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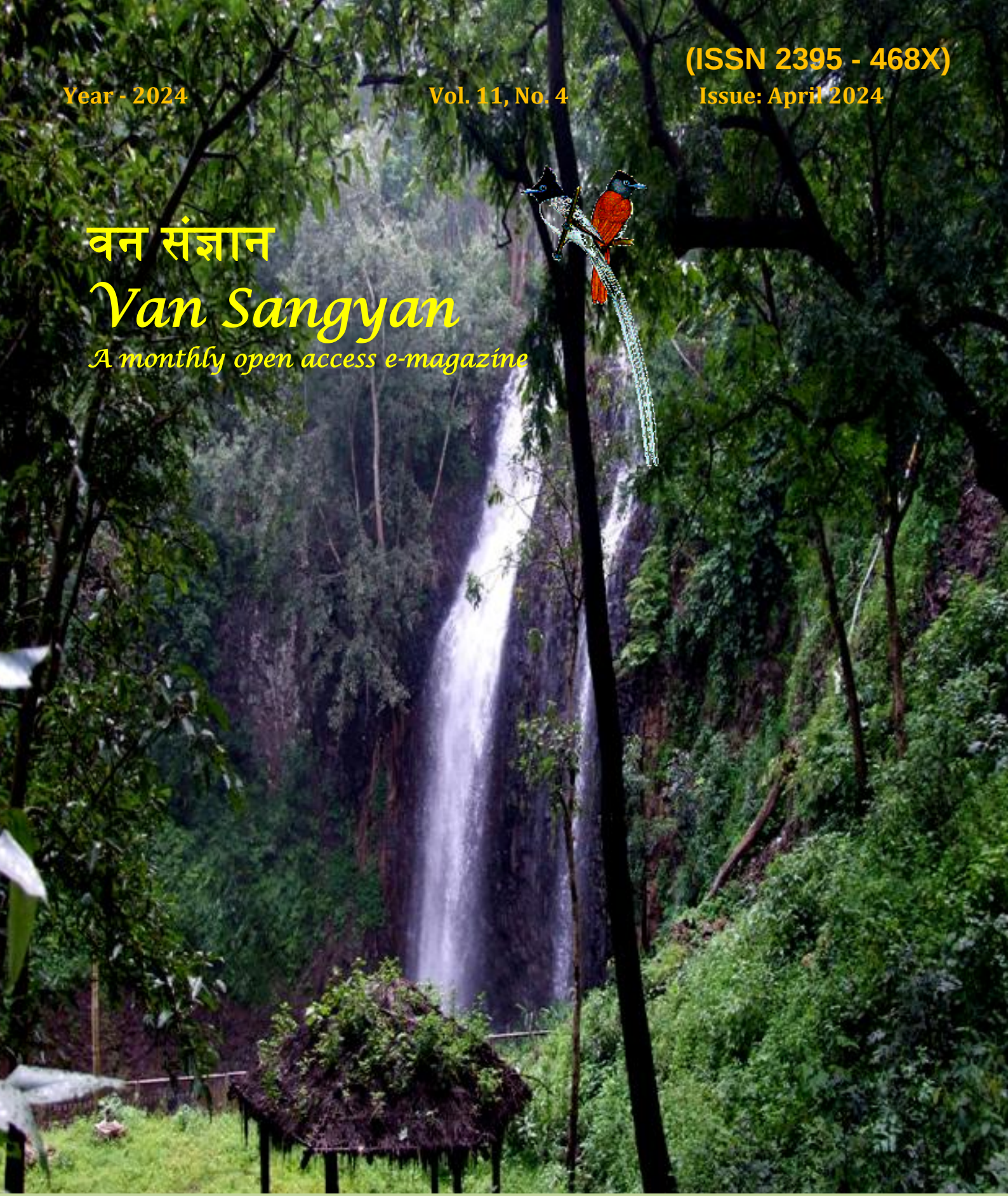

वन संज्ञान
Van Sangyan
A monthly open access e-magazine

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Van Sangyan

Note to Authors:

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

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

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve

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From the Editor's desk

Alley plantation represents a sustainable approach to agriculture that integrates crop cultivation with tree planting in alternating rows or alleys. This innovative farming technique offers numerous environmental, social, and economic benefits. By incorporating trees into agricultural landscapes, alley plantations promote biodiversity, soil conservation, and water retention, while also providing habitat for wildlife. The trees in the alleys offer shade and windbreaks, creating microclimates that enhance crop resilience and productivity. Additionally, alley plantations contribute to carbon sequestration, mitigating climate change impacts. Furthermore, this approach fosters community engagement and empowers farmers by diversifying income streams through the production of both timber and food crops.

In line with the above this issue of Van Sangyan contains an article on Alley plantation: A sustainable approach to agriculture. There are also useful articles viz. Suitable shrubs and grasses for stream bank stabilization with adoration on ecosystem benefits, The role of rhizobia in plant growth and productivity, Tropical home gardens: An epitome of sustainability, Status and trends of wood preservation in India, संकट में है धरती अब नहीं मंडराती मधुमक्खियां---- खाद्य फसलों में परागण और निषेचन की प्रक्रिया हुई बाधित, Harnessing the potentiality of agroforestry systems in coastal areas of Uttara Kannada, Karnataka, Chandan: An important tree in Himachal Pradesh, India, Curcuma alismatifolia Gagnep (Siam Lily): A Note and ग्वारपाठा (एलोवेरा) एक प्राकृतिक महत्वपूर्ण वनौषधि .

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Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Alley plantation: A sustainable approach to agriculture

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Introduction

Alley cropping is an agroforestry technique that involves planting rows of trees or shrubs at a wide spacing with a companion crop grown in the alleys between the rows. It is a sustainable and productive practice that can be used to improve soil fertility, conserve water, and increase crop yields. Alley cropping is particularly well-suited for India, which has a large area of degraded land and a growing population that needs to be fed. Eventually, the system has multiple potentials such as to diversify farm income, improve landscape aesthetics, increase crop production, increase crop yield and provide protection and conservation to crops. Also, the biomass, sometimes called pruning, obtained by pruning the trees and shrubs from the system, is a source of mulch and green manure. Besides, leguminous woody species add nitrogen to the system through biological nitrogen fixation. The main motivation and rationale for alley cropping is to improve soil besides increasing their ability to withstand repeated cutting of fast-growing, leguminous woody species. Hence, this is a beneficial way for agriculture, which generates short-term income from agriculture crops, as well as long term products from trees and shrubs.

History of alley cropping

Alley cropping has been practiced in India for centuries, with evidence of its use dating back to at least the 16th century. However, it was not until the 1970s that alley cropping began to be promoted as a sustainable agricultural practice. This was due in part to the work of Indian scientist B. T. Kang, who conducted extensive research on the benefits of alley cropping. Kang's work helped to establish alley cropping as a viable alternative to traditional agricultural practices, such as shifting cultivation and slash-and-burn agriculture.

In the 1980s and 1990s, alley cropping was widely adopted by farmers in India, particularly in the states of Karnataka, Andhra Pradesh, and Tamil Nadu. This was due in part to the efforts of the World Agroforestry Centre's Alley Farming Network for India, which provided farmers with training and technical support. Today, alley cropping is a common practice in India, and it is estimated that there are over 2 million hectares of alley cropped land in the country.

Examples of alley cropping in India

There are a number of examples of alley cropping being successfully used in India. For example, in the state of Andhra Pradesh, farmers are using alley cropping to grow pigeon pea with

Leucaenaleucocephala, a nitrogen-fixing tree. This system has been shown to increase pigeon pea yields by up to 30%.

In another example, in the state of Karnataka, farmers are using alley cropping to grow maize with *Gliricidiasepium*, a tree that provides shade and nitrogen. This system has been shown to increase maize yields by up to 20%.

Techniques used in alley cropping

There are a number of techniques that can be used for alley cropping. These techniques vary depending on the specific site conditions, the species of trees or shrubs being used, and the companion crop being grown. Some of the most common techniques include:

Single-row alley cropping

This is the simplest method of alley cropping and involves planting a single row of trees or shrubs at a wide spacing (typically 4-8 meters). The companion crop is grown in the alleys between the rows of trees or shrubs.

Multiple-row alley cropping

This technique involves planting multiple rows of trees or shrubs at a wider spacing (typically 8-12 meters). The companion crop is grown in the alleys between the rows of trees or shrubs.

Hedgerow intercropping

This technique involves planting trees or shrubs in a hedgerow formation and growing the companion crop within the hedgerow.

Contour alley cropping

This technique is used on sloping land and involves planting trees or shrubs along contour lines to prevent soil erosion.

Selection of tree species

The choice of trees or shrubs for alley cropping is important. For selection of species, one should have knowledge about the aim and objective of plantation, shape and size of the canopy, texture and colour of foliage/ flower/ fruits, in different seasons, stages of growth, adaptability and suitability to agro-climatic regions/ zones, growth rate of species, average age of maturity, economic and other/ recreational benefits. The species should be adapted to the local climate and soil conditions and should provide benefits to the companion crop.

Some of the most commonly used trees and shrubs for alley cropping in India include:

- *Leucaena leucocephala*
- *Gliricidiasepium*
- *Flemingiamacrophylla*
- *Albizia lebbek*
- *Acacia nilotica*

Selection of companion crops

The choice of companion crop is also important. The companion crop should be compatible with the trees or shrubs being used and should be able to tolerate the shade and competition from the trees or shrubs. Alley cropping utilizes five basic groups of companion crops between rows, with: -

- Food crops (corn, soybean, wheat, barley, oats, sorghum, potatoes, peas and lobia).
- Forage crops like fescue, orchard grass, blue grass, rye grass, brome, timothy, clover and alfalfa.
- Speciality crops like landscape or decorative woody floral plants like blue spruce, dogwood, redbud, Christmas trees, small fruit and nut trees or medicinal crops such as

goldenseal or ginseng. The production of some speciality crops can be enhanced in the shade of the tree rows.

- Coppice biomass crops including poplar, willows, silver maple, birches, herbaceous crops like switch grass.
- Vegetable crops like potato, cauliflower, cucurbits, squash, cabbage, beans, asparagus, pepper, melon and tomato.
- As shade levels increase, cool season plants will perform better than warm season plants.

Some of the most commonly grown companion crops in India include:

- Maize
- Sorghum
- Pigeon pea
- Cowpea

Management Practices

There are a number of management practices that are important for successful alley cropping. These practices include:

Pruning

The trees or shrubs should be pruned regularly to maintain the desired spacing and to provide biomass for mulch or fodder.

Weeding

The alleys should be kept free of weeds to prevent competition with the companion crop.

Fertilization

The companion crop may require additional fertilizer, depending on the fertility of the soil.

Function of alley cropping

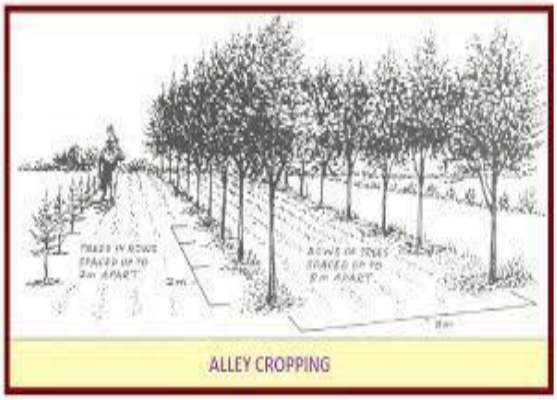
The provision of nutrients through decomposing mulch, a basic feature of Alley cropping, depends on the quantity of the mulch as well as on its quality and time of application. If the ecological conditions do not favor the production of sufficient quantities of mulch (as is the case in the dry tropics), there is no perceptible advantage in using Alley cropping.

- Alley cropping impacts some landscape management including water management, soil quality and pest management.
- This impacts water management by altering the hydrological cycle through increased water infiltration via disruption of overland flow by the tree or grass strip. Water cycled through the system is more thoroughly filtered and any excess is gradually released.
- The soil quality and nutrient cycling are impacted as deeply rooted trees exploit lower soil horizons and additional nitrogen is added to the nutrients pool if a nitrogen fixing tree is used. Reduced soil erosion by wind and water help to keep soil quality. Though, additional moisture is added to the site through interception of rainfall by the tree canopy.
- Microclimates are modified due to reductions in wind velocity which reduces air temperature levels and evapotranspiration of intercropped plants and soil.
- This system creates habitat to build up biodiversity and associated populations of natural enemies of insects, diseases or weed pests.
- This system practices help intercept, fix and bio grade sediments, nutrients, pesticides and

other biological pollutants present on the site.

- It improves wildlife habitat by providing food, cover and travel lanes for a variety of wildlife species.

Not all of these functions exist with each application of Alley cropping. The function is mainly dependent upon the way the plant components are manipulated in the design process.



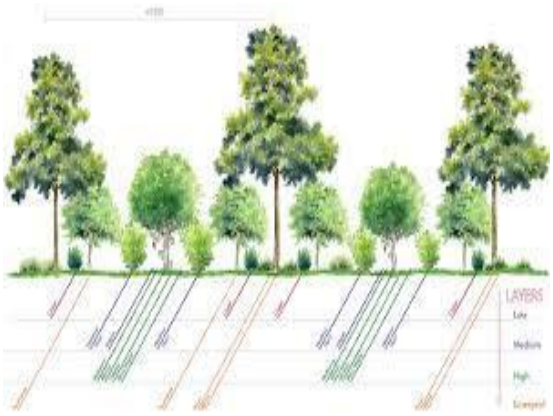


Fig: showing models of Alley cropping

Benefits of alley plantation

Alley cropping has many ecological and economic benefits. There are: -

- Improved soil health
- Reduced soil erosion
- To minimize the pollution
- Improved crop performance
- Nutrient recycling
- Reduced use of chemical fertilizers
- Minimized nitrogen leaching
- Reduces pesticides use
- Availability of timbre/fuel/firewood
- Promotion of biodiversity

Limitations and disadvantages of alley cropping system

Alley cropping requires more intensive technical skill and marketing knowledge.

The following limitations should be considered: -

- Alley cropping requires more intensive management including specialized equipment.
- Requires a marketing infrastructure for the tree products that could not be present in the local area.
- Trees can be an obstacle to crop cultivation if not carefully planned and designed.
- Trees compete with companion crops for sun light and nutrients.
- Companion crops compete with trees for moisture and nutrients.
- Herbicide drift from crop may damage trees.
- More complex pesticide application.
- Longer time horizon for cash flow.
- A more diverse skill set.
- Possible changes for equipment use.
- Huge investment required for changing the alley crop over time.
- Lower crop yield for some commodity crops.

The Future of Alley Cropping in India

Alley cropping has the potential to be a major force in transforming agriculture in India. It is a sustainable and productive practice that can help to improve soil fertility, conserve water, and increase crop yields. As farmers in India become more aware of the benefits of alley cropping, we can expect to see this practice become even more widely adopted.

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Suitable shrubs and grasses for stream bank stabilization with adoration on ecosystem benefits

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Introduction

Stream bank erosion is the removal of soil particles from a site due to the forces of water, wind, and ice. Over time, these forces will slowly wear away or disintegrate the soil. Erosion of streams in agricultural areas normally occurs as a result of one of three factors: change in stream flow, water flowing over or through the stream bank, and the discharge of concentrated runoff from other sources. Streams are subject to wide fluctuations in both flow depth and velocity over a period of years, due to normal seasonal changes in rainfall and large single-storm events. As flow depths and velocities increase, the force of the water flowing against the stream bank removes soil particles from the banks, and in many cases erosion causes banks to slump and fall into the flowing water. In extreme situations where high flows persist over long periods, banks may erode several feet annually. Rain falling on stream banks or runoff from adjacent fields that enters a stream by flowing over the stream banks can also erode soil from stream banks, particularly if banks are inadequately protected.

Bioengineering measures

Bioengineering measures may be primarily desired for erosion control, but often there are other considerations. Thought should be given to important functions that the bioengineering treatment can perform, such as habitat development, archaeological site protection (eg: heritage sites in bank of Yamuna and Chambal rivers), water quality improvement, aesthetics, or a combination of these. Bioengineering is the combination of biological, mechanical, and ecological concepts to control erosion and stabilize soil through the sole use of vegetation or in combination with construction materials. Both living and nonliving plants can be used. Nonliving plants are used as construction materials, similar to engineered materials. The planted vegetation controls erosion and serves as good wildlife and fisheries habitat in riparian systems. For understanding how vegetation can be used in bioengineering and as a basis for conceptualizing a bioengineering design model, it is important to understand both the assets and limitations of using planted vegetation.

Importance of vegetative measures on Streambanks

- To prevent soil erosion.
- To reduce the velocity of overland water flow.
- To foster growth of vegetation by preserving soil moisture
- Reduces soil surface compaction or crusting by protecting the soil surface from raindrop impact.
- To protect stream banks from the erosive forces of flowing water and provide a natural, pleasing appearance.
- To restabilize areas disturbed during erosion.
- Shade provided by woody vegetation and it provides wildlife habitat

Site suitability/ Adoptability

Generally applicable along streams and ditches where bankfull flow velocity does not exceed 5 ft/seconds and soils are erosion resistant. Vegetative techniques usually should be incorporated with structural techniques if the bankflow velocity exceeds 5 ft/seconds.

Criteria for selection suitable plants

Almost all of the plants used in bioengineering can be considered wetland plants, either obligative or facultative. Some of the exceptions would occur in the terrace zone that is infrequently flooded; however, all must be somewhat flood tolerant. Both herbaceous and woody plants are used. Herbaceous plants may be emergent aquatic plants like rushes and sedges or grasses and other forbs that require nonaquatic but moist conditions at least part of the year. The herbaceous plants are usually acquired as vegetative material such as sprigs, rhizomes, and tubers. Sometimes seed is acquired, but is used when the threat of flooding is low in the bank and terrace zones. Otherwise, they would wash out quite easily unless they are seeded underneath or in a geotextile mat or fabric that is securely anchored. Woody plants used for bioengineering purposes usually consist of stem cuttings, those that quickly sprout roots and stems from the parent stem. These are plants such as willow, some dogwood, and some alder. They can be supplemented by bare-root or containerized stock, particularly in the bank or terrace zones where they are not subjected to frequent flooding.

Selection and Preparation of planting material

Such plants that can be used in bioengineering and relate their flood tolerances, along with some other characteristics. The three methods are to: (a) purchase plants, (b) collect plants from the wild; and (c) propagate and grow plants.

Preliminary approach in designing and implementing vegetative measures:

1. The available hydrologic regime and soil types should be determined. General positioning of the plant type, e.g., emergent aquatic, shrubby willow, should be in accordance with the plant zone (splash, bank, and terrace).
2. A list of common wetland plant species in the region and more preferably in the watershed containing the stream of concern should be prepared, and these should be matched to the hydrology and substrate of the target stream bank reach to be addressed.
3. Species should be selected that will match the energy of the environment and the hydraulic conveyance constraints that may be imposed by the situation. For instance, one must be careful to use low-lying and flexible vegetation that lays down with water flows if hydraulic conveyance must be maximized. In such cases, use flood tolerant grasses or grass-like plants and shrubby woody species.
4. Species should be selected that will not be dug out or severely grazed by animals, especially aquatic animals. Other animals may influence plant growth and survival. If plants chosen are unavoidably vulnerable to animal damage, then plant protection measures must be used, such as fencing, wire, or nylon cages around them or use of repellents.
5. Additional special requirements and constraints of the site should be determined. For instance, some sites may be prone to sediment

deposition or have a bank geometry that is almost vertical. In such cases, it may be difficult to obtain success with emergent aquatic plants that may become covered with sediment and suffocate or which have water too deep in which to grow unless the bank is reshaped. The former situation may necessitate the use of willow that can be planted as cuttings or posts and be less susceptible to complete coverage by sediment.

6. A suite of species that would be suitable should be prepared. This may be limited to those currently available from commercial sources if there is no possibility to collect in the wild or have plants contract grown.

Planting method

Gabions with riparian vegetation are now used throughout the world for bed protection, bank stabilization, retaining walls, and numerous other purposes. Gabions come in three basic forms, the gabion basket, gabion mattress, and sack gabion. Gabions are suited to a variety of site conditions. They can be used in perennial or ephemeral streams, and installation can occur in dry or wet conditions with the proper equipment. The gabions can be seeded with grass or other cover vegetation if the soil is intermixed with the lifts of stone and if the hydrology is not limiting. Again, large woody vegetation should be avoided in the area protected by gabions. If the soil that is placed on the gabions is porous enough to allow easy passage of water through the gabion, it may not retain enough water to support the desired vegetation. If a grass cover can be established over gabions, it is possible that the grass will remain stable during high flows since the root system will be firmly attached to the gabion mesh and underlying rock fill. The problems of adequate moisture and sufficient permeability of the soil need to be carefully investigated. While gabions may be able to support some types of vegetation, care should be used when recommending covering and filling the gabions with intermixed soil and rock to support vegetation.

Choice of appropriate species

Pole plantings, or live stakes, provide an inexpensive approach to bank stabilization. Stakes can often be cut from on-site or nearby vegetation and are installed by hand. Live stakes (e.g. willow) generally require a shallow water table, often a feature of riparian areas. They require 1-2 years to establish roots and resist erosion. In general, it is best to use local species of vegetation in Gabions based bioengineering as they are already adapted to the growing conditions, are more likely to be resistant to local diseases, are more readily available, and are likely to be a lower cost option. It can also be useful to choose species that can be used for other purposes as they mature, for example, providing fruit or with branches and leaves that can be used for fuelwood, fodder, or other domestic purposes. This increases the benefit to local people and their acceptance of the measures. Major species that can be used for Gabion bioengineering purposes in stream bank protection include Broom grass (*Thysanolaena maxima*), Typha grass (*Typha angustifolia*), Vetiver grass (*Vetiver zinzaniodes*), Munj grass (*Saccharum spontaneum*), different types of bamboo, Giant cane (*Arundo donax*), Malabar nut (*Adhatoda vasica*), male fern (*Dryopteris filixmas*), Artemesia (*Artemisia* spp.), common williow (*Salix tetrasperma*), Mulberry (*Morus alba*), five-leaved chaste tree (*Vitex negundo*), Ghogar tree (*Garuga pinnata*), Coral tree (*Erythrina variegata*), Tiger's milk spruce (*Sapium insigne*) and Eastern cottonwood (*Populus deltoides*).

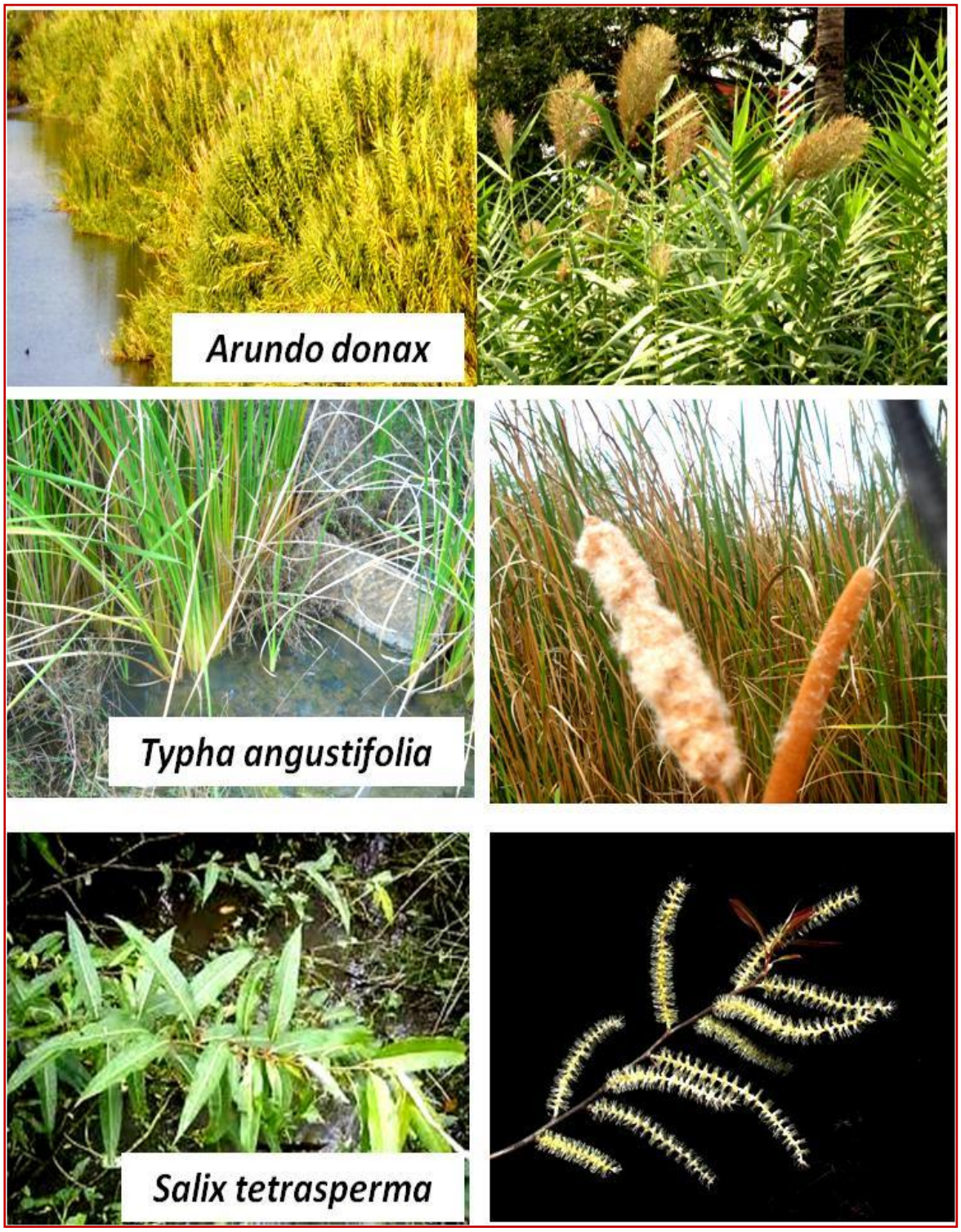

Fig.1: Part-A: Suitable plant and tree species for stream bank planting to achieve effective economic and environmental benefits

Fig.1: Part-B: Suitable plant and tree species for stream bank planting to achieve effective economic and environmental benefits

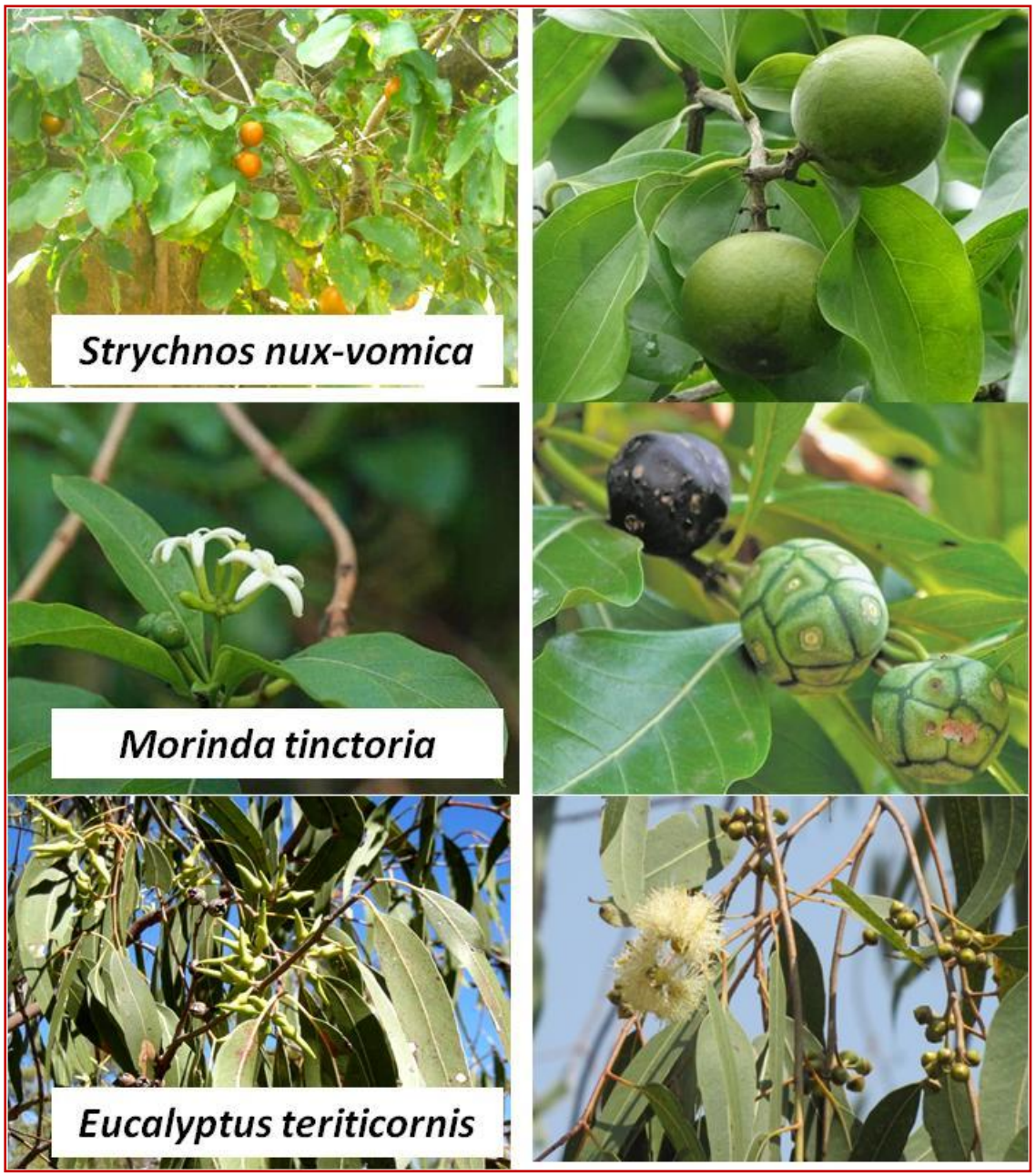

Fig.1: Part-C: Suitable plant and tree species for stream bank planting to achieve effective economic and environmental benefits

Planting technique

Careful planning must be done to acquire the kinds of plants in the amounts needed. This may take up to 1 year before installation of the various treatments because plants either have to be grown in sufficient quantities in nurseries, or they have to be located in the wild and either collected or grown from wild plant stock. There are several planting techniques for bioengineering ranging from simple digging with shovels or spades and inserting sprigs (rooted stems)or cuttings to moving large pieces of rooted material, such as sod, mulch and root pads (large rooted shrubs). Other methods consist of

direct seeding or drilling individual seeds of selected species. All of the above methods capitalize on combining the attributes of plants with some kind of engineered material or structure or relying on the plant itself to form a resistant structure to erosion, such as a live Ipomea post revetment.

Table -1: Suitable plant species for Stream bank stabilization

Sl. No.	Zone wise / Layer of Vegetation on stream bank protection	Common name	Scientific Name	Propagation technique	Spacing	Size of cutting (Length)	Cost of planting material
I	Grass Zone	Kans grass	*Saccharum munja*	Root slips	45 cm x 45cm	15 cm	Rs. 2/ 25 slips
		Cat Tail grass	*Typha angustifolia*	Root slips	45 cm x 45cm	15 cm	Rs. 2 25 slips
II	Reed grass	Giant cane/ Reed cane	*Arundo donax*	Stem cuttings	45 cm x 45 cm	25 cm length	Rs.2/ cuttings
III	Shrubs – medium canopy Zone with mixed tree species	Ipomea	*Ipomea cornea*	Stem cuttings	25 cm x 25 cm	25 cm length	Rs.2 cuttings
		Adulsa	*Adhatoda vasica*	Stem cuttings	25 cm x 25 cm	25 cm length	Rs. 2/ cuttings
		Willow /Salix	*Salix tetrasperma*	Stem cuttings	45 cm x 45 cm	25 cm length	Rs.15/ cuttings
		Eucalyptus spp	*Eucalyptus tereticornis*	Stem cuttings	45 cm x 45 cm	25 cm length	Rs. 15/ cuttings
IV	Tree Zone	Nuna/Jamun/Button Tree/Balamkhera	*Morinda tinctoria/Syzygium cuminii/ Strychos nux-vomica/Kigelia pinnata*	Seedling /Sapling	5 m x 5m	3 ft & above	Rs.45/ sapling

Monitoring and aftercare

Most importantly, monitoring and necessary aftercare must be a part of any bioengineering design and must be included in the plan of development and the implementation stage. The intensity and frequency of monitoring and aftercare will depend on site conditions, such as harshness of climate, probability of animal disturbance, high-wave or current conditions, etc., and on established success criteria. Early monitoring and aftercare of a bioengineering project is essential. Each project should have incorporated into it from the beginning enough time and funds to provide some remedial work within the first year or so after treatment installation. It would be better to provide this contingency for up to and immediately after the first one or two flood events. Once weak spots in treatments are repaired, the bioengineered system continues to gain strength over time. On many sites, it is essential to protect plantings from damage by animals, and other mammals. The use of irrigation may be required during aftercare and will improve growth and survival of plantings that are installed during dry seasons and in dry soils. The decision about irrigation must be made based on economics contrasting the need to irrigate with the cost of possible mortality and the consequences of failing to obtain the desired erosion control and other functions.

Pre-cautionary measures before selecting plants

The availability of plants of the appropriate species, size, and quality is often a limiting factor in the final selection and plant acquisition process. Some native plant species are very difficult to propagate and grow, and many desirable species are not commonly available in commerce or not available as good quality plants. As demand increases and nurserymen gain more experience in growing native plant species, this limitation should become less important. Plant species composition and quantity can often be determined from the project objectives and functions desired. As a general rule, it is advisable to specify as many species as possible and require the use of some minimum number of these species. Maximum and minimum numbers of any one species may be specified.

Plant Species suitable for Steam bank stabilization

- The jetty sloping downstream is effective in diverting the river current away from the bank and maintaining still water or reduces flow velocity for a longer distance downstream than the jetties sloping up stream.

- Vegetative barrier of *Ipomoea carnea* has been used to stabilize stream bank. To reinforce resisting power of Arundo, Munj grass, *Ipomea*, *Hygrophylla*, *Typha*, *Tamarix*, *Jamun*, *Eucalyptus* and *Prosopis juliflora* were also planted which encouraged deposition of silt. Thus the process of bank erosion was reversed to land reclamation and channelization of river into a straight course. In other countries species like water willow and common willow were commonly used for stream bank stabilization.

Benefits of Streambank protection

Role of vegetative measures in stream bank erosion through five mechanisms like reinforce soil through roots; dampen waves or dissipate wave energy; intercept water; enhance water infiltration; and deplete soil water by uptake and transpiration. Selected plants should have some tolerance to flooding and waterlogging. Some will need to be highly tolerant (when it used in lower side bank) while others (when it used on the upper

bank) can be less tolerant. Some legumes are possible choices because of their nitrogen-fixing attributes will helpful enrich soil fertility and pollen source for bees and honey bees.

Example: *Ipomea cornea* based bioengineering measures were developed at Yamuna riverbanks by ICAR –IISWC-Research Centre – This site is located in yamuna riverbanks at Agra –Uttar Pradesh (Refer:Ttraining Manual-IISWC-Dehradun).

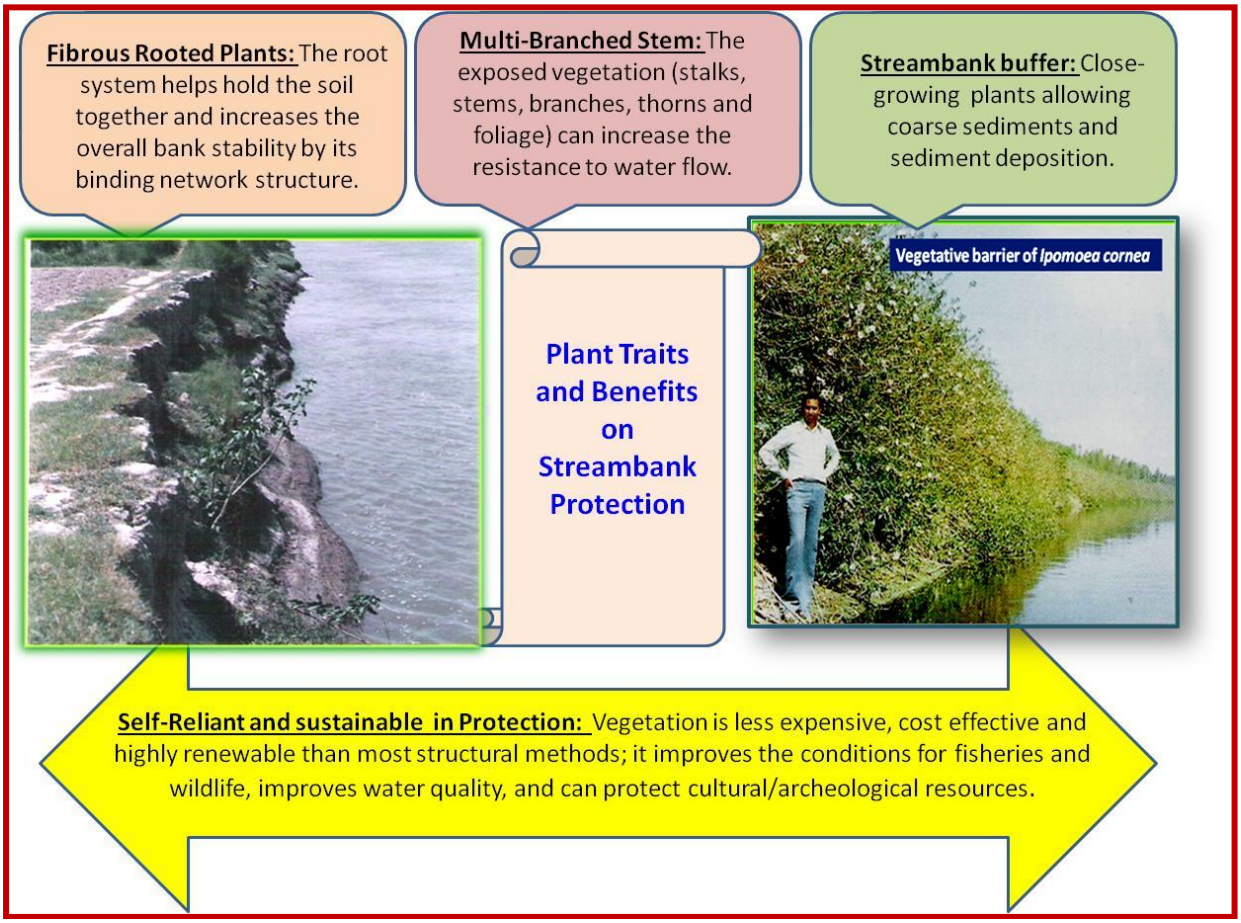

Fig.4: A model designed using *Ipomea carnea* for stream bank stabilization in Yamuna ravines of Agra by ICAR-IISWC-Rc-Agra (Uttar Pradesh)

(Reference: ICAR-IISWC-Annual Reports and Digital library - Dehra Dun, Uttarakhand, India)

The role of rhizobia in plant growth and productivity

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Abstract

Rhizobia, a group of soil microorganisms are essential to the development and fruitfulness of plants, particularly legumes. Through a mutualistic symbiotic connection, these bacteria create specialized nodules on the roots of bean plants. Rhizobia perform nitrogen fixation, or the conversion of atmospheric nitrogen into a form that can be used by plants, inside the nodules. This method improves the soil's ability to hold nitrogen, which encourages plant development and productivity. Rhizobia also contribute to the synthesis of plant hormones including auxins, cytokinin, and gibberellins that control a variety of physiological functions in plants. Overall, rhizobia and legume symbiosis have a considerable impact on plant growth, nutrient uptake, and agricultural productivity.

Introduction

Rhizobia play a vital role in the intriguing world of interactions between plants and microbes. Leguminous plants and these soil-dwelling bacteria have a mutually beneficial interaction that promotes plant growth, production, and ecological sustainability (De Mandal et al., 2021; Gayathri et al.,2023). Rhizobia are amazing nitrogen fixers that transform atmospheric nitrogen into a form that plants can use, minimizing the need for artificial fertilizers. In this article, the critical function of rhizobia in plant development and productivity is examined, emphasizing their symbiotic relationship, the nitrogen fixation process, and the overall influence on sustainable farming methods.

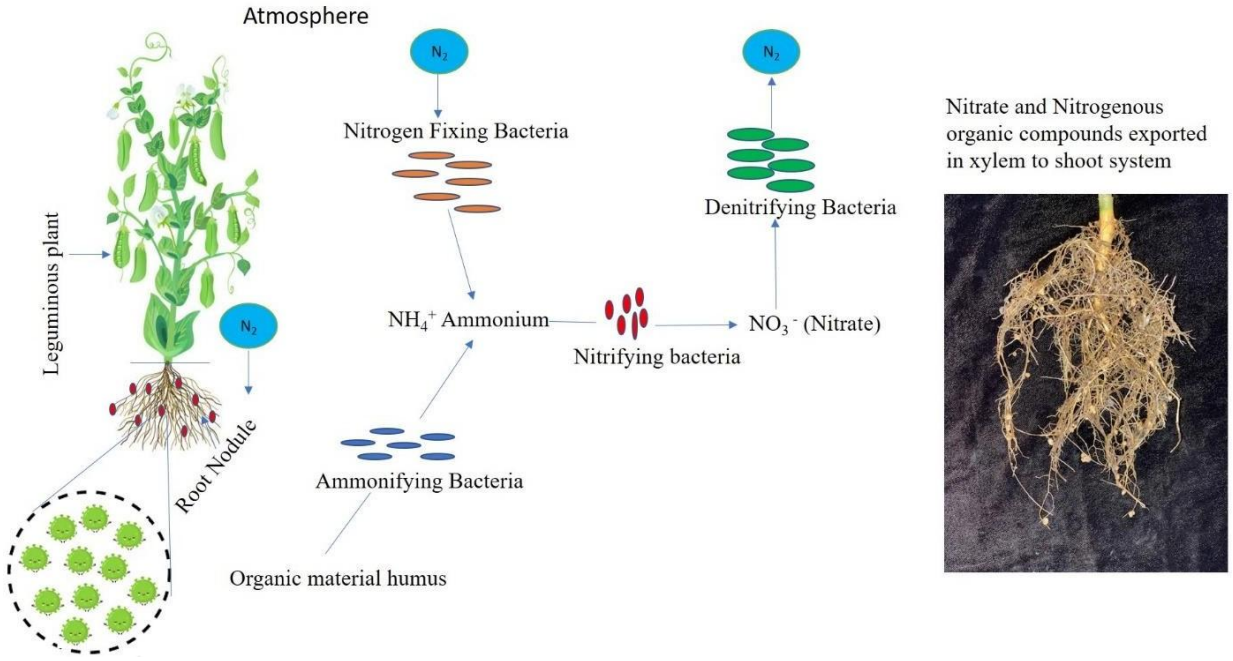
Symbiotic relationship

Rhizobia and leguminous plants engage in a symbiotic relationship known as mutualism. It begins with the recognition and exchange of specific chemical signals between the two partners (Singh and Verma, 2023). The plant releases flavonoid compounds into the rhizosphere, which attract compatible rhizobia (Singh and Singla, 2020). In response, the rhizobia produce nod factors, signalling molecules that induce root hair curling and nodule formation in the plant (Patra and Mandal, 2022). These nodules serve as specialized structures where rhizobia reside and perform nitrogen fixation.

Nitrogen fixation

One of the most remarkable contributions of rhizobia to plant growth and productivity is their ability to fix atmospheric nitrogen. Nitrogen, an essential nutrient for plant growth, is abundantin the atmosphere but not directly accessible to plants (Aczel, 2019). Through the enzyme nitrogenase, rhizobia convert atmospheric nitrogen (N2) into ammonia (NH3), a form that canbe utilized by Plants. This process takes place within the nodules, providing leguminous plants

with a reliable and sustainable source of nitrogen for growth and development (Sheoran et al., 2021).



(a) **(b)**

Fig 1: (a) simplified version of the nitrogen fixation process; (b) nodules attached to the plant roots

Enhanced nutrient availability

By fixing nitrogen, rhizobia alleviate the reliance on synthetic nitrogen fertilizers. The ammonia produced by rhizobia is readily assimilated by plants, promoting robust growth, greener foliage, and improved crop yields. Moreover, the nitrogen fixation process also benefits the surrounding soil. As leguminous plants establishes a symbiotic relationship with rhizobia, the availability of fixed nitrogen increases in the soil, providing a secondary source for non- leguminous plants in crop rotations.

Improved soil fertility and health

Rhizobia contribute to the overall fertility and health of soil ecosystems. The addition of fixed nitrogen enhances soil nutrient content, making it more conducive to plant growth. In turn, thepresence of leguminous plants and their symbiotic relationship with rhizobia enhances soil structure, aeration, and water-holding capacity (Prudent et al., 2020). Furthermore, the continuous interaction between rhizobia and roots stimulates the release of growth-promoting substances, including phytohormones, vitamins, and enzymes, which support soil microbiota and organic matter decomposition (Daniel et al., 2022).

Environmental sustainability

The role of rhizobia in plant growth and productivity extends beyond individual crop yields. By reducing the dependence on synthetic fertilizers, rhizobia contribute to the sustainability ofagricultural practices (Atieno et al., 2020). Synthetic nitrogen fertilizers are energy-intensive to produce

and can have detrimental effects on water bodies, contributing to eutrophication. The utilization of rhizobia for nitrogen fixation reduces the ecological footprint of farming, minimizes nitrogen runoff, and conserves energy resources (Irisarri et al., 2021).

Conclusion

Rhizobia play a vital role in promoting plant growth and productivity through their symbiotic relationship with leguminous plants and the process of nitrogen fixation. By converting atmospheric nitrogen into a usable form, rhizobia enhance nutrient availability, improve soil fertility, and reduce the reliance on synthetic fertilizers. This mutualistic association not only benefits the individual plant but also has far-reaching implications for agricultural sustainability and environmental conservation. Understanding and harnessing the potential of rhizobia can lead to more sustainable and productive agricultural systems, fostering a healthier planet for future generations.

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Tropical home gardens: An epitome of sustainability

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Introduction

Home gardens are multi-species, multi-tier agroforestry production systems that are often located on small pieces of land surrounding homesteads. They are mostly found in humid tropical climates. They combine elements of agriculture, animals, and trees. Intimate, multi-story combinations of varied trees and crops around homesteads, occasionally in conjunction with domestic animals, are how they are classified (Kumar and Nair, 2004). These are enclosed subsistence farming systems that generate a wide range of commodities using traditional low input methods, often giving millions of people in the tropics a reliable source of food and a means of livelihood. The biological diversity of both domestic and exotic species, as well as controlled and wild ones, is greatly increased by these home gardens, and they also greatly improve people's quality of life, economic and social wellbeing.Home gardens are physiologically similar to evergreen forests because they are planted with different trees and crops in a multi-layered, intricately linked manner. Be a result, they are commonly referred to as the most environmentally friendly, socially and economically acceptable, and natural production techniques.

Genesis of homegardens

When it comes to the evolution of home gardening, Kumar and Nair (2004), claim that it is the second-oldest land use activity after shifting agriculture. Cropping has gradually intensified over generations in response to growing human need and the resulting scarcity of arable land. Both the Javanese home gardens in Indonesia and the Kerala home gardens in India—the two frequently mentioned examples—are said to have developed over centuries of biological and cultural changes. They embody the accumulated knowledge and understanding of farmers who have interacted with their surroundings without the aid of outside resources, money, or scientific expertise.According to Wiersum (2006), fishing settlements in the moist tropical area of Southeast Asia between 13,000 and 9,000 B.C. are thought to have been the beginning of home gardening.Despite challenges, several attempts have been undertaken to gather data about the prevalence of home gardens. These estimates include 1.05 million hectares in Sri Lanka, 1.44 million hectares in Kerala, India, 5.13 million hectares under pekarangans in Indonesia, and 0.54 million hectares under homesteads in Bangladesh (Kumar, 2006).

Distribution of tropical homegardens

It is generally accepted that home gardens originated in the warm, humid tropics. In

the past, they were first used in human settlement agriculture, which came before the period of shifting cultivation. From these ancient and presumably dispersed beginnings, home gardens have progressively expanded to several humid areas in South and Southeast Asia, such as Bangladesh, India, Java (Indonesia), the Philippines, Thailand, and Sri Lanka. Early 14th-century travellers in Kerala, India, are said to have planted coconuts (Cocos nucifera), black pepper (Piper nigrum), ginger (Zingiber officinale), sugarcane (Saccharum officinarum), and pulses in their house gardens, according to Randhawa (1980). The regions with heavy rainfall and humidity, namely between 40° N and 30° E, are home to the biggest stretches of home gardens (Fig 1).The areas with the greatest numbers of home gardens, however, are South and Southeast Asia, the Pacific islands, East and West Africa, and Mesoamerica (Montagnini, 2006). The Javanese home gardens in Indonesia and the Kerala home gardens in India are two notable examples of them. The lexicon used locally varies throughout home gardens. Home gardens found on Mount Kilimanjaro in East Africa are referred to as Chagga homegardens, which feature coffee and banana trees combined with multipurpose trees, and Enset coffee homegardens in Ethiopia (Table 1). Similarly, Javanese home gardens are known as Talun-Kebun and "pekarangans," Kerala home gardens as "purayida krishi" (Abebe et al, 2006).

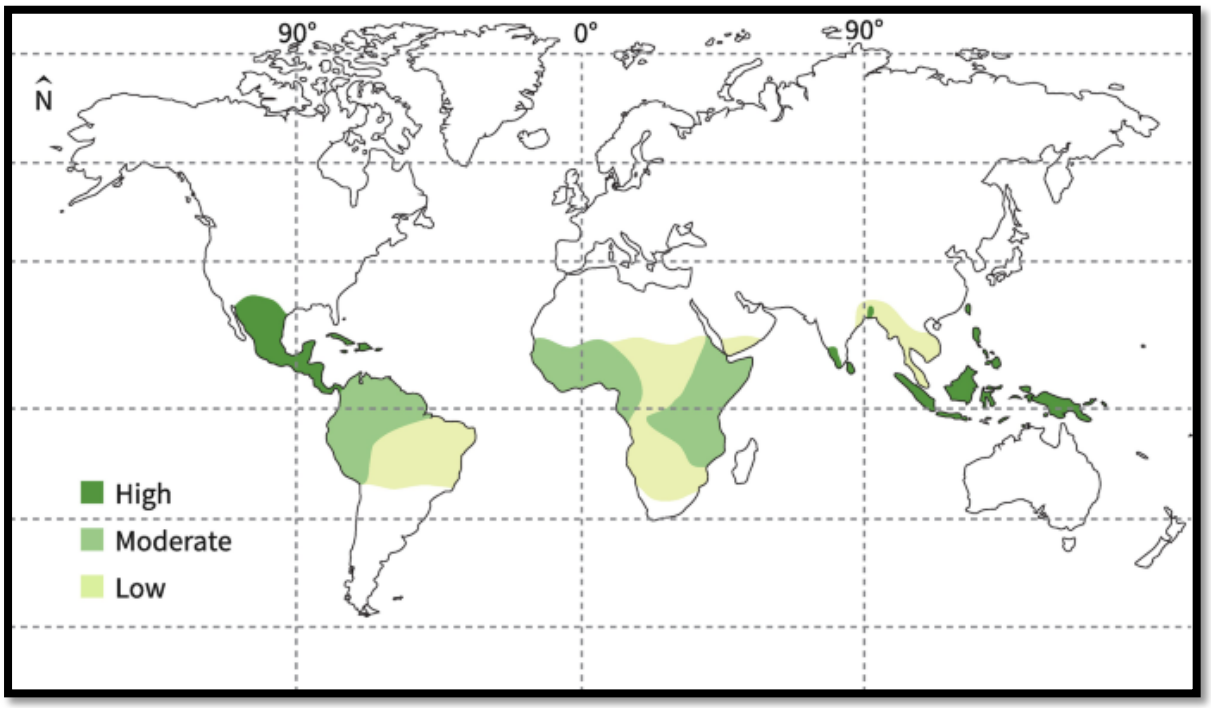

Fig. 1: Global distribution of homegardens (Source: Nair and Kumar, 2006)

Table 1. Homegardens Around the world (Source: Fernandes and Nair, 1986)

Region	Local name	Location	Management unit (ha)
Southeast Asia	Pekarangan	Java,Indonesia	0.01-3.0
Pacific	Homegardens	Phillipines	0.01-1.0
South Asia	Kandy gardens	Srilanka	0.4-2.2
	Compound gardens	Kerala	0.1 – 4.0
Africa	Compound farms	S. E. Nigeria	0.2-3.0
	Chagga homegardens	Tanzania	0.2-1.2
	Ka/Fuyo gardens	Burkina Fasso	0.1-0.8
American tropics	Kitchen gardens	West Indies	0.01-0.5

Uniqueness of homegardens

Structure of homegardens

Each structural ensemble in a home garden is inextricably linked to the others due to the intricate micro-zonal pattern in which they are placed. The main factors influencing this include the garden's size, shape, crop composition, planting pattern, and distance from the home. One of the most distinctive characteristics of home gardens, particularly in wet tropical lowlands, is their multi-tiered canopy structure. The majority of employees design a three-to six-strata scheme that covers around 3/4 of the ground. As expected, the vertical stratification produces a gradient in relative humidity and light, creating distinct niches that may be used by different species groups. Naturally, species with differing degrees of shade tolerance in them make up the top layer, shade-intolerant trees make up the bottom layer, and crops that tolerate shade make up the lower stratum (Fig 2).

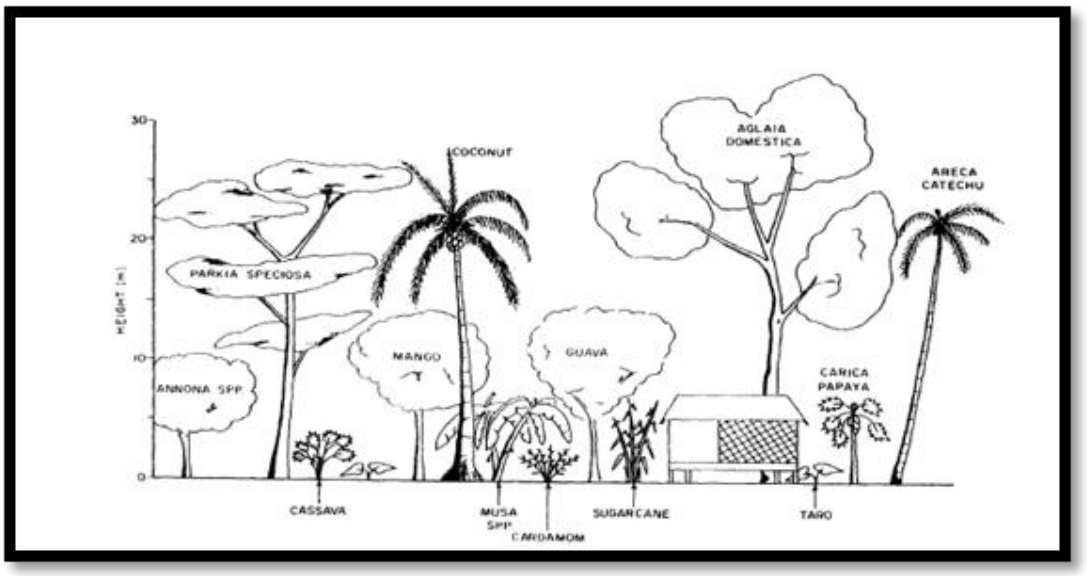

Fig. 2: Typical structure of *Pekarangans (Source:* Kumar and Nair, 2004)

Diversity in homegardens

While agriculture characterized as 'biological deserts', Tropical home gardens are magnificent instances of the diversity of species found in carefully tended plant communities. The home gardens have protected rare and endangered species, as well as many landraces and cultivars. Crop combinations seen in home gardens across an area are heavily impacted by nutritional complementarity as well as the requirements and tastes of the family.

Functional dynamics

Home gardens may be thought of as artificial forests maintained in an early-successional stage, akin to a young secondary forest. Tropical home gardens are known for their exceptional multifunctional sustainability, which can be attributed to their great species diversity and evenness. In this area, the ecology runs more smoothly, and each species has carved out a unique niche for itself in order to survive and ensure its long-term survival.

Management

The majority of management techniques focus more on changing the tree's environment than the actual tree. Weeding, fertilisation, and crop spacing are more frequent practises than hygienic pruning, rejuvenation pruning, trimming low branches, and canopy pruning to enhance light penetration. Cash crops, in particular, are managed using a range of techniques. The most heavily maintained species are the coconut, rubber, and arecanut; their production involves the use of chemical and pesticide fertilisers, regular weeding, organic fertilisation, and tree planting in rows. Not only are they the only crops that receive watering, but they are also shielded from competitors quite frequently. Neem and fruit trees are given less consideration (selective weeding, some application of organic manures). Not much is done to boost the production of the valuable teak wood species.

Sustainability and its attributes of home garden systems

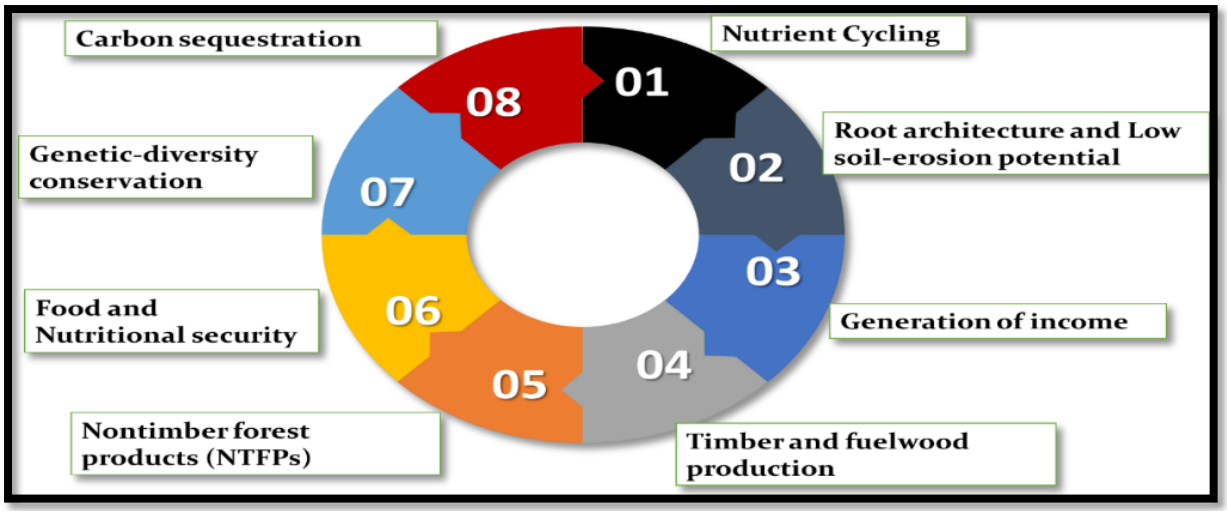

Fig. 3 Sustainability and its attributes of home garden systems

Nutrient cycling

The closed nutrient cycle found in home gardens is comparable to that of tropical forests. Therefore, home gardens can benefit from an understanding of the dynamics of litter formation, decomposition, and subsequent release of bio elements that give these trees their sustainability. There is a lack of data about the behaviour of the numerous N_2-fixing trees in these systems, the amounts of N_2 that are fixed, and the subsequent use of that N_2 by related crops. Either naturally through litterfall and root turnover or purposefully by pruning, the nutrients in tree biomass are returned to the soil.

Root architecture and low soil-erosion potential

Low rates of soil erosion are the consequence of the multi-tiered homegarden canopy and root architecture, which, in addition to the litter layer, serve as multi-layer defensive mechanisms against the effect of falling raindrops (Kunhamu, 2018). It is anticipated that the root systems of various garden components would overlap significantly, leading to a higher root-length density that might potentially minimise nutrient leaching and promote the recycling of nutrients from the subsoil. Under some circumstances, the amount of subsurface-nutrient recovery depends on how close trees are to one another.

Generation of income

Although growing food for sustenance has garnered much of the attention in home gardens, its potential to produce extra monetary flow cannot be understated. The percentage of home garden products utilised for domestic use as opposed to sale has been shown to vary greatly amongst locations. With their extensive and varied use, home gardens offer households a safety net in times of food scarcity.

Timber and fuelwood production

Kerala is the birthplace of the environmentally rich home garden system that yields large amounts of wood. It is a traditional agricultural method. For social and environmental reasons as well as wood production, home gardens including a range of multipurpose trees might serve as a model for similar regions both inside and outside the nation.

Nontimber forest products (NTFPs)

Home gardens are acknowledged sources of Non-timber Forest products (NTFPs), including green leaf manure, bamboo, gums, resins, and aromatic and medicinal plants. Among them, the cultivation of medicinal plants has attracted some limited scientific interest. Rainfall and elevation usually boost plant diversity and density.

Food and nutritional security

The home gardens provide a wonderful opportunity to reduce disparities in food availability, attain gender equity, and enhance the ability to make better decisions about how to spend money for household social needs and education. The COVID-19 Pandemic has caused a disruption in food supply, which has reignited interest in strengthening local food systems globally. Governments and development initiatives worldwide are promoting home gardens as a nearby supply of wholesome, fresh food in the midst of the COVID-19 pandemic.

Genetic-diversity conservation

Indigenous knowledge is a crucial component of the genetic diversity–cultural complex. Diversity as a genetic resource is only viable if the

information/knowledge and biological components are present. Human management of the gardens has a significant impact on residential gardens, which increases diversity. In addition to serving as hideouts for rare genetic variation, home gardens are significant sites for agricultural improvement, plant introduction, and experimentation.

Carbon sequestration potential of homegardens

In comparison to other agroforestry systems, home gardens have a higher capacity for biomass production and the return of a larger percentage of plant materials to the soil to replenish its C stock have been sufficiently shown (Kumar, 2011). Furthermore, they preserve sustainability, take use of the synergies between CBD and the Kyoto Protocol, and guarantee "carbon permanence," which farmers are required to embrace under the terms of the "carbon contracts." The potential for biological fixation of nitrogen and the comparatively low level of herbivory might account for home gardens' strong capacity to sequester carbon..

Urban homegardens and cllotment gardens

An urban home garden is a multispecies production system tailored to accommodate many physical, social, and economic demands and functions on the land surrounding the house. Allotment gardens serve as a communal resource and a hub for social interaction, but its institutional administration and organisation is their most salient characteristic. In order to maintain the equilibrium of the urban microclimate, they can even be situated in protected areas. Allotment gardens serve as a communal resource and a center for social interaction, but its institutional administration and organisation is their most salient characteristic. Every gardener in an allotment garden in Germany must be a member of the corresponding Kleingartenverein (allotment garden association). Nonetheless, gardeners in developing nations are frequently community members rather than affiliates of any organisations. The gardens aren't always close to the houses; instead, they're usually found in areas with enough room and occasionally with ideal soil and water conditions. Naturally, when the distance between houses and gardens grows, transportation problems occur. In other instances, the gardens are set up as buffer zones beside roads and train lines, or they are situated in locations inappropriate for development.

The future of homegardens: Threat of commercialization

Like many other production enterprises, agriculture is more vulnerable to market forces as a result of liberalizations in many formerly strictly regulated economies. The creation and acceptance of novel tactics to encourage the commercialization of even age-old endeavours like home gardens is a direct result of this. These home gardens' ecological traits and social functions have suffered, and the conventional sustainable agricultural system that has provided food and safety for generations may no longer be viable in the absence of outside assistance.

Other threats to Homegardens

- Species loss from homegardens at an unprecedented rate
- Fragmentation of land holdings due to population growth

- 'Acculturation,' has serious consequences on the species grown in homegardens
- Large-scale influx of aggressive exotics that can potentially out-compete the native flora

Conclusion

Tropical gardens at home are fascinating. More often than not, their merits are intuitively understood rather than quantified. Land use regimes are under more strain than ever before due to competing demands from economic development and growing ethical and environmental concerns. Environmental, sociological, and social issues are gradually taking precedence over production and economic concerns, which for the last few decades have been the primary objectives of agricultural and forestry development operations. Sustainability is a fundamental concern in all land use activities today, meaning that current demands must be met without affecting the ability of future generations to fulfil their own requirements. The need to strike a balance between social fairness, economic dynamism, and ecological preservation is at the heart of this idea. Discussions in this context are dominated by current concerns such as the preservation of cultural heritage, gender equity, environmental integrity, biodiversity conservation, respect of indigenous knowledge, and sustainable use of natural resources. Acknowledging home gardens as a potent land use paradigm is an essential shift from the perspective of a single product. Make the case for expanding ecological and economic research to comprehend, appraise, and evaluate well-established systems like home gardens so that these systems may be fairly acknowledged in regional and national policy discussions. Home gardens' tiny plot sizes make it difficult to "scale up" their benefits, but the ideas behind how they work might serve as a basis for the creation of better agroforestry techniques.

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Status and trends of wood preservation in India

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Introduction

Wood is a prominent constructional material because of its low cost and availability in various forms and sizes, together with such properties as relatively great strength with respect to weight, ease of shaping and fastening, low heat conductivity, and sound–deadening quality, have made it outstanding building material from the time of first settlers' down to present. Due to its biological origin, it is one of the most complex construction materials and its strength and durability have become of paramount importance in the general construction field.

Relatively easy to fabricate into beams, columns, and roof systems using simple hand tools. It has an affinity for moisture and this can lead to biological deterioration caused by insects and decay fungi. The various organization and individuals interested in furthering the use of forest products have done much in recent years to increase the serviceability of wood and the resultant economy in its utilization. Biological damage to wood and wood products is mainly caused by mold, stain, decay fungi, and insects such as beetles and termites, and the development of low environmental impact technologies for the elimination of biological damage is one of the vital goals of wood protection industry (Freitag *et al*., 1991).

Protection against these organisms is generally realized by drying or chemical treatment of wood products. Although relatively low-toxic chemicals are presently used as wood protectants, public concerns remain about the use of these chemicals (Byrne1998). Then come the preservatives which help in extending the life span of the wood and give it resistance against all the biotic and abiotic agents.

Wood preservatives are chemical substances that when suitably applied to wood, make the wood resistant to fungi, insects, and woodborer. There are two general classes of wood preservatives: oils, such as creosote and petroleum solutions of pentachlorophenol; and waterborne salts, which are applied as water solutions. The effectiveness of the preservatives varies greatly and can depend not only upon their composition, but also upon the quantity injected into the wood, the depth of penetration, and the conditions to which the treated material is exposed in service (Wood Preserving Industry Production Statistical Report, 2009).

In India, the preservatives used mostly are creosote, pentachlorophenol, CCA, CCB, ACC, Boric acids, and borax.

Wood preservatives can be harmful to humans if not properly handled. The exposure routes by which they can enter the human body are inhalation (vapor, dust, aerosol, etc.), ingestion (solid,

liquid), ocular exposure, and through the skin (vapor, liquid, solid). A number of studies have examined the effects of wood preservatives on settlement patterns, growth, and biomass development in human environments. The majority of leaching from wood happens when it's treated with waterborne preservatives, the rate and overall amount of leaching from a given product is also affected by preservative penetration and retention and by the surface area of the product.

To avoid environmental pollution and health problems caused by the use of synthetic pesticides, wood preservation research is currently focusing on the discovery and application of termiticides derived from plants.

Status of India

Due to the stringent forest policy, wood is not available from natural forests to the wood-based industry.Short-rotation plantation woodthat grows fast has emerged as a major raw material for the future development of the industry.Plantation timbers are susceptible to the attack of various wood-destroying agencies.Only a preservative treatment gives adequate and economic service life to plantation timber. Due to the existence of numerous species of insects and fungi that destroy wood, climatic and biological conditions in tropical countries, like India, make wood preservation more important.In addition, a hot and humid climate speeds up the decomposition of wood. India is one of the major wood-consuming countries in the world.

Preservative treatment of timber has become an indispensable need in India.Nevertheless, the quantity of timber which is given preservative treatment is rather limited.But wood preservation has started gaining importance. India, with a developing economy, needs very large resources of timber for diverse purposes. The shortage is expected to increase with the rapid pace of industrialization.Due to stringent forest policy, short-rotation plantation wood is emerging fast as a major raw material for industries. Most plantation timber needs preservation.

Preservation treatment can reduce timber requirements by enhancing wood service life.India is a major wood-importing country in the world.

Naturally, rot-resistant woods

These species are resistant to decay in their natural state, due to high levels of organic chemicals called extractives, mainly polyphenols. Extractives are chemicals that are deposited in the heartwood of certain tree species as they convert sapwood to heartwood.

Some rot-resistant woods are:

- Ironbark (Eucalyptus spp.)
- Totara (Podocarpus totara)
- Kauri (Agathis australis)
- Coast redwood (Sequoia sempervirens)
- Western red cedar (Thuja plicata)

India timber supply and demand 2010-2030

The demand for wood is about to go from 57 million m^3 in 2020 to 98 million m^3 in 2030.

The productivity of India's forest wood is 0.7 cum/ha/year.

India's wood fiber deficit was estimated to be 12.5 million m^3 in 2012.

India's imports of logs doubled in volume from 3.2 million m^3 in 2006 to an estimated 6.4 million m^3 in 2019.

Pramode & Raman, ITTO Report, sept-2021

The report tells that even though India's forest has increased steadily, timber production is still less. And a large portion is met by imports only.

The study forecasts a jump of nearly 70% in demand for Roundwood in India in the next decade 57 million m^3 in 2020 to 98 million m^3 in 2030

Approximately 74% of India's log imports are hardwood and 26% softwood.

The cultivation of plantation timbers by farmers may minimize this gap.

Treating wood with preservative increase the life of wood, thus, reducing the gap in demand and supply of wood.

Some important wood-destroying organisms

In India, approximately 33% of the wood is lost to biodegradation.

Some of the wood-destroying organisms are;

Fungi: Mould

Sapstain Fungi

Wood rot or wood decay

Brown rot fungi

White rot fungi

Soft rot fungi.

Insects: Pinhole borers

Hot hole borers

Flat-headed borers

Powderpost beetles

Termites: Dry wood termite

Ground dwelling

Carpenter ants

The Solution is preservation

It is the art of protecting wood against any factor whatsoever that may damage and ultimately destroy it. In a practical sense, it refers to the improvement of wood's natural durability by treatment with chemicals. It is an outstanding practice to improve the serviceability of wood by chemical treatment under the condition that favors early deterioration by decay. Many chemicals are used to enhance the durability of wood and wood-derived products that are very important in our life. Such chemicals are copper, chromium, arsenate, zinc, etc. Though these preservatives are useful to protect the wood from biodeterioration, environmental toxicity is also related to them. These chemicals are harmful to many species of our biodiversity including animals, plants, beneficial microbes, nematodes, invertebrates, etc. Shortage in the supply of durable wood species has resulted in an increase in the use of plantation-grown timber species. In order to enhance the service life of plantation-grown non-durable species, preservative treatment becomes necessary. (Tripathi *et al.*,2009).

The natural durability of individual wood species against biotic factors depends mainly on the chemical structure and amount of extractives present (Jelokava&Sindler, 2001). Wood extractives are made up of numerous components that can be isolated from wood using non-polar and polar solvents. Higher the proportion of extractives, the greater the durability of the heartwood (Hillis, 1978). Extractives (oils, tannins, and resins) toxic to biological organisms are thought to be the primary mechanism by whereby wood naturally resists attack. As a tree grows, the cells in the central rings die to create heartwood. Water and nutrients cease to flow through the heartwood, and extractives collect and concentrate in the heartwood. For this

reason, the building code permits only an occasional piece of naturally durable lumber to have a very small amount of sapwood.

Decay of wood is caused by the digestive action of enzymes secreted by the fungal hyphae resulting in loss of both timber production and use of wood. Cellulose hydrolysis is achieved by endoglucanases and cellobiohydrolases, collectively termed cellulases. Hydrolysis of hemicellulose, a mixed polymer, occurs via the action of hydrolytic xylanases, mananases, and possibly other hydrolases with broad substrate specificity (Eaton & Hale, 1993).

Major developments in wood preservation

Historical background

In 1908, wood preservation was introduced in India by Sir Ralph Pearson.

Copper Chrome Arsenic (CCA) and Copper Chrome Boron (CCB) were first formulated by SontiKamesan of FRI in 1930.

The first wood preservation plant in India was established at Bally (Howrah).

India has introduced CCA to the world.

The preservation industry developed with the railroad system.

IS-401:

In India, the Bureau of Indian Standard codes for wood preservation is followed i.e; IS:401-1967 (Indian Standard –code of practice of Timber).

It covers:

- Types of preservatives,
- Their description
- Methods of treatment
- Type and choice of treatment for different species under Indian conditions of service.
- Process of treating refractory timber.

Types of Wood Preservatives:

Oil-Type Preservatives

- Creosote
- Pentachlorophenol
- Copper Naphthenate
- Oxine Copper (Copper-8-Quinolinolate)
- IPBC (IodopropynylButylcarbamate) and Insecticides.

Waterborne Preservatives

- Chromated Copper Arsenate (CCA)
- Ammonical Copper Zinc Arsenate (ACZA)
- Alkaline Copper Quaternary (ACQ) Compounds
- Copper Azoles (CA-A and CA-B)
- Borates
- Other Waterborne Preservatives

Preservatives which are no longer available commercially:

- Ammonical Copper Arsenate (ACA)
- Acid Copper Chromate (ACC)
- Ammonical Copper Citrate (ACC)

Methods of Application of Preservative:

Surface Application

This is done by brushing, spraying, or dipping in the preservative solution for a short period. For this treatment, timber (if it is round) is debarked thoroughly. For the oil type of preservatives, the moisture content in the material shall not be more than 20 percent, with aqueous solutions, moisture content of 20 to 30 percent is permissible. At least two coats should be applied, the second and subsequent coats. Whatever method of treatment is adopted, is to be applied after the first has dried or

soaked into the wood. Where practicable, the treatment is done hot. Surface treatment has a limited scope, and is used mostly for treating material at the site and for the retreatment of cut surfaces. This may be repeated periodically.

Soaking Treatment

In this, the material is debarked thoroughly (in the case of round timber), and the treatment is carried out by submerging it in the preservative solution for a sufficiently long period until the required absorption of the preservative is obtained. Normally,soaking of veneers in the preservative solution for a period of 1 to 2 min is adequate for thickness up to 1.8 mm in the case of refractory species and up to 3 mm for other species. Prefinished joinery/furniture components/items can also be treated with light organic solvent-type wood preservatives by this process.

Hot and cold process

The timber is submerged in the preservative oil or solution, which is then heated to about 90^0C and maintained at this temperature for a suitable period, depending on the charge. It is then allowed to cool until the required absorption of preservative is obtained. During the heating period, the air in the timber expands and part of the moisture is converted into vaporand is expelled; during cooling, the residual vapor/ air in the timber contracts, creating a partial vacuum, which causes the preservative to be sucked into the timber.

Boucherie Process

Treatment of scrapwood of almost all green round timbers, soon after felling with the bark on may be carried out using any of the inorganic water-soluble preservatives. The treatment is carried out by attaching to the butt-end of a pole, a rubber hose connected to a reservoir containing the water-borne preservative solution and placed at a sufficiently higher level. The pole is held in an inclined position, generally at an angle of 45° to the horizontal. Due to hydrostatic pressure, the preservative displaces the sap which is then forced out at the narrow end. The treatment is stopped when the concentration of preservative in the drip is nearly the same as that of the solution in the reservoir. If an air pressure of 1 to 2 kg/cm2 is applied on the surface of the preservative in the reservoir, the reservoir, need not be raised high above the ground and the treatment can be hastened to an appreciable extent. Pressure up to 5 kg/cm^2 maybe used for the treatment of green poles with specially designed pressure caps.

Pressure Process

The pressure process may be employed with any type of preservative. In the case of oil-typepreservatives, a temperature of 80 to 90°C shall be maintained during the pressure period.

Empty Cell Processes:

These processes aim at a maximum penetration of the preservative with minimum net absorption.

Lowry process

The cylinder is loaded with the material and then closed. It is then filled with the preservative; an antiseptic pressure of3.5 to 12.5 kg/cm2, depending on timber species, size, etc, is applied until slightly higher than the required absorption is obtained. When the pressure is released, a certain amount of the preservative isexpelled due to the expansion of the entrapped air in the cells. The cylinder

isthen drained off, applying a final vacuum.

Boulton Process

It is a combination of conditioning wet material by boiling and drawing a vacuum till the desired moisture is taken off and treating the material subsequently in the same cylinder, generally using a creosote-fuel oil mixture.

Wood preservation in sustainable development

Currently, there are more than 150 treatment plants with an annual treating capacity of over 2.5 million m^3 although the existing treatment is only about 1.5 million m^3.

Production of Medium density fiberboards, particle boards, and the wood plastic composite has increased dramatically, and preservative treatments are required to make them resistant to the attack of wood-destroying organisms.

Treating wood with preservatives can last for a longer duration and increase the life of wood and carbon sequestration.

Current indian trends

The most popular wood preservatives are CCA, CCB, Acid Copper Chrome (ACC), creosote, and Liquid Organic Solvent preservatives (LOSP) in the market.

50% of CCA produced in the country is majorly used by the cooling tower industry.

CCA due to carcinogenicity is replaced by CCB (but not fully).

Borax treatment (Boric acid) is the main preservative treatment in the furniture industry.

LOSP is used in brush-in applications and in remedial treatments.

The overall use of preservatives is around 1350t CCA equivalent is quite disappointing, compared with the volume of nondurable woods which is 22.5 million m^3 used annually. (NOTE: 15 sq. meter/liter approx by brushing)

Environmental issues of treated wood-based panel products

Wood preservatives can be harmful to humans if not properly handled. The exposure routes by which they can enter the human body are inhalation (vapor, dust, aerosol, etc.), ingestion (solid, liquid), ocular exposure, and through the skin (vapor, liquid, solid). A number of studies have examined the effects of wood preservatives on settlement patterns, growth, and biomass development of human environments. The majority of leaching from wood when treated with waterborne preservatives, The rate and overall amount of leaching from a given product is also affected by preservative penetration and retention and by the surface area of the product.

The presence of some types of inorganic ions in water has been reported to increase leaching from CCA-treated wood, Water pH can also affect the leaching of preservatives. Leaching of CCA is greatly increased when the pH of the leaching water is lowered to below 3, and the wood itself also begins to degrade. Most controlled leaching trials of preservative-treated wood samples to leaching via immersion. Immersion is perhaps the simplest type of leaching mechanism to control and replicate, and it provides a severe leaching environment (Stan Lebow *et al.*,2004).

CCA-treated pine leached as much as 25% of total active ingredients within 6 months, with total losses only rising to 52% after 85 months (Archer and Preston, 1994).

Leaching of Cu, Cr, and has been shown to be increased at higher temperatures, with the leaching of Cr at 20^0C reported being 0.119 mg compared with 0.079 mg at 8^0C (Van Eetvelde*et al.*, 1995)

There are hazardous chemicals like chromium and arsenic that pose health risks.

The burning of toxic treated wood may emit toxic chemicals.

Disposing near water bodies may contaminate water.

But Chromium is a fixative for many preservatives (Copper ethanolamine borax is under research by IPRITI).

CCA- status, chromium (VI) at 10 mg/kg body weight causes liver necrosis, nephritis, and death in people.

Indian alternatives

- IPRITI, Bangalore developed copper ethanolamine boron as a chromium and arsenic-free wood preservative.
- Eco-friendly preservatives like Neem oil, Cashew nut shell liquid, and Chitin synthesis inhibitors have been developed at IPIRTI.
- ZIBOC (zinc, boron, and copper) has been developed by FRI as an alternative to CCA.

Natural compounds for wood protection

Plants are a rich source of various chemical compounds, including

- Alkaloids,
- Flavones and flavonoids,
- Phenolics,
- Terpenes,
- Tannins or Quinones.
- Antifungal properties of various plant extracts can be used as an alternative for chemical wood preservatives against decay.

Strategies

Use fewer preservatives, through the use of alternative materials such as concrete ties, other materials for poles, use of untreated wood, and movement to wood modification (chemical and thermal) to protect the wood.

Decrease the accepted limits of pesticides in drinking water, surface water, soil, sediments, food, etc. This makes it more difficult to comply with regulations and guidelines at all stages of the life cycle for certain preservatives.

Reduce the use of arsenic, chromium, creosote, and pentachlorophenol-containing preservatives and probably in the longer term, copper-containing preservatives. In parallel with this, the trend is for the introduction of a much broader suite of alternatives, with a main focus on organic preservatives.

Increase reliance on incineration for disposal of most spent wood including treated wood.

Recover inorganic preservatives from treated wood by collecting and treating ashes and condensate from co-generation or incineration facilities.

Require manufacturers to take full life responsibility for their products.

Case Studies

K. S. Shiny *et al.*, (2013) studied the preservation capacity of Coconut Shell Oil (CSO) and cashew nut shell oil in rubber wood stakes and the study indicated that treatment imparted significant termite resistance to wood for 18 months as the total phenol content in CSO was 15.6 which acts as a preservative.

Monica Verma *et al.*, (2015) reviewed that the plant extracts could be exploited to develop new wood preservatives to protect

wooden structures. The plant-based extracts from agricultural crops, plants, and trees can be used as preservatives as these are less harmful to the environment and humans, and suggested that further studies are required to use them as a commercial termiticide.

Sohail Ahmed *et al.* (2020) assessed the effect of jatropha, linseed, eucalyptus, neem, and jojoba oils on the protection of three wood species (Acacia nilotica, Dalbergiasissoo, and Pinuswallichiana) against termite attack by Odontoter genus and justified that wood with high oil retention i.e; in eucalyptus has shown more resistance against the termite.

Essential oils

Reference	Property	Effect
Voda *et al.*, (2003)	High, antifungal effectiveness of anise, basil, cumin, oregano, and thyme oils.	Against brown-rot fungus *Coniophoraputeana* and white-rot fungus *TrametesVersicolor*
Chittenden and Singh (2011)	0.5% concentrations of cinnamon and geranium oils	Against brown-rot fungi *Oligoporus placenta*, C. puteana, and *Antrodiaxantha*, sapstain fungi *OphiostomafloccosumMathiesen*, *Ophiostomapiceae*, *Sphaeropsissapinea*, and *Leptographiumprocerum*
Kartal*et al.*, (2006)	Used cassia oil.	Resistance against brown-rot*Tyromycespalustris* (mass loss of 0.7%) and white-rot C. Versicolor fungi (mass loss of 3.6%).

Tannins

Reference	Property	Effect
Tascioglu *et al.*(2013)	Bark extracts of mimosa (*Acacia mollissima), quebracho (Schinopsislorentzii*) and pine (*Pinusbrutia*).	Against white-rot fungus in beech wood
Tascioglu *et al.*,2013)	*Maclurapomifera*, *Callistemon viminalis*,and *Dalbergia sissoo* bark extracts.	Suppression ofT. harzianum (mold)

Other plant extracts

Reference	Property	Effect

Kwa´sniewska-Sip *et al.*, (2018).	Pure caffeine solutions	Susceptibility to mold and white-rot fungus.
Goktas*et al.*,(2007)	extracts from poisonous *Nerium Oleander* L	Against brown- and white-rot fungi.
Schmidt *et al.*,*(*1995)	Chitin	Against brown rot
Dhyani*et al.*,(2005)	Natural extracts of Rosewood leaves	Against wood decay fungi

Conclusion

The future for wood preservation looks very bright indeed. Various new wood substitutes for solid treated wood like wood-plastic composites, oriented strand board (OSB), laminated veneer lumber (LVL), and parallel strand lumber (PSL). Modern wood preservation is barely two centuries old. Wood, being the most versatile building material that has ever been utilized, will continue to need protection from degrading agencies.

Significant growth in this industry has been seen in every single decade since Bethell originally impregnated timber with creosote in the 1830s. The treated wood industry is undergoing a major transition as CCA is replaced in most residential applications. CCA alternatives have been developed and are becoming more widely available.

The alternatives rely heavily on copper as the primary biocide, with a range of co-biocides to help protect against copper-tolerant organisms. Studies indicate that the CCA alternatives do release measurable quantities of copper and co-biocide into the environment.

However, these components have lower mammalian toxicity than does arsenic, and they are less likely to raise concerns about environmental impacts. As the treated wood industry evolves, it is likely that a wider range of types and retentions of wood preservatives will become available, with the treatment more closely tailored to a specific type of construction application.

The use of newer process technologies holds promise for new wood preservatives and breaks ground for modern advances in commercial production plants, and innovation in research opportunities. There is an increasing need to educate the consumer regarding new wood-treating chemistries and new products.

In India, negligible importance was given to wood preservation, where the gap between demand and supply of wood is more, and suitable use of resources is the only option to bridge the gap.

Now, slowly, the perception of the industry is changing as consumers are demanding insect-proof wood products.

Hence, wood preservation is gaining importance in India.

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संकट में है धरती अब नहीं मंडराती मधुमक्खियां---- खाद्य फसलों में परागण और निषेचन की प्रक्रिया हुई बाधित

अजीत विलियम्स

बैरिस्टर ठाकुर छेदीलाल कृषि महाविद्यालय एवं अनुसंधान केंद्र
बिलासपुर (छ. ग.)

दलहन, तिलहन और नींबू, लीची प्रजाति की फसलों पर अब मधुमक्खियां नहीं मंडराती । परागण और निषेचन में बेहद महत्वपूर्ण भूमिका निभाने वाली यह मधुमक्खियां इसलिए दूर होने लगीं हैं क्योंकि अप्रैल के शुरुआती दिनों से ही तापमान बढ़ जा रहा है। खेती के आधुनिक तौर तरीके और कीटनाशक छिड़काव में समय व मानक मात्रा का ध्यान नहीं रखा जाना भी दूरी के लिए जिम्मेदार माने जा रहे हैं ।

परागण और निषेचन। किसी भी फसल के लिए जरूरी होते हैं। यह काम मधुमक्खी और भंवरे बखूबी के साथ पूरा करते हैं। अन्य कीट, पतंगे भी सहायक बनते हैं इस प्राकृतिक प्रक्रिया में लेकिन जलवायु परिवर्तन और खेती में आधुनिक तौर तरीकों का उपयोग बढ़ रहा है। उसने मित्र कीट&पतंगों का जीवन खतरे में डाल दिया है। ऐसा होना दुनिया के जैव&विविधता के लिए भी बड़ा खतरा है। ताजा अध्ययन में मधुमक्खियों की तेजी से कम होती आबादी की जानकारी सामने

आई है। यह स्थिति दलहन, तिलहन और नींबू, लीची फसलों के लिए घातक मानी जा रही हैं।

बदल रहा जीवन चक्र

38 डिग्री सेल्सियस तक तापमान सही माना गया है । रानी मधुमक्खी के लिए लेकिन जलवायु परिवर्तन के दौर में अप्रैल की शुरुआत इससे ज्यादा तापमान से हो रही है। यही वह समय है । जब रानी मधुमक्खी प्रजनन के दौर से गुजर रही होती है लेकिन तापमान का बढ़ता स्तर, न केवल प्रजनन क्षमता पर प्रतिकूल असर डाल रहा है बल्कि आबादी को भी कम कर रहा है। इसे मधुमक्खी पालन व्यवसाय और दलहन एवं तिलहन फसलों के लिए बेहद नुकसान पहुंचाने वाला माना जा रहा है।

बड़ी वजह यह भी

तकनीक का उपयोग खेती किसानी के क्षेत्र में काफी बढ़ा है। अनुपात में कीटनाशक का छिड़काव भी किसान मानक मात्रा से न केवल ज्यादा कर रहे हैं बल्कि छिड़काव के लिए सुझाए जाने वाले समय का भी ध्यान नहीं रख रहें हैं। ऐसे में मित्र कीट-&पतंगो में शुमार मधुमक्खियों की

आबादी तेजी से घट रही है। इसका असर दलहन, तिलहन और नींबू वर्गीय फसलों के कमजोर उत्पादन के रूप में देखा जा रहा है । फूलों की बागवानी से भी यही शिकायतें आ रहीं है ।

ऐसे करतीं हैं सहायता

भारतीय कृषि अनुसंधान परिषद के अनुसार रानी मधुमक्खी को घेरे में लेकर चलने वाली मधुमक्खियां, फूलों का सही तरीके से परागण और निषेचन करतीं हैं। इस क्रिया में फसलों पर बैठने के बाद एकत्रित पराग और मकरंद छोड़ देतीं हैं। उससे परागण व निषेचन को मदद मिलती है और यह प्रक्रिया फसल की बढ़वार और उत्पादन के काम में सहायक बनती है। मधुमक्खियों की यह क्रिया दलहन, तिलहन और नींबू वर्गीय फसलों के लिए बेहद अहम मानी गई है।

खत्म होने की कगार पर है मधुमक्खियां

मधुमक्खियां पर्यावरण के लिए आवश्यक तो है, लेकिन अब इनकी घटती संख्या चिंता का विषय है। मधुमक्खियां की घटती संख्या के लिए बढ़ता

तापमान, वनों की कटाई, मधुमक्खी के छत्ते के लिए सुरक्षित जगह की कमी, फसलों के लिए इस्तेमाल किए जाने वाले कीटनाशकों का अंधाधुंध उपयो, मिट्टी में होने वाले बदलाव आदि जिम्मेदार है। साथ ही मोबाइल फोन से निकलने वाली तरंगे मधुमक्खियां के लिए भी खतरनाक मानी जाती है।

Harnessing the potentiality of agroforestry systems in coastal areas of Uttara Kannada, Karnataka

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Introduction

A region rich in natural beauty and cultural legacy, Uttara Kannada is tucked away along Karnataka's tranquil coastline. Nevertheless, Uttara Kannada, like many coastal regions, faces a number of difficulties, such as soil erosion, saltwater intrusion, and diminishing agricultural productivity. As a result of these difficulties, agroforestry systems' potential to improve livelihoods and address environmental degradation is becoming increasingly apparent.

Agroforestry, or the coexistence of livestock, crops, and shrubs, provides a comprehensive method of managing land that supports soil conservation, biodiversity preservation, and sustainable production (Stefano, A and Jacobson M 2017). Adopting agroforestry practices holds promise for revitalizing degraded lands, enhancing resilience to climate change, and supporting rural livelihoods in Uttara Kannada, where agriculture is a crucial part of the local economy. Uttara Kannada's distinct coastal ecology offers opportunities and challenges for agroforestry system implementation. Because of shifting water levels, saline conditions, and tidal patterns, coastal ecosystems are by nature dynamic. These ecosystems do, however, also support a variety of flora and fauna that are suited to flourish in these circumstances, offering a wealth of species appropriate for agroforestry.

Farmers in Uttara Kannada can create resilient agroforestry systems that are adapted to the specific environmental conditions of their region by utilizing the diversity of coastal flora. Natural plants like cashew trees, mangroves, coconut palms, and Casuarina provide important ecosystem services like soil stabilization and carbon sequestration. Additionally, combining multipurpose tree species with conventional crops like vegetables, rice, and pulses can increase output while lowering dependency on outside inputs (Schroth *et al.*, 2001). In Uttara Kannada, agroforestry is being adopted to promote socioeconomic development in addition to ecological restoration. Through increased household food security and income source diversification, agroforestry enables farmers to create more resilient livelihoods. Agroforestry also encourages knowledge exchange and community involvement, which helps to develop a sustainable land (Noordwijk 2021).

Dominant agroforestry systems in coastal areas of Uttara Kannada

Many agroforestry systems are used in the coastal regions of Karnataka, India's Uttara Kannada district. This is mostly because of the socioeconomic and agroclimatic

diversity of the area. The following are a few of the prominent agroforestry systems in this area:

Agroforestry centred on coconuts

Uttara Kannada is well-known for its vast coconut plantations. The crops areca nut, banana, pineapple, spices (like cardamom and pepper), and occasionally lumber or fruit trees (like mango or jackfruit) are interplanted with coconut palms. Farmers can earn multiple income streams from this system.

Agroforestry based on Areca Nuts

Cultivating areca nuts, also known as betel nuts, is another important agroforestry technique in the area. Intercropping shade-tolerant plants like cocoa, vanilla, black pepper, and citrus and banana fruits are common in areca nut gardens.

Cashew-based Agroforestry

Because of the sandy soil and ideal climate, cashew nut cultivation is common in coastal regions. Intercropping seasonal vegetables, legumes, and occasionally timber trees like teak or mahogany occurs frequently on cashew plantations.

Agroforestry centered on spices

Uttara Kannada is well-known for its spice production. In agroforestry systems, fruit trees like mango and jackfruit as well as trees that provide shade, like silver oak, are frequently planted alongside spices, cardamom, and vanilla.

Mixed Cropping with Timber Trees

In an effort to engage in agroforestry, some farmers combine food crops with timber trees such as teak, mahogany, or silver oak. Though the understory crops yield more immediate cash, these trees also offer additional revenue in the form of timber. Mangrove-based Agroforestry: In the coastal regions, especially where mangroves are found, agroforestry practices may involve the cultivation of salt-tolerant crops like mangrove apple (Sonneratia spp.) along with fish farming or shrimp culture in integrated systems.

Challenges and constraints for successful harnessing of agroforestry systems

Because coastal agroforestry systems are situated close to the land-sea interface, they are subject to particular difficulties and limitations. The environmental, social, and economic spheres may present these difficulties. The following are some of the main obstacles and challenges:

Salinity

Because of seawater intrusion, coastal areas frequently have high soil and water salinities, which can hinder plant growth and restrict the kinds of crops that can be planted. In agroforestry systems, salinity can also harm tree and shrub root systems.

Water management

The availability and management of water can present difficulties for coastal agroforestry systems. Crop and tree growth can be impacted by floods, droughts, and irregular rainfall patterns, necessitating the use of efficient water management techniques like irrigation and drainage systems.

Soil erosion and sedimentation

These phenomena can occur in coastal regions, especially in places with steep slopes or inadequate soil conservation measures. While sedimentation can clog streams and have an impact on aquatic ecosystems, erosion can diminish soil fertility and lower the productivity of agroforestry systems.

Climate change

Rising sea levels, higher temperatures, and an increase in the frequency of extreme weather events like storms and hurricanes are some of the effects that coastal agroforestry systems are susceptible to. These modifications have the potential to worsen already-existing environmental problems, impair infrastructure, and disrupt agricultural output.

Land tenure and governance

The development and administration of coastal agroforestry systems may be severely hampered by problems pertaining to land tenure and governance. Investment and sustainable management techniques may be hampered by land ownership disputes, ambiguous land tenure agreements, and weak governance frameworks.

Coastal hazards

Storm surges, tsunamis, and coastal erosion are just a few of the natural dangers that coastal agroforestry systems must contend with. In addition to endangering human lives and livelihoods, these hazards have the potential to harm crops, trees, and infrastructure.

Socioeconomic elements

The growth of coastal agroforestry systems can also be hampered by socioeconomic variables like lack of infrastructure, restricted market access, and poverty. Inadequate transportation networks can hinder the adoption of agroforestry practices, as can a lack of funds and credit availability.

Management of Coastal agroforestry systems

Managing coastal agroforestry systems in Uttara Kannada, a district in the Indian state of Karnataka, requires a combination of strategies that address the unique environmental conditions, socio-economic factors, and sustainability goals of the region. Here are some management strategies:

Species Selection

Choose tree and crop species that are well-suited to the coastal environment and provide ecological and economic benefits. Consider native species that are adapted to the local soil, climate, and water conditions.

Integration of Trees with Crops

Design agroforestry systems that integrate trees with crops in a way that maximizes synergies and minimizes competition for resources such as water, nutrients, and sunlight. For example, use nitrogen-fixing trees to improve soil fertility for crops.

Soil and Water Management

Implement soil conservation measures such as contour planting, mulching, and terracing to prevent soil erosion and maintain soil fertility. Use efficient irrigation techniques to conserve water and prevent salinization of soil.

Pest and Disease Management

Employ integrated pest and disease management practices that combine biological, cultural, and chemical control methods to minimize the use of pesticides and reduce environmental impact.

Community Participation

Involve local communities in the planning, implementation, and management of agroforestry systems to ensure their needs, knowledge, and priorities are considered. Encourage community ownership and provide training and capacity-building programs.

Livelihood Diversification

Promote diversified agroforestry systems that provide multiple sources of income

for farmers, such as timber, fruits, nuts, and non-timber forest products. This helps reduce vulnerability to market fluctuations and environmental risks. Climate

Resilience

Design agroforestry systems with climate resilience in mind, considering factors such as sea-level rise, increased temperatures, and extreme weather events. Select tree and crop species that are resilient to climate change and contribute to ecosystem stability.

Policy Support

Advocate for policies and incentives that support the adoption and expansion of agroforestry systems, including access to credit, land tenure rights, market linkages, and subsidies for sustainable practices.

Research and Extension

Invest in research and extension services to generate knowledge, innovations, and best practices for coastal agroforestry management. Disseminate information through farmer field schools, demonstration plots, and extension programs.

Monitoring and Evaluation

Establish monitoring and evaluation mechanisms to assess the ecological, economic, and social impacts of agroforestry systems over time. Use feedback to adjust management strategies and improve outcomes.

Implementation of successful models in coastal areas of Uttara Kannada

A number of well-executed coastal agroforestry initiatives across the globe demonstrate the advantages of combining forestry and agriculture in coastal areas. Here are some instances:

Mangrove agroforestry in Southeast Asia

Projects to restore degraded coastal areas and support coastal communities' livelihoods have been put in place in nations like Vietnam, Thailand, and Indonesia. In these projects, mangrove trees are planted alongside other crops like vegetables, rice, and coconuts. Mangroves aid in preventing erosion, stabilizing coastal soils, and offering fish and other marine life a place to live.

Coconut-Based Agroforestry in the Philippines

Agroforestry systems based on coconuts have been set up in the country's coastal regions. In these systems, coconut trees are grown alongside other crops like bananas, coffee, and cacao. While the other crops give farmers additional revenue, the coconut trees shade and protect the other crops from the wind.

Silvi-pastoral Systems in Latin America

To combine trees with livestock grazing, silvi-pastoral systems have been established in coastal regions of nations like Brazil and Colombia. In these systems, forage grasses for livestock are planted alongside trees like eucalyptus and acacia. The trees sequester carbon, enhance soil fertility, and give livestock shade.

Agroforestry in Coastal India

To solve the problems of waterlogging and salinity in the soil, agroforestry projects have been established in India's coastal regions. In these projects, crops like rice and vegetables are planted alongside salt-tolerant tree species like babul and Casuarina. The trees enhance the soil's structure and aid in removing excess salt, improving the soil's suitability for farming.

Shelterbelt Agroforestry in Coastal Africa

To shield crops from wind damage and salt spray, shelterbelt agroforestry systems have been established along coastal areas in nations like Senegal and Kenya. By acting as windbreaks and lowering soil erosion, the trees improve the microclimate that supports crop growth.

Untapped potentiality of Aqua-based agroforestry systems in coastal areas of Uttara Kannada

Agro-silvi-aquaculture, or agroforestry-aquaculture, is another name for systems that combine trees, crops, and aquatic life like prawns or fish into one cohesive system. These systems are intended to increase biodiversity, optimize land use efficiency, and give farmers multiple revenue streams.

Tree Component

Planting trees next to lakes or ponds gives the ecosystem more organic matter, shade, and protection from the wind. Depending on the goals of the system, they may be fruit trees, timber trees, or trees with the ability to fix nitrogen.

Crop Component

A variety of crops can be planted next to the trees or in between them. These could be perennial crops like coffee or cocoa, or annual crops like grains and vegetables. A number of variables including soil composition, climate, and consumer demand influence crop selection.

Aquatic Component

Within the agroforestry system, water bodies are used to raise fish, prawns and other aquatic organisms. For farmers, this component offers an extra source of revenue and protein. The waste produced by the aquatic organisms can be used as fertilizer for crops, contributing to nutrient cycling and soil fertility.

Water Management

To preserve water quality and guarantee the wellbeing of both terrestrial and aquatic components, aqua-based agroforestry systems require effective water management. To maximise water use and reduce water waste, strategies like irrigation, rainwater harvesting, and water circulation systems can be implemented.

Natural Resources and Ecosystem Services

Aqua-based agroforestry systems support biodiversity by providing homes for different kinds of plants and animals. While aquatic organisms support a diverse range of aquatic life, trees serve as bird nesting sites. These systems also improve overall ecosystem services by aiding in water filtration, carbon sequestration, and soil conservation.

Economic Viability

Farmers can increase their resilience to market fluctuations and environmental risks by integrating multiple components within a single system, thereby diversifying their income streams. Sales of timber, fruits, vegetables, fish, or prawns, for instance, can bring in money and act as a safety net against possible losses in any one industry.

Sustainability

Because aqua-based agroforestry systems mimic natural ecosystems and use resources more effectively than conventional monoculture systems, they are generally more sustainable. Through the decrease of external inputs like pesticides and fertilizers, these systems can lessen their negative effects on the environment and support sustainable agriculture over the long run.

Policy recommendations for coastal agroforestry systems

In Uttara Kannada, Karnataka, policy recommendations for coastal agroforestry systems must take into account a number of factors, including social equity, economic viability, and environmental sustainability.

The following policy suggestions are specific to this situation

Encouragement of Agroforestry Methods

By providing subsidies, technical support, and training opportunities, agroforestry practices can be encouraged and incentivized to farmers. This could entail offering funding in order to buy the tools, equipment, and saplings required for agroforestry.

The Diversity and Selection of Species

Offer advice on choosing tree species that are suitable for Uttara Kannada's coastal environment. Stress the significance of diversity in the selection of species to improve resistance to diseases, pests, and climate change.

Water Management

Put laws into place that support effective techniques for managing water in agroforestry systems, particularly in regions vulnerable to salinity intrusion or drought. This can entail encouraging drip irrigation, rainwater collection, and water-efficient practices.

Soil Management and Conservation

Create regulations to support soil fertility enhancement and conservation in agroforestry systems. This could entail promoting the use of mulching, erosion control techniques, and organic farming methods.

Market access and value addition

Create connections between farmers and markets to make it easier for agroforestry products to find a market. To raise the economic value of agroforestry products, support value-adding operations like product processing, packaging, and marketing.

Land Tenure and Community Participation

Promote community involvement in agroforestry development decision-making processes. Make sure that land tenure laws facilitate the management of land for agroforestry by small-scale farmers and indigenous communities.

Research and Extension Services

To create knowledge and spread best practices in coastal agroforestry systems, invest in research and extension services. This might entail setting up research facilities, carrying out field tests, and planning outreach initiatives and workshops.

Adaptation to Climate Change

Incorporate strategies for adapting to climate change into agroforestry policies and initiatives. Promoting agroforestry techniques that improve carbon sequestration, lower greenhouse gas emissions, and increase resistance to extreme weather events are a few ways to do this.

Monitoring and Evaluation

Create systems to keep an eye on how agroforestry policies are being implemented and evaluate their effects on social, economic, and environmental metrics. Over time, make adjustments to policies and enhance results by using feedback from monitoring and evaluation processes.

Cooperation and partnership

To successfully implement agroforestry policies, encourage cooperation and partnerships between local communities, non-governmental organizations, government agencies, and research institutions. Promote discussions among multiple stakeholders and collaborative efforts to tackle shared issues and effectively utilize available resources.

Conclusion

We explore how Uttara Kannada, Karnataka's coastal agroforestry systems might be used to address socioeconomic and environmental issues. In this distinctive coastal setting, we examine the concepts, methods, and advantages of agroforestry via case studies, professional opinions, and community viewpoints. Uttara Kannada can forge a sustainable route to a resilient and prosperous future by utilizing the synergies between forestry, conservation, and agriculture. By implementing these policy recommendations, Uttara Kannada can promote sustainable and resilient coastal agroforestry systems that contribute to food security, environmental conservation, and rural livelihood improvement.

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Chandan: An important tree in Himachal Pradesh, India

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Abstract

Chandan is a fragrant evergreen tree, with high global commercial value. Given the rising demand and dwindling supply of sandalwood from its native environment, there is a huge opportunity for planting sandal trees on agricultural land, home gardens and other agroforestry systems. With its introduction in Himachal Pradesh, the tree presently grows in the districts of Kangra, Hamirpur, and Bilaspurand Paonta Valley of the state. However, sandalwood cultivation is difficult due to a lack of awareness of the host-parasite connection, as it is a root parasite. Along with this, illegal felling and smuggling are also hurdles to its cultivation. Not only has that, but the long period of economic returns posed a hindrance to its cultivation. The tree has the potential to earn commercial recognition in Himachal Pradesh, particularly in the Lower Shiwalik range, provided farmers become more aware of its economic worth.

Keywords: Chandan, Regeneration, Himachal Pradesh, Challenges, Sandalwood oil

Introduction

Santalumalbum, a fragrant evergreen small to medium sized tree belonging to family Santalaceae, is an important commercial species around the world. The tree has achieved the rank ofRoyal Tree and Green Gold, as well as other names such as Sandal, Safed Chandan and Srigandha. The tree is beloved and deeply embedded in Indian culture and heritage. The tree attains a height of 12 m with girth up to 2 m. The tree prospers in well drained soils, including loam, laterite, sand and black cotton soil types, it also grows well on rocky and poor soils with an elevation of 650 - 1200 m and rainfall of 500-2000 mm.

It is a semi-root parasite that grows with other species found in forests. More than 300 species, from grass to another sandalwood plant, can become parasitized by it. In environments where organisms grow in groups, self-parasitism is prevalent. This tree has distinct host plants in both the nursery and plantation stages. *Casuarina equisetifolia* and *Cajanuscajan* are considered to be the best hosts for its establishment along with hosts such as, *Senegalia catechu, Cassia fistula, Dalbergia latifolia, Albizia lebbek, Acacia auriculiformis*

The tree is commercially known as East Indian sandalwood and produces an essential oil called East Indian sandalwood oil. The oil is a light yellow-to-yellow viscous liquid with sweet, fragrant, lasting, spicy, warm, woody, milky, and nutty aromas. The wood from the tree is termite-resistant and ideal for carving intricate designs.

Distribution in Himachal Pradesh

Himachal Pradesh is not the native home of sandalwood. It was brought to Himachal Pradesh because of its extremely high economic worth and continuously spreading in the Shiwalik ranges due to its climatic suitability and availability of the other host plants. Moreover, cultivating sandalwood is permitted in Himachal Pradesh and farmers shown their keen interest in raising this plant due to its very high commercial value. Approximately 10,000 sandalwood seedlings are being raised by the Himachal Pradesh Forest Department each year in its nurseries in this region.

Regeneration methods

Natural Regeneration

The sandal can regrow in large quantities using seeds and root suckers. Except in rare instances, most years are good seed years. The birds assist in spreading the seed by eagerly consuming the fruits. In the wet season, the seed germinates if there is sufficient vegetative cover and moist soil with good drainage. Early on, roots produce haustoria-like nodular growths. Early leaves are smaller than later ones; they are simple, opposite, and exstipulate. Growth is rapid under average conditions; height reaches 20–30 cm at the end of the first season and 60–70 cm at the end of the second.

Maintaining the trees, getting rid of bothersome weeds, providing sufficient drainage for suppressed trees, shielding seedlings from the sun and drought through lateral shading, and allowing for the free and natural expansion of the crown are all crucial cultural practices for natural reproduction. Raking the ground and covering the seeds with soil aids natural germination. It's also essential to suppress the growth of grass and shield new seedlings from nibbling by rodents and squirrels, deer clipping, etc. Partial shade promotes better growth for seedlings. The regenerated regions should not be used for fire or grazing.

Artificial Regeneration

The sandal can be propagated through vegetative cuttings of root suckers, transplanting plants grown in nurseries, and burying seeds beneath bushes or on mounds. Stump planting is also another method.

Commercial Importance

The tree is mainly exploited for its heartwood and roots. The heartwood is the main element from which the essential oil is extracted through distillation process. Roots also have oil in them which is also used. The essential oil is used in perfumery and beauty industries, as a flavouring substance, also used as medicine. This versatility of sandalwood oil provides the tree a commercial value. The heartwood is sold at a rate of rupees 6000 -7500 per kg, this could be beneficial the farmers.

Challenges faced to establish commercial plantations

Illicit felling and smuggling

The tree is being cut down before it is fully matured; essential oil is not significantly enough if tree is felled early. Hence there is a significant decline in the population of the tree.

Lack of awareness among farmers

Some of the farmers are not aware about the host requirements of the tree so the tree fails to survive during its initial stages

Legal barriers

Certain policies prevented private domestication of the tree, so farmers are

not interested to grow it on a commercial scale.

Long gestation period

As it is known that the tree attains exploitable stage in about 30 years, hence the farmers are reluctant to grow it due late economic benefits.

Pest and diseases

Spike disease that shortens the internodes, reduces the leaf size, kills haustoria, blocks vascular tissue and eventually kills trees, is a serious pathogen in India. Nursery pests include pathogenic fungi, Fusarium and Phytophthora and nematodes. This is also a problem faced by the farmers.

Climate suitability

The tree requires tropical to semi tropical climate hence it cannot be grown by the farmers in the temperate areas of the state if they are interested.

Conclusion

The high economic value of sandalwood provides sufficient incentives to farmers for growing this tree on a commercial scale. However, the area under sandal trees is decreasing fast because of pilferage and difficulty in the field establishment of sandal trees in new area. It is a known fact that felling of Chandan is permitted by the Forest Department, which has led to an increase in illegal felling, thereby declining the population of already established stands of Chandan.So, the Department can strategize economic upliftment through commercial plantations of the species.

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Curcuma alismatifolia Gagnep (Siam Lily): A Note

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The genus *Curcuma* L., incorporated within the angiospermic Zingiberaceae, the ginger plant family, better known as the turmeric genus are found distributed widely from India to South China, South-East Asia, Papua New Guinea and Northern Australia as well as in tropical Asia. In comparison with other places in the world, Thailand boasts of having the highest number of this taxon occurring naturally. There are about 38 species of *Curcuma* found worldwide, divided into 5 different groups: 1) "*Alismatifolia*" group (species *C. alismatifolia*, *C. gracillima*, *C. harmandii*, *C. parviflora*, *C. rhabdota*, *C. sparganiifolia*, etc.); 2) "*Cochinchinensis*" group (*C. cochinchinensis* and *C. pierrena*); 3) "*Ecomata*" group (species like *C. bicolor*, *C. eccomata*, *C. flaviflora*, *C. glans*, *C. singularis*, *C. stenochila* etc.); 4) "*Longa*" group (*C. aeruginosa*, *C. amada*, *C. angustifolia*, *C. aromatica*, *C. comosa*, *C. latifolia*, *C. leucorrhiza*, *C. longa*, *C. manga*, *C. rubescens*, *C. viridiflora*, *C. xanthorhiza* and *C. zedoaria*); and 5) "*Petiolata*" group (species *C. aurantiaca*, *C. petiolata*, *C. roscoena*, *C. rubrobractaea*, etc.).

Unlike the species commonly used as medicinal plants (*eg. Curcuma longa* i.e. edible turmeric, *C. zedoaria*, *C. aromatica* etc.), *Curcuma alismatifolia* Gagnep. also finds wide usage as cut flowers and ornamental. Also known as *Siam Lily*, the leaves of this plant are claimed to exhibit anti-inflammatory, antioxidant and wound-healing properties. A clone of this flower was first selected by Dr. Pisit Wororai from Chiang Mai University, and this selected clone named '*Chiangmai Pink*' was introduced as an ornamental plant in the early 1980s, which nowadays has become popular in the world market. The flowering stems of this species have numerous apical bracts, forming a cup-like structure. Most of the lower bracts are green; however the more distal the bracts, the more they are pink in comparison to the green ones in native species and commercial varieties. There are two types of leaves; (a) the sheath leaves, small and thick leaves as they sprout along with the blade and after that comes (b) the oval leaves, which are dark green in colour and their central vein is red in colour.

The appropriate time to cultivate *Siam Lily* plants is during spring by planting rhizomes in the ground. These plants generally prefer well-drained soil. When cultivating this lily as a houseplant, use a container with drainage holes. A layer of rocks or pebbles in the bottom can also aid with drainage. In the care of this plant, it is good to keep the soil slightly moist at all times, but the roots should never be allowed to sit in wet soil. Plant it in an area that gets very bright, indirect light; in other words, where intense sunlight does not hit the leaves directly. Its care may include supplemental lighting under fluorescent

lights for several hours a day. When cultivating *Siam Lily*, the right light is essential for the plant to bloom.

Siam lilies must be administered with fertilizer on a monthly basis, from April through October. This should be followed by cessation of fertilizer application and allowing the plant to go dormant during the winter months. When the plant is in dormant stage, as a rule a reduced amount of water is required, but care must be taken not to dry out completely. This species of *Curcuma* may lose most of its leaves during the dormant period, but will re-emerge in the spring. Trim off dead or damaged leaves and re-pot as needed. When the plant grows out of its container, transplant it into a larger container. While cultivating Siam lilies as houseplants, dividing the mother rhizome stock every few years to produce more plants. The rhizomes should be cut into two-inch (5 cm) sections and planted in new containers as needed. Owing to its perennial nature and production of abundant inflorescences in summer, *Siam lily* plants are sold online and can also be found at local nurseries.

Fig.1. Siam Lily (*Curcuma alismatifolia*) (a) A plant with inflorescence, (b) Flower garden.

ग्वारपाठा (एलोवेरा) एक प्राकृतिक महत्वपूर्ण वनौषधि

मुजाहिदा सैयद, राजमोहन शर्मा एवं अपर्णा शर्मा
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सारांश

एलोवेरा के औषधीय गुणों की अगर बात की जाए तो इसमें एंटीसेप्टिक, एंटीबैक्टीरियल-, एंटी- हैं। मौजूद गुण अन्य कई ही ऐसे और इंफ्लेमेटरी फोलिक और ए विटामिन इसमें ही साथ इसके हैं। जाते पाए भी तत्व पोषक जरूरी जैसे एसिड लिए के स्वास्थ्य तरह की टॉनिक हेल्थ एक यह लाभकारी हो सकता है। यह एकमात्र पौधा पाचन क्रिया में सुधार से लेकर, रोग क्षमता प्रतिरोधक- जैसी डायबिटीज साथ-साथ के करने बूस्ट को सकता दिखा परिणाम लाभकारी भी में बीमारी है| एलोवेरा के फायदे इसे एक बेहतरीन घरेलू इलाज के तौर पर उपयोगी बनाते हैं। अगर एलोवेरा का उपयोग सही तरीके से किया जाए, तो एलोवेरा न सिर्फ स्वास्थ्य के लिए, बल्कि बालों और त्वचा के लिए भी फायदेमंद हो सकता है| सही तरीके से एलोवेरा का उपयोग कर एलोवेरा के औषधीय गुण के लाभ उठाए जा सकते हैं। एलोवेरा इनर और आउटर दोनों तरह की हेल्थ को मेंटेन करने में मददगार है। यह कई तरह की आंतरिक और बाहरी बीमारियों यानी स्किन डिजीज को खत्म करने में मददगार है। इसलिए इसे ट्रेडिशनली मेडिकेटेड प्लांट कहा जाता है।

प्रस्तावना

विश्व के वन उपवन में अनगिनत पेड पौधे और वनस्पतियां उत्पन्न होती है। ग्वारपाठा भी ऐसी ही एक वनौषधि है। प्राचीन काल में ग्वारपाठा धृतकुमारी के नाम से जाने वाला एक कांटेदार पौधा है। आयुर्वेद में इसे धृतकुमारी की उपाधि मिली हुई है तथा महाराजा का स्थान दिया गया है। औषधि की दुनिया में इसे संजीवनी भी कहा गया है। ग्वारपाठा की 200 से अधिक जातियां पायी जाती है जो रसोन कुल (Liliaceae Family) की वनस्पति है और इसका उदगम स्थल उत्तरी अफ्रीका माना जाता है। एलोवेरा सेहत से भरी खूबियों के साथ ही विटमिन, मिनरल्स, अमीनो एसिड और एंजाइम्स जैसी कई खूबियों से भरपूर होता है। इस कारण यह एक पौधा कई तरह की बीमारियों को ठीक करने में मददगार होता है। औषधीय जड़ी-बूटी के रूप में उपयोग किए जाने के कारण, यह शरीर को अंदर से पोषण देता है - यह पोषक तत्वों से भरपूर है, पाचन में सुधार करने में सहायक है और यहां तक कि प्रतिरक्षा को भी बढ़ाता है।

एलोवेरा की खेती

भारत के सभी हिस्सों में एलोवेरा की खेती की जाती है। मुख्य तौर पर मुंबई, गुजरात और दक्षिण भारत में इसकी खेती की जाती है। इसकी खेती बलुई और अच्छी तरह से सूखी जमीन पर की जाती है। एलोवेरा की खेती के लिए उष्ण जलवायु अच्छी रहती है। इसकी खेती आमतौर पर शुष्क क्षेत्र में न्यूनतम वर्षा और गर्म आर्द्र क्षेत्र में सफलतापूर्वक की जाती है। यह पौधा अत्यधिक ठंड की स्थिति के प्रति बहुत संवेदनशील है। बात करें इसके लिए मिट्टी या भूमि की तो इसकी खेती रेतीली से लेकर दोमट मिट्टी तक विभिन्न प्रकार की मिट्टी में की जा सकती है। रेतीली मिट्टी इसके लिए सबसे अच्छी होती है। इसके अलावा अच्छी काली मिट्टी में भी इसकी खेती की जा सकती है।

इसकी बिजाई 6-8' के पौध द्वारा किया जाना चाहिए। इसकी बिजाई 3-4 महीने पुराने चार-पांचपत्तों वाले कंदो के द्वारा की जाती है। एक भूमि की उर्वरता तथा पौध से पौध की दूरी एवं कतार से कतार की दूरी पर निर्भर करता है। एकड़ भूमि के लिए करीब 5000 से 10000 कदों सकर्स/की जरूरत होती है। पौध की संख्या

एलोवेरा की खेती को बंजर जमीन में भी उगाया जा सकता है. हालांकि फसल से ज्यादा जैल या गूदा इकट्ठा करने के लिये समय-समय पर सिंचाई करना बेहद जरूरी है।

एलोवेरा के कंदों यानी जड़ों की बुवाई बरसात के मौसम में की जाती है| भारत में ग्वारपाठा के नाम से मशहूर एलोवेरा की खेती के साथ-साथ प्रसंस्करण को बढ़ावा दिया जा रहा है। बाजार में एलोवेरा से बने जैल, जूस और कैप्सूल आदि की काफी मांग है । ऐसे में किसान इसकी खेती के साथ-साथ इसकी प्रसंस्करण यूनिट लगाकर दोगुना आमदनी अर्जित कर सकते हैं । जहां एलोवेरा से कई उत्पाद बनाये जाते हैं। कॉस्मेटिक प्रॉडक्ट हो या फिर आयुर्वेदिक दवा, एलोवेरा का इस्तेमाल खूब होता है। इसी वजह से आज हर्बल व कॉस्मेटिक उत्पाद व दवाएं बनाने वाली कंपनियां इसे काफी खरीदती हैं । यदि एलोवेरा की व्यवसायिक खेती की जाए तो इससे अच्छी कमाई की जा सकती है| एलोवेरा की कई किस्में हैं, जिसमें इंडिगो सबसे आम है जोकि आमतौर पर शहरों में लोगों के घरों में देखने को मिल जाता है । लेकिन इसकी एलोवेरा बारबाडेंसिस किस्म किसानों के बीच काफी लोकप्रिय है । इसकी पत्तियां बड़ी होती हैं और इसमें से ज्यादा जेल निकलता है. इसके अतिरिक्त कई और भी किस्में हैं जिनकी खेतों किसानों के द्वारा की जाती है| रणथंभौर राष्ट्रीय उद्यान में इसे व्यापक तौर पर उगाया जाता है । ग्वारपाठा या एलोवेरा के पौधे 2 से 3 फुट ऊंचे होते है । जड के ऊपर कंद से पत्ते निकलते है जो एक फीट तक लंबे होते है। पत्ते शुरू मे अधिक चौडे होते है और ऊपर की ओर पतले हो जाते है। एलोवेरा के पत्ते के आगे का भाग नुकीला होता है। इसके किनारों पर हल्के कांटे होते हैं । पत्तों के भीतर की ओर सफेद निशान होते है। पत्तों के अंदर घी की तरह चमकदार गूदा होता है।जब पौधे पुराने हो जाते हैं तो उनमे लंबे आकार का पुष्प निकलता है । इस पर लाल व पीले रंग के फूल आतें हैं। फरवरी- मार्च के माह में पौधों पर फूल निकलते हैं। इसके पत्तो को काटने पर पीले रंग का तरल द्रव निकलता है । जो शीतल होने पर जम जाता है। इस तरल द्रव को कुमारीसार (एलुवा) कहा जाता है।भारत के अलग-अलग

प्रदेशों में एलोवेरा की कई प्रजातियां पाई जाती हैं। परंतु मुख्यतया दो प्रजातियों का चिकित्सा में विशेष तौर पर प्रयोग किया जाता है जो ये हैं- *Aloe vera* धृतकुमारी और *Aloe abyssinica* (पीतपुष्प कुमारी)|

अन्य भाषाओं में एलोवेरा के कई नाम है : अन्य भाषाओं में एलोवेरा को कई नामों से जाना जाता है जैसे हिन्दी – घीकुआँर, ग्वारपाठा, घीग्वार अँग्रेजी – एलो वेरा (Aloe vera), कॉमन एलो (Common aloe), बारबडोस एलो (Barbados aloe), मुसब्बार (Musabbar), कॉमन इण्डियन एलो (Common Indian aloe) संस्कृत – कुमारी, गृहकन्या, कन्या, घृतकुमारी कन्नड – लोलिसर (Lolisar), गुजराती – कुंवार (Kunwar), कड़वी कुंवर (Kadvi kunvar), तमिल – कत्तालै (Kattale), अंगनी (Angani), अंगिनी (Angini),तेलगु – कलबन्द (Kalband), एट्टाकलाबन्द (Ettakalaband) बंगाली – घृतकुमारी (Ghritkumari),नेपाली – घ्यूकुमारी (Giukumari),पंजाबी – कोगर (Kogar), कोरवा (Korwa),मलयालम – छोट्ठ कथलाइ (Chotthu kathalai),मराठी – कोरफड (Korphad), कोराफण्टा (Koraphanta),अरबी – तसाबार अलसी (Tasabrar alsi), मुसब्बर (Musabbar),परसियान् – दरखते सिब्र (Darkhate sibre), दरख्तेसिन (arkhteesinn)

ग्वारपाठा में विद्यमान पोषक तत्व

पोषक तत्व	मिली गाम प्रति औंस	पोषक तत्व	मिली गाम प्रति औंस
ग्लूटानिक अम्ल	1.04	फास्फोरस	0.90
ग्लाइसिन	0.41	आयरन	0.05
लइसिन	1.21	प्रोटीन	0.10
अमिनो अम्ल	7.10	मैग्नीज	0.10
हिस्टिडाइन	0.41	सोडियम	5.21
वैलीन	0.41	एस्पारटिक अम्ल	0.80
टाइरोसिन	0.41	ल्युसिन	1.01
थ्रियोनीन	1.81	टिप्टोनीन	0.81
आइसो ल्यूसिन	0.41	एलेनीन	0.50
कैल्शियम	14.32		

कैसे काम करती है एलोवेरा ?

हमारे शरीर में कुल 22 अमीनों अम्लों होतें है जबकि ग्वारपाठा में 20 अमीनों अम्ल विद्यमान होतें है। इन अमीनों अम्लों की उपस्थिति से शरीर में कोशिकाओ एंव ऊतकों का निर्माण होता है। ग्वारपाठा के सेवन से रक्त में मिले कोलेस्ट्रॉल की मात्रा कम होती है। एलोवेरा जूस में कैल्शियम, पोटैशियम, आयरन, मैग्नीशियम, क्रोमियम जैसे खनिज और विटामिन ए, ई, सी, ई और विटामिन बी-12 जैसे विटामिन की मात्रा अधिक पायी जाती है। ग्वारपाठा में विद्यमान कार्बेनिक अम्ल शरीर को हानिकारक तत्वों से सुरक्षित रखते है।

एलोवेरा का उपयोग शीर्ष रूप से भी किया जा सकता है, यानी इसके जेल का उपयोग किसी की

त्वचा, विशेष रूप से चेहरे और बालों को निखारने के लिए किया जा सकता है।एलोवेरा जेल में विटामिन सी और ई, बीटा-कैरोटीन भरपूर मात्रा में होता है। इसलिए इसमें एंटी-एजिंग गुण होते हैं। इसमें रोगाणुरोधी गुण भी होते हैं और यह सूजन-रोधी है। यह त्वचा के दाग-धब्बों को मिटाने और उम्र की रेखाओं को कम करने में भी मदद करता है। इसके अतिरिक्त, यह शरीर में कोलेजन के उत्पादन और त्वचा की लोच को बढ़ाने में मदद करता है।एलोवेरा जूस में कैल्शियम, पोटैशियम, आयरन, मैग्नीशियम, क्रोमियम जैसे खनिज और विटामिन ई, विटामिन सी और विटामिन बी-12 जैसे विटामिन की मात्रा अधिक पायी जाती है। एलोवेरा में घावों को भरने वाले गुण होते हैं और त्वचा पर हल्की खरोंच या कटने पर इसको लगाने से यह प्रभावित हिस्से में खून के प्रवाह को बढ़ाकर घावों को भर देती है। इसमें पाए जाने वाले एंटी-बैक्टीरियल गुणों के कारण यह त्वचा की सूजन को कम करती है साथ ही बैक्टीरिया या वायरस को बढ़ने से रोकती है।

ग्वारपाठा या एलोवेरा का उपयोग

विशेषज्ञों ने अनेक परिक्षणों द्वारा ज्ञात किया है कि ग्वारपाठे का गूदा यदि लंबे समय तक सेवन में लाया जाये तो शारीरिक शक्ति विकसित होती है। मनुष्य दीर्घकाल तक स्वस्थ व निरोग रहता है । आयुर्वेद के अनुसार एलोवेरा स्निग्ध, पिश्चिल और शीत होता है। इसलिए पित्त दोष से जुड़ी त्वचा संबंधी समस्याओं के इलाज में यह बहुत उपयोगी है। एलोवेरा में कई तरह के औषधीय गुण होने के कारण यह त्वचा की देखभाल के अलावा घावों को भरने में और बालों की देखभाल में भी मदद करती है। आमतौर पर एलोवेरा के जूस, पत्तियों के रस और पत्तियों के गूदे का उपयोग सबसे ज्यादा किया जाता है। इसे बाज़ार से खरीदने की बजाय आप अपने घर पर ही एलोवेरा का पौधा लगा सकते हैं।

एलोवेरा में पाए जाने वाला एंथ्राकिनोन एक प्राकृतिक लैक्सेटिव की तरह काम करता है और आंतों में पानी की मात्रा बढ़ा देता है। जिससे मलत्याग करने में आसानी रहती है। पेट से जुड़ी कई समस्याओं में एलोवेरा का सेवन करना लाभकारी होता है। अधिकांश लोग एलोवेरा का इस्तेमाल सिर्फ त्वचा संबंधी समस्याओं के लिए ज्यादा करते हैं लेकिन आपको जानकार हैरानी होगी कि आप इसका इस्तेमाल वजन कम करने, बाल बढ़ाने या कब्ज़ दूर करने जैसी अन्य समस्याओं में भी कर सकते हैं। **इसके प्रमुख उपयोग निम्न है-**

1. **शरीर में रक्त का अभाव होने से शारीरिक निर्बलता बढती है। शरीर मे कैल्शिम की कमी से नाखुनों का वर्ण सफेद दिखाई देने लगता है। ग्वारपाठे का गुदा खाने तथा रस के सेवन करने से शरीर मे कैल्शिम की आपूर्ति होती है। शरीर मे कैल्शिम बढने से रक्त व्रद्धि होने पर नाखुनों की लालिमा बडती है।**
2. **एलोवेरा की हेल्थ प्रॉपर्टीज बॉडी में पनपनेवाली कैंसर सेल्स को डिऐक्टिवेट करती हैं। एलोवेरा में एमडिन, एलॉइन, एंथ्रेसिन होते हैं, ये बॉडी में मॉलेक्यूल्स के साथ मिलकर, कैंसर की कोशिकाएं पनपने की संभावना होती है, उस पार्ट में मॉलेक्यूल्स के ऐक्टिवेशन और इनऐक्टिवेशन का काम करती हैं। यानी उन मॉलेक्यूल्स और सेल्स को पनपने से रोकते हैं, जो भविष्य में कैंसर का कारण बन सकते हैं।**
3. **ग्वारपाठा के रस में कपडे का टुकडा भिगोकर जले अंग पर लगाने जलन और पीडा कम हो जाती है। जलने से पडे फफोले भी ग्वारपाठा के रस की वजह से नहीं पडते है। ग्वारपाठा का पत्ता काटकर**

छिलका उतारकर उसका ताजा गूदा निकालकर गूदे को जले हुए भाग पर 30 मिनट तक लगाने से जलन और पीडा नष्ट होती है। इससे जख्म भी नहीं बनते है।

4. ग्वारपाठा के 10 ग्राम रस मे हल्दी का 5 ग्राम चूर्ण मिलाकर मस्तक पर लेप करने से सिरदर्द का निवारण होता है।
5. ताजे ग्वारपाठा का गूदा निकालकर मस्तक पर इसका लेप करने से आधा सीसी दर्द नष्ट होता है।
6. 3-4 चम्मच रस सुबह खाली पेट लेने पर दिन भर शरीर में शक्ति व चुस्ती-स्फूर्ति बनी रहती है।
7. कान दर्द में भी एलोवेरा से लाभ मिलता है। एलोवेरा के रस को हल्का गर्म कर लें। जिस कान में दर्द हो रहा है, उसके दूसरी तरफ के कान में दो-दो बूंद टपकाने से कान के दर्द में आराम मिलता है।
8. ग्वारपाठे के रस में शहद मिलाकर दांतो और मसूडो पर मलने से दांत और मसूडे सुरक्षित रहते है।
9. घाव भरने की प्रक्रिया एक जटिल जैविक प्रक्रिया है और ऊतक पुनर्प्राप्ति को बढ़ावा देना चिकित्सा हस्तक्षेप का मुख्य उद्देश्य है। त्वचा पर घाव अलग-अलग कारणों से होते हैं जैसे कि जलन, धमनी रोग, सर्जरी और आघात।घाव भरना एक गतिशील प्रक्रिया है जो तीन चरणों में होती है। पहला चरण सूजन, जमाव और ल्यूकोसाइट घुसपैठ है। दूसरे चरण में मृत ऊतक को हटाना शामिल है और प्रसार के तीसरे चरण में उपकला पुनर्जनन और रेशेदार ऊतक का निर्माण शामिल है।एलोवेरा पर कई अध्ययन किए गए हैं और त्वचा के घावों की रोकथाम और उपचार में इसे प्रभावी दिखाया गया है।

वजन कम करने में सहायक

एलोवेरा के सेवन से वजन कम करने में भी मदद मिलती है। यह शरीर के मेटाबोलिज्म को बढ़ा देती है जिससे वजन कम करने में आसानी होती है। इसके लिए एक या दो चम्मच एलोवेरा के जूस को अपने पसंदीदा फल के जूस में मिलाएं और खाना खाने से 15 मिनट पहले इसका सेवन करें। एलोवेरा का सेवन एक या दो हफ़्तों से ज्यादा अवधि के लिए नहीं करना चाहिए। इसलिए सभी को यह सलाह दी जाती है कि किसी भी आयुर्वेदिक औषधि का सेवन करने से पहले डॉक्टर की सलाह ज़रुर लें।

त्वचा संबंधी समस्याओं में ग्वारपाठे का प्रयोग

आज के समय में हर कोई खूबसूरत दिखना चाहता है और खूबसूरती बढ़ाने के लिए लोगों द्वारा तमाम तरह के उपाय अपनाएं जा रहे हैं। पिछले कुछ सालों से त्वचा की देखभाल के लिए आयुर्वेदिक औषधियों का प्रचलन काफी तेजी से बढ़ रहा है और इसके लिए एलोवेरा का इस्तेमाल सबसे ज्यादा किया जा रहा है।

मुहांसे दूर करने में सहायक

एलोवेरा का चेहरे पर उपयोग करना सबसे ज्यादा प्रचलित है। इसमें सूजन रोधी गुण होते हैं जिस वजह से यह मुहांसों के इलाज में काफी असरदार है। इसमें मौजूद एंजाइम त्वचा की नमी को सील कर देते है और उनके ऊपर एक एंटीबैक्टीरियल परत बना देते हैं जिससे किसी भी तरह के बैक्टीरियल संक्रमण से त्वचा का बचाव होता है।

चेहरे के मुहांसे और दाग धब्बे दूर करने के लिए एलोवेरा जेल को रोजाना दिन में 2-3 बार मुहांसों पर लगाएं। इस्तेमाल से पहले इसकी थोड़ी सी मात्रा त्वचा पर लगाकर जांच लें कि कहीं आपको इससे किसी तरह की एलर्जी तो नहीं है उसके बाद इसका नियमित उपयोग करें। जिन लोगों की त्वचा अतिसंवेदनशील है उन्हें लम्बी

अवधि के लिए एलोवेरा के इस्तेमाल से परहेज करना चाहिए।

बालों को बढ़ाने में मददगार

एलोवेरा का इस्तेमाल बालों को बढ़ाने के लिए भी किया जा सकता है। एलोवेरा में एक ऐसा एंजाइम पाया जाता है जो सिर की त्वचा को तमाम तरह की बीमारियों से बचाती है जिससे बालों का झड़ना कम हो जाता है। यह प्राकृतिक रुप से नए बालों के बनने में और पहले से मौजूद बालों के विकास में मदद करती है। यह एक आयुर्वेदिक औषधि है जो सिर की त्वचा में मौजूद बालों की जड़ों में रक्तप्रवाह बढ़ा देती है जिससे बाल काले, घने, लंबे एवं मजबूत होते है।

रुसी से छुटकारा

सर्दियों के दिनों में कई लोग बालों में रुसी की समस्या से परेशान रहते हैं। ऐसे में आप एलोवेरा जेल का इस्तेमाल करके रुसी से छुटकारा पा सकते हैं। इसके लिए बालों की जड़ों में एलोवेरा जेल लगाएं या एलोवेरा युक्त शैम्पू का प्रयोग करें।

स्ट्रेच मार्क्स हटाने में सहायक

एलोवेरा का इस्तेमाल आप स्ट्रेच मार्क्स को हटाने के लिए भी कर सकते हैं। त्वचा के जिस हिस्से में स्ट्रेच मार्क्स हैं वहां एलोवेरा जेल लगाएं और कुछ देर तक मसाज करें। 15 मिनट तक इसे सूखने दें और फिर इसके बाद सादे पानी से धो लें। बेहतरीन परिणाम पाने के लिए दिन में दो बार इसका प्रयोग करें।

5. इसके अतिरिक्त त्वचा की तैलीयता को कम करने हेतु और त्वचा की नमी का बनाए रखने हेतु ग्वारपाठा का रस अति उपयोगी है ।

एलोवेरा का सेवन कैसे और कितनी मात्रा में करें?

एलोवेरा को कई तरीके से इस्तेमाल किया जाता है और सबकी मात्रा भी अलग अलग होती है-

- एलोवेरा जेल का इस्तेमाल त्वचा की देखभाल के लिए कर रहे हैं तो दिन में 2-3 बार इसका प्रयोग करें।
- एलोवेरा जूस का सेवन कर रहे हैं तो दिन में 10-20 एमएल का सेवन करना पर्याप्त है।
- प्रतिदिन 1-3 ग्राम एलोवेरा की पत्तियों के गूदे का सेवन पर्याप्त माना जाता है।
- कमर दर्द से परेशान रहते हैं तो एलोवेरा के इस्तेमाल से फायदा ले सकते हैं। गेंहू का आटा, घी और एलोवेरा जेल (एलोवेरा का गूदा इतना हो जिससे आटा गूंथा जाए) लेकर आटा गूंथ लें। इससे रोटी बनाएं। रोटी का चूर्ण बनाकर लड्डू बना लें। रोज 1-2 लड्डू को खाने से कमर दर्द ठीक होता है। एलोवेरा जेल कमर दर्द में दर्दनिवारक दवा की तरह काम करता है।
- जोड़ो के दर्द में भी एलोवेरा के इस्तेमाल से फायदे मिलते हैं। 10 ग्राम एलोवेरा जेल नियमित रूप से सुबह-शाम सेवन करें। इससे गठिया में लाभ होता है।
- घृतकुमारी का गूदा घावों को भरने के लिए सबसे उपयुक्त औषधि है। रेडिएशन के कारण हुए गंभीर घावों पर इसके प्रयोग से बहुत ही अच्छा फायदा मिलता है।
- आग से जले हुए अंग पर एलोवेरा के गूदे को लगाने से जलन शांत हो जाती है। इससे फफोले नहीं होते हैं।
- एलोवेरा के रस को तिल और कांजी के साथ पका लें। इसका लेप करने पर घाव में लाभ होता है। केवल एलोवेरा के रस को पकाकर घाव पर लेप करने से भी लाभ होता है।

एलोवेरा के फायदे और नुकसान दोनों ही हैं, इसलिए फायदों के चक्कर में घृतकुमारी का जरूरत से ज्यादा उपयोग न करें। सीमित और संतुलित मात्रा में ही एलोवेरा का उपयोग करें। जरूरत हो

तो एलोवेरा का उपयोग करने से पहले विशेषज्ञ या डॉक्टरी सलाह भी जरूर लें। इस प्रकार किसान भाई एलोवेरा की खेती के साथ-साथ इसका प्रसंस्करण यानी प्रोसेसिंग करके अच्छी आमदनी अर्जित कर सकते हैं. इसके लिये सरकार किसानों को आर्थिक अनुदान भी देती है. अगर आप भी एलोवेरा की खेती या इसकी प्रोसेसिंग यूनिट शुरू करना चाहते हैं तो कृषि विभाग के नजदीकी कार्यालय या कृषि विज्ञान केंद्र में संपर्क कर सकते हैं

स्त्रोत

ज्ञानदत्त पाण्डेय : रक्त की शुद्धता के लिए ग्वार पाठा , हलचल , 4/02/2012

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