independent of time and produces bisexual flowers, which can assume green, purple and white colours. Flowers are small, inconspicuous and clustered at axillary positions, which can last on the tree for several days.

This tree has become enormously popular for landscaping roads and gardens owing to low maintenance costs. However, there is growing concern from a section of researchers, including botanists that planting *Conocarpus* in the urban settings is responsible for outbreak of allergic symptoms and asthma attacks. Allergy is the hypersensitive reaction of the immune system of the body with symptoms such as itching, allergic rhinitis, red eyes, eczema, hives, or even an asthma attack. The reaction of the immune system to normally harmless materials in the environment is the production of IgE by basophils and mast cells. Among the four types of hypersensitivity, allergy is categorized as type I (immediate) hypersensitivity.The spectrum of manifestations in this inflammatory reaction can range from mildly uncomfortable to dangerous phenomenon, such as sensitization to aeroallergens of plants that may be associated with serious morbidity.

There are two general categories of risk factors for allergy, namely patient characteristics and environmental factors.

Genetic makeup, age, sex, and race are the most significant factors of patient characteristics. Among environmental factors, exposure to infectious disease during the newborn period and early childhood, and pollutants in the environment are the most important causes. However, pollens play a major role in the onset of allergies. Pollen is a fine powder-like substance released by weeds, scrubs, shrubs, grass, and trees. Wind is one of the main sources of pollen dispersal. However, in terms of allergy, people are more exposed to pollen dispersed by the wind. Usually, flowers that have brightly colored petals and sugary scents (to attract insects) are less allergic, while the pollens of flowers with drab colors and small flowers without an obvious scent (mainly dispersed by the

Fig 1: ***Conocarpus erectus***

wind) mostly cause hay fever or allergies. Pollen sensitization is usually restricted to anemophilous plants, which comprise approximately 10–18% of all flowering plants. To increase the chance of fertilization, wind-pollinated plants have evolved characteristic strategies, including having small, dehydrated pollen with good aerodynamic properties that allow its dissemination over hundreds of kilometers. Pollen grains initially enclose a single cell, which eventually develops into the male gametophyte. The inner pollen wall, called the intine, describes a typically multilayered thin cover composed of cellulose and pectin, whereas the exine refers to the very resistant outer wall, which provides robust protection of the pollen grain from disintegration. Apertures in the exine allow outgrowth of the pollen tube during pollination. Allergenic proteins are usually located within the pollen protoplast and readily released during the rehydration process.The Conocarpus pollen grains are small-sized monads and the mature pollen has six lobes in a polar view and has six heterocolpate apertures (three colpates and three colporates, one alternating the other) with a polar axis and equatorial axis. There are two flowering periods of *Conocarpus* in Spring and Autumn, and the coincidence of pollination in the autumn with the increase in the referral of patients with respiratory problems increases the likelihood that the pollen grains of this plant play a role in allergic reactions. So far, there is no unequivocal and conclusive evidence in this regard.

Fig 2 Flowering of *Conocarpus erectus*

It is approximated that about 40% of allergic patients have been affected by pollens. In general, pollen allergens are considered a major risk factor for both seasonal allergic rhinitis and asthma, whereas indoor allergens appear to be a risk factor for perennial rhinitis. Still, some studies showed that more than 50% of patients with perennial allergic rhinitis are sensitized to pollen allergens. On the other hand, global climate change appears to affect the status of plants of each area and also on aeroallergens and their public and clinical health outcomes. This reality urges the need for an up-to-date, frequency, and distribution of allergenic tree pollens in each region.A number of factors such as acid rain, particulate matter, ozone, and polycyclic aromatic hydrocarbon compounds, in addition to airborne pollen grains and fungal spores are potential triggers of asthma attacks.

Allergenic trees may be found almost all over the world, reaching from the temperate climate zones of Europe, North America, and Asia, to the Mediterranean area, North Africa, parts of South America, South Africa, the Indian subcontinent, as well as parts of Australia, whereas in tropical climate regions tree pollen allergies are virtually absent (www.eol.org). Trees belonging to the orders Fagales, Lamiales, Proteales, and Pinales (www.allergen.org) are recognized as the most potent allergen sources, whereas in subtropical climates the Fabales trees mesquite (*Prosopsis juliflora*) and gulmohar (*Peltophorum pterocarpum*) have been acknowledged as clinically important allergen sources. Moreover, date palms, which like grasses belong to the monocots, produce clinically relevant pollen allergens. The Combretaceae family to which Conocarpus belongs includes about 530 species in ten genera, often in the form of trees and shrubs. So far, pollen grains of 130 species belonging to this family have been investigated and were reported to be allergenic, except for three genera *Buchenavia*, *Laguncularis*, and *Strephonema*, which have tricolpate pollen grains. The WHO/IUIS allergen nomenclature subcommittee maintains a systematic database of allergenic molecules. Allergens submitted to the database are reviewed by an executive committee. The database, so far comprises 53 tree pollen allergens from six botanical orders, without any mention of Conocarpus erectus.

Besides the officially acknowledged tree pollen allergens, a wide variety of extracts from many tree species not listed in the IUIS database are being used for allergy diagnosis. The involvement of Conocarpus pollen allergens in eliciting hypersensitivity is only a perceived threat and there is no data on the actual prevalence. While data on the allergenic potential of the Conocarpus tree on the local population is scant, studies in some other parts of the world suggest the administration may be overestimating the danger from the Conocarpus trees. Mere correlation studies indicating the number of hospital referrals associated with asthma attacks before and after pruning of Conocarpus trees do not provide any evidence that it is the Conocarpus-mediated allergy. There have been no reports of asthma outbreaks or

exacerbation of respiratory symptoms in patients resulting in hospitalization in any part of India ascribed to Conocacrpus. Characterization of pollen allergen extracts from Conocarpus is necessary for appropriate diagnosis of allergic disorders using skin prick tests.Without such studies and solid proof of ill consequences, and solely acting on exaggerated fears that pollen from Conocarpus may result in respiratory illness, many individuals and authorities are resorting to axing of tens of thousands of such trees.

A more scientific and rigorous way should be chosen to address the 'environmental catastrophe' in the making. If after extensive studies it is found that Conocarpus indeed is responsible for triggering respiratory ailments, then one could think of simple pruning of the canopy so as to reduce the shedding of seed, followed by phasing these trees out gradually over time instead of felling millions of Conocarpus trees.

Mimusops elengi: A potential medicinal tree

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Introduction

India is one ofthe richest biodiversity hotspots, and reports confirm that a great variety of edible fruiting trees are indigenous to this tropical region. Among the wild edibles, Bakul (*Mimusops elengi* Linn.) has importance as the tree provides fruit and fodder, planted as ornamental and used in traditional medicine practices. ***Mimusopselengi*** Linn. belongs to the family Sapotaceae native to the Western Ghats region of peninsular India. However, today this tree is also found in tropical and subtropical areas of the world (Baliga*et al.,* 2011).

Bakul is a slow-growing, large, evergreen native tree. They are distributed in the Western Ghats, in the dry evergreen forests of the Eastern Ghats, and also in Andaman, Myanmar, and Sri Lanka. It has thick, shiny, narrow, pointed, oval-shaped leaves and spreading branches. It's commonly seen as an ornamental tree. Flowers are tiny, white to yellow in color with fragrances. Fruit is a berry, yellowish in colorand ovoid in shape, edible. Seeds are greyish brown, ovoid, and shining. Wood is strong and durable and used for general construction work.The poles are used as railway sleepers, furniture, vehicles body, and tool handles.Different parts of the tree are used in medicine.

Description

The tree grows up to the height of about 30 to 40 m tall. The bark is smooth and pale brownish-grey to dark blackish in color, occasionally fissured and sometimes peeling off in thin scales. Blaze is pink or reddish. Tree bear simple leaves arranged alternate spirally, oval-shaped, shiny, narrow-pointed, and spreading branches. Tree possesses scanty liquid or white sticky latex. Flowers are bisexualand functionally unisexual. Fruit an ovoid to ellipsoid berry 2–3 cm long, orange-red when ripe, 1–2-seeded. Seeds up to 2 cm long, laterally compressed, with a small circular basal scar, greyish brown ovoid, and shining. Around 1500 to 2000 seeds weigh one kilogram. Seeds are recalcitrant and lose viability in a short period after collection. Fresh seeds can give better germination, *i.e.*, 90 percent. Seeds are soaked to smoothen the hard seed coat before sowing (Martawijaya et al., 1992; Burkill, 2000).

Medicinal properties

The stem, barks, leaves, and fruits are used in various Ayurvedic and folk medications to treat multiple ailments. In the prehistoric days, ripe fruits were an important source of diet but today no one knowstheir dietary use as it is seldom used. Leaves are used as anti-toxic and utilized during poisonous conditions by Sushrutha. The bark is used for cooling, a cardiotonic, alexipharmic, stomachic, anthelmintic, tonic, and astringent, which

cures biliousness and diseases of the gums and teeth. The flower is cooling, astringent to the bowels is used to cure the disease of blood, biliousness, liver complaints, nose diseases, and headache, and their inhaler is good for asthma (Kadamet al., 2012).Bark and unripe fruit paste are applied over the insect or other small animal bite. The pulp from the fruit of *M. elengi* is used to cure chronic dysentery. Ripe fruits are given orally to a pregnant woman to promote delivery. Sometimes they are used as an abortifacient (Purnima et al., 2010). Seeds of *M.elengi* mixed with ghee are applied to the anus of children to cure constipation (Gupta, 2013).

Edible parts and phytochemical constituents

M. elengi was tested for different phytochemicals and reported the medicinal property. Chemical components such as taraxerone, taraxerol, betulinic acid, spinasterol, ursolic acid, and fatty acid esters of alpha-spinasterol are present in the tree's bark. Alpha cadinol, tau muurolol, hexadecanoic acid, diisobutyl phthalate, and octadecadienoic acid are the major constituents of the bark (Kadam et al., 2012).The leaf extract showed in vitro antibacterial. The root extraction ensures that the presence of methanolic acid shows mitogenic activity against lymphocyte cell culture. Quercitol, ursolic acid, dihydro quercetin, quercetin, and alpa-spinasterol are present in fruits and seeds of bakula (Gami et al., 2012).

The fruit is edible, preserved, or pickled. The fruit pulp is starchy with a floury texture, insipid and astringent. Fruits are said to taste like dates but to be drier.Oil is obtained from the seed(Facciola, 1990) and used for cooking. The seed kernel contains about 22% oil. The fatty acid of the refined oil is composed of oleic acid (64%), linoleic acid (14.5%), palmitic acid (11%), stearic acid (10%), and behenic acid (0.5%). The refined oil's nutritional quality is comparable to that of groundnut oil (Grubben, 2008).

Present status

Due to the high medicinal importance and pharmacological activities, the tree has been overexploited from natural populations. The species is enlisted as the Threatened Species on IUCN Red List during the 2018 assessment. The primary threat to the species is harvesting trees for timber and collecting fruits, which hamper germination in natural habitats. In Sri Lanka, Bakul has been announced as Near Threatened. Considering the threats to the species, morethan 35 ex-situ collections are developed, including at least five from India (Barstow M 2019 et al.)

Propagation

Producing the plant material has been a hurdle to conserve threatened tree species. Many attempts were made for quality plant material production either by sexual or asexual techniques. Seeds are recalcitrant, and lose viability in a short period after collection. Germination percentage is 30-60 percent without any treatment as seed coat is hard. Fresh seeds can give better germination, *i.e.*, 90 percent (Mai-Hong et al., 2006), the delayed collection will attract insect pests to the sweet pulp, and seeds may be damaged by pests. Seeds are soaked to smoothen the hard seed coat before sowing. Different seed treatments were reported to enhance germination. Swaminathan et al., 2020 investigated the

effect of hot water and cold water soaking, Acid scarification, GA3, Cow Urine, and Cow dung treatments with a specified time period. The study revealed more than 80% of germination in 6-hourcold water treatment with the first germination on the 33rd day after sowing to till 80th day. Gami et al., 2010 reported enhanced germination of the seeds withered in the presence of manure, whereas sulphuric acid and hot water treatment are lethal for seed health.

Seeds can be sown in raised beds composed of soil, sand, and FYM (1:2:1), preferably using sandy loam soil. Mulching with hay and overhead shade is to be provided to facilitate germination with regular watering. The seedling can be transplanted from the mother bed to a polythene bag when it reaches 2 to 4 cm. The germination percentage of *Mimusops elengi*is 30 to 40, and the germination period is 60 to 70 days (Pattnaik, 2000). Seed germination of this species varies from region to region because of the hard seed coat, low germination, and have shorter period of viability of seeds though the seed production potential varies from medium to heavy on the basis of climatic conditions

An effort was made to determine the effect of the commercial Plant Growth Regulator (PGR) on rooting propensity on *Mimusops elengi* stem cuttings (Bakar, 2016).Four commercial PGRs - ROOTMONElt, AGR ROOTMORE, SADEX, and AKAR SERBAJADf of Malaysia all containing Indolebutyric Acid (IBA) were applied on stem 2-year-old coppice. The cuttings were assesed after 4 weeksfor their rooting. The results showed negative response of cuttings as failed to root for every treatment. IAA 400PPM with a media combination of sand, soil and FYM is best suited for growth, survival and best morphological appearance on cutting of *mimusops elengi* (Sangma and Kumar, 2015).

The *in-vitro* technique for plant propagation was reported by Gami et al., 2010. MS media fortified with plant growth regulators such as IBA, Kn, BA, and GA were proven as superior over the conventional techniques. Bhore and Preveena (2011) reported the use of immature zygotic embryos as explant is more promising than the axillary and apical buds for the production of plantlets. The study also suggests that the MS and other media: N6 and B5 are best for maximum germination, rooting, and vigor. The cryopreservation of hypocotyls and cotyledons is failed as the presence of oil content in the seed (Wen et al., 2013)

Conclusion

The primary and secondary data about *Mimusopselengi* shown in the existing literature strongly indicate the species' threats. As it is a beneficial tree, it has been exploited mostly by the natural population. There is an urgent need for specific species conservation strategies that encourage sustainable harvesting and genetic variety conservation through proper propagation techniques.

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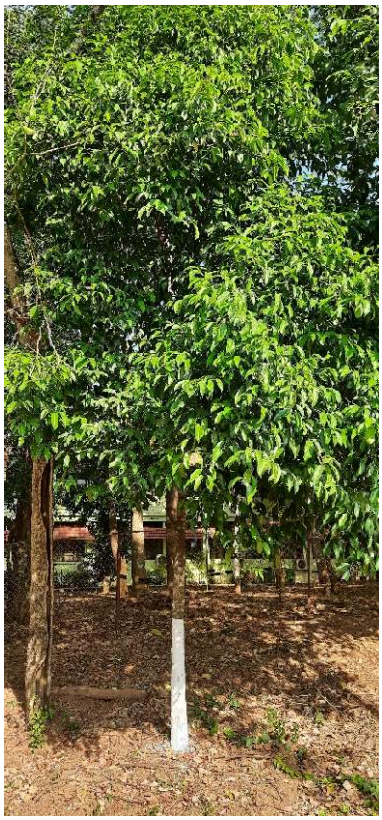

a

b

c

Plate 01. a. Bakul Tree, b. Flowers and c. Seeds

ग्रामीण आजीविका में आय एवं पर्यावरण स्थिरता बढ़ाने हेतु जैविक विधि द्वारा खरपतवार प्रबंधन

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जैविक कृषि एक ऐसी उत्पादन प्रणाली है जो कृत्रिम उर्वरकों, कीटनाशकों, विकास नियामक, और पशुओं के लिए योगात्मक चारे के प्रयोग के प्रयोग की अनुसंशा नहीं देती है । पर्यावरण, सामाजिक, और आर्थिक स्थिरता जैविक कृषि के मूल उद्देश्य हैं। भारत में वर्ष (2020-21) में लगभग 4.33 मिलियन हैक्टर भूमि पर जैविक खेती की जाती है। जैविक खेती के क्षेत्रफल तथा उत्पादन की दृष्टि से मध्य प्रदेश का भारत में प्रथम स्थान है। इसके बाद क्रमशः राजस्थान, महाराष्ट्र एवं उत्तर प्रदेश का नंबर आता है।भारत में कृषि प्रथाएं चार हजार वर्षों से भी अधिक प्राचीन हैं तथा उनमे भी जैविक कृषि देश में बहुत अधिक मूल की है। चाणक्य द्वारा रचित अर्थशास्त्र में भी वैदिक काल के किसानों में मिट्टी की उर्वरता, बीज चयन, पौध संरक्षण, बुवाई के मौसम, और विभिन्न भूमियों में फसलों की स्थिरता के उचित ज्ञान के विषय में उल्लेख किया गया है। कृषि उत्पादकता को बनाए रखने के लिए प्रभावी खरपतवार प्रबंधन महत्वपूर्ण है।

खरपतवारों से हानि

रासायनिक दवाओं के प्रयोग की अनुशंसा न होने तथा खरपतवारों के बीजों से प्रदूषित गोबर की खाद या वर्मीकम्पोस्ट के प्रयोग के कारण आज जैविक कृषि में खरपतवार एक मुख्य समस्या बन गया है। आमतौर पर विभिन्न फसलों की पैदावार में खरपतवारों द्वारा 10 से 85 प्रतिशत तक की कमी आंकी गई है। लेकिन कभी-कभी यह कमी शत-प्रतिशत तक हो जाती है । खरपतवार फसलों के लिए पोषक तत्व, नमी, प्रकाश, स्थान आदि के लिए प्रतिस्पर्धा करके उनकी वृद्धि, उपज एवं गुणवत्ता में कमी कर देते हैं। फलस्वरूप पौधे की विकास गति धीमीएवं उत्पादन स्तर गिर जाता है।खरपतवारों द्वारा फसलों में की गई हानि अन्य कारणों जैसे कि कीट-पतंगों व रोग ब्याधि आदि की अपेक्षा अधिक होती हैं ।

जैविक कृषि में खरपतवार प्रबंधन

खरपतवारों का यदि उचित समय पर प्रभावी नियंत्रण नहीं किया जाता है तो अधिकाधिक उत्पादन प्राप्त करने के लिए किये गये उपाय निरर्थक सिद्ध हो जाते हैं। सामान्यतः फसलें अपनी प्रारंभिक अवस्था में खरपतवारों से प्रतिस्पर्धा नहीं कर पाती हैं। अतः फसलों को प्रारम्भ से ही खरपतवार रहित रखना आवश्यक हो जाता है ताकि खरपतवारों पर प्रभावी नियंत्रण पाकर फसल को होने वाली क्षति से बचाया जा सके। चूंकि जैविक कृषि में रासायनिक खरपतवार नाशी दवाओं के प्रयोग की अनुमति नहीं है इसलिए

सांस्कृतिक जैविक और यांत्रिक खरपतवार नियंत्रण मुख्य रूप से अच्छी फसल उपज और गुणवत्ता प्राप्त करने के लिए किया जाता है।

जैविक कृषि प्रणालियों में पूर्व और बाद के उद्भव यांत्रिक और थर्मल खरपतवार विधियों और खरपतवार नियंत्रण के लिए प्लास्टिक और अपघटन योग्य मल्च के उपयोग की अनुमति है। जैविक खेती के तहत सांस्कृतिक उपायों के न्यूनतम हस्तक्षेप और खरपतवारों के गैर-पूर्ण उन्मूलन की सिफारिश की जाती है, हालांकि कृषि व्यवस्था के भीतर खरपतवार बनाए रखना एक आशीर्वाद और उपद्रव दोनों हो सकता है। खरपतवार जीवविज्ञान और खरपतवार प्रतिस्पर्धा के पहलुओं की जानकारी जैविक कृषि प्रणालियों में खरपतवार प्रबंधन के लिए विशेष प्रासंगिकता रखती है। जैविक कृषि में खरपतवार प्रबंधन के लिए निम्नलिखिल विधियों का प्रयोग किया जा सकता है।

खरपतवार प्रबंधन के लिए निवारक विधिया

खरपतवार रोकथाम के अंतर्गत एक नए क्षेत्र में नए खरपतवारों के प्रवेश और स्थापना को रोकने के उपायों को शामिल किया जाता है। यह खरपतवार मुक्त फसल के बीज, बीज प्रमाणीकरण, खरपतवार कानून और संगरोध कानूनों के उपयोग से प्राप्त किया जा सकता है। सामान्यतया, देश के भीतर खरपतवारों के फैलाव को साफ बीज कानूनों, कृषि उपकरणों की सफाई और उत्पादन, सिंचाई के पानी की सफाई, रेत और बजरी की सफाई और मिट्टी में लौटे हुए खरपतवार बीज की संख्या को कम किया जा सकता है। फसल क्षेत्र में खरपतवार की प्रविष्टि को पूरी तरह से विघटित गोबर की खाद या कम्पोस्ट के प्रयोग, बुवाई से पहले कृषि मशीनरी की सफाई करके, मेड तथा सिंचाई/जल निकासी चौनल को खरपतवार से मुक्त रखकर, खरपतवार मुक्त बीज के उपयोग से रोका जा सकता है।

खरपतवार प्रबंधन के लिए सांस्कृतिक विधियों

सांस्कृतिक विधियाँ खरपतवारों के विरुद्ध फसलों को प्रतिस्पर्धी लाभ प्रदान करती हैं। ये फसलों को तेजी से वृद्धि तथा विकास करने में सहायता प्रदान करती हैं। खरपतवार प्रबंधन के लिए

प्रयुक्त विभिन्न सांस्कृतिक विधियों का वर्णन निम्न है।

स्टेल सीड बेड विधि

इस विधि में खेत की तैयारी के बाद उसे सिंचित कर खरपतवारों के अंकुरण के लिए छोड़ा जाता है। अंकुरण कीक्रिया पूरी होने पर खेत की जुताई से खरपतवारों का प्रबंधन किया जाता है। यह विधि खरपतवारों के जमाव को कम करने के साथ साथ प्रारंभिक फसल-खरपतवार प्रतियोगिता में देरी करती है और खरपतवार बीज बैंक को भी कम कर देती है।

ग्रीष्म ऋतु में गहरी जुताई

इस विधि के अंतर्गत ग्रीष्म ऋतु में खेतों की हल द्वारा गहरी जुताई की जाती है जिससे खरपतवारों के बीज और कंद जमीन के ऊपर आ जाते हैं। इस प्रकार निरंतर तीव्र प्रकाश लगने के कारण खरपतवारों के बीज और कंद अंकुरण छमता खोकर निष्क्रिय हो जाते हैं। इस विधि से कीटों एवं बीमारियों का प्रकोप भी काफी कम हो जाता है। खरपतवारों को नष्ट करने की यह पद्धति वहां अपनाई जा सकती है, जहां ग्रीष्म ऋतु में कोई भी फसल न ली गयी हो अथवा खरपतवारों का अत्यधिक संक्रमण हो।

बीजों के चयन तथा उपचार

बीज के उपचार से पूर्व, सुनिश्चित कर लें कि बीज स्वस्थ, आकार में एक समान और कीट क्षति अथवा रोग से मुक्त हों। प्रमाणित तथा स्वच्छ बीजों के चयन से जैविक कृषि के अंतर्गत अप्रत्यक्ष रूप से खरपतवारों का प्रबंधन किया जा सकता है। बिजाई के लिए अच्छे बीज की निम्नलिखित विशेषताएं होनी चाहिए -

1. बीज शुद्ध प्रजाति का होना चाहिए।
2. बीज स्वस्थ, रोग रहित, विषाणु, सूत्रकृमि तथा जीवाणु आदि से मुक्त होना चाहिए।
3. बीज अंकुरण की सही अवस्था में होना चाहिए।
4. स्वस्थ बीज के चयन के उपरांत जैविक कृषि के अंतर्गत अभिनव बीज उपचार के सूत्र निम्नानुसार है:

- गौ मूत्र द्वारा बीजों का उपचार
- बीजामृत से उपचार
- गौ मूत्र के साथ मिश्रित हल्दी कंद पाउडर द्वारा उपचार
- पंचगव्य द्वारा उपचार
- हींग (एस्फोएटिडा) 250 ग्राम/लीटर विलयन से प्रति 10 किलो बीज का उपचार
- ट्रायकोडर्मा विरिडी (4 ग्राम/किग्रा बीज) या स्यूडोमोनास फ्लोरोसेंस (10 ग्राम/किग्रा बीज) से बीजोपचार
- बायोफर्टिलाइजर्स (राइजोबियम/एजोटोबैक्टर + पीएसबी) से उपचार

बीज दर

फसलों का कृषि क्षेत्र पर **धनत्व** उनकी खरपतवारों के साथ प्रतिस्पर्धा को प्रभावित करता है। साधारणतयाइष्टतमया कुछ उच्च बीज दर का उपयोग खरपतवारों की **संख्या** व उनके शुष्क भार को कम करता है तथा फसलों को प्रतिस्पर्धी लाभ प्रदान करता है। अतः फसलों में इष्टतम पौध संख्या को सुनिश्चित करके जैविक कृषि के अंतर्गत खरपतवारों को प्रभावीढंगसे नियंत्रित किया जा सकता है। विश्व **स्तर** पर हुए विभिन्न शोधकार्यों से पता चला है कि जैविक पद्धति से उगाई अनाजवाली फसलों में बीज दर को बढाकरप्रभावी खरपतवार **प्रबंधन** किया जा सकता है।

बुवाई का समय

फसलों की बुवाई का समय एकगरै-माSि◌द्रक निवश्sा है जो फसल **उत्पादकता** को बहतु प्रभावित करता है प्रारं◌िभक रापेण फसलों को खरपतवारों से अधिक प्रतिस्पर्धी बनाता है जिससे खरपतवारों को उनके उदभ्~ाव और विकास के लिए पयाप्Zत सर्यू **प्रकाश** व अन्य आवश्यक साधन प्राप्त नहीं हो पाते है।

प्रतिस्पर्धी फसल किस्मों के चयन

जैविक खेती में प्रभावी खरपतवार **प्रबंधन** प्राप्त करने के लिए प्रतिस्पर्धी फसल **किस्मों** का चयन जरुरी है। खरपतवार दमन और खरपतवार सहिष्णुता खरपतवार प्रतिस्पर्धी फसल किस्मों के चयन के लिए महत्वपूर्ण है। बहुत से गुण जैसे कि जड़ों की आकृति, प्रारंभिक **वृद्धि**, पत्तियों का आकार तथा एलिलोपैथिक **अंतःक्रिया** किसी प्रजाति को अधिक प्रतिस्पर्धी बनाती हैं। अतः उपर्युक्त गुणों से युक्त प्रजातियों के चयन द्वारा जैविक कृषि में खरपतवार **संक्रामकता** को कम किया जा सकता है।

फसलों में सिंचाई

फसलों में सिंचाई का इष्टतम समय और उसकी संख्या खरपतवारों के घनत्व और शुष्क भार को कम कर देती है। कुछ अध्ययनों के अनुसार बुवाई से पूर्व की गयी सिंचाई से चीनोपोडियम (बथुआ) खरपतवार के संक्रमण को लगभग 20 प्रतिशत तक कम किया जा सकता है। अतः जैविक विधि से फसलों के उत्पादन के समय **सिंचाई** के साधनो का समुचित प्रयोग अति **आवश्यक** है।

उचित फसल चक्र

एक ही फसल को बार-बार एक खेत में लेने से उस फसल में खरपतवारों का **प्रकोप** बढजाता है। उदाहरणार्थ एक ही खेत में बार-बार चने की फसल उगाने से बथुआ तथा **फेलरिस** माइनर (गेहूँ के मामा) खरपतवार का **प्रकोप** बढ जाता है, जिसके परिणामस्वरूप कुछ समय बाद इनकी संख्या इतनी अधिक हो जाती है कि उस खेत में चने की पैदावार ले पाना **आर्थिक** –ष्टि से लाभकारी नहीं रहता है। **विभिन्न** जीवन अवधियों की फसलों को एक चक्रीय क्रम में लगाकर फसल और **खरपतवारों** के बीच की

साझेदारी को तोडा जा सकता है। उपर्युक्त साझेदारी को तोड़कर मुख्य रूप से स्मूथरिंग और एलोपैथिक प्रभाव से खरपतवार बीज उत्पादन में महत्वपूर्ण कमी की जा सकती है। अतः यह आवश्यक है कि एक ही फसल को बार-बार एक ही खेत में न बोया जाए एवं उचित फसल चक्र अपनाया जाए।

हाथ से खरपतवार निकालना

हाथ से खरपतवार निकालने की विधि तभी अपनाई जानी चाहिए जब खेत का क्षेत्रफल थोड़ा हो तथा श्रमिक आसानी से कम मूल्य पर उपलब्ध हो।यह खरपतवारों पर नियंत्रण पाने की सरल, प्रभावपूर्ण तथा उत्तम विधि है। फसलों की आरंभिक अवस्था बुवाई के 15-45 दिन के मध्य का समय खरपतवारों से प्रतियोगिता की –ष्टि से क्रांतिक समय है। परिणामस्वरूप, आरंभिक अवस्था में ही फसलों को खरपतवार से मुक्त करना अधिक लाभदायक होता है।

इटंरक्रॉपिगं (अतंर-फसलीकरण)

विभिन्न प्रकार की फसलें जोकि आकारीय रूप से अलग हो को साथ उगाकर जैविक खेती के अतंगर्त खरपतवार प्रबधं ान किया जा सकता है इटंरक्रॉपिगं (अतंर-फसलीकरण) के माध्यम से उत्पादन के साधनोका एक बड़ा भाग लाभकारी फसलों तक पहचांया जा सकता है जोकि समय के साथ उनकी व'ि द्ध और विकास को अधिक गति प्रदान कर उन्हे ंप्रतिस्पर्धी बनता है इसके अतिरिक्त अतंर-फसल की बुवाई से खरपतवारों के नियत्रंण में लगी लागत को भी कम किया जा सकता है तथा कृषकों की आमदनी को भी काफी सीमा तक बढ़ायाजा सकता है। विभिन्न शोधकर्ताओ के अनुसार केवल गन्ने की मुख्य फसल की तुलना में गन्ने तथा मूंग की इन्टरक्रोप्पिंग द्वारा खरपतवारों के शुष्क भार को प्रभावी रूप से कम किया जा सकता है।

हरी खाद

जैविक कृषि के अंतर्गत कवर और हरी खाद वाली फसलों जैसे किढैंचा,लोबिआ आदि के अनुप्रयोग की अनुशंसा की जाती है। ये फसलें अपने त्वरित विकास, अधिक जैवभार उत्पादन, एलीलोपैथिक प्रभाव इत्यादि गुणों के कारण जैविक कृषि में खरपतवारों का प्रबंधन करने में सहायक हैं। इसके अतिरिक्त कवर फसलों और हरी खाद वाली फसलों के उपयोग से मृदा में लाभदायक फफूंद, जीवाणु और मायकोराइजा समुदायों को बढ़ावामिलता है जो खरपतवारों को अपने द्वारा बने वृद्धि नियामक पदार्थों से नियंत्रित करते हैं। जुताई के दौरान हरी खाद का भूमि में अधिग्रहण खरपतवार के जमाव को रोकने के साथ साथ उनकी वृद्धि को भी रोकता है।

थर्मल खरपतवार नियंत्रण

थर्मल खरपतवार नियंत्रण के अंतर्गत फ्लेम तथा खरपतवारों के मध्य सीधा संपर्क बनाने के लिए ज्वलनशील उपकरणों का उपयोग किया जाता

है। इस विधि में तीव्र ज्वाला के प्रभाव से खरपतवारों में कोशिकीय स्तर पर हानि पहुँचती है तथा उनके जलाकर भी तेजी से नष्ट किया जा सकता है। थर्मल खरपतवार नियंत्रण विधि का प्रयोग फसलों के जमने से पूर्व किया जा सकता है ताकि फसल को खरपतवारों की तुलना में प्रतिस्पर्धात्मक लाभ प्राप्त हो सके। इस विधि का प्रयोग फसलों के जमने के बाद भी किया जा सकता है हालाँकि, फसल उत्पादन की अवधि के दौरान थर्मल खरपतवार नियंत्रण से फसलों को भी नुकसान पहुँच सकता है। इस विधि के अंतर्गत खरपतवार नियंत्रण के लिए फ्लेमर्स उपयोगी होते हैं। सामान्यतया प्रोपेन से परिचालित फ्लेमेर्स का प्रयोग इस विधि में किया जाता है। तापमान में अचानक वृद्धि से पौधों की कोशिकाओं में कोशिका द्रव्य का विस्तार हो जाता है, जिससे कोशिकाओं की दीवार टूट जाती है तथा खरपतवार नष्ट हो जातें हैं। खरपतवारों का प्रभावी नियंत्रण प्राप्त करने के लिए उनकी 2 से 3 पत्ती वाली अवस्था में ज्वाला निराई का प्रयोग किया जाना चाहिए।

मृदा सौरकरण

इस विधि के अंतर्गत नम मृदा में सौर विकिरण को फँसाने के लिए पॉलीथीन फिल्म (आमतौर पर काला या स्पष्ट प्लास्टिक शीट) द्वाराढकदिया जाता है। इस प्रकार कई सप्ताह तक सौरकरण द्वारा मिट्टी के तापमान में वृद्धि से खरपतवार, खरपतवार बीज व अन्य रोग ब्याधियों का नियंत्रण किया जा सकता है। विभिन्न अध्ययनों में खरपतवारों पर मृदा सौरकरण के नकारात्मक प्रभाव की जानकारी देखने को मिलती है। साथ साथ यह भी पाया गया है कि तंबाकू और सब्जी फसलों में ऑरोबांचे परजीवी खरपतवार और घातक साइपरस रोटंडस का बेहतर नियंत्रण मृदा सौरकरण से किया जा सकता है।

जैव खरपतवार प्रबंधन

जैव खरपतवार नियंत्रण विधि के अंतर्गत खरपतवारों को नियंत्रित करने के लिए बायोएजेंट जैसे कि कीट, रोगजनक जीव तथा अन्य जीवों का प्रयोग किया जाता है। कीट और रोगकारक जीव खरपतवारों को संक्रमित करके उनकी वृद्धि और विकास को अवरुद्ध करते हैं अथवा उनको पूर्णतया नष्ट कर देते हैं। जैविक नियंत्रण विधि से खरपतवार कम हो सकते हैं लेकिन उनका पूर्णतः उन्मूलन संभव नहीं है। जैविक नियंत्रण खरपतवार नियंत्रण के लिए प्रदूषण मुक्त और आर्थिक विकल्प है।

एकीकृत खरपतवार प्रबंधन

एकीकृत खरपतवार प्रबंधन खरपतवार प्रतिस्पर्धा को कम करने के लिए दो या अधिक खरपतवार नियंत्रण विधियों का संयोजन है। एकीकृत खरपतवार प्रबंधन प्रणाली मूल रूप से प्रभावी, भरोसेमंद और व्यावहारिक खरपतवार प्रबंधन प्रथाओं का एकीकरण है जिसे उत्पादकों द्वारा

आर्थिक रूप से उपयोग किया जा सकता है। यह खरपतवार प्रबंधन सिद्धांतों पर निर्भर करता है जो सांस्कृतिक, यांत्रिक, थर्मल और जैविक साधनों के संयोजन से दीर्घकालिक खरपतवार प्रबंधन के लिए उपयुक्त साबित हुए हैं।

उपरोक्त सूचना से यह निष्कर्ष निकाला जा सकता है कि जैविक कृषि के अंतर्गत खरपतवारों से उपज को होने वाली हानि से बचाने के लिए निवारक उपाय करते हुए एक दीर्घकालिक – ष्टिकोण अपनाने की आवश्यकता है। खरपतवार नियंत्रण की लागत को कम करने तथा खरपतवारों से होने वाली उपज के नुकसान को रोकने के लिए दीर्घकालिक लक्ष्य के साथ-साथ विभिन्न प्रत्यक्ष और सांस्कृतिक विधियों को एकीकृत करने की आवश्यकता है।

Bee keeping in agroforestry - A potential role for a sustainable rural livelihood

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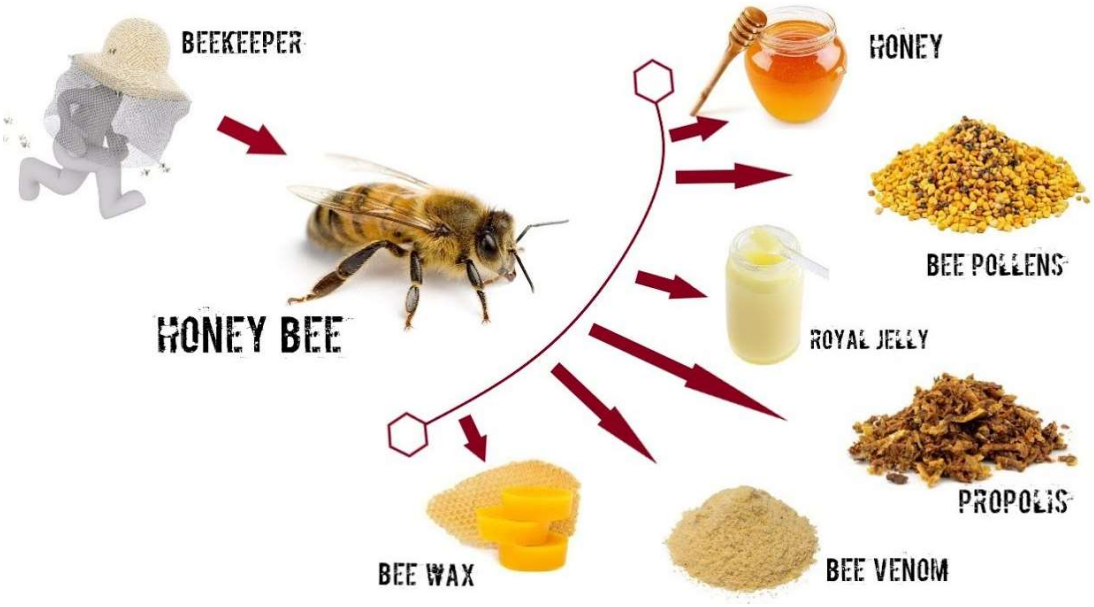
Introduction

Interactions between plants and pollinators contribute to biological diversity, ecological function, agricultural output, food security, and livelihoods. Insects are by far the most significant animal pollinators, and bees are the most specialized pollinators among insects. For adult and larval nutrition, more than 16000 species of bees rely almost entirely on angiosperm pollen and nectar (Michener 2000; Wcislo 1996). As a result, they are a major part of world biodiversity, serving a crucial functional role in ecosystems and providing vital pollination services (Ashaman *et al*. 2004). Unfortunately, human-induced causes such as deforestation, urbanization, increase of agricultural land, intense chemical usage, and the introduction of genetically modified and alien species are all threatening this interaction. Pollinator diversity, lower pollinator numbers, pollination deficits, and low seed output due to pollen limitation are all consequences of habitat loss and fragmentation, all of which have negative consequences for plant populations and agricultural production (Foley *et al*., 2005). In natural ecosystems, pollination services given by managed bees, for example, may play a positive role in the plant-pollinator relationship. Forests are important foraging, breeding, roosting, and mating sites for most pollinators. Beekeeping is important activity that can help local people makes more money from protected areas and native forests. Beekeeping in the agroforestry system can provide alternate livelihood security, higher land productivity, and improved microclimate.

Bee Products

There are several bee products such as honey, bee wax, pollen, nectar, propolis and royal jelly etc., which are obtained from the domesticated and wild bees. Honey is used for a variety of purposes, including as a natural sweetener, antioxidant, anti-inflammatory, antibacterial agent, and medicine. Many commercially popular honeys are produced from the tree species namely Oak honey, Eucalyptus honey, Acacia honey, Mahua honey, Tupelo honey, Litchi honey etc. Honeybees are extremely valuable economically because they pollinate a wide range of fruit, vegetable, and seed crops. As a result, beekeeping can be considered as a good, profitable agro-based business for landless farmers and entrepreneurs, as well as a good

source of supplementary income for farmers.



Bee products

Bee Keeping in the Agroforestry System

Through bee pollination, agro-forestry makes a significant contribution to honey production. Many studies have shown that the combined yield of diversified agriculture outperforms the output of a single crop. Honey bee domestication with agro-forestry crops improves microclimate and consequently increases agricultural yield. This combines system allows farmers to diversify their production by cultivating a variety of agricultural crops, trees and honey bee products in the same place as alley cropping, boundary plantation, riparian buffer strips, and windbreaks etc. As a result, they limit the risk of losing money if one of their crops fails or the market price falls. The foundation for renewing industrial development is agroapicultural self-sufficiency. Apart from their economic goods, trees such as Eucalyptus spp., *Deris indica*, *Tamarindus indica*, *Peltophorum pterocarpum*, *Quercus* spp., *Azadirachta indica*, *Anthocephalus cadamba*, *Syzygium cumini*, *Cocos nucifera*, *Moringa oleifera*, *Borassus flabellifer*, *Dalbergia sissoo*, *Acacia nilotica*, *Acacia auriculiformis*, *Leucaena leucocephala*, *Sapindus laurifolius*, *Malus domestica*, *Prunus* spp. etc. contribute to honey production. Agroforestry systems could benefit bee forage or hive protection by strategically planting trees. As a result, agroforestry provides a viable potential for honey bees and honey production to improve nectar and pollen sources

Bee hive in agroforestry system

Conclusion

Honeybees supply a wide range of products as well as services (pollination) to humans and the environment. Beekeeping is a significant enterprise that is linked to agricultural and horticultural products. The development of honey bee cultivation in agroforestry systems can provide opportunities for alternative sources of livelihoods and increases in crop productivity.

Droneochory: A novel approach to forest restoration

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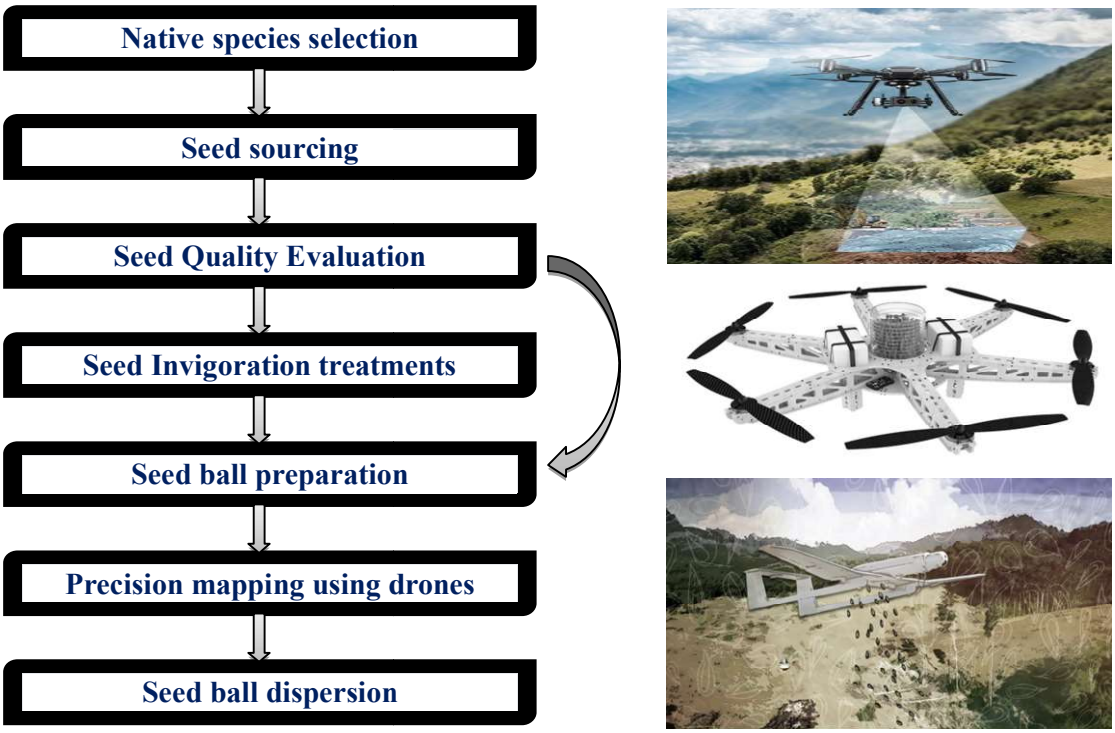
Only five countries (Russia, Brazil, Canada, the United States of America, and China) account for about half of the world's forests, but forest areas in these countries are disappearing at an alarming rate. Agriculture (which is the leading cause of deforestation), logging, human migration and population growth, extractive industries (mining, oil and gas), transportation and infrastructure developments, and developing towns and cities are all contributing to deforestation. Loss of biodiversity, increased atmospheric CO_2, increased wildfire, increased flooding, increased drought and disruption of water cycle are some of the consequences of deforestation. To overcome these, forest restoration is very much essential.Forest restoration is the process of returning a forest or landscape to its former state after it has been degraded or harmed by anthropogenic or natural processes. It's a tool for achieving a variety of objectives, such as climate mitigation, biodiversity conservation, socioeconomic advantages, food security, and ecosystem services. The commitment to rehabilitate 350 million hectares of deforested and degraded lands by 2030 was pledged in the New York Declaration on Forests in 2014. India pledged to repair 13 million hectares of degraded and deforested land by 2020 when it joined the Bonn Challenge in 2015, but then amended its restoration aim to 26 million hectares by 2030. To achieve these goals, national, regional, and local seed and plant supply systems must be strengthened to ensure that appropriate material from a diverse range of suitable species, adapted to local conditions and capable of persisting over generations in a changing climate, is available for each restoration project. Reforestation has mostly relied on physical labour and rudimentary instruments such as spades and machetes thus far. The time-consuming strategy of sending workers to tough terrains to manually plant seeds is unlikely to assist the world in meeting the UN's reforestation goals. Today's forestry faces issues such as large-scale forest fires, heavy outbreaks of Invasive Alien Species (IAS), and manpower shortages, among others, and to address these issues, it is necessary to develop/identify appropriate technologies to ensure appropriate planting material at the required location in a short period of time. Aerial seeding has been used to circumvent these barriers for decades. It is a method of planting seeds using an aerial mechanical system such as a plane, or helicopter. However, there are various issues with direct seed broadcasting, including germination, pests, and seed predation by mice or other wild animals. This old method of aerial seeding has a low yield and requires 25% to 50% more seeds to obtain the same results as drilled seeding. Hence, such kinds of

direct seeding through aerial systems are unpopular among stakeholders. As a result, significant changes have been made to modern aerial seeding procedures. Instead of seed, a seed ball/seed bomb is created in which seeds are wrapped in a mixture of clay, compost, and other components and sprayed on the ground using aerial equipment. Finance Minister of India, in her 2022 Budget speech emphasised the government's commitment to promoting "Kisan Drones". The ministry of civil aviation liberalised the drone use rules in August 2021, allowing certain types of drones to operate without prior approval. The Department of Agriculture and Farmers' Welfare has developed a standard operating procedure (SOP), for using drones to spray pesticides in agricultural, forestry, and non-cropped areas. Farmers Producers Organisations (FPOs), can obtain a grant of up to 75% of the cost of an agriculture drone after the department updated its policy to incorporate drone subsidy plans. These Kisan drones would be utilised for crop evaluation, digitization of land records, and insecticide and nutrient spraying. It is hope that Kisan drones could be a disrupter in India's traditional agri-industry. It can make farming more intelligent, precise and productive.Dronecoria (Dronechory) is a set of tools for drone-assisted ecological restoration, including aerial seeding of seed balls. Drones are unmanned aerial vehicles that have a variety of uses, ranging from package delivery to surveillance, agriculture, and more. Seed sowing drones can help with reforestation by planting a huge number of trees that have been lost due to forest fires or natural disasters. This seed sowing drone is an efficient answer to the problem because it sow seeds swiftly and accurately.

Mechanism of dronecoria/droneochory

Drone technology combined with native pelleted seeds has the potential to revolutionize the efficiency of ecosystem restoration. The restoration is divided in two phases. First, a precision map is created using machine learning to determine the best location for each seed ball. The sowing operation is then carried out in a flight path.The species chosen must be native to the area, hardy, and contain seeds of an acceptable size for making seed balls. The seeds balls or seed pellets are first disseminated by low-flying drones in a specific region before dropping to the ground. The weight provided by the covering of clay, compost, char, and other materials allows seeds to fall on a chosen location rather than disperse in the breeze. When there is enough rain, these pellets will sprout, with the nutrients within them assisting in the initial growth. They must also have a better survival rate. In order for the plantation to be effective, the time of the seeding must also be precise.



Advantages of dronochory (Aerial seeding)

1. Aerial seeding can be used to target areas that are inaccessible, have high slopes, are fragmented or disconnected,land that is too hard to reach by non-aircraft or ground conditions being too wet and have no forest corridors, making conventional plantation challenging.
2. The germination and growth of the seed is such that it requires no more attention once it has been spread. This is why seed pellets are referred to as the "fire and forget" method of planting.
3. They eliminate the need for ploughing and drilling holes in the soil, and the seeds do not need to be planted because they are already surrounded by soil, nutrients, and microbes.
4. Birds, ants, and rats are all protected by the clay shell of these pellets, as well as the other ingredients in the mixture.
5. It will create jobs for the local population, particularly for women who can prepare the seed balls.
6. It achieves the most efficient coverage of a large area in the least amount of time.
7. It may be used when existing crops are already planted. This is important when living in an area where there is a small window between harvesting the crop and the end of the growing season, because seeding cover crops after harvest can cause poor stand

establishment due to cold temperatures or moisture.

8. Aerial seeding improves crop yields while also shifting the task of forest restoration from locals to smart drones. Furthermore, seed bombing is a non-disruptive procedure for crops.
9. Aerial application prevents soil runoff by not causing soil compaction. Tropical forests will benefit the most from this type of planting approach because they absorb carbon faster than other forest types and support far higher biodiversity.

Challenges/Constraints

1. Before any method of reforestation can be used, the species chosen must be tailored to the area's temperature, growing season duration, rainfall, humidity, photoperiod, and other environmental factors. Trial plots should be developed before aerial seeding to assess which plants are most likely to germinate and flourish well on the specified sites. Even if one species has all of the necessary qualities, it's a good idea to test seed from many provenances to determine the ones that are most suited to the location. Characteristics that determine whether a species is suitable for aerial sowing include:

- seed size
- seed availability
- ability of the seed to germinate on the soil surface
- germination and seedling growth speeds
- ability to withstand temperature extremes and prolonged dry periods (orthodox seed)
- ability to tolerate soil conditions
- light tolerance
- seed stability when stored in large quantities
- suitability of seed for handling with mechanical seeding devices,
- Development speed of a deep taproot by seedlings to enable them to withstand adverse climatic conditions in the period following germination.

2. Environmental circumstances have a big impact on seed balls and aerial reforestation. In some circumstances, seed deployment is not possible because the location needs to be prepared or the season is incorrect.
3. On some sites, ground preparation may be required. To achieve the biological requirements for fast seed germination and seeding survival, site preparation and seeding must be well synchronised. Dry locations may need to be ridged or disked to maximise the amount of rain that reaches the seed. Sites that are excessively wet may need to be ridged or drained..
4. As long as seeds locate a receptive seedbed, the degree of field slope is unimportant. Aerial seeding is frequently appropriate for steep watersheds, eroding mountain slopes, bare hillsides, and spoil-banks with limited vegetation

(however, on some steep slopes with smooth, bare soil, rain may wash the seeds away too easily for successful seeding).

5. Reforestation is most needed on arid and savanna lands (for example, those with annual rainfall of less than 800 mm). In theory, airborne seeding offers remarkable promise in these areas. They include vast areas of undeveloped or underutilised terrain with minimal forest cover that is not restricted to private land holdings, making them readily accessible to aircraft.The native trees (such as species of Acacia, and other genera) in these areas are generally well adapted for survival under difficult field conditions.
6. Wildlife eat highly palatable seeds before they can germinate, hence species with highly palatable seeds have a limited chance of survival unless they have been palletized. Chaffy seeds are also more likely to drift in the wind, making them more difficult to target during the drop. Small seeds, on the other hand, are more likely to fall into fissures and be covered by soil, increasing their chances of survival. Aerial seeding may be most effective with "pioneer" species that germinate quickly on open locations, are adapted for development in bare or disturbed environments, and thrive in direct sunlight.

Conclusion

To achieve our country's commitments on many international platforms, we need to use cutting-edge technologies like drone-assisted aerial seeding for speedier forest restoration. Still there is a lot of technological progress required before drones can effectively replace people when it comes to seed planting. Drones may save money, but the danger of seeds dropping in the wrong place cannot be ruled out. Many factors, including soil chemistry, animal predation, and weed competition, might prevent seedlings from emerging after they reach the ground. Dronechory is not meant to replace the conventional methods rather it is to supplement them.

Ban on single-use plastic: Possible alternatives

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Introduction

Every year, 3.5 million tonnes of plastic waste are produced in India. According to government statistics, India produces 3 kg of plastic garbage per person each year. Approximately 41,26,997 tonnes of plastic garbage will be produced annually in 2020–21, according to data from all State Pollution Control Boards. According to the Minderoo Foundation (2021), 98 percent of the plastic produced worldwide, or single-use plastics, is made from fossil fuels. The bulk of plastic that is thrown away is likewise made of single-use plastic. 130 million metric tonnes will be burned, buried in landfills, or dumped into the environment globally in 2019. By 2050, it has been predicted that single-use plastic might contribute 5–10% of greenhouse gas emissions, depending on the production trajectory currently in place. With domestic production of 11.8 million metric tonnes per year, imports of 2.9 MMT, and a net creation of 5.6 MMT, India ranks 94 out of the top 100 nations in terms of the production of single-use plastic garbage. The top three countries are Singapore, Australia, and Oman. Global and sometimes severe effects of this plastic trash on the ecosystem and our health. Reusable alternatives are less likely to enter our oceans than single-use plastic products. A three-pronged plan is being

considered by the government to outlaw single-use plastic in India:

High propensity for littering

This refers to things that are rapidly discarded after use. The majority of them are throwaway things that are discovered in drains and are considered to be products that encourage littering.

Low utility

After being utilised, these plastic items have the least amount of use or utility. For instance, once the container is opened, plastic sheets used for wrapping are rarely used.

Availability of alternatives

If they can be replaced with other options. For instance, bamboo spoons rather than plastic spoons, paper bags, paper wrappings (which might be manufactured from recycled materials), etc.

Single use plastic

As the name suggests, it refers to single-use plastic objects that are thrown away. The amount of plastic produced and utilised for single-use items, such as packaging for goods, bottles (for shampoo, soap, and cosmetics), polythene bags, face masks, coffee cups, cling film, rubbish bags, and food packaging, is among the greatest. With effect from July 1, 2022, the government has outlawed the production, importation, stocking, distribution, sale, and use of the following single-use plastics, including polystyrene and expanded polystyrene. Earbuds, balloon sticks, candy and ice cream sticks, plates, cups, glasses, forks, spoons, knives, trays, sweet boxes, invitation cards, cigarette packs, PVC banners measuring under 100 microns, and polystyrene for packaging are among the items that the Central Pollution Control Board (CPCB) has declared illegal. The initial ban's selection of single-use plastic products was based on their "difficulty of collection, and thus recycling." Not the existence of plastic per se, but the presence of plastic in the environment, is the adversary. Microplastics are created when plastic is left in the environment for a very long time without decomposing and then enters our food supply before eventually making its way into our bodies. This is incredibly dangerous. These objects were chosen because they are challenging to gather, especially since many of them, like ice-cream sticks, are either little or dumped into the environment. In contrast to the much larger pieces, it becomes harder to collect after that for recycling.The Environment Protection Act of 1986 allows for penalties of up to 5 years in prison, up to Rs 1 lakh in fines, or both, and the ban will be overseen by the CPCB at the Center and the State Pollution Control Boards (SPCBs).The SPCB may also require violators to pay environmental damage compensation. Municipalities also have their own plastic trash regulations and criminal codes.

Global status on use of single-use plastic

India was one of 124 nations that signed a resolution earlier this year to create an agreement that will eventually make it legally binding for the signatories to address the complete life of plastics from manufacture to disposal in order to stop plastic pollution. 68 nations had plastic bag bans in place as of July 2019 with various levels of enforcement. The Single-Use Plastics Directive entered into force in the European Union on July 2, 2021. (EU). The directive prohibits the sale of some single-use plastics for which substitutes are readily available; this includes single-use plastic plates, cutlery, straws, balloon sticks, and cotton buds. The same measure applies to cups, food and beverage containers made of expanded polystyrene, and all products made of oxo-degradable plastic.The list of banned items in India includes:

- Ear buds with plastic sticks
- Plastic sticks for balloons
- Plastic bags
- Candy sticks
- Ice - cream sticks
- Polystyrene (Thermocol) for decoration
- Plastic plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays

- wrapping or packing films around sweet boxes
- Invitation cards
- Cigarette packets
- Plastic or PVC banners less than 100 micron
- Stirrers

Available alternatives

1. Try stainless steel, bamboo orstainless steelstraws. Paper and reusable silicon straws are also good if you like the flexibility.In corporate offices and public places, plastic coffee/tea stirrers were very common but now they have gradually replaced them with those made of bamboo or wood. Sometimes, stirrers are also made of herbs
2. Rather of balloons, opt for more eco-friendly decorations like flowers, homemade paper flowers, paper lanterns, and recycled bunting.
3. Replace your plastic earbuds with bamboo cotton buds or liquid ear cleanses instead. An average person discards roughly 415 buds annually, according to research. Buds manufactured with paper sticks are also available on the market.
4. Help the environment by bringing a reusable glass or ceramic mug to the office or school. Plastic throwaway cups are frequently tossed on the ground after being used.
5. For grocery shopping, carry jute or cloth bags from home
6. Use reusable cutlery made of stainless steel or use biodegradable ones made of wood, bamboo or other natural fibres. Using plastic cutlery is quite wasteful. Instead, use reusable bamboo utensils or get a set of travel cutlery. Instead of a plastic bottle, invest in a steel one for long-term use. Use containers that can be recycled or decomposed that are made of sustainable materials, such as glass, food-grade stainless steel, bamboo, rice husks, etc. Don't forget to say no to plastic cutlery while ordering food online by opting not to include it. It is our duty to save the planet so each time you order food offline or online, you can request the restaurant to not include plastic cutlery.

Teak seed orchard, Behrai, Seoni, Madhya Pradesh

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Abstract

Madhya Pradesh is one of the most important states with extensive teak forests, highest number of genetically superior teak clones, teak seed orchards and famous for its high quality wood. Teak being a quality timber species of world-wide reputation, there is always a great demand for seeds. Quality teak seed production is achieved by establishment of seed orchards. The present article deals with teak seed orchard located at Behrai, Seoni, Madhya Pradesh. The details of this seed orchard are succinctly described.

Key words: Teak seed orchard, Behrai, Seoni, Madhya Pradesh.

Introduction

Teak (*Tectona grandis* L.f.) (family Verbenaceae), has world-wide reputation as a *primus inter pares* among timber species. It is referred to as standard timber for comparative evaluation of the qualities of other tropical hardwoods in assessing their utilization potential (Bhat et al., 2005). Teak is truly an Indian species because Indian region is considered to be the only known centre of maximum genetic diversity and variability of teak (Hedegart, 1975) with distribution over 8.9 million hectare (Seth and Kaul, 1978). The natural teak forests of India are confined to Peninsular India below 24^0N latitude with a total area of about 1.4 million hectare (Pande, 1983). The major teak growing states are Kerala, Karnataka, Tamilnadu, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Maharashtra, Orissa, Uttar Pradesh, Gujarat and Rajasthan (Tewari, 1992). The most important teak forests, however, occur in Wynad of Kerala, North Kanara of Karnataka, Anamalai hills of Tamilnadu, Hoshangabad and Betul of Madhya Pardesh and Chanda and Melghat of Maharashtra (Kumaravelu, 1992).

Madhya Pradesh, the heartland of India, is one of the most important states with extensive teak forests, highest number of genetically superior teak clones, teak seed orchards (TSOs) both clonal seed orchards (CSOs) and seedling seed orchards (SSOs) and famous for its high quality wood (Tiwari et al., 1998a,b; Roychoudhury et al., 2003). It has geographical area of 308 lakh km^2 and, the largest forest area of 95,221 km^2 and highest forest cover of 77,265 km^2 with growing stock of 50 million m^3. Teak occurs in over 35,000 km^2 of forest area, which is predominantly distributed in southern and central part of Madhya Pradesh (Gangopadhyay, 2005). The rich teak forests are found in the districts of Hoshangabad, Harda, Betul, Chhindwara, Seoni, Mandla and Balaghat. Teak forest of relatively lower site quality is also found in Panna, Sagar, Raisen, Vidisha, Sehore, Dewas, Guna and

Khandwa districts. This state has also 377 superior phenotypic trees (plus trees) of teak which have been identified from the 16 Forest Divisions of Madhya Pradesh namely Hoshangabad, Harda, North Betul, South Betul, Khandwa, East Chhindwara, South Seoni, South Balaghat, East Mandla, West Mandla, Dewas, Indore, Jhabua, Damoh, Sagar and Bhopal, and an area of 358 ha CSOs and 186 ha SSOs established in different eco-zones of Madhya Pradesh (Shukla et al., 2003).

Seed orchard

A Seed Orchard is a plantation of genetically superior trees isolated to reduce pollination from genetically inferior outside sources, and intensively managed to produce frequent, abundant, easily harvested seeds (https://aranya. gov.in /downloads/FR-15%20TREE - IMPROVEMENT- WORKS.pdf). It is established by setting out clones or seedling progeny of trees, selected for certain, desired characteristics. There are two types of Seed orchards, viz. Seedling Seed Orchard (SSO) and Clonal Seed Orchard (CSO). Seedling Seed Orchard is raised from seedlings, which are produced from selected parents through natural or controlled pollinations. Clonal Seed Orchard is raised from selected clones, which are propagated through grafting, cutting, air layering or tissue culture.

Teak seed orchards in Madhya Pradesh

In Madhya Pradesh, the first teak seed orchard (TSO) was established in 1977 at Nepanagar, Seoni (Behrai), Chhindwara (Delakhari and Chourai) (Tiwari et al., 1998a; Roychoudhury, 2016). Since, then a good number of clonal seed orchards (CSOs) of MP teak have been established in different ecozones of Madhya Pradesh (Betul-52.50 ha, Chhindwara-2.08 ha, Jabalpur-0.83 ha, Napanagar-59.50 ha, and Seoni-61.06 ha) till 1998 and covers a total area of 175.97 ha (Table 1).

Table-1: Clonal seed orchards of MP teak established in Madhya Pradesh

Place	Seed orchard location	Year of establishment	Area (ha)
Betul	Kosmi	1982-1994	52.50
Chhindwara	Delakari	1977	2.08
Jabalpur	State Forest Research Institute, Polipathar	1978	0.83
Nepanagar	Masak	1977-1981	59.50
	Hassanpura	1985-1995	
Seoni	Behrai	1977-1985	61.06
	Nanditola	1994-95	
	Maile	1998	
Total			**175.97**

Source : Tiwari et al. (1998a).

Teak seed orchard, behrai, seoni

Teak clones of Madhya Pradesh origin were planted during 1977-1985 in teak seed orchard (TSO) located at Ghisi, Behrai, Seoni, Madhya Pradesh. This seed orchard is an assemblage of 123 genetically superior teak clones collected from eight Forest Divisions of Madhya Pradesh, viz., Balaghat, Betul, Chhindwada, Hardha, Hoshangabad, Khandwa, Mandla and Seoni (Table 1) and planted in compartment No 54, with randomized block design and 8 x 8 m spacing in 10 plots, during the year 1977-1985 (Figs. 1-2). This is the largest TSO in Madhya Pradesh, India, with a total area of 50 ha, which lies between $79^0$19'and $80^0$17'E longitude, $21^0$11'and $22^0$57'N latitude and at an altitude of 619 m above the mean sea level. The mean maximum and minimum temperature are 43.4 and 5.6^0C respectively with an annual rainfall of 1200 mm. The plantation details and a total of 6874 grafts of 123 MP teak clones planted in TSO, Behrai, Seoni, during the different years are presented in tables 2 and 3 respectively.

Considerable amount of research has been carried out on this excellent TSO, Behari, Seoni (Roychoudhury, 2006; Roychoudhury et al., 2020). Still, there is a wide scope to do research involving silviculturist, geneticist, entomologist and pathologists, on these assembled genetically superior teak clones collected from different teak forests of Madhya Pradesh.

Fig. 1. View of TSO, Behrai, Seoni (M.P.)

Fig. 2. View of TSO, Behrai, Seoni (M.P.)

Table 1. Teak clones of Madhya Pradesh origin planted in TSO, Behrai, Seoni, Madhya Pradesh

Forest Division	**MP teak (Code)**	**Locality from where plus tree selected**	Clone number	**Total**
Balaghat	BLC	Balaghat Lanjhi	BLC-1, 5, 6, 7, 8, 10, 11	7
Betul	G	Betul	G-1	1
	F	Betul	F-1	1
	BBC	Betul Baretha	BBC-12, 14, 15	3
Chhindwada	CSC	Chhindwada Sillewani	CSC-1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 60	31
Hardha	B	Hardha	B-1	1
Hoshangabad	BHC	Bori Hoshangabad	BHC-16, 17, 18, 19	4
Khandwa	K	Khandwa	K-1	1
Mandla	M	Mandla	M-1	1
	MBC	Mandla Barela	MBC-4	1
	MKC	Mandla Kalpi	MKC-24, 25	2
	MTC	Mandla Tikaria	MTC- 6, 7, 8, 12, 27	5
Seoni	C	Seoni Kurai	C-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14,	55

			15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 56, 57, 59, 60	
	PT	Seoni Rukhar	PT-1, 3, 5, 6, 7, 26, 41, 45, 46, 47	10
Total				**123**

Table 2. Plantation details of TSO, Behrai, Seoni, Madhya Pradesh*

Establishment Year	Area (ha)	No. of grafts planted	No. of Clone	Plot No.
1977 Part I	3.68	505	19	I
1978 Part I	1.45	220	9	II
1979 Part I	7.31	986	42	III
1979 Part II	1.84	250	16	IV
1980 Part I	10.36	1575	46	V
1980 Part II	1.22	192	12	VI
1981 Part I	8.00	1221	48	VII
1981 Part II	1.20	314	15	VIII
1981 Part III**	0.77	99	24	
1982 Part I	8.09	1445	37	IX
1985 Part I	0.96	154***	20	X
1985 Part II	1.61	218***	17	X
Total	**46.49**	**7179**	**305**	

*Total area = 50 ha. **National provenance trial. ***206 grafts belongs to Maharashtra

Compartment No. 54. Spacing between ramets = 8 mt.

Table 3. Number of grafts of different MP teak clones planted in TSO, Behrai, Seoni, in different years

MP teak clone*	Year of Establishment										Total
	1977	1978	1979		1980		1981		1982	1985	
			I	II	I	II	I	II		I & II	
B-1	17										17
C-1	30		12				50	15		13	120
C-2	44		15				40				99
C-3	20	35	14								69
C-4		10			35		50	20			115
C-5		10	15				15				40
C-6	46						10		56		112

C-7									47		47
C-8	20		40	12	33				56	15	176
C-9	20				35				44		99
C-10	20				35				12		67
C-11	43	10			35				49		137
C-12	15								56		71
C-14									12		12
C-15		25	40						56		121
C-16									12		12
C-17			25						12	13	50
C-18							10		17		27
C-19			30				30				60
C-20			30								30
C-22			40	18							58
C-23			15								15
C-24			30								30
C-25			15	12	35		11				73
C-26			30	10	30				10	12	92
C-27			30	18	35						83
C-28			35	18		16					69
C-29						16					16
C-30									39		39
C-31								12			12
C-32						16					16
C-33									47		47
C-34			25				50	42		13	130
C-35			35	18		16					69
C-36							11				11
C-37			35								35
C-38				18	35						53
C-39			30	18	35						83
C-40			30	18	35		50				133
C-41			18		35		30				83
C-42			18				50	46	56		170
C-44			13	10							23
C-45			30	18	35	16	50	13			162
C-46			30	14						12	56
C-47			30				50	12		13	105
C-48			25				10				35
C-49			30		30		20			12	92

C-50			33		42						75
C-51			27								27
C-52			31	18							49
C-53										12	12
C-54			11	12							23
C-56			11	18			50				79
C-57			15		30		10				55
C-59					35				52		87
C-60			11		30						41
F-1	20		11		35						66
G-1	16										16
K-1	16				35						51
M-1					12						12
PT-1	21	25			35	16	50	40		14	201
PT-3	43								54	11	108
PT-5							30				30
PT-6		35					20				55
PT-7							50	20			70
PT-26	26										26
PT-41	27										27
PT-45	35	35							50	13	133
PT-46	26		30							13	69
PT-47		35							52		87
BBC-12					35						35
BBC-14					35						35
BBC-15					35	16					51
BHC-16					35						35
BHC-17					25				19		44
BHC-18					35	16					51
BHC-19			10		35	16					61
BLC-1									13		13
BLC-5					42				21		63
BLC-6					42				54		96
BLC-7					35						35
BLC-8			14		35				35		84
BLC-10			17								17
BLC-11									44		44
CSC-1							30				30
CSC-4							40				40
CSC-5							50				50

CSC-6							10				10
CSC-7					35				56		91
CSC-8									56		56
CSC-9					35	16	30		56		137
CSC-10					35		50	27			112
CSC-11							15		54		69
CSC-12									12		12
CSC-13							13				13
CSC-14						16	25				41
CSC-15					35				12		47
CSC-16							30				30
CSC-17					30		10		21		61
CSC-18					35		10				45
CSC-19					35						35
CSC-20					35				35		70
CSC-21					25		12				37
CSC-22							20				20
CSC-23					42		10				52
CSC-24							10				10
CSC-25						16			56		72
CSC-26									56		56
CSC-27									56		56
CSC-28					35						35
CSC-29							30				30
CSC-30							19				19
CSC-31							20				20
CSC-32					42						42
CSC-60					35						35
MBC-4							10	15			25
MKC-24								13			13
MKC-25							10				10
MTC-6							10	15			25
MTC-7								10			10
MTC-8							10				10
MTC-12								14			14
MTC-27							10				10
Total	**505**	**220**	**986**	**250**	**1575**	**192**	**1221**	**314**	**1445**	**166**	**6874**

*Number of clones 123. Figures indicate number of grafts planted during the year. Part I and II.

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Published by:

Tropical Forest Research Institute
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