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From the Editor's

Dear Readers,

In the June issue of our Newsletter, we received several popular articles from diverse fields. All the authors deserve great appreciation for sharing articles in huge numbers. Please continue sending articles to our Publication team and share published newsletter with your friends also.

I would like to thank the Editorial team including Print, Designer and Publication committee for their efforts throughout the edition.

Your suggestions are always welcome for improvement.

Dr. R. S. Tomar
Editor-in-Chief
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TRIBAL ART: A TRUE REFLECTION OF ENVIRONMENTAL ETHICS AND ENVIRONMENTALISM

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The Indian Tribal art has a rich socio-cultural history spanning somewhere between 30-40k years; and bears a strong heritage of indigenous art and culture. There are numerous tribes across India and most of them express themselves through their unique art, handicrafts, music and songs. With the passage of time, and under the influence of modernity and changes in their life style patterns; Tribal art has moved from stone and mud walls to the modern day canvas. Tribal art refers to the subject and craftsmanship of artefacts from various unique indigenous tribal cultures. These unique indigenous artworks are often ceremonial or socio-religious in nature; originating among tribal artists often living in remote, inaccessible, isolated rural, and heavily forested or mountainous areas.

The simplicity and style of art objects from different tribal communities refers to their unique history, culture, customs and heritage. Tribal art depicts the tribal lifestyles, daily rituals and customs, their unique livelihoods, religious faiths, beliefs and practices and their unique indigenous customs. Their immediate environment has significant impact on their artistic styles and expressions. Thus mountains, river, valleys, deserts, forest, trees, wildlife, domestic animals, birds, insects etc find a very significant and prominent place in tribal art and handicrafts. The use of bright colours in their artwork signifies the vibrancy and joys of their lives captured in their candid yet artistic expressions. Tribal handicrafts like masks, dolls, toys, various figurines, jewelleries, basketries, wall hangings, weaponries, decorative pieces,

potteries, wood carvings, simple models are examples of their outstanding artworks. The rich diversity of subjects in their art stems from the deeper philosophical perspective of tribal life, livelihood, life style and socio-cultural practices. Nature is the key subject area of tribal art and often occupies the central theme depicted in tribal sketches, handicrafts, songs and dances as well as in their unique music that portrays nature in every form, shape, shade and colour.

The materials used for producing various handicrafts are procured from the environment in which they have thrived for generations. The materials used are sea shells, wood, twigs, branches, bamboos, twines or tendrils of woody plants, roots, flowers, buds, leaves, animal skin and leather, fur, teeth, nails, skeletons, bones and feathers. The organic paints used for the tribal paintings, motifs and designs comes from various natural resources like vegetable paints (available from the plants and trees of the forests procured from plant roots, bulbs, corms, stems, leaves, gums, powdered seeds or grains, flower petals etc), rocks and minerals, chalks, ochre, soil, sand, stones, rocks, major or minor forest products available in their immediate ecosystem in which they have existed and thrived for generations.

Renowned anthropologist, Professor Suparna Sanyal Mukherjee from the Seacom Skills University, Bolpur, Birbhum, West Bengal suggests, "Tribal painting is considered minimalistic in it's appearance. The artists use numerous lines and dots in specific culturally defined patterns. The layout often follows a symmetrical pattern or shape in defining the subject or the theme. The simplicity in tribal art stems from a very organic and deep philosophical aspect of their immediate and past lives and their socio-religious and socio-cultural context." She further added, "Tribal art is unique in it's presentation and carries significant ethnographic messages circulating around their socio-cultural life, beliefs and faiths, dreams, ceremonies, past, present and future expectations from life, post life faiths and legends, stories shared by their elders about their ancestors, their depiction of life challenges, obstacles and joys of living from a complex tribal perspective. Nature constitutes an important and invaluable aspect of Tribal art." According to Professor Sanyal Mukherjee very little and only superficial research has been conducted on Tribal art in India; and needs much deeper introspection in better understanding and deciphering them.

Tribal artists to this day are being exploited ruthlessly. They do not have the opportunity to sell their products directly to the targeted customers without going through the clutches of the middlemen who are regulating, dictating and manipulating the indigenous trade. There is a huge demand for tribal artworks both in India and overseas; however, these indigenous artists barely make any income out of their dedicated back breaking hard work. The bulk of the profit is swallowed by the greedy middlemen who buys them at the cheapest possible rate from the helpless indigenous communities and sell them at higher prices to big city-based art dealers and wealthy businessmen. These




dealers and we'll connected businessmen, in turn sell these products across India and export them overseas at hefty prices.

The tribal artists at the bottom of these trade make next to nothing to support their livelihood. This has been the case in both pre colonial as well as post colonial India; where tribal artists have been ruthlessly exploited and cheated disproportionately; and this needs to change. There is an urgent need to provide financial support to tribal artists who have been engaged in practising and protecting their indigenous artworks against all odds for several past generations. Both government and non-government agencies operating in tribal dominated areas need to organize the artists into self-help groups or small indigenous cooperatives. Such agencies need to buy and/or collect artworks from tribal communities across the country against genuine prices fixed by the government. The products collected could then be sold or auctioned or exported for higher profits. A percentage of the net profit should be returned to the indigenous self-help groups or indigenous cooperatives to fund their local economic development or economic empowerment. Tribal art is an unique heritage of India; and hence needs proper conservation of these unique artworks and protection of the tribal artist who has helped keeping the indigenous art alive and breathing in modern India.

Photo credit: **Saikat Kumar Basu**

STATUS AND PROSPECTS OF STINGLESS BEE IN JHANSI DISTRICT OF BUNDELKHAND REGION

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Stingless bees are the most abundant and bees diverse group of social insects. They play a significant cultural and economic role and are active pollinators. Their primary function is to pollinate both cultivated and wild flowers, making them vital to the preservation of biodiversity and food security. They are essential to preserving the diversity of plant species. Stingless bees are also known as dammar bees' with additional local names in different Indian states such as, e.g., putka (Sikkim), ngap siwor and ngap hamang (Khasi language), cheruthenеecha and arakki (Kerala), Tenetigalu (Andhra Pradesh), Mulijenu, Mujanatejenu, Misrijenu, Nasarujenu, and Kirujenu (Karnataka). Since stingless bees are among the most economically significant and physiologically fascinating insect groups, bee scientists worldwide are paying close attention to these insects (Hymenoptera: Apidae: Meliponini). They produce 200–500 g of honey, which is more valuable medicinally than honey produced by Apis bees. In the world, there are thought to be more than 500 species of stingless bees. The two genera into which stingless bees can be divided are Melipona and Trigona. There are 22 species of stingless bees known to exist in India. They are classified into three genera: Tetragonula, Lisotrigona, and Lepidotrigona. Tetragonula are tiny, dark bees that live in cavities such as tree hollows.

A naturally occurring species of bee found on practically every continent is the stingless bee. They are typically built in pre-existing cavities, such as termite and ant mounds, tree trunks, stone walls, wall corners, cracks, and other substrates created by humans. It presence has been observed in India, Sri Lanka, Bangladesh, Kenya, Africa, America, Australia, Uruguay, Southeast Asia, Taiwan and Malaysia, Nepal. In India it is found in different states like Himachal Pradesh, Chhattisgarh, Gujarat, Kerala, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Rajasthan, Sikkim, Uttar Pradesh, West Bengal, Tripura, Tamil Nadu, and north-eastern states. In Jhansi district of Uttar Pradesh, stingless bee presence has been observed in all nine blocks and through different surveys, foraging plants visited by a stingless bee are Portulaca (*Portulaca oleracea*), Rose (*Rosa spp.*), Crape myrtle (*Lagerstroemia indica*), Sun flower (*Helianthus annuus*), Hollyhock (*Alcea rosea*), Common mallow (*Malva sylvestris*), Pak choi (*Brassica rapa subsp. Chinensis*), Garlic vine (*Mansoa alliacea*), Dombey (*Dombeya spectabilis*), Brinjal (*Solanum melongena*), Hawaiian Ti Plant/ Good-Luck Plant (*Cordyline fruticose*), Marguerite daisy (*Argyranthemum frutescens*) Curtain creeper (*Tarlmounia elliptica*), mango (*M. indica*), Strawberry (*Fragaria x ananassa*), Citrus

Crepe-myrtle

Sun flower

Paper flower

(*Citrus spp.*), Tomato (*Solanum lycopersicum*), and Cucumber (*Cucumis sativus*).

Throughout history, people have utilised this bee's honey extensively. This honey stands out due to its natural storage in the pot (cerumen), which enhances its therapeutic abilities and promotes better health overall. Stingless bee honey (SBH), pot-honey, sugarbag honey, kelulut honey, and meliponine honey are some of the names given to honey made by these bees. A number of useful products that the stingless bee produces, including propolis, or cerumen, honey, and pollen, can be used as a source of revenue for future generations.

In addition, stingless bees are crucial to the economy, culture, and ecology. For many tropical plants, both cultivated and natural, they serve as the primary pollinators. A vast array of medicinal benefits can be derived from stingless bee honey, such as anti-aging, wound healing, anti-viral/fungal, anti-inflammatory, anti-cancer, and antioxidant qualities. One of the best natural remedies for wound healing, eye conditions, gastrointestinal system illnesses, neurological conditions, and infertility issues is stingless bee honey.

Despite their importance, stingless bees face numerous threats causing alarming population declines due to several factors in the regions such as the occurrence of heat waves, intense heat during summer, less foraging plants, and awareness regarding stingless bees is very poor, Moreover, stingless bees have a great cultural and traditional value therefore, in future much attention has to be given for the protection of stingless culture through the planting of new bee specific forest, planting of bee-friendly plants as avenue plants./tree in a home garden, roof garden, roadside, and in wasteland area. Besides this more research needs to be done for the conservation and identification of polleniferous and nectariferous plants preferred by these bees.

ENROLL YOURSELF TO NESA NEWSLETTER EDITORIAL BOARD MEMBER

Editorial board members of NESA newsletter will be revised for the year 2024. All the interested applicants may send their curriculum vitae to **Editor in Chief** by **15th July, 2024.**

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BIOAVAILABILITY OF NUTRACEUTICAL COMPOUNDS IN FRUITS

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In present situation, the global nutrition sector not only facing the nutritional deficit and malnutrition but also anomalous nutrition associated with luxuriance in food habits. Child brain development takes place in early age but due to lack of healthy diet in developing and some developed nations, the malnutrition of children is alarming. This leads to neurological disorder. The other condition of anomalous nutrition promotes obesity, diabetes, and coronary heart diseases in developed countries with abundance availability of high calorie food. Therefore, nutritional requirement could be compensated by the intake of functional foods. In tropical and subtropical countries, the fruits and vegetables are loaded with diverse nutraceuticals. A vast majority of economically poor countries are blessed with rich biodiversity reserves. Although, due to climate change preserving this genetic variability are critical in current concerns. For example apple fruit quality and their bioactive compounds affect drastically due to adverse environmental conditions, such as temperature, solar radiation, and precipitation, as well as management practices, as these contributes to wide variations in accumulation of bioactive compounds. In response to increasing concerns over climate change and increasing temperatures, there is an increased interest in developing and selecting for fruit varieties that are resilient to climate change. Bioavailability involves the absorption and transport of nutrients to the relevant body tissues and its conversion to the physiologically active compound, in such a way the nutrient can be used to maintain normal metabolic functions. The stages of digestion and absorption are fundamentally important in nutrient bioavailability. Bioaccessibility is the first step in making a nutrient bioavailable. In this step, the nutrient is liberated from the food matrix and turned into a chemical form that can bind to and enter the gut cells or pass between them. Chewing, enzymatic digestion of the food in the mouth, mixing with acid and enzymes in the gastric juice, and release into the small intestine are the unit operations of the process by which the nutrients are rendered bioaccessible. Any human health-promoting benefits of bioactive compounds of a food component, such as apple, mango, citrus fruit, are dependent on absorption, metabolism, and distribution of these compounds within a human body. In fact, bioavailability of phenolic compounds present in apple fruit, once these are absorbed and are available for biological activity, are influenced by pH, enzymatic activity, solubility, chemical structure, free and bound forms, as well as those synergistic effects with the food matrix. Although absorption of phenolic compounds begins in the small intestine, it is gut microbes in the large intestine that are responsible for transforming these complex phenolics into metabolites that are easily released and absorbed. These phenolic compounds of fresh and processed apple can be detected in human plasma and urine. Furthermore, as the apple fruit contains various nutrients and phytochemicals, it is also the apple's non-nutrient component, referred to as the food matrix that plays a critical role in both absorption and bioavailability of these phytochemicals as demonstrated in several studies. Apple consumption has strong prebiotic effects wherein the fiber content supports bioaccessibility of other beneficial phytochemicals. At the cellular level, fiber is present in the plant cell wall of the fruit crops wherein various phytochemical compounds are reported to bind to plant cell wall components. On the other hand, consumption of processed fruits , in various forms such as juice, sauce, or cooked, impacts the integrity of the plant cell wall and fiber content, thereby modifying bioaccessibility, bioavailability, and phytochemical compound interactions with gut microbiota. To increase the bioavailability of nutrients content of fruits, eating them unpeeled. Frozen produce can actually be equally nutritious than the fresh one. The reason for this is that fresh produce is often picked before its peak ripeness, to ensure that it survives the transport and storage before being presented to consumers on the shelves of our favourite supermarket. However, this also gives them less time to develop a full spectrum of nutrients, such as antioxidants and vitamins, and minerals. During transport and storage, fresh fruits and veggies are also often exposed to lots of heat and light, which degrades some nutrients, particularly delicate vitamins B and C. On the other hand, fruit and vegetables intended for freezing tend to be picked at their ripeness peak, when their nutrient content is generally at their maximum, and are then flash frozen which preserves most of their nutrients. For fruits and vegetables that you do buy fresh, we recommend buying seasonal and locally grown produce when you can, as this will be picked closer to its full ripeness, fuller with nutrients and will also help lower your carbon footprint. Moreover, make sure that your gut flora is well balanced is crucial too.

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AGROFORESTRY: THE FUTURE OF A CIRCULAR BIO-ECONOMY

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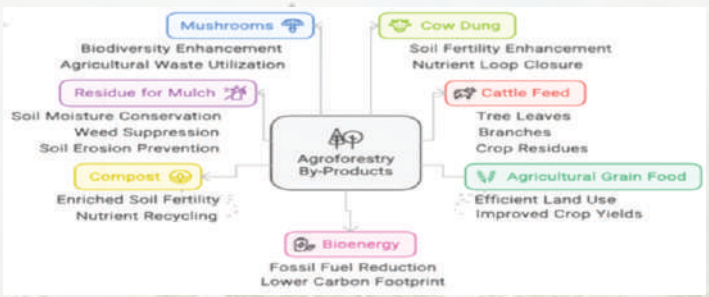
The pursuit of economic growth has frequently resulted in negative impacts on the environment. The objective is to convert our growth into a sustainable economic model, thereby integrating a circular bio-economy as a potential solution to significant global challenges. The goal of a circular bio-economy is to minimize waste, maximize resource efficiency, and promote regenerative systems. Agroforestry embodies these principles by utilizing the inherent synergies between trees, crops, and livestock within an integrated system. Unlike traditional monoculture farming, which often depletes soil fertility and relies heavily on external inputs, agroforestry promotes biodiversity, enhances soil health, and mitigates climate change. Agroforestry is a holistic strategy that improves production while addressing increasing agricultural requirements like food security; helps protect and support natural ecosystems, improving resilience and sustainability. By empowering small farmers and local communities, agroforestry promotes social cohesion and equitable development.

Agroforestry systems, which integrate trees, crops, and livestock on the same land unit, generate a variety of by-products that play a crucial role in a circular bio-economy. These by-products are reused, recycled, or transformed, enhancing sustainability, reducing waste, and promoting resource efficiency. Key by-products include agricultural grain food, residue for mulch, compost, mushrooms, cattle feed, cow dung, and bioenergy. Agricultural grain food is cultivated alongside trees, providing food for human consumption. This contributes to efficient land use and improved crop yields through nutrient cycling and microclimate benefits provided by trees. Residue for mulch, such as crop residues, fallen leaves, and tree prunings, is used as mulch to conserve soil moisture, suppress weeds, and prevent soil erosion. Compost, made from organic waste from crop residues, tree litter, and animal manure, is decomposed into compost, enriching soil fertility and promoting nutrient recycling. Mushrooms are grown using agroforestry by-products like leaf litter, wood chips, and straw, providing an additional income source, enhancing biodiversity, and making efficient use of agricultural waste. Cattle feed is provided by tree leaves, branches, and crop residues, serving as fodder for livestock. Cow dung, manure from cattle, is used as organic fertilizer for crops and trees, enhancing soil fertility and closing the nutrient loop. Bioenergy production from agricultural waste reduces reliance on fossil fuels and lowers carbon footprints. The integrated benefits of agroforestry by-products include improved soil health and fertility, enhanced biodiversity and ecosystem services, reduced financial risks for farmers, and reduced input costs for fertilizers and feed.

As the world grapples with challenges like climate change, resource scarcity, and food insecurity, agroforestry emerges as a viable solution offering a harmonious landscape for both people and the planet. By harnessing the power of nature-based solutions, we can create a more resilient, inclusive, and sustainable future for all.



Principles of Agroforestry in a Circular Bio-Economy

The principles of agroforestry in this context are designed to optimize resource efficiency, reduce waste, and enhance the regenerative capabilities of agricultural systems. Here are the key principles:

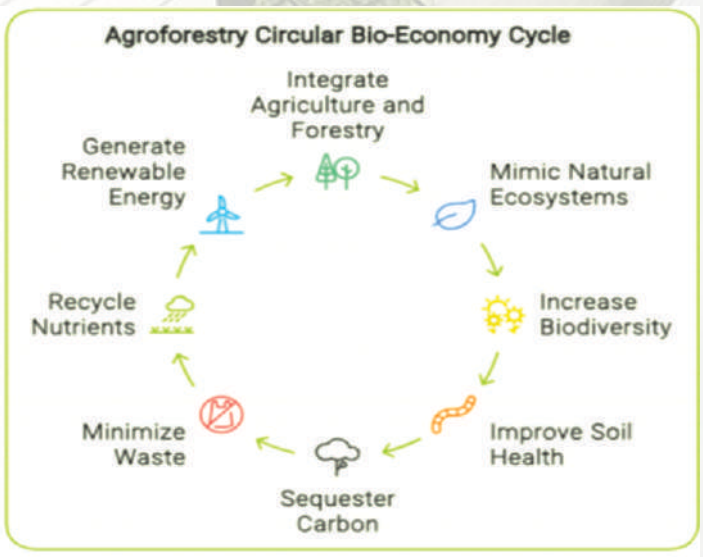
Resource Efficiency: Agroforestry maximizes resource use by optimizing nutrient cycling, water management, and energy flows through natural processes. Trees and shrubs in agroforestry systems contribute organic matter to the soil, enhancing its fertility and reducing the need for synthetic fertilizers and pesticides.

Waste Reduction: By diversifying agricultural production, agroforestry reduces waste generation and promotes synergies between different system components. For instance, crop residues can be used as mulch or animal feed, while tree prunings can serve as biomass for energy production or raw materials for value-added products.

Nutrient Cycling: Agroforestry systems facilitate automatic nutrient cycling by integrating nitrogen-fixing trees, enriching the soil with nitrogen and reducing reliance on external nitrogen inputs. Additionally, agroforestry promotes the use of organic fertilizers like compost, which help maintain soil fertility in the long run.

Biodiversity Conservation: Agroforestry enhances biodiversity by creating diverse habitats and ecological niches for a wide range of plant and animal species. The varied vegetation structure in agroforestry systems supports pollinators, natural pest predators, and soil organisms, contributing to ecosystem resilience and stability.

Economic Resilience: Agroforestry diversifies agricultural income streams by providing multiple products such as timber, fruits, nuts, forage, and medicinal plants. This diversity protects farmers from market fluctuations and climate risks, enhancing their economic resilience and livelihood security.



Agroforestry Models for a Circular Bio-Economy: Various agroforestry models have been developed to address specific ecological, economic, and social objectives, allowing for their applicability in diverse climatic and geographic contexts.Source: https://www.savannainstitute.org/event/permaculture-design-forest-farming-workshop

Permaculture-Based Agroforestry: Agroforestry plays a central role in permaculture design, enhancing ecological adaptation and resource efficiency. Agroforestry is a prominent technique utilized in permaculture design. The agroforestry system exhibits a variety of interdependent

relationships that are in line with permaculture's focus on mutually beneficial connections and adaptability. The focus of this model is on diversity, specifically through the practice of planting a variety of crops and trees to enhance biodiversity. The objective is to design and develop systems that possess resilience in the face of environmental stresses. Resource efficiency refers to the practice of optimizing the utilization of natural resources while minimizing waste generation. Source:https://igfri.icar. gov.in/grassland-silvipasture-management/

Silvopasture Systems: Integrating trees with pasture and livestock production, silvopasture provides benefits like shade, forage, and improved animal welfare. Studies show that silvopasture can increase livestock productivity, carbon sequestration, and soil health compared to traditional grazing systems. Source: https://www.a ftaweb.org/ about/what-is-agroforestry/alley-croping.html

Alley cropping: It is a farming technique where crops are cultivated in designated rows, known as alleys that are situated between lines of trees or shrubs. The current model enhances land use efficiency and offers various advantages, including erosion control, nutrient cycling, and biodiversity. The implementation of soil erosion measures includes the utilization of trees and shrubs, which have a significant impact on mitigating soil erosion. The nutrient cycling process entails the utilization of deep-rooted trees to extract nutrients from lower soil layers, thereby conferring a substantial advantage to shallow-rooted crops. The enhancement of biodiversity is achieved through the integration of multiple plant species, resulting in the subsequent contribution to pest control. Source: https://www.britannica.com/topic/windbreak

Windbreaks and Shelterbelts: These structures consist of the practice of establishing rows of trees or shrubs as windbreaks or shelterbelts serves to safeguard crops and livestock by mitigating the detrimental effects of wind. This model further enhances the concept of a circular bio-economy by: Energy Cost Reduction (Windbreaks have

been shown to effectively decrease heating costs for both livestock), enhancing crop yields (measures to protect crops from wind damage has been shown to significantly increase crop yields) and the process of sequestering carbon involves the utilization of trees as carbon sinks, which aids in the mitigation of climate change. Source: https://en.wikipedia.org/wiki/Riparian_zone


Source: https://www.britannica.com/topic/windbreak

Riparian buffers: Riparian buffers are composed of trees, shrubs, and grasses that are strategically planted alongside waterways. Buffers play a vital role in water management and environmental protection, specifically in improving water quality. They achieve this by filtering runoff, which effectively reduces nutrient and sediment pollution. The stabilization of stream banks is achieved through the presence of plant roots, which effectively prevent erosion. Riparian buffers are natural areas of vegetation that are located along the banks of rivers, streams, and other water bodies. These buffers serve as important habitats for both aquatic and terrestrial wildlife species.


Source: https://en.wikipedia.org/wiki/Riparian_zone

Agroforestry is a nature-based solution that addresses one of the most pressing challenges of our time - climate change mitigation. One of the benefits of agroforestry is its ability to sequester carbon dioxide from the atmosphere. This means that it captures and stores carbon dioxide in the form of biomass (such as trees and plants) and soil. By doing so, agroforestry helps to mitigate climate change by reducing the amount of carbon dioxide in the atmosphere. Trees function as carbon sinks, actively absorbing and sequestering carbon dioxide from the atmosphere. In addition to their carbon storage capacity, trees also offer benefits such as shading and temperature reduction. Agroforestry practices, including alley cropping, windbreaks, and riparian buffers, make a substantial contribution to carbon sequestration and efforts to reduce greenhouse gas emissions.

Conclusion

In conclusion, Agroforestry emerges as a promising solution for sustainable development in the circular bio-economy. This approach combines conventional farming methods with forestry techniques, offering economic, social, and ecological benefits. Adopting circular bio-economy principles in agro forestry systems can improve resource efficiency, reduce waste, and increase resilience in tackling global issues like climate change and food insecurity.

It is essential for policymakers, researchers, and practitioners to collaborate in scaling up agroforestry initiatives and leveraging its full potential to shape a brighter future. Collaboration between policymakers, researchers, and practitioners is crucial in order to effectively scale up agroforestry initiatives and maximize their potential impact on shaping a more positive future.

WORLD ENVIRONMENT DAY 2024: LAND RESTORATION, DESERTIFICATION AND DROUGHT RESILIENCE

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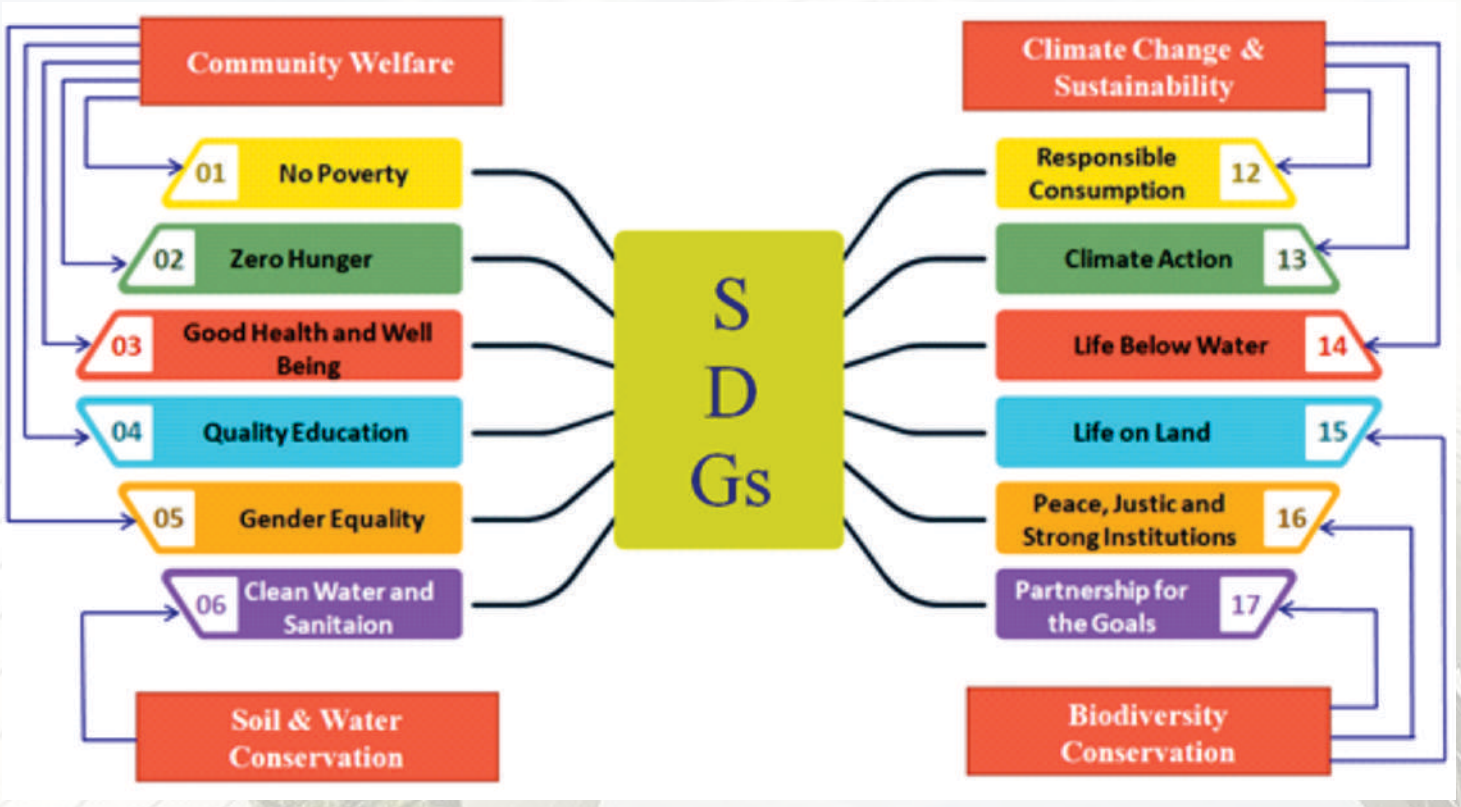
In 1972, the UN General Assembly designated 5 June as World Environment Day (WED). The first celebration, under the slogan "Only One Earth" took place in 1973. In the following years, WED has developed as a platform to raise awareness on the problems facing our environment such as air pollution, plastic pollution, illegal wildlife trade, sustainable consumption, sea-level increase, and food security, among others. Furthermore, WED helps drive change in consumption patterns and in national and international environmental policy. World Environment Day, celebrated annually on June 5th, is a pivotal event that brings together people from around the globe to champion the cause of environmental protection. Ecosystems are the lifelines of our planet, providing essential services such as clean air, water, food, and climate regulation. However, human activities have significantly degraded these ecosystems, leading to biodiversity loss, climate change, and the depletion of natural resources. The focus on ecosystem restoration aims to reverse this damage and ensure a sustainable future for all. This year's World Environment Day emphasizes both global initiatives and local actions. Governments, organizations, and individuals are encouraged to participate in activities that promote restoration efforts.

Advancing SDGs through Land Restoration and Resilience:

The SDGs are integrated, recognizing that action in one area will affect outcomes in others, and that development must balance social, economic, and environmental

sustainability. They are designed to be a blueprint for achieving a better and more sustainable future for all (Fig. 1).

This year's World Environment Day emphasizes both global initiatives and local actions. Governments, organizations, and individuals are encouraged to participate in activities that promote restoration efforts. These include reforestation projects, wetland conservation, marine ecosystem protection, and sustainable agricultural practices.



Reforestation Projects: Planting trees and restoring forests are crucial steps in combating climate change and preserving biodiversity. Communities around the world are engaging in large-scale tree-planting campaigns, aiming to restore forested areas and create new green spaces.

Wetland Conservation: Wetlands are vital ecosystems that support a wide range of species and provide natural flood control. Efforts to protect and restore wetlands help maintain water quality and biodiversity, contributing to overall ecosystem health.

Marine Ecosystem Protection: Oceans and coastal areas are under threat from pollution, overfishing, and climate change. Initiatives to clean up beaches, protect coral reefs, and promote sustainable fishing practices are essential for the health of marine ecosystems.

Sustainable Agriculture: Agricultural practices that prioritize soil health, water conservation, and biodiversity can significantly reduce the environmental impact of food production. Supporting local farmers and promoting organic farming methods are key components of sustainable agriculture.

Land Restoration: Reviving the Earth's Vital Landscapes
Land restoration is the process of restoring degraded, damaged, or destroyed ecosystems to their natural, healthy state. This practice is crucial for maintaining biodiversity, mitigating climate change, and ensuring the sustainability of the resources that human societies depend on. As global environmental challenges intensify, the importance of land restoration efforts has never been more evident.

Successful land restoration requires the involvement of local communities, governments, and international organizations. Policies that support sustainable land management, provide incentives for restoration activities, and promote education and awareness are essential. Community participation ensures that restoration efforts are culturally appropriate and meet the needs of the people directly affected by land degradation. Land restoration is a vital component of global efforts to combat environmental degradation and climate change. By restoring the health and productivity of ecosystems, we can safeguard biodiversity, support sustainable livelihoods, and build resilience against the impacts of climate change. As we continue to face environmental challenges, the commitment to restoring our landscapes will play a crucial role in securing a sustainable and prosperous future for all.

Drought Resilience: Strategies for Sustainability

Drought resilience refers to the ability of ecosystems, communities, and economies to withstand and recover from the impacts of drought. As climate change intensifies, droughts are becoming more frequent and severe, making resilience a critical aspect of sustainable development. Effective drought resilience involves proactive planning, resource management, and the implementation of adaptive practices to mitigate the adverse effects of drought on agriculture, water supply, and overall ecosystem health.

Building drought resilience is essential for ensuring the sustainability of ecosystems, economies, and communities in the face of increasing climate variability. By adopting a holistic approach that integrates water management, agricultural practices, ecosystem conservation, and community engagement, we can enhance our capacity to cope with and recover from droughts. As we move forward, continued innovation, collaboration, and commitment to sustainable development will be key to achieving drought resilience and securing a stable and prosperous future.

Land Desertification: Challenges and Solutions

Land desertification is the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture. It is a significant environmental challenge that threatens ecosystems, economies, and communities worldwide, particularly in arid and semi-arid regions. Combating land desertification requires a multifaceted approach that integrates sustainable land and water management, reforestation, policy support, and community involvement. By addressing the root causes and implementing effective solutions, we can restore degraded lands, improve agricultural productivity, and enhance the resilience of ecosystems and communities. Collaborative efforts at local, national, and global levels are essential to achieve sustainable development and mitigate the impacts of desertification.

The 2024 theme of "Land Restoration, Desertification, and Drought Resilience" calls for a collective commitment to sustainable land management. It emphasizes the interconnectedness of environmental health, economic stability, and social well-being. As we strive to achieve the Sustainable Development Goals, particularly those related to land and water, let this theme inspire concerted efforts and innovative solutions to restore our lands, combat desertification, and build a resilient future. Together, we can ensure a healthier planet and a more prosperous future for all.

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NOTIFICATION NO. 1

APPLICATIONS ARE INVITED FOR NESA ANNUAL AWARDS – 2024

LAST DATE: 30th September, 2024

This is to notify that applications are invited for the NESA Annual Awards 2024 from the Life Members of the Academy. The prescribed application forms for the following categories can be downloaded from our website: www.nesa-india.org • https://nesa-india.org/nesa-annual-awards-2024/

Separate applications should be submitted for independent awards. For detailed guidelines the website of NESA may be approached by log in to website: https://nesa-india.org/nesa-annual-awards-2024/

The last date for all the categories of awards is 30th September, 2024. For the brochure please log in to our website: http://tmt-3d-2024.nesa-india.org

The categories of Awards are given as under:

(1) NESA FELLOWSHIP AWARD - 2024
(2) NESA EMINENT SCIENTIST AWARD - 2024
(3) NESA DISTINGUISHED SCIENTIST AWARD - 2024
(4) NESA SCIENTIST OF THE YEAR AWARD - 2024
(5) NESA ENVIRONMENTALIST AWARD - 2024
(6) NESA GREEN TECHNOLOGY INNOVATIVE AWARD - 2024
(7) WOMEN EXCELLENCE AWARD - 2024
(8) NESA YOUNG SCIENTIST AWARD - 2024
(9) NESA JUNIOR SCIENTIST AWARD - 2024

Contact for more details:
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IMPORTANT DAYS AND DATES IN MAY 2024

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1 June – World Milk Day

Every year on June 1st, the world commemorates World Milk Day to honour the dairy industry's significant contributions to sustainability, economic development, livelihoods, and nutrition.

1 June- Global Day of Parents

Every year on June 1st, the World Day of Parents is commemorated. The United Nations General Assembly declared this day in 2012, honouring parents for their unwavering support, sacrifice, and commitment to their children.

3 June - World Bicycle Day

The United Nations General Assembly established June 3rd as International World Bicycle Day to honour the bicycle's distinctiveness, longevity, and versatility as a low-cost, ecologically benign, and long-lasting mode of transportation.

4 June – International Day of Innocent Children Victims of Aggression

Every year on June 4th, the United Nations (UN) observes the International Day of Innocent Children Victims of Aggression to raise awareness of the children who have been victims of physical, mental, and emotional abuse around the world. On this day, the United Nations reaffirms its commitment to preserve children's rights.

5 June-World Environment Day

Every year on June 5th, more than a hundred countries commemorate World Environment Day. The environment is a serious issue that not only impacts people's well-being but also impedes economic development around the world. "Beat Plastic Pollution" is the subject of World Environment Day 2023.

7 June – World Food Safety Day

On June 7, World Food Safety Day is commemorated to raise awareness about the dangers of polluted food and water to human health. This day also focuses on how to lower the danger of food poisoning. Food safety is essential for reaching the Sustainable Development Goals.

8 June- World Brain Tumour Day

Every year on June 8th, it is commemorated to draw international attention to the plight of people suffering from terrible diseases and the urgent need for greater research. Several activities are being held all around the world to raise awareness about brain tumours.

8 June – World Oceans Day

Every year on June 8, World Oceans Day is commemorated to encourage people of all ages to take charge of their own destiny and stop damaging the oceans and other bodies of water. This day was dedicated to raising awareness about the importance of eliminating single-use plastics and taking the steps necessary to effect genuine change.

12 June - World Day Against Child Labour

The International Labour Organization (ILO) has declared this day to draw attention to the worldwide abolition of child labour, as well as the efforts and actions required to do so. The Sustainable Development Goals (SDGs), which contain a commitment to stop child labour, were endorsed by world leaders in 2015.

14 June - World Blood Donor Day

Every year on June 14th, World Blood Donor Day is commemorated to promote awareness about the importance of blood donations around the world and to thank blood donors

for their contributions. "Donating blood is an act of solidarity," says this year's slogan. "Join the fight to save lives."

15 June - World Wind Day

Every year on June 15th, the world celebrates World Wind Day to promote clean energy. It's a day to learn about wind energy, its power, and the potential it offers to alter our energy systems, reduce carbon emissions, and boost job creation and growth.

15 June - World Elder Abuse Awareness Day

Every year on June 15th, this day is commemorated to raise awareness about the importance of caring for the elderly. Elder abuse is a worldwide social problem that impacts the health and human rights of millions of senior citizens. The United Nations General Assembly declared the day a global holiday.

16 June -Martyrdom of Guru Arjan Dev

On June 16, 1606 the Mughal Emperor Jahangir ordered the fifth Sikh Guru Arjan Dev to be tortured and sentenced to death. As a result, the Sikhs celebrate Guru Arjan Dev's martyrdom every year on June 16th.

17 June - World Day to Combat Desertification and Drought

Since 1995, this day is observed to spread awareness about international cooperation to combat desertification and the effects of drought. The United Nations General Assembly in 1994 declared 17 June as the "World Day to Combat Desertification and Drought".

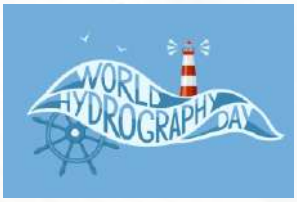
18 June -Autistic Pride Day

Every year on June 18th, it is commemorated to honour variety and limitless possibilities. This is a day for patients with autism and their family or carers to get together. A day dedicated to promoting awareness, acceptance, and self-determination.

3rd Sunday of June - World Father's Day

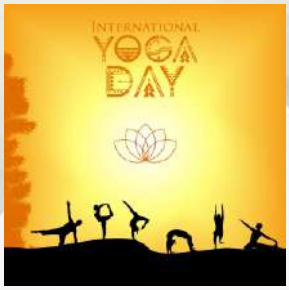
Every year on June 20th, this day is commemorated to raise awareness about the hardships that refugees endure around the world. World Refugee Day is also an important opportunity for the public to demonstrate their support for families who have been forced to escape their homes.

21 June - World Hydrography Day



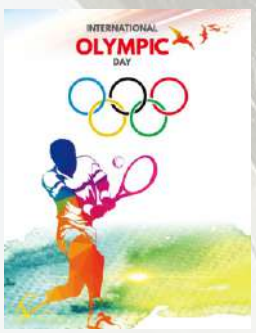
Every year on June 21st, World Hydrography Day is held to raise public awareness about hydrography science. This day is commemorated every year by the International Hydrographic Organization (IHO) and its international members.

21 June – International Yoga Day



International Yoga Day is observed on June 21st all over the world to create awareness about the importance of yoga in daily life and to inform people about its advantages. The Ministry of AYUSH in India commemorates International Yoga Day.

23 June - International Olympic Day



Every year on June 23rd, the International Olympic Day is commemorated to raise awareness of the value of games in everyday life. Olympic Day is about much more than sports. It is time for the entire world to become involved.

23 June -International Widow's Day

Every year on June 23rd, International Widows Day (international) is commemorated to raise global awareness about the human rights violations that widows face in numerous nations after the loss of their spouses.

29 June: National Statistics Day

On June 29th, the day is commemorated to promote the use of statistics in everyday life. Prof. P C Mahalanobis' birthday is celebrated on this day.

29 June: International Day of the Tropics

Every year on June 29th, it is commemorated to raise awareness about conservation measures and to promote the world's tropical regions.

30 June - World Asteroid Day

On June 30th, Asteroid Day is observed to promote online education on asteroids. A resolution was voted by the United Nations declaring June 30th as Asteroid Day.

EXPLORING PALMYRAH FOR AGROFORESTRY

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Abstract
Borassus flabellifer, or Palmyrah, is a versatile, long-lived palm used for various purposes, including irrigation. Beyond its nutritional fruits, Palmyrah is valuable in agroforestry for bund stabilization, field boundary demarcation, and windbreaks. Research since 1970, with key centers in Tamil Nadu and Andhra Pradesh, has led to advancements in sap tapping, neera yield, preservation techniques, nursery methodologies, and disease control. These efforts highlight Palmyrah's significant potential and multifaceted applications, especially in sustainable agriculture.

Introduction
Borassus flabellifer commonly known as Palmyrah, Asiatic palm or as pannai, is one of the tallest multipurpose palm among the palm family (Arecaceae) that is dioecious, drought hardy, saline tolerant with physical rotation of 80 – 100 years (appx.). The multipurpose nature of Palmyrah, it can be also justified from the nickname given to it - “karpgha virksham” (Tamil) meaning that lives for very long and provide benefits. The significance for the name can be understood from the character from epic *Mahabharata Bhisma* - grandeur man who had Palmyrah as symbol in his flag signifying his long and purposeful life as that of Palmyrah tree.

From the tender fruit (nungu or ice apple) to wood obtained from the mature tree are being used. Scientifically many nutritional property of nungu/ice apple, neera (sap) and the jaggery out of it are studied exclusively. The main theme of article is not to emphasis on the already well known usage but to open the door of Palmyrah as potential species for agroforestry as one more additional utility parameter.

The Palmyrah have been traditionally used for bund stabilization, field boundary demarcation and as wind break too which are the forms of agroforestry. To provide more justification for this idea one should look into the R & D aspect in Palmyrah. The R & D for Palmyrah starts from the initiation of All Coordinated Coconut and Arecanut Improvement Project that was initiated in 1970. It was only during 1991, the Palmyrah was included and the project was revamped as All India Coordinated Research Project on Palms with only two centres 1. Agricultural College & Research Institute, Killikulam, Tuticorin Dist., Tamil Nadu (TNAU, Coimbatore) 2. Horticultural Research Station, Pandirimamidi, East Godavari Dist., Andhra Pradesh (Dr. YSRHU, Andhra Pradesh) dedicated for palmyrah. In the annual report released for AICRP project as well as the annual report of the research station you can predominately see that their prime activity is survey and collection of best performing germplasm and maintaining the germplasm which indicate the level of research and development. One should not conclude that the output from these research are negligible. There are many achievement from the project such as 1. Standardization of tapping techniques of inflorescence sap 2. Steps to increase the neera yield 3. Standardization of preservation techniques for palmyrah tender fruit endosperm 4.Estimating the growth potential at different stages of tree 5. Standardization of nursery methodology and transplanting procedure 6. Selection of accession with more desirable character. For example accession TN 11/04 produces yellowish fruit with good quality of tender fruit 7. Value addition of the products from the fibres obtained from the leaf and the trunk 8. Value addition of tubers 9. Enhancement of Jaggery quality and the research have gone up to understanding the disease that are affecting the Palmyrah. E.g. Bud rot and leaf blight disease caused by *Pestalotia palmarum* and leaf spot caused by *Stigmina palmviora* for which control measures are being developed.

Characteristics of tree component in Agroforestry
For inclusion of tree in agroforestry system there are few important criteria that are satisfied by Palmyrah. The criteria are

1. The multipurpose nature of the tree is off at most importance and the diverse utility of the palmyrah is known to all
2. Canopy management is a vital criteria as shading may reduce the yield very drastically where in the palmyrah has no shading effect
3. Longevity of the tree is additional advantage
4. Less management in terms of irrigation and fertilization.
5. It can tolerate extremity of the surrounding whether its drought, water logging or salinity
6. Does not have a predominate allelopathic effect due to its litter

One can simply agree on the above mentioned points by mere observation of the palmyrah. The final argument that I would like to bring the deep rooted nature of the palmyrah. To understand the root distribution an experiment was conducted by AICRP on Palm which is as follows - Trees of various age groups i.e., 5,10,15,20 and 25 years were selected for the study and four trees were selected per age group. A trench was dug from the base of the palmyrah tree to a distance of 90 cm with a dimension of 30 cm width, 60 cm depth and 90 cm length. The trench was divided into three equal linear zones of 30 cm (Zone A), 60 cm (Zone B) and 90 cm (Zone C) away from trunk. Each of these three zones were again divided into three depths of 0-30 cm, 30-60 cm and 60-90 cm and as such 9 trench zones ie. A1, A2 and A3 under zone A; B1, B2 and B3 under zone B and C1, C2 and C3 under zone C were prepared. All the 9 zones were filled with coir pith and irrigation was provided to the above trees at regular intervals. The result of the study was that during the initial stage of growth especially from 5-15 years the root density was little bit high but once the palmyrah cross this particular stage of growth the root density gradually reduces in the zone A where our agricultural component thrives i.e. the crops it may paddy, vegetables or green leaves.

So, it can be concluded that the palmyrah, a monocotyledon, dioecious, multipurpose palm can be incorporated in the agroforestry system. As there will be certain catastrophe in any activity introducing palmyrah has certain difficulties such lack of proper package of practices, lack of quality planting material, the dioecious nature (only female tree bears fruits and had more neera yield than the male; so proper ratio has to be maintained) and finally lack of continuous marketing for the products derived from palmyrah. Once these problems addressed, we can save not only the declining population of the palmyrah but also improve the livelihood of many farmers

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2. **Jambulingam, R. and Fernandes, E.C.M.,** 1986. Multipurpose trees and shrubs on farmlands in Tamil Nadu State (India). *Agroforestry Systems*, *4*(1):17-32.
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PHYTOREMEDIATION – A PROCESS OF REDUCING TOXIC CONTAMINANTS

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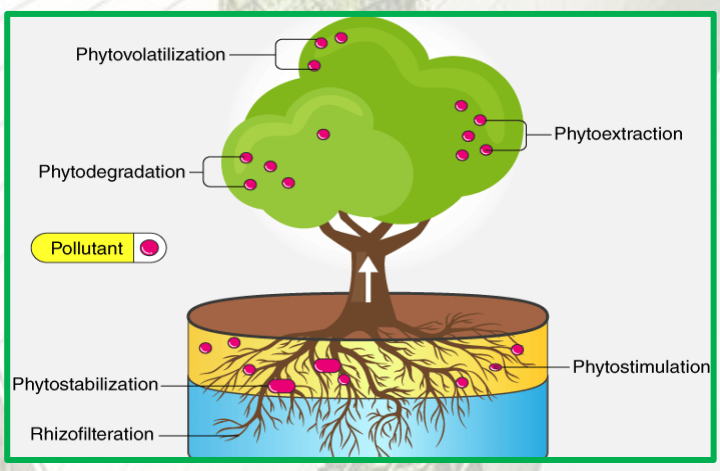
Instead, then digging up pollutant materials and disposing of them elsewhere, phytoremediation treats environmental concerns (bioremediation) by using plants that reduce the problem. From the Greek "phyto" meaning "plant" and the Latin "remedium" meaning "restoring balance" or "remediation," the word "etymology" is formed. By growing plants that can absorb, break down, or remove pollutants such as metals, pesticides, solvents, explosives, crude oil, and its derivatives, phytoremediation reduces the concentration of pollutants in polluted soils, water, or air. Here, pollutants in the soil are removed or contained by means of plants. There will be no need to dig up the pollutant material and send it somewhere else to dispose of it thanks to this bioremediation technique.



Application:
Wherever soil or static water environments have become polluted or are experiencing chronic, continuous pollution, phytoremediation may be used. Restoring abandoned metal-mine workings, mitigating ongoing coal mine wastes, and decreasing the impact of areas where PCBs were discharged during manufacturing are all examples of where phytoremediation has been applied successfully.

Advantages and limitations:
Advantages:

- Compared to conventional methods, phytoremediation is more cost-effective both in-situ and ex-situ.
- Plants are easy to be monitored
- Companies that specialize in phytomining can potentially collect, recover and reuse important metals.
- The utilization of naturally occurring organisms and preservation of the ecosystem make it the least destructive option.

Limitations:

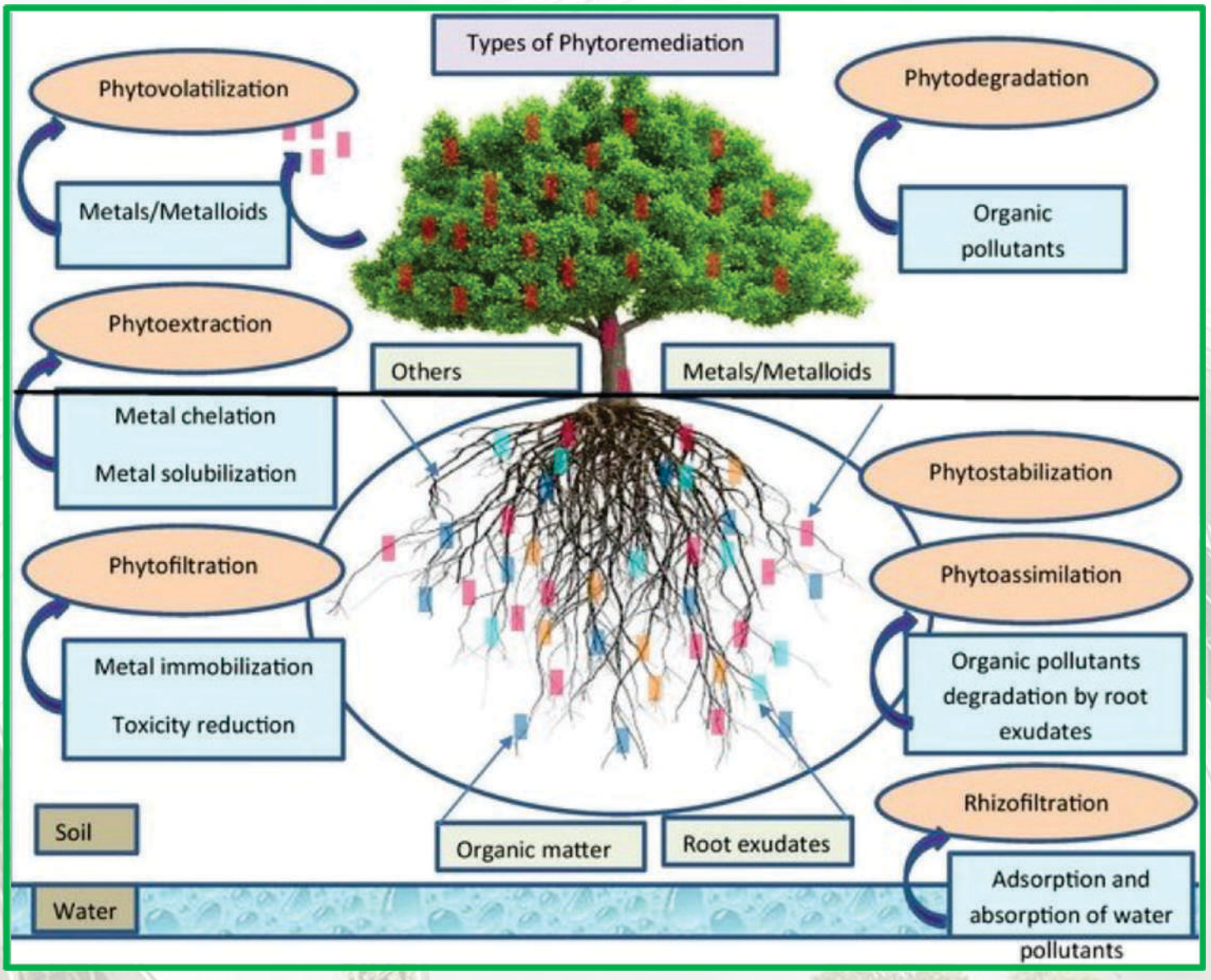
- Phytoremediation can only work within the root zone, which is both shallow and covered in roots.
- A long-term dedication is necessary due to the low biomass and slow growth rate.
- The toxicity of the polluted land and the overall state of the soil impact the plant life, making it impossible to entirely avoid the contamination of groundwater through plant-based remediation systems.
- Remediation efforts alone cannot eliminate contamination, as they do not involve removing all contaminated soil.
- The bioaccumulation of pollutants, which make their way up the food chain beginning with the most basic consumers and continuing onward.

Phytoremediation techniques:
For environmental issues or problems, there is a variety of processes that can be facilitated by plants or algae: The methods are

- **Phytoextraction**, which involves bringing environmental chemicals into the plant biomass by absorption and concentration.
- **Phytostabilization**, which is lowering the environmental mobility of chemicals by minimising their leaching from soil and other sources.
- **Phytotransformation** - chemical modification of environmental substances as a direct result of plant metabolism, often resulting in their inactivation, degradation (phytodegradation) or immobilization (phytostabilization). This process is known as phytotransformation.
- **Phytostimulation** - Increased soil microbial activity for pollutant breakdown, usually by root-associated organisms, is known as phytostimulation. One such name for this is rhizosphere degradation.
- **Phytovolatilization** - When plants undergo phytotransformation, they can become more volatile and/or less polluting, which can lead to phytovolatilization, the process of removing chemicals from water or soil and releasing them into the air.
- **Phytofiltration** – Rhizofiltration, caulofiltration, and blastofiltration are three main methods of phytofiltration, which involves cleaning polluted surface or waste waters using plant roots, shoots, or seedlings.
- **Phytoassimilation** – It is a biological process created by light-dependent reactions, involves the

production of monosaccharides from photo-synthesis in leaves, which store energy.

- **Phytodegradation -** Phytodegradation, a process involving root-released enzymes or through metabolic processes within plant tissues, directly degrades organic pollutants into less harmful compounds.
- **Rhizofiltration -** Using a network of roots to remove or filter out pollutants or surplus nutrients is known as rhizofiltration. The pollutants or contaminants remain adsorbed to the roots or absorbed into the plant.



1. Phytoextraction:

Phytoextraction, also known as phytoaccumulation, which is the process of converting plant biomass into usable plant matter by removing pollutants from water, sediments, or soil. In the last twenty years or more, phytoextraction has seen explosive growth in popularity across the globe. The extraction of heavy metals has typically seen more trials with this method than the extraction of organic compounds. Contaminants in plant matter tend to be more concentrated at the time of disposal due to the material's reduced volume compared to the initially polluted soil or silt. A related practice, known as phytomining, or "mining with plants," is also being investigation.

Plants take in harmful substances via their roots, where they may stay put in the root biomass or are transported to higher parts of the plant, such as the stems and leaves. Until it is plucked, a live plant can be soaking up pollutants. It is common practice to grow and harvest multiple crops in succession in order to accomplish a substantial cleanup, as only a little amount of the pollutant remains in the soil after harvest. The procedure is complete when the dirt is clean enough to sustain additional plant life.

Two types of phytoextraction:

- In natural hyper-accumulation, contaminants in soil are taken up by plants without any assistance;

- In induced or assisted hyper-accumulation, a conditioning fluid containing a chelator or another agent is added to soil to increase metal solubility or mobilization, making it easier for plants to absorb the metals. Natural hyperaccumulators often include metallophytes, which are able to both absorb and process extremely high concentrations of hazardous metals.

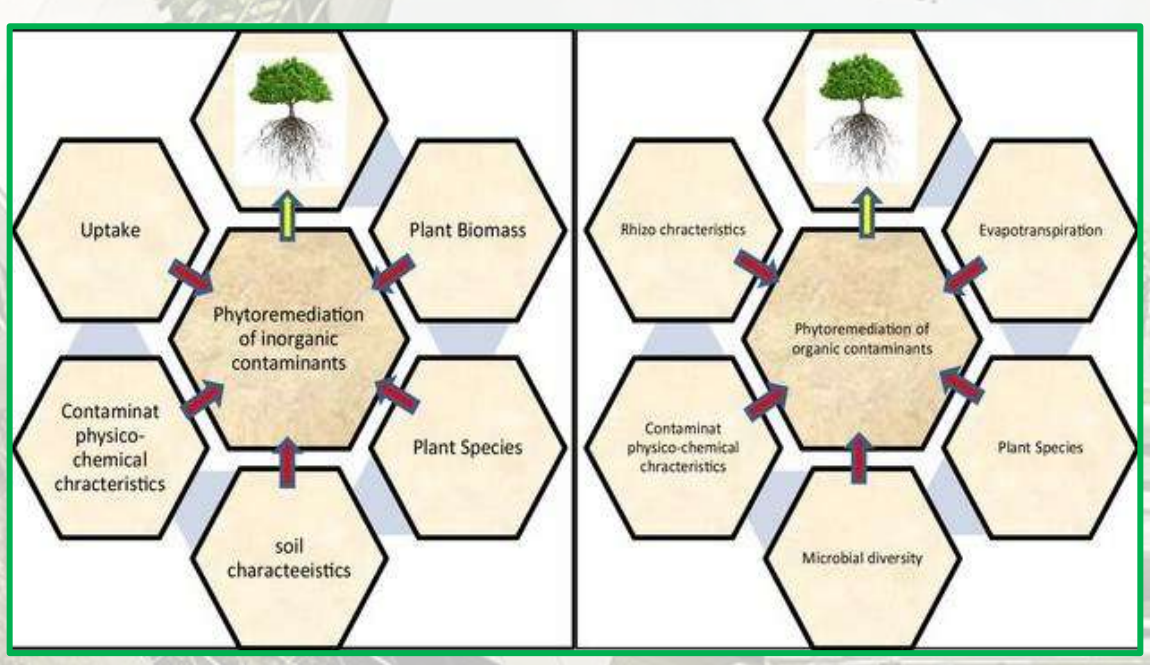
Phytoextraction from soils:

You can find examples of phytoextraction from soils in the list of hyperaccumulators.

- One hyperaccumulator is arsenic, which can be removed by means of the sunflower (*Helianthus annus*) or the Chinese brake fern ("*Pteris* spp"). Arsenic is stored in the leaves of the Chinese brake fern.
- Alpine pennycress (*Thlaspi caerulescens*) is a hyperaccumulator of cadmium and zinc, which is a problem because many plants are poisoned by amounts of these metals. However, according to the table, its growth is hindered when copper is present.
- Lead, which can be removed from the soil by means of plants such as Indian Mustard (Brassica juncea), Ragweed (Ambrosia artemisiifolia), Hemp Dogbane (Apocynum cannabinum), or Poplar trees, which contain lead in their biomass.
- Extraction of sodium chloride (common salt) from salt-tolerant (moderately halophytic) barley and sugar beets is a typical practice for reclaiming lands that were formerly inundated by salt water.
- Uranium, as utilized during the Chernobyl disaster, through the usage of sunflowers.
- Transgenic plants that include genes for bacterial enzymes have proved successful in removing mercury, selenium, and organic contaminants like polychlorinated biphenyls (PCBs) from soils.

2. Phytostabilization: This method is all about keeping the pollutant in check and stable for the long term. To give only a few examples, plants can mitigate wind erosion and water erosion through their roots, which also trap pollutants in place by adsorption or accumulation and create a stabilizing zone surrounding the roots. While phytoextraction involves removing contaminants from plant tissues, phytostabilization mostly involves removing them from the soil around the roots. Livestock, wildlife, and humans are exposed to fewer pollutants because they are less bioavailable. The use of a vegetative cap to contain and stabilize mining tailings is one example of this type of application.

3. Phytotransformation: The metabolic processes of some plants, like cannas, make xenobiotic compounds (such as pesticides, explosives, solvents, industrial chemicals, and the like) non-toxic. On the other hand, these compounds can be broken down in soil or water by microbes that live on plant roots. Because plant molecules are unable to completely decompose these complex and resistant substances into simpler molecules like water and carbon dioxide, the word "phytotransformation" is used to describe a change in chemical structure rather than a complete breakdown of the component. To explain how plants deal with these xenobiotic chemicals, often known as foreign compounds or pollutants, the "Green Liver Model" compares plant behaviour to that of the human liver. Enzymes in plants add functional groups, including hydroxyl groups (-OH), to xenobiotics after they have been taken up, making them more polar.



Phase I metabolism is just like the way medicines and foreign chemicals are processed by the human liver (drug metabolism). The first reactions take place in the human liver by means of enzymes like Cytochrome P450s. Enzymes like nitro-reductases do the same thing in plants. To further strengthen the polarity of the xenobiotic, plant biomolecules like amino acids and glucose are added to it in the second step of phytotransformation, which is called Phase II metabolism. This process is called conjugation. This is quite similar to what happens in the human pancreas during glucuronidation and glutathione addition reactions on the reactive centres of xenobiotics, which are enzymes of the UGT class (e.g., UGT1A1). Although there are several exceptions, the general idea is that molecules are made more polar and less poisonous through phase I and phase II reactions. The xenobiotic is also able to be transported more easily through water channels due to its enhanced polarity.

The last step of phytotransformation, known as Phase III metabolism, involves the plant's internal sequestration of the xenobiotic. In a process similar to lignin polymerization, the xenobiotics build a complex structure and are eventually locked away in the plant. This guarantees the xenobiotic is stored securely and would not harm the plant's ability to grow. Plants engaged in phytotransformation may require a closed enclosure due to their toxicity to small animals, according to early research. This includes snails. Plants use phytotransformation to minimize toxicity and store xenobiotics, with a few notable exceptions. A transformation route involving trinitrotoluene has been postulated after substantial research on the subject.

Role of genetics:
Genetics play an important role; breeding programmes and genetic engineering offer effective ways to improve plants' inherent phytoremediation capacities or to impart new traits to plants. Plants that are more suited to the conditions at the cleaning site may have their phytoremediation genes transferred from another type or they may have originated in microorganisms. Faster elimination of TNT and greater resistance to its harmful effects were observed in tobacco that had genes expressing a nitro-reductase from a bacteria put into it. Also, scientists have uncovered a process in plants that lets them survive in soils where untreated plants would die from the high levels of pollution. Exogenous polyamines are one example of a natural, biodegradable compound that gives plants the ability to absorb and withstand 500 times higher amounts of contaminants than plants that are not treated.

Hyperaccumulators and biotic interactions:
Thlaspi caerulescens and *Alyssum bertolonii* are hyperaccumulator plants. Among metal hyperaccumulators, *T. caerulescens* is perhaps the most well-known. This fungus hyperaccumulates Cd, Zn, and Ni. In the process of hyperaccumulation, metals are bioactivated in the rhizosphere through root-microbe interaction; metal transporters in the plasma membranes enhance uptake; and finally, distribution detoxifies the metals. These are the main processes involved in the hyperaccumulation of trace metals from the soil to the shoots by hyperaccumulators. In the context of biotic interactions and hyperaccumulators, a plant is considered to be hyperaccumulator if it can concentrate pollutants to a minimum percentage that differs for each pollutant; for instance, for nickel, copper, cobalt, chromium, or lead, it must be more than 1,000 mg/kg of dry weight; for zinc or manganese, it must be more than 10,000 mg/kg. Plants have developed this ability to accumulate as a result of hypertolerance, also known as phytotolerance, which is an evolutionary response to stressful environmental conditions. Metal hyperaccumulation has the capacity to influence several interactions, including biofilm development, mutualistic relationships (such as mycorrhizae, pollen, and seed dispersion), interference with neighboring plants of different species, protection, and commensalism.

SEAWEEDS AND ITS UTILIZATION

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Seaweed includes marine algae, which are basic creatures that live in seawater and have many fewer tissue types than terrestrial plants. Seaweed, also known as macroalgae, is a group of marine plants and algae that thrive in various aquatic environments, mainly oceans. It includes over 800 species, including sea lettuce, sea fan, and sea holly, found along India's 7,516 km coastline. These plants, which are specialized in photosynthesis, have stems, roots, and leaves. The main parts of a seaweed are the stipe, holdfast, and blade or frond. Seaweeds, similar to terrestrial plants, use photosynthetic pigments to convert light energy into food. They do this by using nutrients found in saltwater and sunshine. The coastal zone, from high tide to low tide, and the subtidal zone, up to a depth of 0.01% photosynthetic light, are both inhabited by seaweeds. Seaweed distribution and variety are influenced by a multitude of environmental factors, including plant pigments, light, exposure, depth, temperature, tides, and coast characteristics. New biochemical, physiological, and electron microscopy research has established the following criteria as useful for classifying algae:

(a) Photosynthesis pigments
(b) Food items for long-term storage
(c) Components of cell walls

(d) Cell structure at the microscopic level and
(e) Flagella

Distribution:
On a global scale, there are 9200 known species of seaweeds. Of these, 6,000 are red algae, 2000 are brown algae, and 1200 are green algae. The southeast coast of Tamilnadu, which stretches from Mandappam to Kanyakumari and encompasses 21 islands in the Gulf of Mannar, the Gujrat coast, Lakshadeep, and the Andaman and Nicobar Islands are some of the possible locations in India where various types of brown, red, green, and blue algae could flourish. Mumbai, Karwar, Ratnagiri, Goa, Barkala, Vizhinjam, Pulicat, and Chilka are some of the other east and west coast locations where we can find abundant seaweed beds. In certain backwaters and estuaries in Pudducherry and Tamil Nadu, we can find harvestable numbers of the seaweeds *Gracilaria arcuata* and *G. verrucosa*, which yield agar, and *Hypnea balentiae*, yields carrageenan.

Green Seaweed Family- Chlorophyceae
Both freshwater and saltwater environments are home to green algae. They come in a wide variety of sizes, from microscopic to macroscopic, and from unicellular to multicellular. Their thalli can be either freely arranged filaments or solidly formed structures. Depending on the degree of calcification, the photosynthetic parts of thalli can take shapes, including fan-shaped segments, feather-like or star-shaped branches with teeth or pinnules, and clavate or globose branchlets.

Vary from motile forms with a single cell to parenchymatous forms with many cells. Chlorophyll a and b are the defining pigments. Carotene, lutein, and zeaxanthin are the secondary pigments. There are 213 species belonging to 43 genera that have been documented from the waters of India. *Valoniopsis pachynema, Caulerpa sclpelliformis, Ulva lactusa, Ulva fasciata*, etc. are some of the most common types of green algae in India.

Functions of verdant seaweeds:
Fish, crabs, and gastropods rely on it as a food source. Soups and salads made with green algae, such as *Ulva, Caulerpa*, and *Enteromorpha,* are popular. Several taxa, notably *Caulerpa*, *Chaetomorpha,* and *Ulva*, have yielded bioactive chemicals such as diterpenes, sesquiterpenes, triterpenes, and ceramides. Green algae include bioactive chemicals that have antifungal, anticancer, and antiviral characteristics. Scientist found that organic beta-carotene, made from green algae, is highly helpful in preventing some malignancies.

Caulerpa scalpelliformes

Caulerpa scalpelliformes

Ulva lactusa

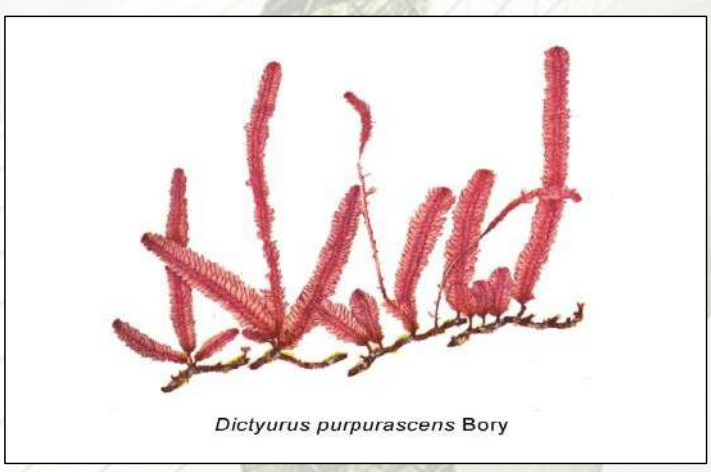
Ulva rigida

Red Seaweeds Family: Rhodophyceae

With the exception of a handful of species, they always inhabit water. Shape and size can differ among them. We can find these plants as epiphytes, which grow on rocks, or as thalli, which are huge, fleshy, branching, or blade-like projections from the shell. The basic structure of the thallus can be either simple or branching, and it can be either free floating or compressed to create pseudo-parenchyma with either a uni-or multi axial arrangement. Intertidal, subtidal, and deeper seas are their habitat. Phycoerythrin and phycocyanin are the pigments that give these algae their characteristic red hue. Floridian starch and floridoside are usually the primary reserves. Cellulose and the long-chained polysaccharides agar and carrageenan are the building blocks. Species of red algae such as *Purpurescens, Botryocladia*, *Crypto nemiacoriacea*, *Halymenia venusta*, *H. porphyroides, Rhodymenia palmata, Gelidiella*, and *Gracilaria* can be found along the coast of India.

Red seaweed applications:

For countless generations, red algae have been revered for their culinary and medicinal properties. The many easily absorbed vitamins, minerals, and antioxidants make it a healthy choice. The primary advantage of red seaweed is its capacity to enhance the body's circulation, control blood sugar levels, and decrease harmful cholesterol. Retroviruses are successfully inhibited by red seaweed extract. For the benefit of the digestive system, carrageenan and agar are utilised. Agar, a substance used as a stabiliser, thickener, and gelling agent, is made from *Gracilaria* and *Gelidiella.*



Dictyurus purpurascens

Botryocladia spp.

Cryptonemia spp.

Halymenia spp.

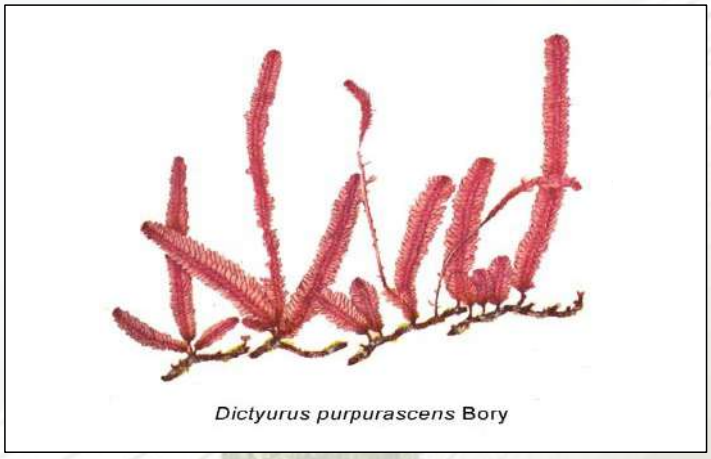
Brown Seaweed Family - Phaeophyceae

Only in the ocean can you find brown algae. Their forms range from highly distinct structures to more basic, freely branching filaments. Erect branched axis or leaf like blades displaying the haplostrichous state arise from prostrate basal filaments held together by mucilage, which forms a compact pseudo-parenchymatous aggregation of filaments into prostrate crust. Floats, air bladders, or vesicles provide many species their enormous thalli their buoyancy.

Fucoxanthin, a xanthophyll pigment, is abundant in these algae and is responsible for their brown hue. Complex polysaccharides, sugars, and higher alcohols are the usual components of food reserves. The main source of carbohydrates is laminaran. There are 289 species belonging to 37 genera that have been recorded from the waters of India. Some species of brown algae that can be found along the coast of India include *Dictyopteris delicatula, Sargassum, Padina boergesenii, Dictyota bartayresiana*, and others.

Brown seaweed applications

Brown seaweed is a treasure trove of beneficial nutrients. It has a lot of beneficial nutrients, including iodine, iron, fibre, folate, and riboflavin. Food items such as sherbet and ice cream employ algin, a hydrocolloid material derived from brown algae, as a thickening ingredient. Paints and ointments also use algin as a stabiliser. As a blood purifier, brown seaweed extract aids in the healing of arthritis. *Herpes* virus can also be treated with brown seaweed extract. The polysaccharide laminarin, which comes from the seaweed *Laminaria* (Kombu), has been found to be useful in the treatment and prevention of cardiovascular disorders.



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Padina spp.

Sargassum spp.

Dictyopteris spp.

Dictyota spp.

The current state of seaweed agriculture and its future prospects:

Worldwide, wet seaweeds are harvested at a rate of about 7.5-8 million tonnes annually. The industrial sector in India makes use of seaweeds, particularly in the mass-produced agar and alginate. The lack of an adequate supply of raw materials has resulted in the least developed carrageenan industries.

The two red algae now cultivated commercially in India using CSMCRI technology are *Kappaphycus alvarezii* and, more recently, *Gracilaria edulis*. In 1940, utilising *G. edulis* as the raw material, agar manufacture in India began on a cottage industry scale. Cultivation is currently underway on a pilot size in Gujarat and an experimental one in Andhra Pradesh. The southern Indian states of Tamil Nadu, Kerala, Karnataka, Pudducherry, Andhra Pradesh, and Gujrat are home to over twenty-five agar and algin factories. Commercial propagation of these algae over 12,000 sea rafts is a common practice in Tamil Nadu, where over 540 families across three districts - Ramnad, Tuticorin, and Tanjor - are involved. Pepsi intends to quickly extend the rafts to 1.5 lakh, which will cover a 100 km stretch along the coast. This will create coastal jobs for more than 2000 families. Indian coastal towns stand to gain in a number of ways if the country becomes a major exporter of seaweed based products.

Proper husbandry and conservation of seaweed resources are necessary for their sustained utilisation. The standing crop of these seaweeds was depleted due to the unplanned and ongoing picking of them from their native habitats. Prolonged use of these resources might deplete them to the point that the following season's propagation efforts require only the most fundamental nuclei.

Cultivating seaweed:

A sustainable livelihood option for coastal communities in India with scientific cooperation from the Marine Algal Research Centre, CSMCRI, Mandapam, Pepsi Foods Ltd. (PFL) has begun its journey along a 10 kilometer stretch of the Palk Bay side towards Mandapam (District Ramanathapuram) in Tamil Nadu, India. Through a contract farming method, they have begun growing *Eucheuma cottoni* and *Hypnea musciformis* seaweeds in a 100 hectare region in individual plots of 0.25 ha (40 m x 60 m). Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, and Gujarat are among the maritime states in India where seaweed extraction companies have set up shop, so it's safe to say that the sector is well on its way to being well established there.

Overexploitation is causing marine capture fisheries in India to become depleted. Seaweeds and their processed products have a well established domestic and international market. There is no need for specialised

knowledge or expertise when growing seaweed. Employment and livelihood security could be achieved through the production and utilisation of seaweed through the development of products and processes. India has all the makings of a world leader in seaweed cultivation and processing. Assure the nutritional well being of the Indian populace by providing food. Seaweed cultivation requires little inputs. Growing seaweed is good for the planet.

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