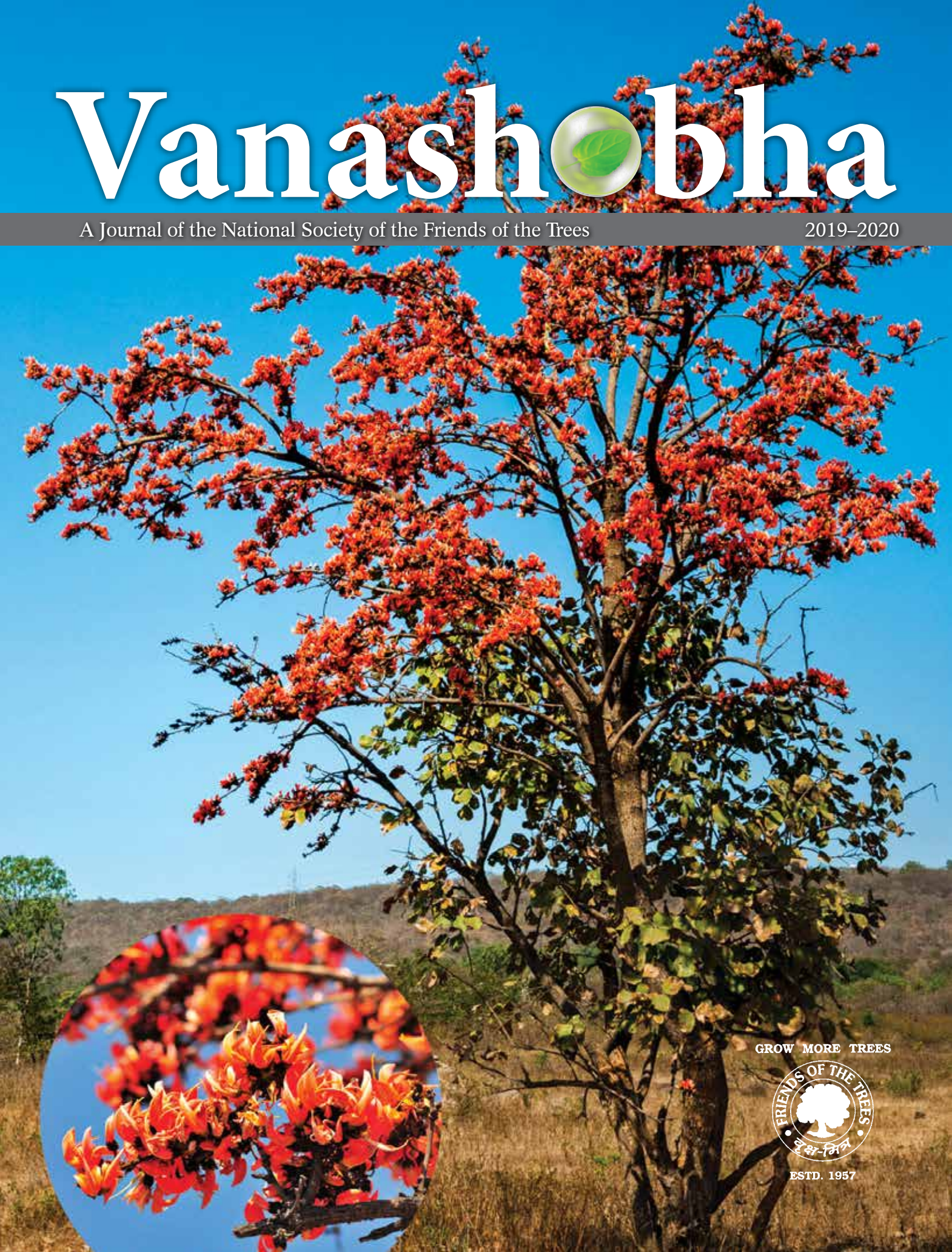


Vanashobha

A Journal of the National Society of the Friends of the Trees

2019-2020

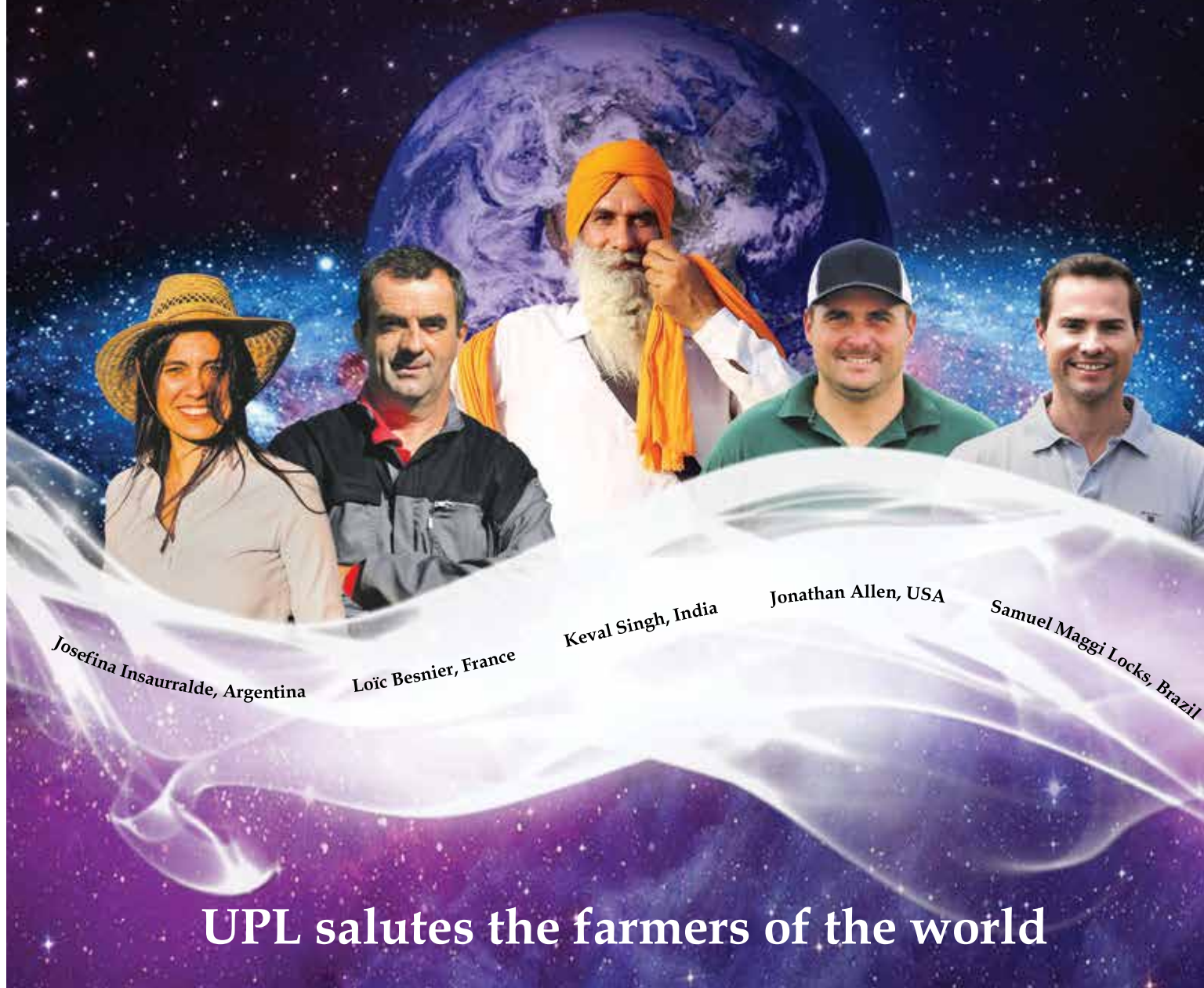


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ESTD. 1957

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Vanashobha

A Journal of the National Society of the Friends of the Trees

FRIENDS OF THE TREES FOUNDED IN 1957

A fellowship of tree lovers seeking to create and foster a tree sense in India

Registered under the Societies Registration Act, 1860, and the Bombay Public Trust Act, 1950.

Published by:

National Society of the Friends of the Trees,
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3rd Floor, 28, Sir P.M. Road,
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Editorial Consultant: Dr Gayatri Ugra

Design & Printing:

Spenta Multimedia Pvt Ltd
www.spentamultimedia.com

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OF THE TREES – 2020

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Front Cover: Red Butea Back Cover: Pink Ixora

Courtesy: Horticulture Services, Godrej Construction

From the Desk of the President Emeritus



2020 – what a year we all have been through! It began with a dreadful bushfire in Australia that killed or displaced 300 crore animals, followed by unprecedented outbreaks this summer of wildfires across the entire Western United States. In California, fires consumed over four million acres in 2020, which is twice more than the 2018 record. Natural disasters happened in different parts of the world, leading to more scenes of carnage. India, for example, witnessed floods and cyclones in the year, leaving an enormous mass of destruction in their wake, not to forget the desert locusts swarming the northern part of India, leaving crops destroyed. And as if that was not enough, came the Covid-19 pandemic that left almost 30 million people diseased and has killed more than a million worldwide, also causing massive economic setbacks around the world with job losses in several sectors.

But was 2020 a blessing in disguise for Nature, as was being proclaimed during the lockdown? The lovely stories about animals walking freely on deserted roads which were otherwise busy, dolphins carrying corals to the coastlines, and cleaner skylines indicating low pollution levels over major cities of the world, including our own, made us feel that Nature was probably having its revenge. Everyone believed that the shutting down of all economic activities to curb the spread of the virus would bring down greenhouse gas (GHG) emissions too.

Well, the belief was only a blip in the long-term GHG emission trends, according to the latest State of the Global Climate provisional report by World Meteorological Organization (WMO) of December 2020. The planet was warmer by 1.2 °C from January to October in 2020, than the pre-industrial average measured between 1850 and 1900. While 2020 will be memorable for many reasons, it is quite likely that 2020 will also be the warmest year for the Earth's surface since the mid-1800s. Had it not been for Covid-19, this would probably be the top news for 2020.

Loss of jobs during lockdowns led to people migrating from cities back to their native homes, causing stress on the rural natural resources available in hometowns. Illegal mining, land-grabbing, deforestation, and even wildlife poaching is on the rise globally, as policing is difficult with the focus being on Covid-19.

Yet, the year forced us to understand the difference between need and want. We can truly come out of this crisis if we have the right plan for a global economic revival; the focus for this being humans and nature, responsive regeneration, swift restoration, and fair redistribution. A recent study prioritizes protection of tropical forests, mangroves, and peatlands. It says, protecting carbon-rich ecosystems will decrease the risk of zoonotic disease outbreaks in future. It is no surprise that, time and again, it keeps getting evident that every solution to combat climate change and every remedy to our health crisis ends up requiring us to maintain a healthy biodiverse ecosystem by protecting and conserving our greens, while planting more and more trees. Trees are and will remain the greatest climate regulators of our planet.

In this edition of *Vanashobha*, we present you with interesting reads through articles on Junipers as Bonsai, Vegetation as Integrator of Climatic Factors, and an inspired one on Wild Edible Plants – Vital for Sustainability. I am sure you will also relish knowing about an Ethnobotanical Study of Plants used in Indian Festivals and enjoy interesting information on Trees: Immortalized in Verse. While we revere trees, we do not forget our own lovely Microgreens, and how to grow them! Do read a few words on them as well.

While we struggled through this extraordinary year, we did have moments of pleasure when we had the privilege of hearing talks by Dr Amit Lahiri, Dr Mandar Datar, and Dr H.S. Singh in our Annual Seminar 2020. I am greatly appreciative of the stalwart assistance given to me by Dr Rajendra Shinde in conducting this informative yearly event on the FoT calendar.

In the 59th year of celebrating bountiful nature, our Annual Vegetable, Fruit & Flower Show 2020 was graced by our Chief Guests, Mrs Usha Thorat and Mr R.L. Mopalwar, endowing us with inspiring addresses. We are at all times overwhelmed with the continued enthusiasm of participants and visitors from Mumbai and outside who keep inspiring us to continue to do more.

I would like to thank Dr Gayatri Ugra for all the support she has given to us over the years for editing the articles for the journal. I would also like to thank Ms Tejashree Joshi, Associate General Manager, Environment Department at Godrej & Boyce Mfg. Co. Ltd. for her year round support to me personally.

My personal thanks also to our publisher Mr Maneck Daver of Spenta Multimedia for printing hardcopies of *Vanashobha*, and from this year for simultaneously bringing out an electronic version of the journal as well.

Dr Pheroza J. Godrej
President Emeritus
National Society of the Friends of the Trees

GROW MORE TREES



ESTD. 1957

NATIONAL SOCIETY OF THE FRIENDS OF THE TREES

A fellowship of tree-lovers seeking to create and foster a tree sense in India

Objectives

- 1 To inculcate love of trees and plant life in general among the people.
- 2 To create an enlightened public opinion for promoting the setting up and maintenance of more avenues on our highways and for building more parks and gardens in our cities and for growing of suitable trees in all public places to enhance the beauty of our landscape both rural and urban; and for preserving and extending our forests now in grave danger due to various causes.
- 3 To organize public lectures, talks to select groups including schools and colleges, film shows, exhibitions on trees and allied subjects.
- 4 To hold competitions, flower, vegetable, and fruit shows, national or state conventions and seminars for the furtherance of the objects of the Society.
- 5 To plant and protect trees.
- 6 To organize publication of suitable literature including periodicals and maintaining library or libraries for the encouragement of such studies.
- 7 To undertake special studies of the needs of, and suggesting tree planting schemes for large private institutions, local bodies, community projects, national extension services, etc.
- 8 To establish contacts with other organizations having similar objects.
- 9 To secure government and public support for activities on the lines mentioned above.
- 10 Generally to undertake activities deemed necessary and desirable for the promotion of the objects aforesaid.
- 11 To establish branches of the organization in different cities, towns and villages where enough organizational element is available and local membership potentialities exist.

Past Presidents of the National Society of the Friends of the Trees

From its inception to this day, the honorable members who have held the post of President of the National Society of the Friends of the Trees have given generously of their time and resources, to support and enhance the standing of the Society. FoT honours them and records here its appreciation of their valuable contributions. Given below are the dates of their tenures.

Mr B.G. Gade 1957–1962



Mr V.P. Naik
1962–1971



Mr J.J. Bhabha
1971–1998



Mr S.P. Godrej
1998–2000



Dr Pheroza J. Godrej
2000–2016

FRIENDS OF TREES 59TH ANNUAL VEGETABLE, FRUIT, AND FLOWER SHOW, FEBRUARY 8, 2020

Address by the Chief Guest, Mrs Usha Thorat, former Deputy Governor, Reserve Bank of India & Vice President, Bombay Natural History Society



Dear Ashokbhai, Dr Sawant, Dr Tatke, Dr Salunkhe, my friend Saraswathy Unnithan, Mrs Sakina Gadiwala, and respected members associated with the Friends of the Trees for so many years:

It is true that I am a real lover of trees. This book on Ranibagh presented to me is, in fact, one of the most precious books that Mumbai can have. Firstly, we are very, very privileged to have Ranibagh, and

we are thankful for the fact that it is maintained, for the fact that it has not been brought down. As recently as two months ago, I went there for a walk — it is one of my favourite places to walk in as I live just across from it. And I say that Ranibagh is really a living museum, a museum of trees. Every time you go there, you start feeling the great efforts made to bring in all varieties of trees, set out in such a beautiful location. I came to know during that walk that it was actually created by the

Agro-Horticultural Society of Western India, and originally it was not intended to be a zoo at all. The Society went bankrupt sometime when the transfer of power took place from the East India Company to the British Crown, and at that time they had ordered the Flora Fountain statue to be made to be kept in Ranibagh, but could not afford to pay for it. So the eminent person who was in charge of the city at that time acquired it for the city.

When you go to Flora Fountain and look close, you will realize that it is all about flowers and vegetables and greens, so it is a very befitting statue for Ranibagh actually, not so much for the city. At Flora Fountain, you realize that the people who wanted to create the statue were thinking of the wonderful fruits and vegetables and greens, or the agriculture of India, and what it is that the state represents. For those who haven't gone there recently, I would very much advise them to go and see how Flora Fountain has been restored, and all the inscriptions which are there.

First of all, I must congratulate Friends of the Trees and Ruparel College for holding this programme. To have done so for 59 years is not a mean job. It is easy to start something, but to continue doing it and keep it up with increasing impact, year on year, is a tremendous effort, and I heartily congratulate Dr Ashok Kothari, Dr Arun Sawant and all the others who are involved with this continuation. Today it is wonderful to see that people are growing plants, people are growing trees — this is a reaffirmation of our belief in man and nature around us. So, while thinking about what exactly to talk to you about, I came across a story that I wish to share with you.

There was once a king in India who wanted to build himself a palace more beautiful than any other in the country. He decided that the entire building would be supported by just one massive column. He called his Chief Minister and told him to send his men to forests far and near, and tell them to cut down and bring to the city the biggest and strongest tree that they could find. The Minister at once sent off 30 foresters. The foresters soon returned, saying that though there were many strong and gigantic trees in the kingdom, they could not carry or even drag them all the way to the city.

“Very well,” said the king. “You must find a tree just as big in one of my own parks, and bring it here within seven days.” The foresters left and went

straight to a splendid sal tree that was located not far from the palace. The tree was worshipped by the people of the nearby villages because within it lived a tree spirit. It was a tree of unusual strength, size, and beauty. So the foresters decided that the King's column must be made of that beautiful sal tree. They came with garlands, lamps, and music to offer to the spirit inside. They wanted to warn her that she must leave the tree within seven days, as it would be cut to the ground.

The tree spirit understood what was to happen. She remained quiet as a resting breeze for a few moments, and all the leaves began to whisper. This is what the leaves were whispering to each other: “Shhh... If the tree falls, it will crush all the little sal trees that have sprung up and thrived under her. For ourselves we do not care, but for our children's sake we wish the King does not fell the tree.” The spirit within the tree thought that this must not be allowed, and she must visit the king and persuade him to change his mind. That night when the king was sleeping, a shining, luminous face appeared to him in a dream, and spoke to him in a soft voice, “I am the spirit of the sal tree and I have learnt today that you have ordered your men to fell me. I have come to plead with you to change your decision.”

“No, I cannot,” answered the king. “Yours is the only tree trunk in the park strong enough to support the palace, and therefore I must have it.”

“Oh King, for thousands of years the people of many villages have worshipped me, the birds have built their nests in me, and against my trunk many take rest in the cool shade.”

“True,” said the king, “that is all very well, good sal spirit, but for this I cannot spare you and I cannot change my mind.”

The tree spirit folded her hands and spoke, “Then, mighty King, grant me a wish and let me be felled in three parts, first my head with its waving greenery, next my middle with its hundreds of strong arms and hands, and last of all my trunk.”

“That is a very strange request,” said the king. “I never heard of anyone who wished to suffer three times, why not endure it once and have it over?”

The tree spirit replied, “Because my family has grown around me, thousands of young trees have

sprung from me and thrived in my shadow. If you fell me with one mighty stroke, my weight would certainly crush all my children to death. But if I suffer the blow three times and fall in three pieces, some of the little ones may escape. Do you grant my prayer?”

“Yes, I do,” said the King and the tree spirit wafted away. The next morning, the King called the Minister and his foresters, and told them that he had changed his mind. He said that the column for the new palace should be made of stone and not wood, because a very noble spirit lived in the sal tree, and then he told them the story. This beautiful fable symbolizes the sentiments that we uphold in our tradition towards nature and towards trees.

Then again, I have come across a tradition which everyone must be aware of. It is the custom of a one-time mandatory prayer by the head carpenter at the “katla” ceremony held prior to building a house, and many of you may be familiar with it. At this ceremony, the carpenter offers a prayer seeking forgiveness from all the birds, insects, reptiles, mammals, and worms to whom the tree offered shelter, and apologizing for his part in cutting down trees for timber for the house for humans to live in, thus displacing them all. This is one of the reasons for the “katla veppu” ceremony and the related prayer. It is a wonderful concept, by which we give so much respect to nature, and appreciate how, like human beings, all other creatures have the right to their place in the scheme of things.

Today, because humans act as if they are the only living beings on earth, and have treated nature in the manner that they have been doing, it is quite likely that nature is not going to allow the survival

of humankind, unless significant and serious action is taken. Action in terms of climate change, in terms of the loss of biodiversity, as these have been flagged as the two most important risks to mankind. Nature is something that we take for granted, and natural resources too we take for granted. But today I think there is a global realization that if we don’t do something about the havoc we have brought about, because of the use of fossil fuels and because of the destruction of the natural environment, the environment itself is not going to allow us to continue to survive on this earth.

Therefore, one of the most important aspects of nature conservation is to save trees, save all living things, and the most important actions are the planting of trees — restoring trees and restoring forests. I think this has become tremendously significant for people living in today’s world. You must have heard what the green girl Greta Thunberg shouted at the UN. In effect, she asked... “What have you people been doing? What has your generation been doing? We don’t see any reason for going to school because this planet is not a place for us to survive and live in. You owe it to us to change. You have done great harm, and you owe it us to make the changes that are needed to make this world a place where we can survive.”

So I believe that organizations such as the Friends of the Trees reinforce this consciousness in us, that we have to respect nature, we have to live in coordination with nature, and respect all living things, don’t consider man to be the most important living being in the whole universe. Therefore, I wish this organization all the very best. It has been a wonderful afternoon, and I thank you all very much. 🌿

"Have you noticed that the tree gives its shade to the man who is chopping it down? And if it is a sweet-smelling tree, it will leave its scent on the axe!"

-- Anonymous

FRIENDS OF TREES 59TH ANNUAL VEGETABLE, FRUIT, AND FLOWER SHOW, FEBRUARY 9, 2020

Address by the Chief Guest, Mr R.L. Mopalwar, IAS, Vice Chairman & Managing Director, Maharashtra State Road Development Corporation



Dr Ashok Kothari, President of the Friends of the Trees, Dr Arun Sawant, Dr Saraswathy Unnithan, Mrs Sakina Gadiwala, Dr Chandrakant Salunkhe, Vice Principal of the host Ruparel College Dr Neeta Tatke, and friends:

First of all let me confess that I am extremely impressed by two aspects. The first is the level of participation, 90 institutions and individuals are

taking part in this show. I have been attending such a flower show in Navi Mumbai because I was staying there for six years. They also regularly hold such shows, but here the participation is on an absolutely wonderful scale.

Secondly, this is the 59th continuous year that the FOT Show is being held. These are days when we are into instant messaging, and what we speak is

known to the entire world in another two seconds through Twitter, Instagram, WhatsApp and Facebook. Yet nothing is permanent and relations change so fast, but here there are dedicated people who have been working in this institution for decades together.

I have had the honour to meet the dignitaries of BARC for the first time. Of course, my very first interacton with BARC was about 20 years ago, when they started Nisarg Rule, i.e., the protection of the environment by treatment of solid waste. Solid waste management is a great challenge for all of us, as 50% of the population of Maharashtra is in the urban sector. Since the rise of urbanization, the generation of solid waste has increased manifold. If you take a look at a small village, the per capita generation of solid waste is hardly 50 to 150 gm per day, depending on the size of the village. But in a city like Mumbai, per capita solid waste generation is from 600 gm to almost one kilogram. It is a huge challenge for environmental preservation and management, and against this particular scenario, the National Society of the Friends of the Trees was founded in 1957.

Let me tell you, till 1962 it was not only acceptable but the official policy of the Government of India to permit felling trees. For 120 years, government programmes allowed felling trees. If you examine the history of the British Raj, you will find that large tracts of forests were clear-felled to create tea gardens, indigo plantations, and coffee plantations. In this manner, lakhs of hectares of land were deforested. After Independence, we launched a programme called Grow More Food in 1948, and this official programme included felling trees and clearing forests. We even invited people from Andhra Pradesh to Chandrapur and Nashik districts to fell trees, to actually create paddy fields. So, in the context of the official policy till 1962 to fell trees, clear lands, grow more food, many individuals with great foresight started the Friends of the Trees, whose aim is basically growing more trees.

In another two years, worldwide environmental awareness, which was generated by the landmark Stockholm Conference in 1972, will reach its 50th year. The Stockholm Conference was the first to establish an agenda on the issue of environmental degradation and denudation of the earth on large scale. This is the first year [2019] in India that our forest cover is marginally higher than

the forest cover which was recorded in earlier years. So we may say that it took 48 years to come to this stage of stabilization of environment awareness and legislation, the Water Act in 1969, the Wildlife (Protection) Act in 1972, the Air Act in 1982, the Forest Protection Act in 1980, and the Environment Protection Act in 1986. So two decades were spent creating the legal framework for protection of the environment. Though the legislative framework was created by 1986, it was not truly effective till 1996. It is a huge task to try and change people's thinking and behavioural patterns, when we have a population of 130 crores. We are talking about Almitra Patel's public interest litigation in the Supreme Court for the last 20 years. In actual terms, we started urban solid waste management by segregating wet and dry waste, but we have still not achieved 100% success in this one aspect.

So, protection of environment is a monumental task. Each one of us is focused on our own personal progress, we feel that we are at one level today and should go to the next level tomorrow – a Honda City car today, so tomorrow a Mercedes, then a BMW, and then a Bentley, an endless pursuit. In fact, each of us wants to go to a higher level of material happiness and comfort. However, thinking about society at large, thinking about the country, creating a sustainable behavioural pattern, creating best practices, showcasing them, documenting them, and actually inspiring others should be our priority, the way a number of schools and colleges that are participating in this show are doing here. Young boys and girls, aged 10, 12, 15 years, the way they are focused and what they are talking about at this age, such dedication has been created by organized efforts which are well-meaning, effective, and consistent.

Last but not least, as Dr Arun Sawant just told me, the construction of highways is another issue as trees would be felled for them. We read in school that Sultan Sher Shah Sur first created the Grand Truck Road and planted trees on both sides of it, to provide shade and shelter to people travelling on camels, horses, and bullock carts. But now if you driving along a highway, trees can become a danger. The present highway code does not allow you to plant trees 30 or 45 metres from the highway, or in the median, because they become a hazard. We have almost 150 deaths per year in such road accidents. So how does one

create a balance in constructing highways and protecting nature? Let me tell you.

We are constructing the Mumbai-Nagpur expressway which will be the longest in the country; 700 km will be constructed in the next two years; 30% of the work is already over; and we are planting 8,65,000 trees. The Botanical Survey of India, the Indian Roads Congress, and the Wildlife Institute of India have recommended planting 583 trees per kilometre. We have a retired Chief Conservator of Forests on board; we worked on this ratio and enhanced it to 663 trees per km. So we will be doing better than the parameters suggested. Secondly, we are doing it in a very scientific way, and will be planting only local trees, and no exotics. The surest way to destroy natural flora or natural forests is to introduce exotic varieties into that ecosystem. So not a single exotic tree will be planted.

Dr Sawant specifically said that highways should have trees, and we will have more than 8,65,000 trees. In Mumbai Municipality, we have an Agroculture Register; we have numbered each tree, and counted a total of 1,25,000 trees present. The expressway will be the most beautiful road as it will be landscaped; to avoid accidents there will be no fruit trees because they attract birds and monkeys, we are planting tree species in consultation with the Forest Department. Having come here, I thought I should assure you that we like to contribute the way you want us to contribute.

I compliment the National Society of the Friends of the Trees from the bottom of my heart, and I am grateful to the Society, as well as to D.G. Ruparel College, for inviting me to be the Chief Guest at this valedictory function. Thank you all very much, and wish you all the best for the conservation of nature. 🌿



Colourful entries at the 59th Vegetable, Fruit, and Flower Show

The case for livelihood-based conservation

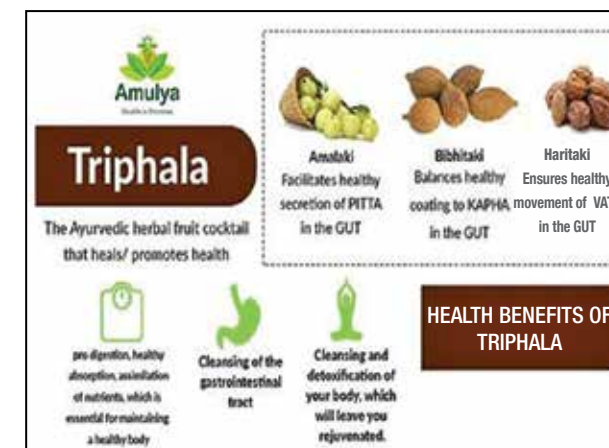
The story I tell here is largely represented by two trees, Haritaki *Terminalia chebula* and Bibhitaki *Terminalia bellirica*. I made my first acquaintance with them in a field trip to the northern Western Ghats in the spring of 2019. Almost 2,000 feet above sea level in the majestic Western Ghats, running through Maharashtra into three more states southwards, are two beautiful locations, Sangameshwar in Ratnagiri district (about six hours south of Pune) and Bhima Shankar around the Bhima Shankar Wildlife Sanctuary (about three hours north of Pune). I met the giant Bibhitaki in Sangameshwar, and the verdant green Haritaki in Bhima Shankar. Here is my story of the two trees!

then we all know what happens to dense forests when so many humans from far and wide arrive, the pilgrimage becomes a stampede.

- It must have at least 1,500 vascular plants as endemics, which is to say, it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is irreplaceable.
- It must have 30% or less of its original natural vegetation. In other words, it must be threatened.



Ironically, as humanity battles with finding a cure for one of the biggest existentialist crises of the 21st century – Covid-19 – there is yet another lurking quietly in the background – Climate Change. Trees have much to do with arresting the disaster of climate change. They produce fresh oxygen and absorb carbon, which is the excessive surplus created by only one species – humans – by burning fossil fuels. But this species also wipes out trees and forests as no other natural causes do, resulting in deserts, floods, disruption of natural habitats, leading other species to extinction. Most of all, destroying the most potent agent of carbon sequestration – trees. And the resulting atmospheric carbon traps solar energy to raise the surface temperature of the earth's land and oceans, producing what we know as climate change.



Around the world, 35 areas qualify as biodiversity hotspots. They represent just 2.3% of the earth's land surface, but they support more than half of the world's plant species as endemics, i.e. species found no place else, and nearly 43% of bird, mammal, reptile, and amphibian species as endemics. According to Conservation International, to qualify as a biodiversity hotspot, a region must meet two strict criteria:

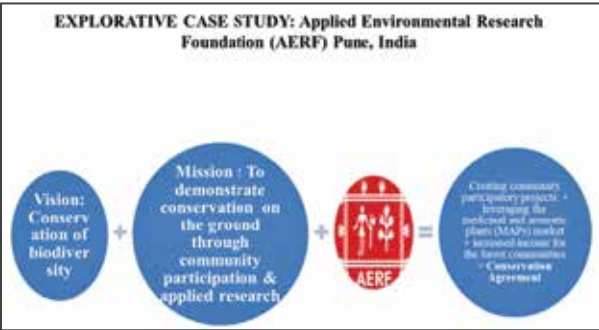


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While the pandemic has elicited a well-orchestrated science and evidence-based global response, combined with the collective political will of nations to contain the devastating spread of the virus, the response to climate change lacks such a definitive response from the powerbrokers controlling the fate of humankind. Yes, there is the globally ratified Paris Convention of 2015, leading to a compromise reiteration of the urgency of arresting surface warming of the earth to less than 2 °C. But lack of political will stands in the way of achieving the consensus target, and is a reflection of a faltering collective human will to deviate from “business as usual”. But business and its singular institution, the marketplace, has emerged to be perhaps the most potent creative yet simultaneously destructive agency of the 20th and 21st centuries. The cumulative impacts of just the last 150 years of human existence on earth’s roughly 4.5 billion-year history, through industrial globalization and climate change, even though an unintended consequence, have set in motion a whole new geological age, the Anthropocene. There is rising scientific evidence that the slow but inevitable ticking of perhaps the most powerful time bomb for life on earth has engulfed our civilization in unprecedented crises, many times more potent than Covid-19, termed as the “grand challenges of the 21st century”. It is to study such grand challenges at a local level that I embark on field trips such as the one to the Western Ghats. That is the tale of the two trees I wish to recount.

A good way to learn has always been through stories documented or told by communities of people who experience the lessons. This method is known in academic circles as ‘community-based research’. It involves travelling to meet the communities that have a powerful narrative to share, which they are creating through their lived experiences in response to such grand challenges as water scarcity, food shortage, scarce resources, lack of education and capital, and declining agricultural income. Such community-based experiences are often ignored by more conservatively trained researchers, who fear getting lost in too much subjectivity. But it would have taken me many years to understand the implications of the Anthropocene, had I not embarked on that journey to Sangameshwar and Bhima Shankar to see the narrative of a remarkable 25-year old community-based conservation organization called AERF (Applied Environmental Research Organization). They have honed their skills along with the local farming and indigenous

communities to bring more than 7,000 acres of land under conservation agreements, by learning to harness the ecosystem services provided for free by giant old trees like Bibhitaki and Haritaki into livelihoods for whole villages. In so doing, they help develop skills, education, and capacity locally, to offer value-added natural products to global supply chains of multinational corporations. The result is livelihood-based conservation of the rich and endemic biodiversity of the northern Western Ghats.



An environmental case study profile from AERF, Pune

Leveraging the connect of people with their environment via livelihood is one of the foundational pillars of Applied Environmental Research Foundation (AERF), a registered non-governmental organization based in Pune, which recently celebrated its 25th anniversary in August 2020. The organizational model of AERF is based on harnessing the creative and positive aspects of markets to help create a vehicle of demand and supply of natural products for the (often) marginal local communities that most need a sustainable livelihood as an incentive to maintain their role as protectors of the pristine biodiversity of the Western Ghats.



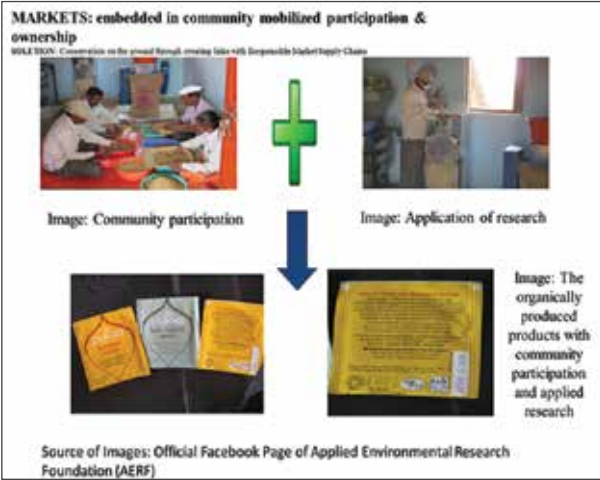
AERF conducts community based conservation initiatives

AERF is an excellent exemplar of community-based conservation, providing the often-missing part of ‘livelihood’ in the conservation narrative. AERF believes in natural resource management models that are community participative and inclusive in the larger cause of environment protection. The organization uses local communities as facilitators and protectors of the planet and its resources through consensual conservation agreements. These agreements are made possible when communities are not only taught about the economic benefits of their habitat, but also enabled to appreciate their environment by empowering them to make a living from it through sustainable harvesting. Certification partners like FairWild UK work together to train, educate and provide branding, to attract market premiums from herbal product customers of Pukka Herbs, UK, which was recently acquired by the global multinational Unilever Ltd.

AERF objectives:

- To develop and implement feasible and locally effective models of sustainable natural resource management.
- To study and preserve indigenous knowledge and practices linked to environmental protection, natural resource management and agriculture.
- To design and undertake conservation awareness programmes for different target groups including women and children
- To mainstream biodiversity issues in cross-cutting areas and to promote dialogue with diverse stakeholder groups on biodiversity concerns through capacity building.

Source: <http://www.aerfindia.org/about.html>



Organically produced products with community conservation

The company thus both creates the demand for the fruits of endangered trees to be sustainably harvested, as ingredients of the ancient Ayurvedic Triphala, a remedy for gastro-intestinal disorders, and supplies markets with their needs for nature-based remedies.

Thus the tale of two trees, Bibhitaki and Haritaki, pointed me in the direction of a “Solidarium”, a compact between the state, the market, and local communities, as a way to respond to the crisis that human civilization has created on earth. The World Count Project in Sweden teaches us that the human species constitutes only one ten thousandth of life on earth, i.e. one percent of one percent of all life on earth measured by the dry weight of carbon that life is made up of, called biomass. Plants make up more than 80% of the biomass, and yet stand threatened by the human species. If the earth’s roughly 4.5 billion years of history is equated to one calendar year, then humans have existed for only the last 37 minutes, yet have used up 33% of the earth’s resources in the last 0.2 seconds (since the agricultural and industrial revolutions). Although Charles Darwin proved in 1859 that humans have evolved naturally and have not been created in the image of ‘God’, perhaps human exceptionalism (or anthropocentrism), the belief that humans are endowed with the unique ability to reflect on the world around them, and act beyond instinct to make meaningful long-term choices, will ultimately be the saviour? Perhaps Covid-19, a naturally recombinant zoonotic virus most probably originating from illegal animal trade in exotic species from biodiversity hotspots like the Western Ghats, is giving us the opportunity to test our human exceptionalism?

Finally, I thank my alma mater, St Xavier’s College, which was a life transforming educational experience as a life sciences undergraduate of the batch of 1987, for presenting me with the opportunity to reconnect with this exceptional institution in February 2020, to share my meagre understanding of ‘Tree Ecology and Urban Forest Management’ amongst my vastly more erudite fellow speakers. And my sincere thanks to *Vanashobha*, the journal of the National Society of the Friends of the Trees, for inviting me to reflect on the relationships between ecologies, communities, and markets. 🌿



Forest in the Kolhapur region, Maharashtra, Western Ghats

Northern Western Ghats

A diverse landscape of fragmented forests

Bhushan Shigwan and Mandar N. Datar

India is a megadiverse country and is known for its wide array of climatic and geographical heterogeneities. The country has four biodiversity hotspots, namely the Himalaya, Indo-Burma region, Sundaland including Andaman & Nicobar Islands, and the Western Ghats. The Western Ghats, a chain of mountains running parallel to the West Coast, is one of the most

celebrated biodiversity hotspots in the world. It extends from the Tapi River at its northern boundary to its southern tip at Kanyakumari. The Western Ghats may be called a lifeline, as numerous rivers that originate in the Western Ghats quench the thirst of a large human population as well as other biodiversity of peninsular India.

THE NORTHERN SEGMENT

Biogeographers have often classified the Western Ghats into its Northern, Central, and Southern sections, with each of these regions having their own distinctiveness and unique features. The southern and central parts of the Western Ghats are covered with thick forests, while the northern region is comparatively dry with the predominance of open habitats. The northern Western Ghats, locally known as Sahyadri, extends from the southern region of Gujarat from Tapti River, western stretches of Maharashtra and Goa, to the northern region of Karnataka till the Kali River. The northern section is largely different from the southern and central Western Ghats in terms of climate, geology, and the biodiversity it supports. This region experiences four months of precipitation and eight months of dry period. Besides, it has lower elevational gradients, mainly below 1,600 m, compared to some magnificent peaks in the southern region. The Sahyadris show a habitat mosaic of forests intermixed with laterite and basaltic outcrops and grasslands.

The Northern Western Ghats can be treated as two major divisions from west to east, the first being the coastal plains of Konkan intermixed with lower elevational hills; the second includes high, steep, open rocky escarpments merging in the Deccan plateau, and offshoots of spurs descending gradually towards the eastern side. The eastern slopes comprise valleys and a dense network of east-flowing rivers, with dams as major water bodies, and flood plains. The crest line of the Ghats is topped with the broken chain of high elevational plateaus. This geographical heterogeneity is responsible for interesting habitats in the Northern Western Ghats.

HABITAT DIVERSITY

The Western Ghats is known for its lush green and wet forests. However, the northern part being comparatively drier has many unique habitats

including grasslands among its plateaus, mountain tops, and rocky cliffs. The flat-top mountains of the Northern Western Ghats are composed of base rocks of laterite and basalt, and are technically classified as rock outcrops. These plateaus are characterized by more than 50% of open rock surface, intermixed with different depths of soil layers. They are peculiar for having ephemeral vegetation composed of many seasonal elements. These outcrops have been recorded as the type localities of many new species of plants and animals. The seasonality of the vegetation is a peculiar feature of the outcrops. The rock plateaus (called *sadas* in Marathi language), are entirely dry and almost barren during the summer and winter, but show gregarious mass blooming of ephemeral herbs in mid and late monsoon.

The cliffs are among the interesting habitats in Northern Western Ghats, abundantly found along hilltops and man-made mountain passes. The vegetation on these cliffs faces climatic extremes and the species are adapted to living in these challenging conditions. Many endemic, including threatened endemic species are found to be restricted to these cliff habitats. Besides, large stretches of the Northern Western Ghats are covered by grasslands which are the home of many species of plants, animals, and lesser known fauna.

FRAGMENTED FORESTS

The forests of the Northern Western Ghats are highly fragmented due to various anthropogenic activities, in addition to their natural limitations. The present-day forests are confined to a few protected areas managed by the government, private lands, and a large number of sacred groves that are community protected. But despite their fragmented conditions, these forests are precious repositories of medicinal plants, endemic species, and wild relatives of crop plants and wild edible plants.

By definition, forest fragmentation is a process in which the entire stretch of a continuous forest is broken into small patches due to various anthropogenic activities. These include road building, agriculture, construction of hydro corridors, and other human developments, along with their ancillary anthropogenic activities. changes. Since these forest patches are degraded from original pristine forest tracts, they are termed as remnants. The isolation faced by such patches results in alteration of the microclimates along the entire original forest tract. Well-documented consequences of such alteration are a decrease in



Mangaon, a traditional sacred grove in Pune, Maharashtra



Post-monsoon, the Maval region of Maharashtra has rich biodiversity

forest health leading to loss of biodiversity, increase in invasive plants, pests, and pathogens, and a reduction in water level.

Isolation and edge effect are major forces of fragmentation. Isolation hampers the movement of plants and animals, which limits the breeding and gene flow, ultimately reducing the population. Moreover, as forest fragments become smaller, practicing forestry becomes operationally impractical, economically unviable, and culturally unacceptable. In turn, we lose the corresponding and important contributions that forestry makes to our economy and culture. The result is a rapid acceleration of further fragmentation, and finally, a permanent loss.

LOCAL CONSERVATORIES

Sacred groves, protected in many parts of the world as a part of cultural heritage, are pristine forest pockets dedicated to local deities. Religious beliefs and myths are largely responsible for their conservation and protection from exploitation for personal and commercial purposes. They are

preserved and managed traditionally by the local inhabitants and are repositories of biodiversity that once existed in surrounding areas. In the Northern Western Ghats, the origin of sacred groves dates back to the time when the inhabitants were hunter-gatherers, and groves are representatives of climax vegetation. In some of the groves, cutting or harvesting of plants is taboo, while in others, the wood is used only for religious purposes. Sacred groves range in size from a stand of a few trees to half a square kilometre or more.

Sacred groves not only preserve the plants and animals inhabiting them, but also help in soil and water conservation. Hence, the grove functions as an ecosystem generating a large amount of nutrients, which ultimately diffuse into adjoining agroecosystems like paddy fields. The sacred groves of the northern Western Ghats have been studied for their floristic composition, socio-economic values, and their importance as repositories of relict vegetation. Based on a report by Dr Sanjay Deshmukh, it is assessed that there are 2,778 sacred groves in the Western Ghats and Konkan Region,



In Tamhini Ghat, construction has come too close to sacred groves

which form an integral component of a network of fragmented forests in the northern Western Ghats.

PROTECTED AREA NETWORK

In addition to this community-driven protection, state forest departments manage large stretches of territorial forests as well as protected areas. A chain of protected areas has been created in the northern Western Ghats from north to south, to provide the best possible protection to wilderness areas. There are many wildlife sanctuaries (WLS) and national parks (NP) in this region. Some of these are Bhimashankar WLS, Tansa WLS, Sanjay Gandhi National Park, Mumbai, Koyna WLS, Chandoli NP (together constituting Sahyadri Tiger Reserve), Phansad WLS and Radhanagari WLS in Maharashtra; Madai WLS, Bhagwan Mahavir (Mollem) NP, Netravali WLS, Cotigao WLS, and

Bondla WLS in Goa; and Dandeli WLS and Anshi NP in Karnataka. All these protected areas shelter diverse forests, ranging in type from moist deciduous to semi-evergreen and evergreen.

THE AGHARKAR RESEARCH INSTITUTE STUDY

In the backdrop of the major threat of forest fragmentation in the Northern Western Ghats, we are studying the tree diversity of forest pockets across the entire length of the region. Our work is focused on understanding the tree diversity and effects of the disturbance mediated fragmentation on tree composition. The work is spread across forest fragments with different levels of protection, such as private forests, community protected areas such as sacred groves, and protected areas like sanctuaries and national parks. It is planned to document changes in forest structure and composition across the latitudinal gradients of the northern Western Ghats.

Though fragmented, the northern Western Ghats shelter a great diversity of tree species. In addition to the common ones, many unique trees that are endemic to the Western Ghats are present in these forest fragments. We hope that our ongoing work will be beneficial in building evidence that will ultimately serve in the conservation of these forests. 🌿



Situated on the crest of Western Ghats, Varandha Ghat is well-known for its rich forests



Banyan *Ficus benghalensis* provides shade and shelter

ASHOK S. KOTHARI

Urban Forestry in India

H.S. Singh

INTRODUCTION

Although cities occupy c. 3% of the earth's surface, their inhabitants use three quarters of its natural resources. These cities are major contributors to economy, but also a major concern for environmental pollution. A century ago, just one tenth of the global population lived in cities, which now exceeds 55%, expected to swell to 70% by 2050 (FAO 2016). Thus, there is a need for social awareness, for the governance of urban systems that counter the menace of environmental degradation, and to sensitize people to environmental issues. Forests, trees, lakes, ponds, and rivers in urban and peri-urban environments, if properly managed, can make important contributions to the planning, design, and management of sustainable urban landscapes.

Urban development, as practiced in India and other countries, results in the pollution of basic environmental components such as air and water, which sustain human life. As the world continues to urbanize, sustainable development challenges will increasingly concentrate in cities, where urbanization happens rapidly, spontaneously, and with insufficient strategic planning, resulting in unsustainable growth (FAO 2016; Anon. 2014). Evidence of the unsustainability of urban growth is increasingly drawing public attention to the need for sustainable urban models capable of responding to increasing demands for green space.

Intensive practice of urban forestry becomes necessary in the present context, because urban forests and tree cover help in making cities more

liveable, safe, pleasant, healthier, wealthier, more diverse and attractive. Urban forestry is generally defined as the art, science, and technology of managing trees and patches of forests in and around urban areas for their physiological, sociological, economic, environment and aesthetic benefits. In North America and Europe, definitions of urban forestry have become more comprehensive. Green canopy cover in these countries includes all patches of natural forests, groves or tree stands, and individual trees in and around urban areas (Nowak *et al.* 2006). To support the world's cities in reaping the benefits of urban and peri-urban forests, FAO initiated a collaborative process to develop voluntary guidelines in 2016, aimed at optimizing the contributions of forests and trees to sustainable urban development. On similar lines, the Urban Development Department of the Government of India issued Urban Green Guidelines in 2014.

INCREASING URBANIZATION AND DECREASING GREEN COVER

Globally, human populations consistently migrate from rural to urban areas. As a result, for the first time in history, the urban population reached upto 50% of the global population in 2008, which is expected to swell to 66% of the global population in the next 40–50 years. Urbanization in fast developing countries follows the growth of the GDP, as rapid urbanization is a key feature of economies that have sustained 8–10% growth for decades. In South Korea, the urban population rose from 26.8% of the total population in 1966 to 85.7% in 1995. In China, it grew from 19% in 1981 to 59% in 2018. In these countries, the economic growth followed the trend of population growth (Pangariya 2020). Fortunately, these countries addressed environmental issues by increasing and managing green spaces in their cities.

Growing cities and towns reshape natural landscapes as they expand, creating microclimates in which temperatures, air and water quality and winds differ from those of the surrounding countryside. The majority of the population in developed countries has already shifted to urban areas. In recent decades, most cities are growing quickly, with the majority of growth projected to be in developing countries in Africa and Asia. In 2018, just over 55% of the world population lived in cities and towns. About 86%

of total population in Australia, 82% in USA, 76% in European Union, 59% in China, and 34% in India live in urban areas. As the world continues to urbanize, sustainable development challenges will increasingly concentrate in cities, particularly in developing and under developed countries, where urbanization has often taken place rapidly, spontaneously and with insufficient strategic planning, resulting in unsustainable patterns of land use (FAO 2016).

In 2011, about 31.2 % of the India's population resided in urban areas, which increased to over 34.0% in 2018. It is expected to rise above 40% by 2026 (Anon. 2014). During the last 50 years, the gross Indian population has grown 2.5 times, whereas the urban population has grown nearly five times. Urbanization in India is rapid, but not as fast as in South Korea and China since the 1980s. During the last few decades, economic growth was relatively high in India and is expected to be higher in future. This implies that urbanization in India is expected to increase its pace. As Indian cities continue to grow demographically and spatially, the challenges and opportunities of managing their environment are enormous. It is expected that the number of towns and cities, which was 7,933 in 2011, is likely to cross the 10,000 mark in a decade (Anon. 2014). In 1901, Kolkata was the only metropolis (million plus citizens). Subsequently, the number of metropolitan cities increased to 5 in 1951, 12 in 1981, and 53 in 2011, and is expected to be c. 100 by the next census in 2021. These 53 metropolitan cities held a population of 158 million in 2011, i.e. 42% of India's total urban population (Anon. 2014).



Jacaranda *Jacaranda mimosifolia* flowers in semi-arid conditions

ASHOK S. KOTHARI



Umber *Ficus glomerata* flourishes in medium to heavy rainfall

ASHOK S. KOTHARI

Cities expand at the cost of green space and environment; natural patches of forests and tree groves, and lakes are shrinking fast in the majority of cities in India. All cities have three infrastructures: Grey infrastructure (residential and industrial buildings, roads, utilities, parking lots), blue infrastructure (rivers, lakes, ponds, water channels), and green infrastructure (trees, shrubs and grasses in parks, forests, gardens, avenue trees). The grey infrastructure is growing fast and consistently, whereas the other two are depleting. Battles are being fought in cities across India, where growth has come at the cost of thousands of urban trees, especially old street trees, leading residents to protest in dramatic ways (FAO 2016). A recent example of people's movement is from Mumbai, where the municipal corporation allowed felling of over 2,600 trees in the green zone of Mumbai-Aarey to set up a metro carshed. This is being strongly opposed by green activists and local residents.

Urban sprawl and unplanned growth of Indian cities are significantly impacted by the local climate. While the inland cities of Pune, Bhopal, Ahmedabad, Allahabad, and New Delhi remain intensely hot, the cooling effect of the sea restricts increase of temperature in coastal cities like Chennai, Trivandrum, Visakhapatnam, and Mumbai.

BENEFITS OF URBAN GREEN SPACE

Urban forests can be defined as systems comprising all natural and planted woodlands, groves, trees along street and river, in parks and gardens, and individual trees located in urban and peri-urban

areas (FAO 2016). They are the backbone of green infrastructure, bridging rural and urban areas and ameliorating a city's environmental footprint. Green space in urban areas includes urban forests, tree cover, lakes, rivers, gardens, and play grounds. Establishing an enabling environment is the first step in optimizing the contribution of urban forests to sustainable development. Scientific findings in the last few decades emphasize the crucial necessity of green areas within urban social-ecological systems to ameliorate several problems. Urban trees are true environmental and economic capital, benefiting urban inhabitants tangibly and intangibly, as below.

- (i) Urban tree cover or forests absorb pollutants, filter and efficiently remove pollutants and particulate matter, and release oxygen.
- (ii) They act as temperature buffers, providing shade in summer, and as wind breaks, in addition to reducing noise pollution. They improve the urban micro-climate, maintain the balance of the city's natural environment, and offer significant benefits in reducing air-conditioning needs and energy consumption.
- (iii) Trees and forests in and around cities contribute to climate-change mitigation directly by sequestering carbon and reducing greenhouse gas emission, and indirectly by saving energy, reducing the urban heat island effect, and mitigating flooding.
- (iv) Urban tree cover, lakes, and other green spaces reduce the cost of urban infrastructure, provide ecosystem services for all citizens, improve the living environment, and increase property values, ultimately boosting the local green economy.
- (v) Urban tree cover and other green spaces in and around cities provide ideal settings for outdoor recreation.
- (vi) They are efficient regulators of urban hydrological cycles. They filter drinking water, reducing biological and chemical pollutants, reducing the risk of floods and erosion, and water loss by minimizing mesoclimatic extremes through evapotranspiration.
- (vii) Sustainably managed urban forests can produce renewable energy for use by urban communities.
- (viii) Urban forests help create and enhance habitats, constitute a pool of biodiversity, significantly improve soil quality, and contribute to land restoration.
- (ix) They are direct sources of food (e.g., fruits, seeds, leaves, mushrooms, berries, bark extracts, sap, roots, herbs, wild meat, and edible insects).

- (x) They help communities to maintain cultural identity across generations, and provide residents with community spaces for socializing.
- (xi) Green cover is crucial to mental health. Access to green spaces can reduce health inequalities, improve well-being, and aid in treatment of mental illness. Some analysis suggests that physical activity in a natural environment can alleviate mild depression and reduce physiological stress indicators.

With so many benefits, it is easy to understand why cities around the world are pushing to incorporate urban greening into their future, though it is yet to be recognized as a core infrastructure of economy. Environmental benefits from trees, as mentioned above, cannot be calculated in terms of money, although some exercises have been done in several countries to evaluate them. According to a study, urban trees in the United States remove some 784,000 tons of air pollution annually, which is valued at \$3.80 billion (Nowak & Crane 2002; Nowak *et al.* 2006) and currently store 770 million tons of carbon, valued at \$14.30 billion. In New York City, every dollar spent on tree-planting and care provides up to 5.6 dollars in benefits. A valuation of urban forests carried out in the City of London showed that 8 million trees growing in the city produce annual benefits of c. £132 million,

mostly related to the removal of air pollution, and they have an amenity value estimated at £43 billion (FAO 2016). Recognizing the benefits, authorities in London City seek to increase the surface area greened in the Central Activities Zone by at least 5% by 2030, and a further 5% by 2050. The authorities also plan to plant two million trees by 2025. A report on 245 major cities in 2016 found that trees can reduce concentrations of particulate matter by 7–24% and lower nearby temperatures by 2–4 °F (Chandrashekhara 2019). In California, 15% of the urban area is under tree cover, bearing 173.2 million trees, five per resident. The annual value of ecosystem services was estimated at \$8.30 billion and the urban forests asset value was \$181 billion (McPherson *et al.* 2017).

WHAT IS URBAN GREEN COVER?

Urban greening is defined as “public landscaping and urban forestry projects that create mutually beneficial relationships between city dwellers and their environments”. The most common forms of urban greening are installing trees, parks, and landscaped green areas in newly-built urban projects. This urban green space includes: (i) Urban forests such as The Ridge forest in Delhi, forests within Chandigarh, natural forest of Victoria Park in Bhavnagar, and Girnar forest adjoining Junagadh; (ii) Protected Areas such as Sanjay



Neem *Azadirachta indica*, a beneficial medicinal tree

ASHOK S. KOTHARI



ASHOK S. KOTHARI

Fragrant Gulchin *Plumeria alba* enhances urban habitats

Gandhi National Park, Borivli in Mumbai or the Bird Sanctuary in Porbandar city; (iii) Parks, gardens and cultural forests; (iv) Green belt/green strip; (v) Avenue trees; (vi) Tree cover in private and institutional compounds; (vii) Trees along lakes and rivers; (viii) Lakes, ponds and rivers; and (ix) Play/sport grounds with grass cover.

**URBAN TREE COVER:
THE GLOBAL SCENARIO**

Many countries have provided their cities ecological security, such as the USA where urban land currently occupies c. 28 million hectares with c. 3.8 billion trees (average density 136 trees/ha). The average tree cover in the 20 main metropolitan areas in USA is estimated at c. 27.1% of the geographical area (Nowak *et al.* 2006). In the cities of Japan, tree crown coverage is 26.7% in the urban and suburban areas. It is c. 18.5% of the geographical area within municipal limits of 26 large European cities (Chaudhary & Tewari 2011). Except Gandhinagar, Delhi, Chandigarh, Greater Noida, and a few more urban centres, Indian cities do not meet these standards.

In 439 cities in China, the overall green space was 380,000 ha or 20.1% of the city areas in 1991. Subsequently, with progress of urbanization, the green space in these cities increased to 23.0% (6.52 m²/inhabitant) by 2000, and then to 32.5% by the end of 2006; China aims to achieve green space of 40% (Wang 2009; Yang *et al.* 2004). In its second stage, China’s State Forestry Administration officially launched the National Forest City programme in 2004, with the aim of advancing urban ecological development. The programme represents a new model of urban forestry development, with both strong national policy support and successful local community involvement. Its main strategy aims at “bringing forests into cities and letting cities embrace forests”. By 2015, more than 170 cities and 12 provinces were actively involved the National Forest City programme. Tree cover in these urban communities had increased to 40% or more, almost double since 1981 (FAO 2016). In New York City in USA, every dollar spent on tree-planting and care provides up to 5.6 dollars in benefits. In Netherland,

average green space cover is about 19% in 22 of the largest Dutch cities (228 m²/inhabitant) (Chaudhary & Tewari 2011).

Tree coverage in important cities has been assessed using Google maps. The “Green View Index” used Google Street View panoramas to evaluate and compare green canopy coverage in 10 major cities. The green canopy coverage index was 12.7% of geographical area in London; 15.2% in Los Angeles, USA; 17.5% in Tel Aviv, Israel; 18.2% in Boston, USA; 19.4% in Miami, USA; 19.5% in Toronto, Canada; 20.0% in Seattle, USA; 20.6% in Amsterdam, Netherlands; 21.4% in Geneva, Switzerland; 21.5% in Frankfurt, Germany; 25.9% in Vancouver, Canada; and 29.3% in Singapore (Walsh 2018). Atlanta has the reputation of being the “city in a forest” due to abundance of trees and forests, unique among major cities in USA. Similarly, Gandhinagar, the capital of Gujarat, is a green city, the “city in a man-made forest”.

**URBAN TREE COVER:
THE INDIAN SCENARIO**

Due to unprecedented urbanization, the chasm between city dwellers and nature is increasing, yet New Delhi is one of the greenest capitals in the world. The green cover in Delhi is c. 324 sq. km, 21.9% (13.2% forest + 8.7% tree cover) of its geographical area (FSI 2019). Another green city in India is Chandigarh, with 47.0 sq. km (40.3% of its geographical area) under forests and tree cover (FSI 2019). Gandhinagar is the greenest city in India, and one of the greenest in the world. The combined forest and tree cover in Gandhinagar is c. 53.9% of its geographical area. Bhavnagar in Gujarat has 31.7% of its area

under forest and tree cover (Singh 2012). The forests of Victoria Park in Bhavnagar contribute majorly to its greenery.

A study in 2017 led by the Centre for Ecological Studies at Indian Institute of Science, Bengaluru, estimated that Mumbai’s total green cover is less than 13% of the city’s area. Urban growth was found to be the highest in Mumbai among metropolitan cities, with 94% of the city paved and concretized.

Bengaluru, the garden city, recorded good tree cover, c. 19.9% of its geographical area, in the 1980s (Chaudhary & Tewari 2011), which declined to less than 15% due to expansion of urban construction (Padmanaban 2016). Vegetation clearing and fragmentation became predominant in the areas peripheral to Bengaluru city. The declining urban vegetation and

tree cover of Bengaluru has been documented and estimated at only 14 lakh trees, against high official estimates. In this city, the vegetation cover declined by 66% and water bodies by 74%.

Kolkata’s green cover fell from 23.4% to 7.3% over 20 years, and built-up area increased by 190% during the same period. Hyderabad’s tree cover fell from 2.71% to 1.66% over 20 years; whereas urban built-up rose by 400% between 1999 and 2009. It is projected that by 2024, green cover would be 1.84% of city’s area, if present trend continues



GAYATRI UGRA

Asoka *Saraca asoka* variant with yellow flowers



ASHOK S. KOTHARI

Asoka *Saraca asoka* flowers abundantly in urban spaces

(Padmanaban 2016). Similar trends were observed in Bhopal, Madhya Pradesh and Ahmedabad, Gujarat. In stark contrast to the situation in China, tree cover in India is depleting with urbanization in the majority of cities.

WHAT SHOULD BE THE NORM FOR GREEN COVER?

Globally, there are wide variations in coverage and in per capita availability of green spaces. Cities well-

known for green cover often have 20–40% of their geographical area under green cover, and 20–100 m² urban green spaces per capita. What should be minimum extent of green space in a city? Japan and other countries proposed a standard green space of 40 m²/inhabitant (Anon. 2014). The World Health Organization recommends that cities should provide at least 9 m² of green and open space for every inhabitant, which appears to be low in the cities which have high level of pollution.

Higher norms of tree cover have been advocated in developed countries, which may not be possible for highly populated countries such as India to achieve. According to India’s Urban Green Guidelines, 2014, 12–14% in small towns, 18–20% in medium towns, and 20–25% in metropolitan cities should be green and open space (Anon. 2014).

As indicated in several studies, c. 15% of total geographical area should be under forest and tree cover, or average tree density of 30 trees/ha, should be a minimum realistic target for urban planners in India (Singh 2012). Planners should also aim

to reserve at least 5% of a city area for lakes, open gardens, and play grounds. Thus, about 20% of the geographical area under green space seems logical in the Indian context. Achieving this norm may be difficult in several cities, but it can be compensated by raising green belts surrounding the cities. Thus, the focus should be shifted to the villages which are included in the area of the urban development authorities. Raising a green belt around cities should be a focused programme to compensate for the shortfall within the boundaries of cities.

INITIATIVES

The first planned urban afforestation in Gujarat was in Gandhinagar, after Government decided to develop a barren, dusty area as a State Capital. The Forest Department began tree plantation in a planned manner in the mid 1960s. From 1971 to 2011, c. 3.50 million saplings were planted (Singh 2012). In 2005, Gujarat Urban Development Mission (GUDM) of the Urban Department and Forest Department initiated a new tree plantation scheme “Nagar Nandan Van Yojana” in 129 urban areas in 2005–06, to plant 834,000 saplings and also to distribute about 633,000 saplings to the people. This programme helped to improve tree cover in several towns. Subsequently, the plan was extended to other towns (Singh 2012). Through notification of the Gujarat Urban Development Department in November 2009, the Government emphasized an Urban Green Plan. Provision was made for creation of cultural forests, oxygen park, and green guards, to involve people, NGOs and civil society. Urban authorities are advised to earmark a budget for raising trees. Gujarat State initiated another programme to establish cultural forests “Sanskritik Van” near urban and suburban centres in 2004 during state level celebrations of “Vana Mahotsava”. Since then, more than 20 such forests had been created in and around cities, towns, and heritage sites by 2019.

In 2011–12, the Social Forestry Wing of the Gujarat Forest Department initiated 100% tree enumeration in eight municipal corporations and 159 municipalities. In eight municipal corporations, 3.30 million trees were counted in 133,322 ha of municipal area, with an average tree density of 24.8 trees/ha and 9.65% of tree cover. The tree cover varied from just 3.0% of geographical area (8.4 trees/ha) in the Surat Municipal Corporation limits to 53.9% of geographical area (152 trees/ha) in the Gandhinagar Municipal Corporation area. Of the eight municipal

corporations in Gujarat, Gandhinagar, Bhavnagar, and Vadodara each had tree cover above 15% of the geographical area. Average tree cover in these eight municipal corporation limits was 8.8 m²/inhabitant, which varied from 2.7 m² in Surat to 147.6 m² in Gandhinagar. In 159 municipalities, average tree cover was 5.4% of the geographical area, which is low (Singh 2013). This survey helped in launching a campaign for greening urban areas in the state. Every year, green urban area campaigns are taken up in the cities and towns of Gujarat.

New Delhi, the capital of India, is one of the greenest capitals due to its consistent emphasis on growing more trees. The Municipal Corporation of Delhi maintains nearly 14,000 parks, while Delhi Development Authority has many parks, city forests, biodiversity parks, and other green belts. Delhi Ridge (about 6,000 ha) is entirely under low forest and scrub cover.

Chandigarh, a Union Territory, incorporated tree planting in its urban plan at the very outset. It has turned out to be one of the greenest cities in India. Sukhna Lake, Rose Garden, forests and tree cover and its ecofriendly environment make it an evergreen city. Naya Raipur in Chhattisgarh aims to become a model city with the target of 27% green cover, planting eight crore saplings under the “Harihar Chhattisgarh” mission.

TREE SPECIES FOR URBAN AREAS

No hard and fast rule can be laid down for selection of species and spacing of urban plantations. The species selected must depend on climate, soil types, and local conditions within an urban area. For example, waterlogging prone areas need species that can adapt to high moisture levels. In gardens, along lakes and rivers, long living tree species should be planted. Laying pipes along streets is a regular phenomenon in our cities, thus, small to medium-sized species should be selected, which do not interfere with this system. Gulmohur *Delonix regia*, Jacaranda *Jacaranda mimosifolia*, Amaltas *Cassia fistula*, Kachnar *Bauhinia variegata*, Pink Cassia *Cassia javanica*, Queen’s Crepe Myrtle *Lagerstroemia speciosa*, Copperpod *Peltophorum pterocarpum* are important flowering trees for urban areas in the semi-arid zone. Air Pollution Tolerance Index (APTI) is highest for Neem *Azadirachta indica*, making this species most suitable as a sink for air pollution in cities having low to moderate rainfall.



Bakul fruit attracts birds and squirrels



Bakul *Mimusops elengi* has fragrant flowers in abundance



Peepul *Ficus religiosa* in the city provides shade and shelter to all

In dry zones, the following trees do well: Neem, Amaltas, Imli *Tamarindus indica*, *Ficus* spp., Black Sirish *Albizia lebbek*, Arudosa *Ailanthus excelsa*, Babool *Acacia nilotica*, Karanj *Pongamia pinnata*, Indian Elm *Holoptelea integrifolia*, Copperpod, Queen’s Crepe Myrtle, Gorakh Imli *Pithecellobium dulce*, Mango *Mangifera indica*, Gulmohur, Asopalav *Polyalthia longifolia*, *Eucalyptus* sp., Amla *Emblica officinalis*, *Terminalia* spp., Pink Cassia, Sheesham *Dalbergia sissoo*, Champa *Michelia champaca*, Red Silk Cotton *Bombax ceiba*, Devil’s Tree *Alstonia scholaris*, Putranjiva *Putranjiva roxburghii*, Kachnar *Bauhinia purpurea* and *Bauhinia variegata*, and Palash *Butea monosperma*. In the cities of central and south India, Teak *Tectona grandis*, Axlewood *Anogeissus latifolia*, and *Terminalia* spp. are common.

In waterlogged areas, along rivers, lakes and in gardens, Jamun *Syzygium cumini*, Banyan *Ficus benghalensis*, Peepul *Ficus religiosa*, and Babool are important species. Rain tree *Samanea saman*, Kadamba *Anthocephalus cadamba*, Asoka *Saraca asoka*, Red Silk Cotton, Kaim *Mitragyna parvifolia*, and Mahogany *Swietenia mahagoni* are suitable in moderate to high rainfall areas.

CONCLUSION

Numerous concepts and methods have been tried to accommodate the growth of cities without impairing sustainability – the Green City Concept is best of all. The theory of sustainability reconciles social equity, economic growth, and environmental preservation with city development. The world is learning more about the impact of green space and climate change on humans, which has led to green spaces being featured more prominently in urban planning. The benefits of urban greening are numerous. It is fundamental to the

quality of life of residents, and as such, urban planning includes strategies directly or indirectly related to greening. Though the role of tree cover is well-known to generate positive effects such as cooling, particle trapping by tree canopy, reducing pollution, runoff reduction, and function as ecological corridor, it is yet to get priority as a core area of urban planning. Though trees are the first victims of infrastructure expansion in urban areas, laws and institutions for the protection of trees have not kept pace with increasing developmental pressures. A fundamental reform in the law is needed, to comprehensively protect trees, especially heritage trees in an urban landscape.

Sustainable Development Goals adopted by the global community in 2015 can be reached through sustainable management of urban green space. Unplanned urban growth without adequate green space threatens to undermine the achievement of these goals. Strategic urban forest governance requires the recognition of the value of ecosystem services delivered by urban forests and tree cover, and the adoption of nature-based solutions as strategic governance tools for improving urban places while reducing the cost of city management. Strategic urban forest governance also requires sound knowledge management and collaboration between the municipality and relevant knowledge institutions, to ensure that urban forests are recognized as integral parts of city infrastructure. The effective governance of urban forests requires policies and laws aimed at harmonizing the range of interests in urban land by developing and strengthening a common vision and collaborative actions for green infrastructure in and around cities. Also, each city or town should develop its own plan to green its landscape.

Based on landscape ecological principles, the city planner should establish how to create an urban green space to achieve long-term sustainability. In recent years, the Green Factor tool has been adopted by some cities to increase the share and effectiveness of green areas. Green Factor tools such as policy, legislation, guidelines, and the government resolution, offer support to the planning of green areas. There is greater need to involve planners, developers, and policy makers to lay down effective policies to deal with issues like urban forestry and conservation of urban biodiversity. Every climatic zone should develop technical guidelines for urban silviculture, in terms of site-specific selection of trees, seedling quality, plantation techniques, pruning, shaping the canopy, treatment of diseases and related protocols.

ACKNOWLEDGEMENT

All photographs reproduced courtesy of Dr Ashok S. Kothari.

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Ethnobotanical Study of Plants Used in Indian Festivals

Text and Photographs: Vijaya Chakravarty



Ash gourd is used ritually to represent the human head

“Celebrations are punctuation marks that make sense of the passage of time. Without them, there are no beginnings and no endings. Life becomes an endless series of Mondays,” says David Campbell of the Center for Creative Leadership, USA. With its diverse cultures, India has a galaxy of festivals – celebrations where culinary skills, artistic abilities, traditional attire, and religious rituals are showcased. Festivals often speed up economic activity, as seen during Dussehra, Divali, and Christmas, even in Covid times.

Plants have always been at the centre of many festivals, and religions have shared an intimate relationship with plants from time immemorial. In the Amazon, the Indian subcontinent, and China, where there are over 60,000 plant species, the connection is far more intimate than in the Middle East, where the number of plant species is far smaller due to the arid environmental conditions. In almost all religions, plants are used in rituals, festivals, and other traditional practices.

Human history and human future on this planet are both deeply connected with plants. Early in the history of humankind, plants began to be considered sacred, as offerings to the gods and as a gateway into the next world. This helped in their conservation, particularly in traditional sacred groves which were largely protected by the community. Studies on indigenous people and their belief systems is necessary to understand how they use plants, and the role their belief systems played in environmental conservation.



Bilva fruit and leaves are offered during the Hartalika festival

Ethnobotany is the scientific study of the interrelationships of plants and people, with special reference to religious festivals, medicine, economy, architecture, and culture. Ethnobotany is multi-disciplinary, encompassing natural and social sciences like archaeology, pharmacology, zoology, economics, sociology, linguistics, botany, and anthropology. The last three disciplines are essential, as knowledge of the indigenous culture, language, and ability to identify plants is critical in an ethnobotanical study. The term ethnobotany was coined by the American taxonomic botanist John W. Harshberger in 1895, but it was half a century later, in 1941, that ethnobotany was made popular by the father of modern ethnobotany, Richard Evans Schultes, who travelled far and wide in the Amazonian region and researched the ethnobotanical practices of the Americas. In India, S.K. Jain of the Botanical Research Institute of India was a pioneer in ethnobotanical studies in the various regions of this vast country.

“In the traditions of every culture, plants have been highly valued for their nourishing, healing, and transformative properties. The most powerful of those plants, which are known to transport the human mind into other dimensions of consciousness, have always been regarded as sacred,” said Schultes. Two such hallucinogenic plants, Haoma and Soma, were used by the Zoroastrians and Vedic Hindus respectively, to communicate with their gods and ancestors. The Haoma plant has been identified as a member of genus *Ephedra*, but Soma continues to be a mystery. Poppy *Papaver somniferum*, species of *Datura*, and

cannabis *Cannabis sativa* and *Cannabis indica*, are a few of the many hallucinogenic plants used in rituals.

In the course of time, plants replaced animals and humans as offerings to the gods. Human sacrifice was common in ancient times, and was replaced by animal sacrifice during festivals like Bakr-Eid and Kali Puja, and later these too were replaced by offerings of plants, such as ash gourd and coconut, which roughly denote the human head. Thus, the use of plants during festivals became widespread. The species of plants offered had culinary, nutritive, and medicinal value, and other uses.

Festivals fostered several traditional conservation practices. Children were taught by their elders to identify certain plants and learn their uses. Many of these plants were cultivated at home for convenience. Children thus learnt agricultural practices while tending these plants at home. The traditional vegetables used to celebrate Rishi Panchami were wild foods like tubers, berries, and tree leaves. Foraging, a survival skill that is taught to commandos, was picked up by children from their elders. Bonding between grandparents and grandchildren strengthened during these foraging trips. Today, many of these plant skills are sadly lost. It is now necessary to introduce these plants into urban gardens, to conserve them and enable city dwellers to learn their culinary, medicinal, and other properties.

Among the prominent rituals connected with plants is the Vat-Savitri festival which falls in the



Bishnoi women faced a royal army to protect khejri trees

hot summer month of *Jyeshtha*, and is celebrated around a banyan tree *Ficus bengalensis*. Women worship the tree and spend the day under its shade, singing, dancing, and bonding with each other, away from their daily chores. Many cultures across the world consider the banyan as sacred, probably because of its immense size, the way the aerial roots grow into new trees, and for its longevity. The late Mr S.P. Godrej, past President of Friends of Trees and a dedicated conservationist, advocated the planting of banyan, a keystone species among Indian trees, to enrich the environment.

Hartalika festival, celebrated in August, is also associated with sacred trees. Women offer the leaves, flowers, and fruits of bilva *Aegle marmelos*, banana *Musa indica*, and shami *Prosopis cineraria* to Lord Shiva. The leaves of all these three trees have medicinal properties. The shami or khejri tree, on which the Pandavas hid their weapons during their wanderings in exile, is the *Kalpavruksha* of Rajasthan, as it provides shade, food, fodder, and timber. The first eco-

feminist movement in India began in the year 1730 around this tree, when the Maharaja of Jodhpur wanted to cut down khejri trees for timber to build his new palace. The women of the village, led by Amrita Devi, confronted the soldiers and prevented them from chopping the trees, which led to the massacre of 363 people. Finally, the king relented and issued a decree to stop the felling of khejri trees. Almost 250 years later, the Chipko Andolan – a movement opposing deforestation in Uttarakhand – was inspired by the “Khejrali” massacre of 1730.

Ethnobotanical studies help us to locate the history, politics, and culture of a region. The celebrated Ganesh festival started out as a religious event, and then during the struggle for Independence, it acquired a political flavour. Today, it is more like a social event where people gather, greet each other, and are entertained by music, dance, drama, and other cultural events. Worshipping Lord Ganesha with 21 leaves is very popular in the states below the Vindhya. The offerings are from diverse plants: tiny ones of the ground-hugging herb



Flowers are an essential part of Indian cultural traditions

bhringaraj *Eclipta alba*, leaves of the towering peepul *Ficus religiosa*, fruit trees like mango *Mangifera indica*, and the tiny sour berries of ber (jujube) *Ziziphus jujuba*, poisonous kaner *Nerium oleander*, and the thorny kevda or ketaki *Pandanus odoratissimus*, along with fragrant jasmine *Jasminum* sp. Biodiversity itself is celebrated and every plant, small or large, poisonous, thorny, sweet or sour, is offered equally and without discrimination.

The Monthi festival of Mangaluru which marks the birthday of Mother Mary, the Onam festival of Kerala, and Bathukamma of Telangana, are all flower festivals, where women and children collect flowers from the neighbourhood and make artistic rangoli-like floral arrangements. Many of the flowers traditionally used, like thumba *Leucas aspera*, terda *Impatiens balsamina*, and tangedu *Cassia auriculata* are disappearing due to degradation of forests. Attempts are now being made to cultivate these flowers in home gardens and public parks. Bathukamma has been declared the State festival of Telangana, leading to the revival of these traditional practices. During the Monthi festival and Onam, several local greens and gourds are cooked; this keeps the local cuisine alive. The festival of Onam links the cultural past of Kerala to the current cultural practices of the state, and is celebrated by all Malayalis, irrespective of religion. Kerala art, dress, cuisine, and nature are all showcased, and this has helped create a contemporary identity for Keralites. These three flower festivals celebrate nature, biodiversity, and medicinal knowledge through the resilience and enthusiasm of women

who actively contribute to traditional and sustainable ecological practices.

Did you know that the bilva leaf is linked to the introduction of the Modi script of Marathi. It is said that King Ravana and his family would visit Mahabaleshwar Shiva temple in Gokarna. A frightened Brahmin, who hid in a basket of bilva leaves when he saw the gentle giant Vibhishana, was accidentally transported to Lanka where he learnt the Modi script. When he returned to Gokarna, he taught the script to the local people; later Chhatrapati Shivaji Maharaj introduced the

Modi script for Marathi, and its use continued till Independence when it was replaced with Devanagari.

Ethnobotanical studies are of paramount importance as traditional knowledge of medicinally useful plants has led to the discovery of many modern life-saving drugs. Two examples that immediately come to mind are quinine for malaria, and reserpine which is extracted from *Rauwolfia serpentina* and used to treat neurological disorders. According to the archaeologist Bruna Rocha, the death of an elder, a shaman or vaidya, is akin to the burning down of huge libraries, national museums, and parliaments, as a humungous body of information, learning, and knowledge is gone with them, lost to the world forever. Besides being treasure troves of knowledge on the environment, history, culture, nutrition, and medicine, these revered elders also provide political and spiritual guidance to society at large.

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Neem leaves are medicinal and add subtle flavour

Thoughts on Trees and Other Plants

Hashim Mirza

GAYATRI UGRA

As I sit in my balcony this morning, I observe the trees more closely, marvelling at the diversity of the foliage all around me. Each tree is so distinct from the other, its shape, foliage, canopy, colour, and shape of the leaves all fulfilling a distinct purpose in a marvel of design, even the shades of green more diverse than I have ever noticed, never having bothered to pay so much attention earlier. This was all because I attended a wonderful webinar by Vijaya Chakravarty of the Friends of the Trees, on wild edible plants vital for sustainability. Even for a neophyte and layman like me, it was gripping as she wove her stories with personal anecdotes, legends, and history, drawing from her wide range of experiences. It was an eye opener for me, to the richness of our biodiversity, so vital to our survival as a species, which is under threat due our own short-sightedness and over reliance on a few species, to the exclusion of the rest.

We are frittering away our natural heritage, a treasure trove of abundance that we have been gifted with. She held us spellbound and captivated us for over an hour, with her easygoing style weaving her stories and drawing us in, captivating us with trivia that underscored the depth of her knowledge and experience. She talked about the more than 10,000 varieties of rice and paddy that are in danger of being lost, as the next generation can scarcely name one. She spoke about ancient traditions like that at Jagannath temple in Odisha, where fresh paddy is part of a daily offering, and how this has ensured a diverse variety of paddy to be planted. How traditional remedies are being repackaged at the altar of commercialism, with our children turning their noses up at *haldi doodh*, but hankering after the trendier “turmeric latte”.

I learnt from her talk how hardy species like mangroves are essential for soil conservation; how traditional species like moringa or drumsticks are now being touted as the new wonder food; how the practice of offering “chhappan bhog” originated, as a bow towards the diversity in our cuisine. Even contemporary stories about cooking sambar, when a neighbour objected to the strong spicy aroma, linking

it with a similar tale of the curry revolution in Singapore, found so much resonance with me. Tales of her grandmother and father, and the conventional wisdom passed on from one generation to another, now in danger of dying out – how simple recipes with leaves like neem lend such a unique flavour to our food; how her interaction with tribals led to a rediscovery of almost forgotten treasures like kantola, mahua, and more.

In our quest for globalization we have neglected the value of hardy homebred species, in favour of more exotic foreign ones, and traditional grains like ragi and millet are not given as much attention as the latest fad, quinoa. For while the focus of conservation has been on protecting our wildlife, it has unintentionally become less intensive towards so many species of traditional herbs, shrubs, and trees, which are all fighting a losing battle against extinction. They have been sacrificed at the altar of commerce and convenience. and we have failed to notice that the loss is completely ours, and a monumental loss at that.

The wisdom of our ancestors, who had an intimate connection with Mother Nature, has been forgotten in our quest for a quick fix, as we conveniently miss the wood for the trees, hurtling blindly towards a path of destruction and doom. I salute people like her who are trying to make a dent on our consciousness, to awaken us from our slumber before it is too late, they are a veritable treasure and may their tribe increase. 🌿



GAYATRI UGRA

The fruit of Amla is high in vitamin C

Microgreens

Window Farming for the Urban Dweller

Text and Illustrations: Behnaz Bomi Patel

The history of mankind saw an unexpected and bizarre occurrence in the year 2020. Man, who wrongly believed that he is master of the planet, fell victim to a virus – Covid-19. And before we could react, we were in the midst of a global pandemic. No one, in their scariest nightmares, had imagined a world where one lives in continuous fear of infection, death, even no final rites! Yet, people adapted and endured this occurrence. And then we began to introspect on what we have done to ourselves, from the time we evolved into *Homo sapiens* – man the wise, to the present sad state.

It has been a long journey, from cave dwelling to living in a rural or urban set up, from hunting-gathering to cultivation of food. Man has also been responsible for several revolutions – the industrial revolution, the blue, the white, and most importantly, the green revolution, with the modernization of agriculture and creation of high yielding varieties of seeds. Sadly, with these advancements, especially in the last 50 years, our lifestyle has become more sedentary. We have also proved that we may call ourselves *sapiens*, but are foolish enough to become slaves of our own inventions.

Another unfortunate change is in our food habits, with an increase in the use of sugars, refined flour, antibiotics, artificially coloured, flavoured, and preservative laden food, fast food and junk food, in place of fresh home-cooked unadulterated fruits, vegetables, and cereals.

The condition of our planet today is indeed pathetic! Millions of people are struggling to feed themselves in developing countries, where there is malnutrition and starvation. On the

other hand, a sizable population is struggling to stop overfeeding itself. Both these populations are struggling to survive. The overfed population suffers from several chronic degenerative age and lifestyle related diseases like obesity, which is spreading like an epidemic, with an estimated 86% of the population on the way to becoming obese by 2030! Our dietary practices are responsible for the prevalence of cardio-vascular diseases, cancer, diabetes, osteoporosis, and the list goes on. World health agencies across the globe have recommended a reduction in the consumption of refined sugars, sodium, and alcohol, and an increase in complex carbohydrates, and dark green vegetables.

Considering our present lifestyle, with no time for our own health and wellbeing, it would be difficult to go back to past dietary habits. However, we can supplement our diet with healthy food which we can grow ourselves, irrespective of where we live or how busy we are, even in an urban setup, by spending 30 minutes a day, in a balcony, windowsill, or grill, with sunlight for about three to four hours a day, or in artificial light in a corner of the living room, dining room, or kitchen! The crop would be ready to harvest in about 10 days from sowing, and even if the crop fails we don't lose much! We would have the joy of growing what we should eat – a harvest rich in nutrients, unexposed to harmful chemicals and pollutants, straight from the window farm to the table – the solution lies in microgreens!

UNDERSTANDING MICROGREENS

Though the term is recent, possibly coined as a marketing gimmick, we have been consuming microgreens all along, as an integral part of our diet, in dals, curries, vegetables, and even snacks like pakodas. Microgreens are the seedlings

of vegetables and herbs, harvested at the two to four true-leaf stage. Several edible plants, most importantly of the families Brassicaceae, Fabaceae, Cucurbitaceae, Apiaceae, Asteraceae, Lamiaceae, Chenopodiaceae, Amaranthaceae, and Amarillydaceae, can be consumed as microgreens.

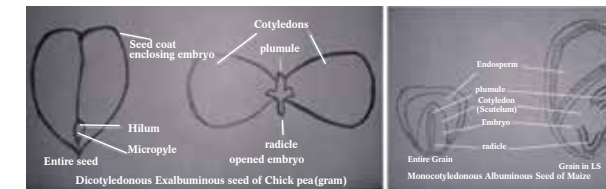


Fig. 1. Dicot and monocot seed structure

The life cycle of a sexually reproducing flowering plant begins with the seed. The seed (Fig. 1) comprises the embryo enclosed in a protective seed coat. The embryo comprises an embryonic axis and one or two cotyledons. Accordingly, it is a monocotyledonous or dicotyledonous seed. The embryonic axis contains the root primordium (radicle) at one end, and a shoot primordium (plumule) at the other. The embryo may or may not be accompanied by nutritive tissue – the endosperm – and the seed is said to be albuminous (endospermic) or exalbuminous (non-endospermic).

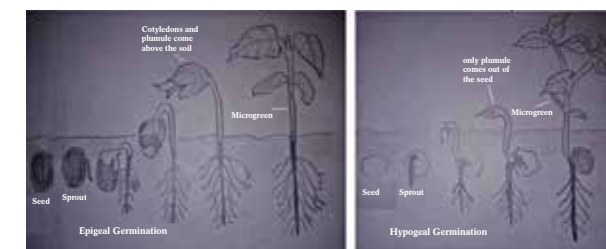


Fig. 2. Seed, sprout, and microgreen stages during epigeal and hypogeal germination

A seed sown under suitable conditions imbibes water and germinates or sprouts (Fig. 2), by the emergence of the radicle, and then the plumule, with (if germination is epigeal) or without (if germination is hypogeal) the cotyledons. In exalbuminous seeds, the cotyledons supply food to the growing seedling; in albuminous seeds the endosperm supplies food to the germinating seed and seedling. The first true leaf or leaves emerge, and this stage is termed microgreen, which is followed by the *petite* or baby green stage, and the mature vegetative stage. The reproductive stage, which follows the vegetative stage, comprises the flowering and fruiting stages. In most plants, the nutritive value of the shoot is at its peak at the microgreen stage, higher than that of the sprouts or mature leaves!

Microgreens are an important part of the rituals of Asian countries. Plant offerings to deities were made in several ancient cultures, where tradition and ritual revolve around useful and medicinal plants. Plants with high nutritional and medicinal properties were revered in ancient times, to ensure their regular use and to prevent their extinction. Microgreens too found a place in these traditions, signifying their high nutritive value. In India, during the Navaratri festival, *sapta-dhan*: barley (*jau*), sesame (*til*), wheat (*gehun*), rice (*dhan*), green gram (*moong*), foxtail millet (*jwari*), and chickpea (*channa*) are sown on the first day of the Navaratri Pooja and the seedlings (microgreens) are ritually offered to the goddess on the last day. Similarly, in Central Asia where Navruz or New Year is celebrated on the day of the spring equinox, seven types of pre-soaked seeds (barley, wheat, lentil, moong beans, red bean, chickpea, and watercress – representing the seven *Ameshashpents* are sown seven days prior to the New Year, and these microgreens called *sabjeh* (a symbol of rejuvenation and spring) are laid on the Haftsin table along with other offerings. *Valutil methi* is often added to dals or mixed with besan and spices, fried and consumed as pakodas or added to chapati dough.

In the 1980s, microgreens entered fine dining, mainly as visually attractive and flavourful ingredients. They were used by chefs to garnish salads, soups, sandwiches, and even to serving plates to add appeal. The flavour, generally being stronger than that of the mature plant, was highly appreciated and microgreens became popular.

Studies by several universities and United States Department of Agriculture (2012–14) have proved that microgreens are supercharged with nutrition, because of which they have an important place in our diet. They are claimed to possess anti-cancer; energy boosting; hormone, blood and organ health promoting properties; they are richer in nutrition than the seeds, sprouts, petite greens, and mature leaves.

Nutritive Value and Health Benefits of Microgreens vs Seeds, Baby Greens, and Mature Leaves

Seeds

Stored within the seed is the food required for germination, in the form of proteins known as SSPs (seed storage proteins), stored carbohydrates (starch), or fats (oils), vitamins, and minerals. This reserve is stored in the cotyledons in exalbuminous seeds and in the endosperm in albuminous seeds. SSPs provide nitrogen and sulphur for the

germinating seedlings, and also dietary proteins for man and cattle. They have no enzymatic function, and are mobilized during germination, serving as a source of reduced nitrogen. Many seed storage proteins are from tissue specific genes expressed exclusively in embryos, e.g., soybean β -conglycinin gene (Chen *et al.* 1989), β -phaseolin gene (Bustos *et al.* 1989), *napin* and *cruciferin* genes from rapeseed (DeLisle & Crouch 1989). Some seed storage proteins accumulate solely in endosperm tissue, such as wheat *glutenin* genes (Colot *et al.* 1987). In order that the stored food is not wasted by being respired away prior to germination, the seeds remain dormant until germination.

Germination

When a viable seed is sown in optimum conditions (water, oxygen, required temperature), its dormancy is broken and it germinates. On imbibing water and becoming metabolically active, respiratory rates increase and hydrolytic enzymes are synthesized, resulting in hydrolysis of stored starch, lipids, proteins, hemicellulose, polyphosphates and other storage materials into simple form for uptake by the embryo. Likewise, the SSPs get hydrolyzed into free amino acids which are used for protein synthesis. Inorganic nutrients like calcium, magnesium, potassium, phosphate, stored in seeds as phytin, are liberated during germination by the activity of enzymes like phytase. All these are available on consumption. Next, the radicle emerges, and this is the sprout stage.

Sprouting

Sprouts are rich in essential nutrients, and an excellent source of amino acids. They high-fibre, low-calorie, and easy to digest, and therefore excellent food for weight loss. Sibian et al. (2017) reported that cereal sprouts tend to contain higher levels of essential amino acids, with certain amino acids increasing by up to 30%. According to Singh et al. (2015), anti-nutritional factors are reduced during germination, increasing the availability of minerals from the cereals. Sprouts are a great source of anti-oxidants and other beneficial compounds (Tang *et al.* 2014). However, one must be cautious in consuming them. At home, sprouting is done in an overcrowded, humid environment, which may encourage the growth of bacteria and fungi, which were probably present on the seed coat. One must be careful of such contamination.

Young seedlings

If sprouts are allowed to grow unhindered, they develop into seedlings, reaching the stage known as

microgreens. The radicle or young root continues to grow, and simultaneously the plumule emerges from the seed, along with the cotyledons in epigeal germination [cotyledon(s) coming above the soil]; or just the plumule, in hypogeal germination [cotyledon(s) within the seed]. On exposure to light, the plumule develops chlorophyll and can assimilate its own food through photosynthesis. Until this stage, the seedling sustained itself on the reserve food in the seed.

The United States Department of Agriculture (USDA) in its Agriculture Research magazine of January 2014 published an article titled “Speciality Greens Pack a Nutritional Punch”, in which were reported studies based on testing 25 microgreens. The findings highlighted that microgreens contained levels of vitamins and carotenoids about five times higher than their mature plant counterparts, showing that microgreens are super foods. They also demonstrated that the highest concentration of vitamin C was present in microgreens of red cabbage, of carotenoids in cilantro (coriander), vitamin K in garnet amaranth, and vitamin E in green daikon radish.

Comparative nutritive analysis of microgreens with their sprouts and/or mature leaves has revealed that microgreens are an excellent source of phytonutrients. Xiao *et al.* (2012) and Sun *et al.* (2013) found them to be a good source of vitamins, carotenoids, and polyphenols. Pinto *et al.* (2015) showed that two-week old microgreen lettuce *Lactuca sativa* var. *capitata* had higher content of many the minerals [calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn), selenium (Se), molybdenum (Mo)], and phytonutrients (ascorbic acid, β -carotene, α -tocopherol, phylloquinone) than mature 10-week old lettuce. An analysis of 30 cultivars of *Brassica* microgreens by Xiao *et al.* (2016) revealed that they are good sources of the macro-elements potassium (K) and Ca, and microelements Fe and Zn.

Sun *et al.* (2013) found 165 phenolic compounds, comprising many highly glycosylated and acylated quercetin, kaempferol, cyanadin aglycones; and complex hydroxycinnamic and benzoic acids in five microgreen cultivars of the genus *Brassica*. They reported a greater variety of polyphenols in the microgreens than in their mature leaves. Xiao *et al.* (2019) also revealed that *Brassica* spp. are excellent sources of ascorbic acid, phylloquinone, carotenoids, tocopherols, glucosinolates, and polyphenols.

Kyriacou *et al.* (2016) reported that basil and Swiss chard microgreens are excellent sources of K and Mg; purple basil is particularly high in ascorbic acid and green basil and coriander are excellent sources of beta-carotene and total polyphenols. Klopsch *et al.* (2018) showed that the nutritional value of bread can be enhanced by adding pea and lupine microgreens to the dough. Carotenoids and chlorophyll values declined on baking, but the flavonoid levels were maintained, besides a significant pheophytin formation occurred.

Baby Greens or Petite Greens

Like microgreens, the term baby greens does not have a formal definition, it too is a marketer’s creation. It can be said that baby greens are leafy vegetables harvested before they are fully grown into mature plants. They are rich in nutrients, yet lower in nutritive value than microgreens. *Brassica* species like radish (leaves), kale, and rocket salad, and Asteraceae like lettuce are consumed as baby greens.

Mature Leaves

These are generally less nutritive than microgreens, but Klopsch *et al.* (2018) found that the concentration of carotenoids was higher in mature leaves of pea and lupine than in their microgreens. Similarly, de la Fuente *et al.* (2019) reported that mature leaves of kale and mustard had higher ascorbic acid than their microgreens.

Plants that can be consumed as microgreens

The stage at which various plants are harvested for human consumption can be conveniently divided into 1) sprouting stage, 2) microgreen stage, 3) mature leaf stage (along with flowering and tender fruiting stage), and 4) seed stage. All of the following can be used as microgreens too:

- **All sprout crops**
 - o Legumes (family Fabaceae) – some Fabaceae commonly consumed as microgreens are moong, chavli, french beans, green peas, chickpea, and fenugreek. Beans and peas (groundnut not preferred) provide vitamins B2, B6, C, and several minerals. Fenugreek microgreens contain potassium and iron. Chickpea microgreens are a good source of vitamin K.
 - o Cereals (family Poaceae) – wheat, barley, maize.
- **Leaf, flower, and tender fruit crops**
 - o Brassicaceae: Crucifers radish, cabbage, cauliflower, broccoli, Brussels sprouts.

- o Cucurbitaceae: Melons, cucumber, gourds.
- o Apiaceae: Carrots, coriander, dill, fennel, all rich in vitamins A, C, and K, and carotenoids; minerals like Ca, Fe, and P (Phosphorus).
- o Asteraceae: Lettuce, a rich source of vitamin A, carotenoids, and antioxidants.
- o Lamiaceae: Tulsi, basil.
- o Amaranthaceae: Amaranth, rich in vitamin C, beta-carotenes, and neo-xanthin.
- o Chenopodiaceae: Spinach, beet microgreens have a sweet earthy flavour, excellent source of vitamin B6, folate, vitamin C, Mg, K, and dietary fibre.
- o Liliaceae: *Allium* sp. (onion and garlic).
- **Seeds consumed as condiments and spices**
 - o Mustard (Brassicaceae).
 - o Coriander, dill, fennel, cumin (Apiaceae).
 - o Basil (all types like tulsi, sabja, Italian basil), chia (Lamiaceae).

Important: *Members of the tobacco family Solanaceae cannot be consumed as their microgreens are toxic to man – e.g., tomatoes, brinjal, potatoes, chillies, and capsicum.*

WINDOW FARMING

Microgreen farming was probably the first project at preprimary school, when we soaked chickpea seeds overnight and placed them in a shallow dish lined with moist cottonwool, with tissue paper over them, covered them with another dish and left them in the dark till the seeds germinated. The geminated shoots were yellow – when exposed to sunlight, they turned green. We proudly carried the seedlings to school. And this is exactly how to grow microgreens, with a few modifications in the protocol, to get a bumper harvest. They are the easiest to grow, require low maintenance, little time (a maximum of 21 days), and less space. However, the seedlings are fragile, and rate of respiration is higher. So, if not tended properly, their nutritional quality is affected. They require tender loving care!

Requirements

The basic requirements for growing microgreens at home are containers, medium, water, light, and most importantly, viable seeds.

1. Containers: Since harvest will be at the two-to four-leaf stage, the container need not be deep. Any shallow dish or tray would suffice, like reused trays from fruit packaging, hanging baskets, coconut shells, ceramic or plastic mugs. Care should be taken to make enough holes in the



Fig. 3. Improvised containers for growing microgreens at home

container for drainage, to prevent water-logging, fungal contamination, and decay. A tray or a basket with net would also suffice. Trays for growing microgreens are available in the market. Microgreens can also be grown in pots which already have large plants, where the top soil receives sufficient sunlight for the plantlets (Fig. 3).

2. Medium: The seed contains all the food required from germination to the seedling stage, so one may presume that microgreens can be grown in water, and the solid medium would merely provide anchorage. However, this is not always so – microgreens are found to grow better in organic media (Xiao *et al.* 2012). Though microgreens, by and large, have higher levels of nutrition than mature leaves, much variation in the level of various nutrients has been observed, depending on where they are grown, when they are harvested, and the soil medium used. Soil, or soilless media like cocopeat, perlite, rock wool, absorbent cotton, cardboard, or tissue paper, can be used.

3. Soil: is the tried and tested medium, and can be used for microgreens. It should be free of other seeds, and it is better to bake it in an oven, or leave it out in the sun for a few days before sowing. To prevent fungal growth, the soil should be loamy but not soggy, with organic manure like cowdung. Pea, sunflower, buckwheat, beet, coriander, lentils, and moong microgreens do well in soil.

4. Soilless media: A variety of natural and artificial media are available.

Perlite is lightweight, provides aeration and optimum moisture retention for superior growth of microgreens. It is always at a neutral pH and free of weeds.

River sand has all the benefits of perlite, except that it has low water holding capacity.

Coco peat which is a waste product of the coconut industry, is made by powdering coconut

fibre and husk, and compressing it into cakes. To use it, the block is placed in water till it swells and becomes fluffy. It has good water holding capacity, and also high oxygen capacity. It is lightweight and can be mixed with any manure for better results.

Absorbent cotton, cardboard, and tissue paper can be used as media. Tissue paper is ideal for very small seeds like those of chia, tulsi, sabja, and basil. Researchers have reported combinations of various media for enhancing the growth and quality of microgreens. Muchajib *et al.* (2015) found that equal parts by volume of coconut coir dust and peat gave the highest yield for spinach microgreens, while equal parts of coconut coir dust and sugarcane filter cake gave maximum yield for radish and mustard microgreens. Gioia *et al.* (2017) reported a 15% higher yield with peat and recycled textile fibres or jute and kenaf fibres, as against the popular synthetic medium Sure-to-grow®. Coco peat or coir dust, soil, and cowdung manure in equal parts by volume was reported by Polash *et al.* (2019) to give better germination, longer shoot length, upright plants, and tougher stalk in various microgreens. In general, sprouts (ready in 3–5 days) need only water to germinate, while microgreens absorb nutrients from the soil, such as minerals to strengthen the cell wall and for growth and development. Cowdung manure also helps to attain optimal water holding capacity and to promote root penetration.

Growth mats made from natural and synthetic materials like coir, hemp, wood, bamboo, jute, and rockwool have become popular. They are cut to size and used in trays to grow microgreens. Hydroponics systems are used in such cases, which are ideal to use with soilless media. The major advantage of using a growth mat (pad) is that it is cleaner than soil and chances of mould infection are lower. Harvesting too is easier. Table 1 gives a comparative account of the various properties of growth mats.

Table 1. Media for growing microgreens and their properties

Medium	Type	Cutting to size	WHC	Ideal for (seeds)	Not suitable for	Taste Alter/Smell	Decomposable
Coir	Natural, sturdy	Difficult	Good	Small	Large seeds	Yes	Takes time
Hemp	Natural	Easy	Okay	Large	Small seeds	Yes	Very easy
Wood	Sustainable	Fragile when wet	Okay	--	--	No	100%
Bamboo	Natural, no binders	Easy (soft as cloth)	High	All	--	No	100%
Jute	Natural, no binders	Messy	Very high		Reuse, else expensive	No	100%
Rockwool	Melted igneous rock, no chemicals	May be uneven	95%		Growth slow, mould likely	No	No

5. Water: Absorption of water helps seeds to start metabolic activities, leading to germination. Further, when sufficient water is available, plants can remain turgid. The seedlings are delicate, and heavy watering would destroy them, so a sprayer (Fig. 4) is ideal to water the soil. The frequency of watering depends upon the weather and the medium used.



Fig. 4. A sprayer for watering

Alternatively, a self-watering wick system can be developed (Fig. 5). The wick is immersed in a trough below the shallow tray, and water rises by capillary action. The wick should not be left permanently in the water trough; excess water should be drained off, to prevent water logging and to ensure proper aeration in the roots. In the self-watering system, one can use a netted tray lined with growth pads.

The roots would pass through the medium pad, enter the nutrient solution below, and imbibe the water along with dissolved nutrients.



Fig. 5. Preparing the container – a shallow tray as a self-watering system

6. Light: It is not just the quantity of light, but also its quality (wave length) that is important in photomorphogenetic responses like seed germination. Seeds generally require a dark period to germinate. Once the plumule is above the soil, all plants require light for photosynthesis. The shoot bends towards light – phototropism also being a photomorphogenetic response.

Natural sunlight is the cheapest and best source, and should be available for three to four hours at least, following germination. If natural sunlight is not available, that is if the plants are indoors, regular artificial light or LED (light emitting diode) light can be used to grow microgreens. White light is considered the best, if monochromatic light is being used. Blue light gives better results than other wavelengths, and is important for increased leaf thickness and number of chloroplasts; it also keeps microgreens denser. The carotenoid zeaxanthin has been hypothesized to be a blue light receptor

for phototropism. Kopsell *et al.* (2014) proved that blue light helps to increase the phytochemical constituents of broccoli microgreens, thus improving their nutritional value.

7. Seeds: These can be procured from the kitchen or purchased from plant nurseries, or online. There are no separate or specific seeds for microgreens. When seeds from the kitchen are used, the germination may be slow or viability may be low, as it may be lost in prolonged storage. Seeds purchased from the market must be checked for viability date on the seed packet. One's own seed stock can be developed by planting a few seeds in the soil, waiting till flowering and seed set, and collecting the seeds. For all imported seeds, one must follow the official quarantine regulations.

Protocol
1. Preparing the container

Proper aeration of the roots is one of the most important requirements of seedlings. To prevent water logging, make holes in the base of the container. If a netted tray is being used, this step is obviously omitted. In a self-watering system, cotton twine can be passed through and the system prepared as shown in Figs 5 and 6.



Fig. 6. Preparing the container – coconut shell as a self-watering container

2. Sowing the seeds



Fig. 7. Soaking large seeds in water

Preparation: Wherever possible, seeds should be washed in running water by placing them in a vial or wide-mouthed bottle, covering the mouth with muslin cloth and placing the bottle under a running tap. Large seeds can be soaked in water to germinate prior to sowing (Fig. 7). Small seeds, e.g., those of family Lamiaceae (chia, basil, and sabja) should not be presoaked.

Some species of seeds have a dormancy period and do not germinate immediately. The dormancy may be physical in the form of a hard seed coat. Such seeds can be gently rubbed on sand paper – this is called scarification. If such seeds are not scarified, they take a little longer to germinate. The acids and microorganisms present in soil act upon the seed coat and break the dormancy. Some plant seeds have a physiological dormancy, which can be broken by temperature treatment or by soaking them in solutions of specific plant growth regulators.

Sowing in soil or coco peat and manure: (Figs 8 and 9) The medium is leveled and moistened with water, and the seeds are evenly spread on top by hand, or systematically with forceps, in rows and columns. Sowing density varies with the taxon. Avoid overcrowding, as that may attract mould. The seeds are next covered with a thin layer of cocopeat and pressed gently by hand. This is called blanketing. Alternatively, small cavities can be made in the medium and individual seeds sown in them. It is desirable to apply a weight or pressure with another tray on top for sunflower seeds. Blanketing is not to be done for small seeds like mustard and basil, as pressure from above would prevent their growth, or for seeds that require light to germinate, like lettuce and dill.



Fig. 8. Filling the container with cocopeat and manure



Fig. 9. Sowing large seeds

Sowing on tissue paper: Tissue paper is the preferred medium for very tiny seeds like those of chia or basil. Dry, pre-soaked, or even germinated seeds can be uniformly spread out on a dish or tray lined with tissue paper. Another sheet of tissue paper can be put above as a blanket, and moistened, which should be removed following germination. The seed tray should be covered with another tray as shown in Fig. 10, to inhibit light but allow gaseous

exchange, as oxygen is required for respiration, to generate energy for germination. This step, where light is inhibited from falling on the seeds, is termed the blackout period. Seeds like those of lettuce which require red light of 660 nm for germination, and dill seeds, should not be subjected to blackout period. The blackout period should be till plumule (hypogeal germination), or plumule and cotyledons, have emerged above the soil. At this time, having been deprived of light, they would be yellow.



Fig. 10. Blackout period, keeping newly sown seeds in darkness

Sowing on growth mats, cotton or cardboard: Seeds are spread on the surface, the medium is misted, and the seed trays are stacked one above another. The trays are checked daily for germination if presoaked seeds have been sown, or after three days followed by daily, if dry seeds were sown.

Watering: This is crucial, and must be done carefully and gently, preferably just a misting with a sprayer, as roots require air for respiration. Watering with a can would injure the seedlings. Overwatering would make the medium soggy and encourage fungal growth; less watering would dry out the seedlings. Watering can be done from beneath by capillary action. All extra water should be drained by emptying the trough below (Fig. 11).



Fig. 11. Watering by capillary action

Light: Once the seeds germinate, light is the most crucial requirement: ideally, natural sunlight

for about four hours per day. The commercially available LED plant light bulb contains grow-lights with 186 LED chips, with an optimal spectrum which promotes various stages of plant growth. It can be used for growing all types of plants indoors, from sprouts to microgreens, through vegetative growth, flowering, and fruiting. It can also be used for greenhouse plants, house plants, tropical and medicinal plants, with its three modes: (i) vegetative mode for seedlings, microgreens, and leaves; (ii) bloom mode, and (iii) fruiting mode.

Optimizing conditions to overcome problems
To enjoy a rich, nutritious harvest, it is essential to optimize cultivation conditions in a window farm.



Fig. 12. Non uniform vs uniform germination



Fig. 13. Yellowish seedlings in low light

1. Slow germination and non-uniform germination: Ideally, most microgreens should germinate in two to three days. For slow germinating seeds, pre-soaking often helps. For seeds like coriander, place them in muslin cloth and roll a rolling pin over them gently to break the fruit and release the seeds. Non-uniformity in germination (Fig. 12) may be due to variation in seed age or dormancy. It is essential to use good quality, viable seeds. A viability or germinability test can help to assess seed quality. Seeds like those of sabja, chia, tulsi, and flax have a mucilaginous coating which swells and gets sticky upon soaking, hence they should not be pre-soaked.

2. Yellowish seedlings: Extension of the blackout time till the cotyledons open, results in yellowish seedlings (Fig. 13), a condition easily overcome by merely placing them in light, which promotes the conversion of leucoplasts to chloroplasts. Maize microgreens can be harvested in five days while still yellow.

3. Fungal attack: This is a common problem and easy to avoid. (Fig. 14) Soggy soil, high humidity, bad drainage, poor ventilation, and overcrowding all encourage the growth of pathogens. Damping off disease caused by *Pythium* is a common problem in



Fig. 14. Fungal attack

seedlings. The spores of this fungus may be present on the seed coat. Surface-sterilize the seeds prior to sowing, by soaking them in 1% sodium hypochlorite for 5-10 minutes, then wash in sterile water.

4. Seedlings thin, drooping, falling over: If the blackout time is longer than required, the seedlings become leggy and tall (Fig. 15). This problem cannot be rectified, but one can learn to reduce the blackout time. Some growers prefer thin, tall, weak shoots. Insufficient light and/or water make the seedlings droop and fall over, starting with the central shoots, and going towards the periphery.



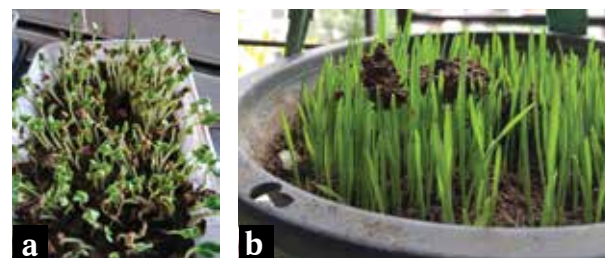
Fig. 15. Leggy, tall, and drooping seedlings



Fig. 16. Uneven growth

5. Uneven growth: Seedlings being taller on one side and shorter on the other indicate uneven lighting (Fig. 16). The pot or tray can be rotated everyday, so that all the seedlings get sufficient and even light.

6. Microgreens dirty at harvest: The outer seed coat or testa has been in contact with the soil. In epigeal germination, the seed coat may rise up, carrying soil with it. This may remain stuck to the testa (Fig. 17a). The seedlings too may carry the soil up with them as they germinate (Fig. 17b). If the seeds are not blanketed with coco peat or soil, this problem can be avoided, but it would affect the germination rate. Hence, it is always better to wash the harvested microgreens to remove dirt.



Figs 17a & b. Microgreens dirty at harvest time

7. Risk of contamination with E. coli: This risk increases with storage time; it is partly dependent on the type of microgreen, some being more susceptible than others. The source of contamination can be the soil or growing medium, or water supply. Some commercial growers use disinfectants like chlorinated water to prevent contamination; others rinse the microgreens several times following harvest.

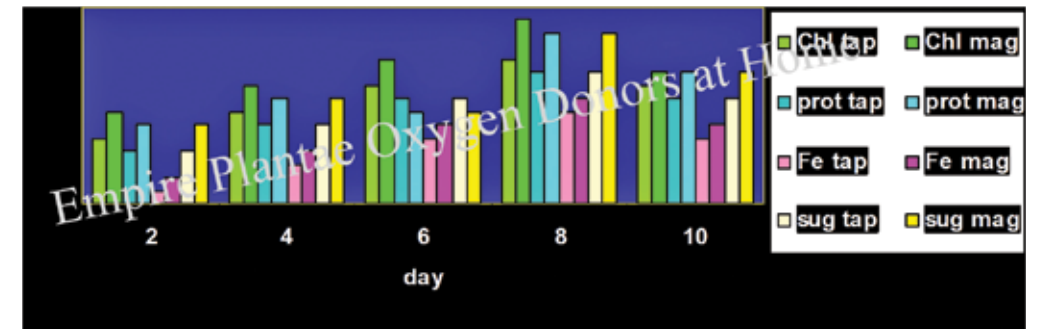


Fig. 18. Wheat microgreens are richest in nutrients on day 8 after germination

THE HARVEST

Microgreens are generally harvested at the seedling stage, when they are 2.5–7.5 cm tall, depending upon the choice of the consumer. The plants are snipped with scissors very close to the soil. There is no need to uproot them, as the roots are not consumed. The underground plant parts provide nutrition for future crops.

In epigeal germinators, seedlings are harvested at the cotyledonary stage, or the one or two (true) leaf stage, e.g., methi microgreens at the cotyledonary stage; moong at the two (true) leaf stage.

In hypogeal germinators, seedlings can be harvested even at the three (true) leaf stage. Microgreens of family Poaceae, like barley and wheat, are harvested at the jointing stage (at which the internodal tissue begins to elongate, forming a stem). In wheat, this is the 8th day after germination, and the microgreens are richest in all nutrients (Fig. 18). Among the monocots, maize microgreens grow fastest, being ready to harvest within 5–6 days following germination.

Post-Harvest Management

If microgreens are to be consumed fresh, just wash in water and use. To use later, they can be stored in the refrigerator up to eight days. It is essential that they remain crisp; washing adds excess moisture and results in rotting, while loss of moisture makes



Fig. 19. Storing microgreens in an air-tight box

them lose crispness. They can be placed in an airtight box (Fig. 19) or zipper pouch, lined with tissue paper. Microgreens are heavy breathers. If stored in a ventilated box, at least one vent should be kept open. They must be washed before consuming.

Microgreen can also be dehydrated and powdered. This can be done at home at room temperature, letting them dry in the open or placing them in a tray in the chiller compartment of the refrigerator till they become brittle. They can be powdered and stored at ambient temperature.

A challenge encountered in post-harvest management at home is from fungal and E. coli contamination and decay. If stored properly, shelf life at 5 °C is up to 14 days, but it is better to consume them in a week or 10 days. They must be washed before consumption, preferably with chlorinated water.

CONSUMING MICROGREENS

Microgreens are an intense version of their full-grown counterparts. They add nutritive value, flavour, colour, and texture to a dish. Added raw, they are crisp, pungent, tangy, and appetizing. Consume them by simply munching them, or add to juices, smoothies, spreads, curd, soup, or dal; to omelettes, scrambled eggs, sandwich fillings. Dehydrated and powdered, they can be taken as food supplements in tablets or capsules. Now that we know how healthy and nutritious they are, how to window farm and harvest them, how to prolong their shelf life, and how to consume them, let us pledge to grow microgreens and make them a part of our diet for a healthy planet, and to be worthy of the name *Homo sapiens* – Man the wise, not *Homo fatua* – Man the foolish!

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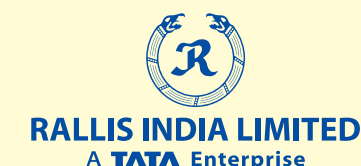
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MICROQUOTES ON MICROGREENS

“Microgreens are miraculous, perfect, tiny, nutritious representations of fresh vegetables, herbs, and greens.”

“Sprouts are like love, tend them and let them grow.”

“Big things often have small beginnings.”



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Trees Immortalized in Verse

Shobha Ramana Pakala

ASHOKS KOTHARI

Himalayan forests inspired the great poet Kalidasa.

“Trees are poems the earth writes across the sky,” said Kahlil Gibran, the Lebanese-American writer and poet. From time immemorial, trees have enchanted artists and poets, whose testimonials in canvas and verse remain a source of joy and inspiration to people around the world. Every tree, every leaf, and every flower is a perfect masterpiece of nature, as well as a visual delight. A full-grown tree is a captivating sight, with its branches so widespread, its trunk so massive, its leaves so green, its flowers and fruit so inviting! The poet Alfred Joyce Kilmer has rightly said, “I think that I shall never see a poem lovely as a tree,” and goes on to conclude, “Poems are made by fools like me, but only God can make a tree.”

I was fortunate to have grown up in a house surrounded by majestic trees, ornamental shrubs, and a host of perennial and seasonal flowering plants. I was lucky to have lived in sprawling cantonments with tree-lined streets and immaculately maintained gardens. However, I must confess, that my passion for literature and poetry added to my deep love for Mother Nature. Here I would like to share some of the soul stirring poems, quotations, and songs that have filled my heart with delight, transporting me to a realm

of multi-textured greenery, and a kaleidoscopic amalgamation of rich colours.

Let me begin with India’s nightingale, Sarojini Naidu, who wrote these beautiful lines in the poem, ‘In Praise of Henna’:

*Hasten maidens, hasten away
To gather the leaves of the henna-tree.
The tilaka’s red for the brow of a bride,
And betel-nut’s red for lips that are sweet;
But for lily-like fingers and feet,
The red, the red of the henna-tree.*

Sarojini Naidu beautifully showcases the different shades of red in this poem. The vermillion on the forehead, the betel stain on the lips, but for the hands and feet, she suggests the red dye of henna. Her poem compels us to recall the glorious henna bush with its smooth lance-shaped leaves, that grows in many a garden. It makes us remember the heady perfume of freshly hennaed hands. It reinforces in our minds the auspiciousness of henna, which is considered a symbol of love and fertility. It reminds us of the elaborate patterns drawn on tender hands and feet during marriages and festivals.



GAYATRI UGRA

Awesome Sal trees in the rich forests of Central India.



SHOBHA R. PAKALA

Oak trees in a public park provide shade and shelter.

Now, let us sojourn from the arid henna growing regions to the dizzy heights of the Alps, to look for a beautiful white flower:

*Edelweiss, Edelweiss, every morning you greet me!
Small and white, clean and bright, you look happy
to meet me.
Blossom of snow, may you bloom and grow, bloom
and grow forever,
Edelweiss, Edelweiss, bless my homeland forever.*

Who can forget Christopher Plummer strumming a guitar, singing this haunting melody from the ‘The Sound of Music’! Thanks to this soulful number, people across the globe learnt about a rare mountain flower. The European Alps are known for their breath-taking beauty and awe-inspiring landscapes. Growing on the dizzy heights of the Alps is this pretty white flower, edelweiss, which is a symbol of purity and love. It also exemplifies devotion, endurance, and bravery. Young men went to great lengths to procure edelweiss from the mountain tops. Undertaking a hazardous trek, they carefully plucked the flower and presented it to their lady love, to profess undying adoration and devotion. This star-shaped flower, which belongs to the sunflower or daisy family, means ‘noble white’ in German.

From the pristine white of edelweiss, we move on to the flashy orange of the flower that came from Mexico, but became an integral part of Indian customs and traditions, the ubiquitous marigold!

*A garden of Marigolds ... orange, yellow, and rust,
Bright, soft, and rich, touched with yellow dust.
Quiet and regal, sun-kissed and fair,*

*Basil-citrus fragrance that mellows the moist air.
A thousand smiling marigolds,
A thousand smiling suns,
Sweet nectar, ambrosia for nature’s gentle ones.*

In this poem, Nishu Mathur paints a flamboyant picture of the brilliant marigold. The different shades of ochre, the pungent fragrance, and a metaphoric comparison with the sun, all add to the beauty of the verse. A picture appears before our eyes – of heaps of marigolds being sold on the streets during Indian festivals. The blazing yellow blooms, woven into garlands to adorn deities in temples, doorways, and wedding venues, seem to intoxicate our senses. The evocative folksong “Sasural Genda Phool” which appeared in the movie, Delhi 6, compares the marital home to a marigold flower. The beautiful and fragrant marigold is like a bride’s dream of an idyllic existence in her new home. The petals of the flower signify the many novel relationships she will encounter. Just as the fragrance of the marigold initially appears too strong, but mellows gradually, so also, getting accustomed to married life is a slow, ongoing process.

After feasting our eyes on the cheerful marigolds, let us turn our attention to something more fanciful, cherry blossom, that looks like showers of pretty, pink snowflakes! When I visited Dehradun, I had the opportunity to see the Indian Military Academy, which has a sprawling, immaculately maintained campus, with an abundance of trees. While exploring this enchanting city, I recollected an interesting story by Ruskin Bond, titled ‘The Cherry Tree.’ The protagonist of the story is a boy

named Rakesh, who plants a cherry seed in the corner of his garden on the advice of his grandfather. The story revolves around how the tree thrives, despite facing trials and tribulations right from its nascent stage. Ruskin Bond traces the growth of the cherry tree, describing its leaves, blossoms, and fruit, as well as the birds and insects that visit the tree. As my visit did not coincide with the blossoming season, I missed a visual feast, though I did finally see blossom laden cherry trees in Washington during spring. As I stood beneath one, I recalled the words of the British classical scholar and poet A.E. Housman:

*Loveliest of trees, the Cherry now, is hung with
blooms along the bough.*

Can any sight be more alluring than a cherry tree in full bloom? William Wordsworth, the renowned English poet would have said without hesitation, “A host of golden daffodils!” Written in 1804, ‘Daffodils’ is one of the most famous English poems. Wordsworth was awestruck by a field of these golden flowers swaying in the breeze:

*Ten thousand saw I at a glance,
tossing their heads in sprightly
dance.*

Daffodils are so attractive, fragrant and fascinating, that myths are woven round them. Another name for them is linked with the Greek hunter Narcissus. Legend tells us that the youth Narcissus was incredibly handsome and broke many hearts. Once, as he bent over a pool of water, he saw his own reflection and fell desperately in love with it! As he could not satisfy his lust for his own beauty, he lay beside the water, wasting away, and was ultimately metamorphosed into a flower – that flower was named Narcissus.

Daffodils are mostly bright yellow, though some of them could be pink, cream, or orange. They have an inner ring of deeper coloured petals in a trumpet-like form, set against the outer delicate



J.P.K. MENON

Marigolds are used in profusion in floral rangolis.



J.P.K. MENON

A multicoloured display of flowers enhances Indian festivals.

petals. Sometimes the trumpet is frilled. The poem not only describes the beauty of the daffodils, but also emphasizes that just thinking about flowers in bloom can lift our spirits:

*For oft when on my couch I lie, in vacant or in pensive mood,
They flash upon that inward eye, which is the bliss of solitude.
And then my heart with pleasure fills, and dances with the daffodils.*

It is time now to leave the daffodils on the ground and look up at lofty oak trees. The monarchs of the wood, oaks are known for their resilience, longevity, and endurance. A scaly bark, broad lobed leaves and of course, acorns, are the distinguishing features of these opulent shady trees. It is so difficult to imagine a mighty oak growing from a tiny acorn, such are the wonders of nature! In the poem, ‘Sing for the Oak Tree,’ Mary Howitt praises the oak tree:

*Sing for the oak tree, the monarch of the wood:
Sing for the oak tree that groweth green and good.
That groweth broad and branching, within the forest shade;
That groweth now, and yet shall grow when we are lowly laid.*

While listing the innumerable uses of a tree, one may miss out the sheer joy of climbing one, which my siblings and I did regularly. I am glad to see future generations in my family carrying on this tradition.

Thomas Fuller had said, “One that would have the fruit must climb the tree.” There are numerous arboreal delights to be experienced amongst the boughs of a sturdy tree. Our attention is often drawn towards squirrels scampering up the tree, birds chirping in a frenzied manner while hopping about on the branches, and the garden lizard waiting in the shadows for a hapless fly. The snail making its slow journey across a leaf, a snake slithering sensuously across the limb of a tree, or a toddy tapper effortlessly climbing a tall palm. Tree climbing is a unique experience which children must explore. A bit of curiosity, some strength, and coordination not only give us that unforgettable tactile experience, but also an opportunity to look at the world from a greater height. In the poem, ‘Ode Owed to a Tree,’ Susan Noyes Anderson writes:

*I start to feel good sitting there,
Secure within my branchy chair,
Up high, the things that made me frown,
Look way too small to bring me down.*

I salute the great poets who have elevated our minds, to see the grandeur of nature through their fertile imagination, spontaneity, and power of expression. What better way to conclude than with these lines from Samuel N. Baxter:

*When I pass on to my reward
Whatever that may be,
I'd like my friends to think of me
As one who loved a tree.* 🌿



Children deserve the joy of growing up amidst trees and nature.

BEST WISHES

TO

**NATIONAL SOCIETY OF
THE FRIENDS OF THE TREES**

FROM

**MEMBERS OF FRANGIPANI GARDEN GROUP
MUMBAI**

IT IS A GROUP OF LIKE MINDED PEOPLE WHO SHARE THE JOYS OF GARDENING

*MEMBERS TRY TO FULFILL SOCIAL OBLIGATIONS TOWARDS ENVIRONMENT PROTECTION,
GREENERY AND CLEANER SURROUNDINGS BY WAY OF MEETINGS ON TERRACE GARDENING
OR SMALL FARM MANAGEMENT AND GARDEN CRAFT/HEALTHY COOKING.*

**FRANGIPANI OR TEMPLE TREE IS IDENTIFIED WITH
PSYCHOLOGICAL
PERFECTION ON THE WAY TO FULFILLMENT.**

*ITS FLOWER HAS FIVE PETALS AND SIGNIFIES FIVE ELEMENTS AND FIVE SENSES.
WE AT FRANGIPANI GARDEN GROUP STRIVE TO LIVE LIFE IN HARMONY AND
PEACE AMIDST GREENERY.*

JYOTI & NIKUNJ PAREKH

Vegetation as Integrator of Climatic Factors

V. M. Meher-Homji



The alpine zone is recognized on the basis of low temperature and typical vegetation

JAYANTI UGRA



GAYATRI UGRA

Vegetation is sessile, directly impacted by weather conditions, therefore it is the ideal indicator of climate

INTRODUCTION

On the basis of temperature, geographers have recognized equatorial, tropical, subtropical, temperate, and polar or alpine belts; whereas considering rainfall, zones are delineated as arid, semi-arid, dry, sub-humid and humid.

The climate of a place is generally described by the values of the mean annual temperature and mean annual rainfall. This could be quite deceptive, as shown by the following examples. Buenos Aires in Argentina, Nanking in China, and Miliana in Algeria each receive annual average rainfall of 950 mm, and have the same mean annual temperature of 16 °C. However, Nanking receives the bulk of rainfall in summer, Miliana in winter-spring (with summer dryness), whereas Buenos Aires experiences well distributed rainfall over the year. Vegetation-wise, Miliana has Mediterranean type of forests, Nanking a temperate type, while Buenos Aires has what is called steppic vegetation. Therefore, to test the validity and suitability of a climatic classification, the tendency is to match the classification with the



ASHOK S. KOTHARI

This flowering Asoka tree is typical of the Western Ghats

vegetation. Animals are mobile and seek their own convenient habitats or micro-climates, but vegetation is sessile and exposed to the direct impact of weather conditions, therefore it remains the ideal indicator of climate.

COMPENSATION BETWEEN THE AMOUNT OF RAINFALL AND LENGTH OF ITS DISTRIBUTION

In any discussion on rainfall, a good deal of attention is given to the total amount or annual average, ignoring the number of days or months over which the rainfall is distributed, or yet the season of occurrence of rain. In the Mediterranean countries (Middle East, North Africa), rains occur in winter-spring-autumn (summer being dry), while conversely in the tropics, the rainy season is in summer, with winter dryness.

The interplay between the volume of rainfall and the length of the rainy season may be illustrated with a few examples (see Table). Southern Kerala receives annual average rainfall of 2,000 to 3,000 mm, spread over a period of seven months (leaving five



ASHOK S. KOTHARI

Total amount of rainfall and time period of the monsoon determine the vegetation



ASHOK S. KOTHARI

Lagerstroemia, the state tree of Maharashtra, flourishes in heavy rainfall areas

months dry). A month is considered dry if its mean monthly rainfall in mm (P) is less than twice its mean monthly temperature in degrees Centigrade (T), or $P < 2T$. This part of the country receives rains both from the south-west monsoon (June to September) and the so-called north-east monsoon (October to December) when rains are brought by the depressions and cyclones formed in the Bay of Bengal.

Further north, Agumbe in the Western Ghats of Karnataka bears the full impact of the south-west monsoon, experiencing 8,000 mm, and therefore is called the Cherrapunji of South India. However, the dry rainless season here lasts for seven to eight months, as against five months in southern Kerala with lower amount of rain. As a result of compensation between the amount and length of distribution, both southern Kerala and Agumbe are clothed with evergreen forest.

Another example of such interplay between the volume of rainfall and its spread over the year is provided by Mumbai on the one hand, and Bengaluru-Mysuru on the other. Mumbai receives 2,000 mm in four months, while Bengaluru-Mysuru experience half that amount in seven months (four from the south-west monsoon and three from the north-east monsoon). Sanjay Gandhi National Park in Mumbai, Bannerghatta near Bengaluru, and Bandipur in the vicinity of Mysuru, all bear deciduous forests.

SUB-SOIL MOISTURE

What accounts for the apparent contradiction between the amount and distribution of rainfall is underground moisture storage. The humus-rich forest soil absorbs water during four months of torrential south-west monsoon, and this underground storage enables trees to tide over the dry period. 🌿

Table: Interplay between rainfall and its distribution over the year

Place	Annual average rainfall (mm)	No. of rainy months	No. of dry months	Forest type	Comments
Southern Kerala	2,000 to 3,000	7	5	Evergreen forest	Medium amount but good distribution over 7 months
Agumbe	8,000	4 to 5	7 to 8	Evergreen forest	Very high rainfall, but only over 4 to 5 months
Mumbai (Sanjay Gandhi National Park)	2,000	4	8	Deciduous forest	Medium rainfall distributed over 4 months
Bengaluru (Bannerghatta Forest)	800 to 1,000	7	5	Deciduous forest	Low rainfall but better distributed over 7 months
Mysuru (Bandipur Forest)	800 to 1,000	7	5	Deciduous forest	Low rainfall but better distributed over 7 months

Four Decades with Junipers as Bonsai Art

Text and Photographs: Nikunj & Jyoti Parekh

Our fascination for growing *Juniperus* bonsai began in 1979. The world-renowned bonsai expert John Naka of USA encouraged us to pursue the art of miniaturizing trees. Next was an event in 1982, when Mr Suzuki of Singapore created a rock-grown Juniper, where the medium is cinders (the slag from a metal furnace). Then came the visits of Mr Chase Rosade of USA, followed by Mr Peter Chan of UK in 1993, as well as Mr Tom Yamamoto and Susumu Nakamura from Japan, who showed us different techniques for working on junipers. With their teaching, and our keenness to learn, we realized that junipers can be trained to grow to conform with nearly all styles of bonsai.

Subsequently, we were invited to conduct workshops with demonstrations across India and the world over, giving us time for improvisation, innovations, and gaining knowledge on a subject of our liking. More than anything, we cherish the blessings of two of the world's greatest bonsai Gurus, John Naka and Saburo Katoh of Japan, who taught us the meditative, spiritual aspects of the art of bonsai, an aesthetic experience that kept us engrossed in the calm and soothing effects of greenery. Having trained under these Masters, we surely cannot claim that we are self taught!

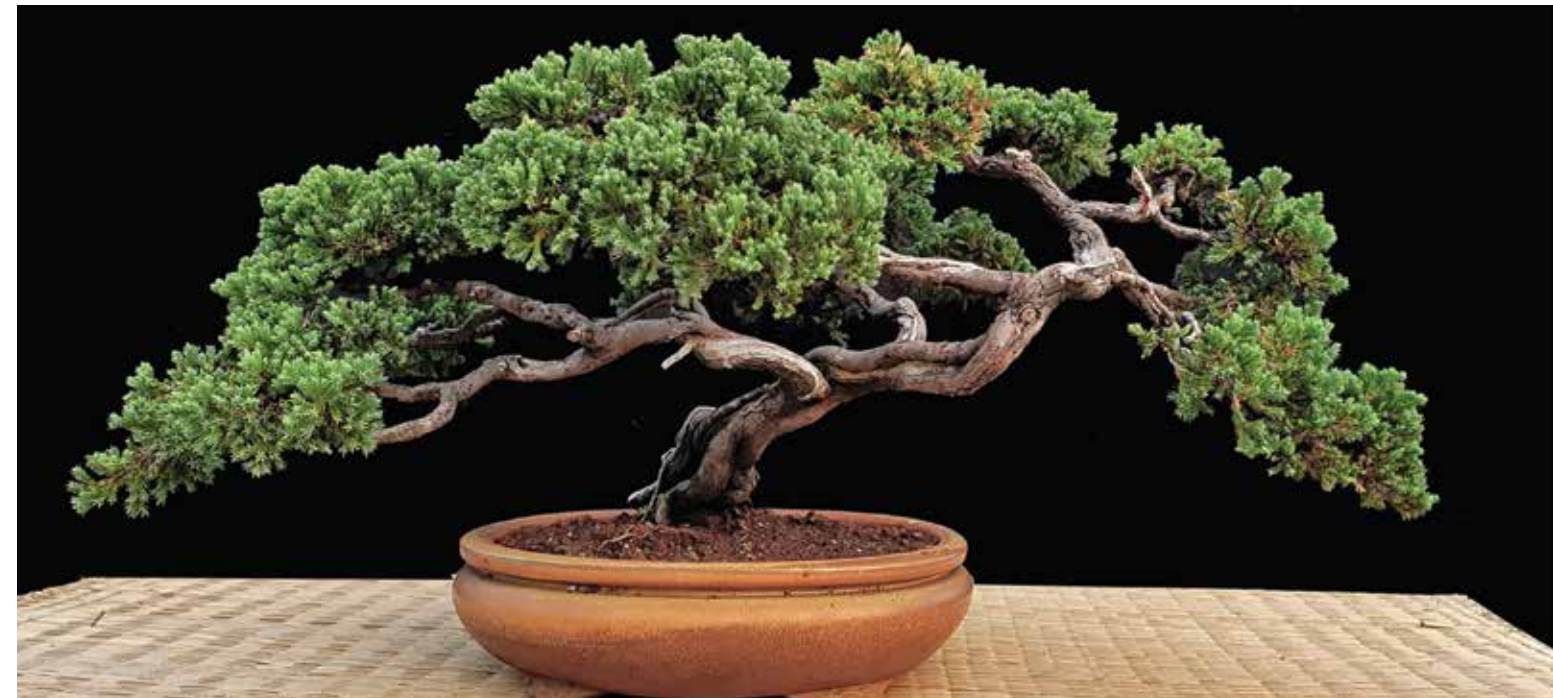
All junipers belong to Cupressaceae, the evergreen cypress family. Junipers grow and flourish in many

parts of the world. In India, junipers grow particularly well in the Hooghly river delta of Bengal. Here we give a few tips that work for junipers in particular, and bonsai plants in general. The basics are the same, but with time and practice, one can learn the very specific requirements of each species. In the photographs here, we show some of our juniper bonsai specimens styled and designed since 1980. The year of creation is mentioned in the captions.

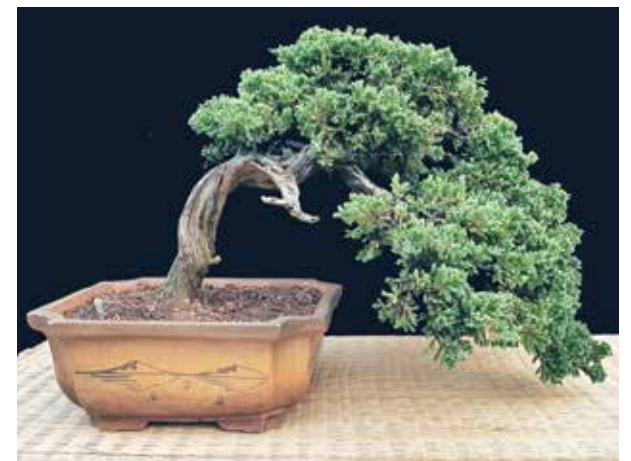
Junipers have a main “tap root” to imbibe water and nourishment from deeper soil layers. Nearer the soil surface, they have fibrous roots which are capable of capturing rain water. Junipers adapt well to a variety of different, well-drained soil, but require good exposure to the sun, or light shade, to grow. Insects are not attracted to these plants normally, but bees or flies are attracted to the sticky sweet honeydew secreted by smaller pests like mealybugs, which feed on junipers.

Pruning is one of the most important components of growing a healthy, aesthetically pleasing, and spiritually uplifting bonsai specimen. If you do not prune straggly or overgrown branches, the canopy blocks sunlight from reaching all parts of the tree, making the lower branches dull and lanky. To keep a bonsai healthy, one must use a clean, sharp pair of pruning scissors or secateurs. The secateurs can be sterilized to make sure that no fungus spores or

bacteria enter the cuts made while pruning. This precaution reduces the chance of diseases spreading among your junipers. Take care to remove each dead branch from the tip to the base. Overgrown top branches result in die back at the lower or bottom level of the specimen. Leave the new green shoot closer to the trunk. Trim back individual new shoots selectively, by observing the direction in which you want to encourage growth for the next spring season. Many junipers grow laterally, with branches extended sideways. Some branches which are directed vertically can be allowed to grow according to a particular style of bonsai. Old and even dead branches in a specimen can be preserved by applying lime-sulphur solution to preserve them.



Juniperus prostrata with roots exposed, 2003



Juniperus prostrata with roots exposed, 1990



Juniperus prostrata on a lime stone rock, 1980



Ceramic rock creation with three *Juniperus prostrata*, 2006



Juniperus prostrata forest in root connected style, 1994

Bonsai, like all plants, is susceptible to damage and disease. With some experience, it is easy to spot a diseased tree and to take preventive measures. These are the signs and symptoms of a diseased tree:

1. Too many dead branches which tend to break easily.
2. Leaf discoloration becomes visible.
3. Cracks or holes appear in the bark.
4. The juniper needles (leaves) turn brown due to excessive evaporation of water, due to severe dryness or freezing climate, when moisture is lost.

Simple measures can be taken to prevent such a condition, and to save a tree from dying:

1. Correcting the moisture level through judicious watering will ensure that fresh green needles appear on a juniper.
2. Excessive salt level (Sodium) in water, or salty air, is no good for junipers. Take care to check the pH level of the water, which should be neutral. Protect it from direct flow of wind in seaside places.
3. Do not spray too much fertilizer, excess of it makes the plant look dull.

4. In dormancy, the branches of the juniper still remain pliable, which means that the tree is alive and well. A light scrape on the bark of the trunk or of old branches, showing a green colour, means that the plant is alive.

Juniperus procumbens

Commonly called Garden Juniper, this is a low growing, evergreen conifer of the Cypress family. For this reason, it has also been named *Juniperus prostrata*. The subvariety “nana” is a compactly growing plant with trailing branches radiating in all directions. For nourishment, slow release organic fertilizers like vermicompost can be added during the drier months, as this helps to retain moisture in the soil. Leaf compost or leaf mould also helps nourish junipers. An organic fertilizer rich in nitrogen, potassium, and phosphorus is useful when the soil gets depleted.

Repotting once a year, either at the end of the rainy season or in early

February – near about Basant, the Indian spring, is good for junipers. If the growth is good, one can do “half repotting” by removing the upper level of the soil, scraping it out and replacing it with new soil.

Soil composition is important, and we recommend two parts garden soil, sun-dried and without lumps, plus two parts cowdung manure, again sun-dried and without lumps, plus two parts broken brick pieces to improve aeration and retention of water in the pores of the bricks; this would prevent soggy soil causing root rot. Occasionally, powdered goat or sheep manure can be added to get lush green needles on junipers.



Juniperus prostrata on cinders, mounted on marble tray, 1984



Miniature tray landscape with three *Juniperus prostrata* on rock, 2015

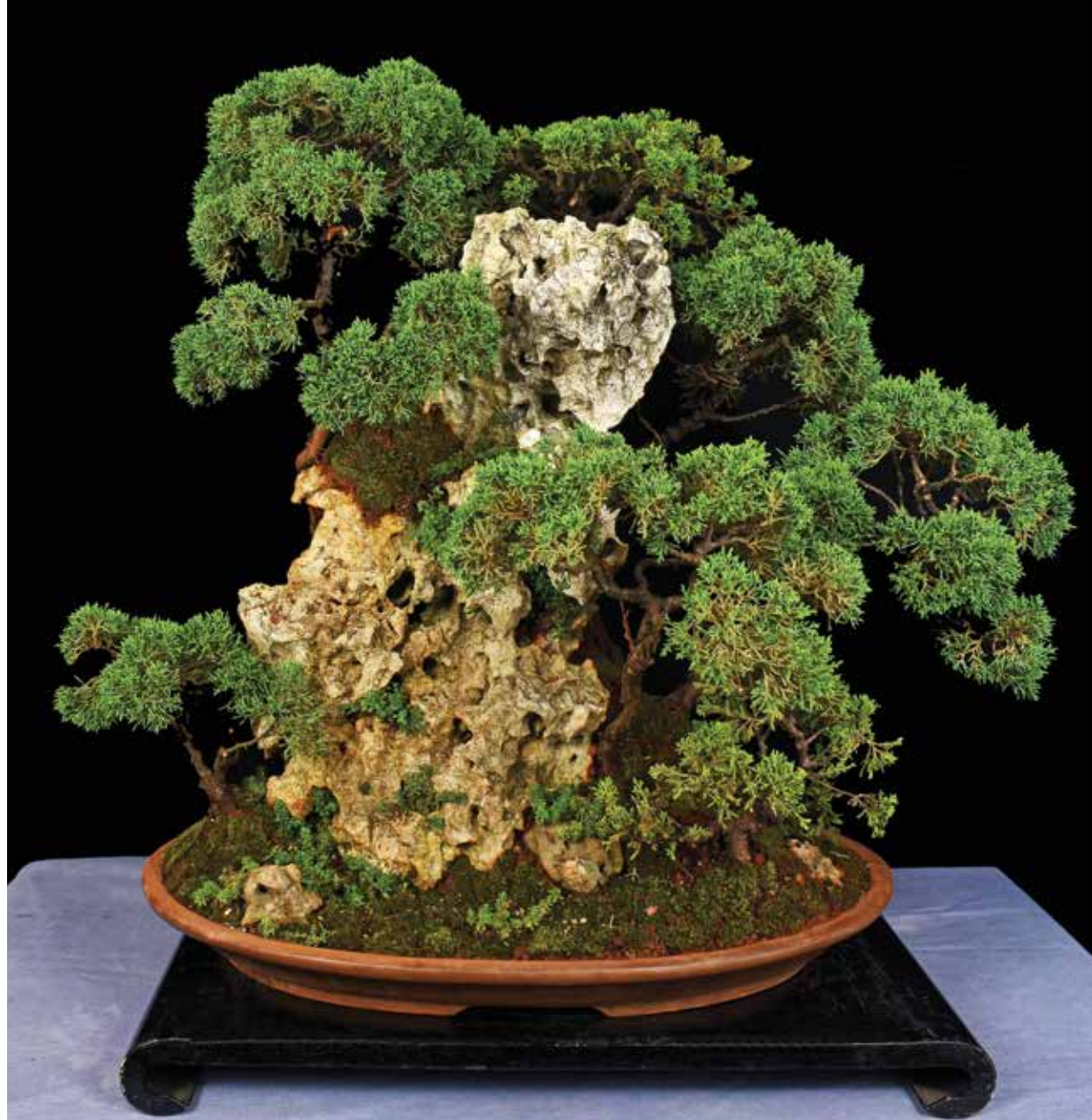
Juniperus chinensis

Commonly called Chinese Juniper, this member of the Cypress family is an evergreen conifer, popularly grown in Japan, China, and the Himalaya. Normally, while growing in the ground, Chinese Juniper can become 5 metres wide and 15 metres tall. Shorter shrub forms or spreading forms with fairly dark green needle foliage are also available. They prefer moist but well-drained soil, particularly till the plant gets well established.

The top branches should be trimmed with a good, sharp pair of scissors, as many branches grow laterally. The branches should be cut back to



Juniperus chinensis var. Blauw with multiple twisted trunks, Jin and Shari effect, 2006



Single rock with *Juniperus chinensis* trees, 2003

about 2 to 3 cm to encourage more rapid vertical growth. Cut the branches back to almost a quarter of their length, if they are sticking out from the bush. These side branches take up most of the space on an overgrown juniper. Branches drooping or sagging downwards can be wired to face sunlight, giving the tree a much healthier appearance. But wiring done on the trunk or branches of a bonsai specimen needs to be periodically checked, otherwise the wire begins to bite on the branches or tree trunk. One would not like to be called a cruel bonsai hobbyist.

After a few years of experience as an artist, one can leave wires to bite into the trunk or branches, specifically to create a Shari effect for a mature, weather-beaten look. This takes time to achieve, and

the bonsai artist must adhere to the aesthetic aim, not because it was done casually or due to neglect. Do not trim new growth during summer time. New growth is soft, light green, and pliable compared to the hardwood of old mature growth. Be gentle with the new growth as it is very delicate. While pruning, one needs to be careful not to trim the apical (top) branches excessively. Remove dead or damaged branches, or try creating a Jin effect, wherein it appears as if lightning has struck the tree.

Juniperus rigida

The Needle Juniper or Temple Juniper is a large, evergreen, coniferous shrub native to Japan, Korea, Taiwan, and China. In nature, it grows 6 to 10 metres in height. It bears leaves or needles all round



Small *Juniperus rigida* in Bunjin Literati style, 2019

the year, and can be grown from tender cuttings. It is commonly called Nezu or Tosho in Japan. On maturity, the tree yields berries or small cones.

Watering should be done in the morning, to give enough time for water on the needles to dry. Night time or late evening watering

causes fungal attack, as water droplets get trapped in the needles. When all needles on the tree turn brown, the plant is possibly dead. But if you see patches of brown needles, it could mean that the plant is stressed out due to disease, insect attacks, or inadequate watering.

Juniperus chinensis var. *Blauw*

This is a popular variety of *Juniperus chinensis*; its needles are more greenish with a blue tinge. It can be grown from tender cuttings and styled by bending the branches well with wires. It can be trained for a Jin or Shari effect.

The passage of time brings about a change in appearance, be it a human being or a bonsai tree. Age brings with it a certain mellowness, a time to restyle the design and give the tree a weather-beaten look – with grace, patience, tender loving care. Aesthetic bonsai styling means adding depth and flow to the branches, harmony, built on a foundation of strong roots, with a graceful trunk, picturesque bark, and elegant spread of primary, secondary and tertiary branches. As maturity comes, try to redesign the bonsai; highlight its lines, bark, and branches with Jin and Shari effects, as relics of graceful ageing. 🌿



Juniperus rigida forest planted on a stone slab, 2020



Some Landmark Events

... TREE PLANTATION AT YEOOR PANDIT SCHOOL
... AND VIVEKANAND ASHRAM, THANE
... 21st & 22nd June, 2019



FoT members get together for the Tree Plantation ceremony



FoT members doing their bit for the environment



Children at Yeoor Pandit School learn to contribute to greening India



FoT members planting saplings at Vivekanand Ashram, Thane



School children and teachers at the Yeoor Pandit School



Mrs Manik Gade and Mrs Sakina Gadiwala at the Tree Plantation ceremony at Shantivan, Panvel



School girls at the Vana Mahotsava in Shantivan, Panvel



All set for the tree plantation at Shantivan, Panvel



Members of Friends of Trees planting a sapling



Joyful FoT members contributing to greening the environment



... TREE PLANTATION AT
... SHANTIVAN, PANVEL,
... 13th July, 2019



.....
NATURE DRAWING
COMPETITION FOR
SCHOOL CHILDREN,
.....
30th November, 2019



Group 1: Ist Prize, Rundra Chile



Group 3: Ist Prize, Pavani Mohan Gawde



Group 4: Ist Prize, Palak Mayur Khania



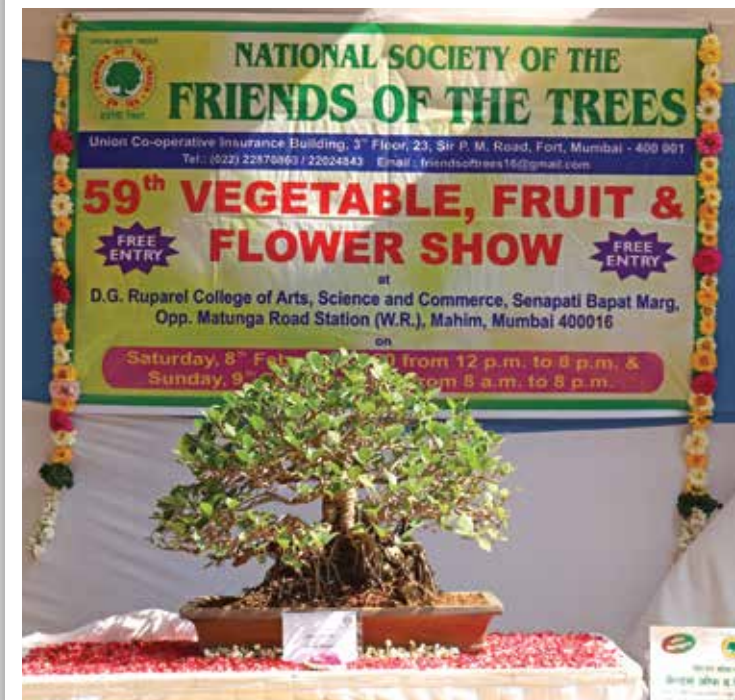
Group 2: Ist Prize, Srushti Bhaskar Shinde



Group 5: Special Children, Ist Prize, Dhairya Gangar



FoT President Dr Ashok Kothari, Vice President Dr Arun Sawant, FoT Office Bearers and Dr Nita Tatke, Vice Principal, Ruparel College, with Mrs Usha Thorat at the release event



The ever popular VFF Show started on 8th February, drawing numerous crowds



59TH VEGETABLE,
FRUIT AND FLOWER
SHOW HELD AT
RUPAREL COLLEGE,
MUMBAI,
8TH & 9TH FEBRUARY, 2020



VANASHOBHA 2018-19
RELEASE EVENT,
8TH FEBRUARY, 2020



Chief Guest Mrs Usha Thorat at the VFF Show releasing *Vanashobha*



Chief Guest Mrs Usha Thorat, former Deputy Governor, Reserve Bank of India & Vice President, Bombay Natural History Society, presenting the prizes on Day 1 of the VFF Show, with FoT Office Bearers Dr Arun Sawant and Mrs Sakina Gadiwala



Mumbai Police receiving a trophy from Mrs Usha Thorat and Dr Arun Sawant, Vice President FoT, with Dr Ashok S. Kothari, President FoT, looking on



Students of Infant Jesus School, Malad (W) explain their herbaria to the visitors



Flower Arrangement by individuals is a popular category at the VFF Show



Shri R.L. Mopalwar (IAS), Vice Chairman & Managing Director, Maharashtra State Road Development Corporation, Chief Guest on Day 2, welcomed by Dr Arun Sawant and other FoT Office Bearers



An amazing display of plants grown in the Japanese Kokedama style by Sacred Heart School, Mumbai



Fascinating forms of bonsai specimens were on display at the Show



Sansevieria, a popular succulent in Kokedama style



Tabernaemontana grown by the Kokedama technique, a relatively new style to India



Marigolds, rose petals, and green leaves add vibrant colours to this traditional floral rangoli



FoT President Dr Ashok Kothari addressing the gathering at the National Seminar



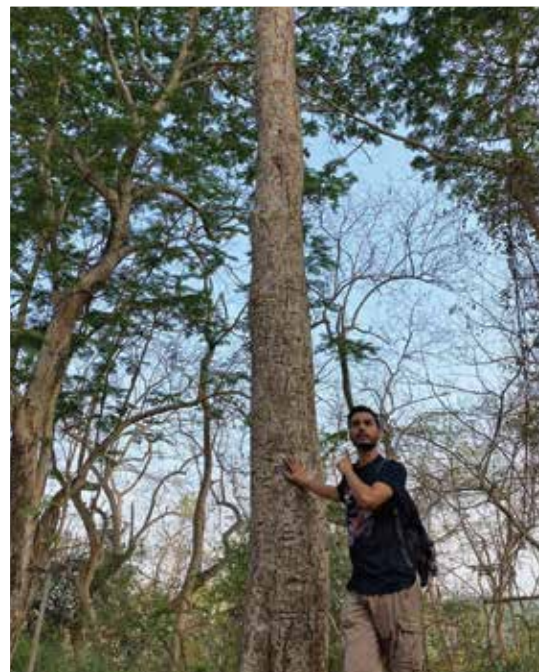
• NATIONAL SEMINAR
• ON TREE ECOLOGY
• & URBAN FOREST
• MANAGEMENT, HELD
• AT ST XAVIER'S
• COLLEGE, MUMBAI,
• 13TH FEBRUARY, 2020



FoT members and St Xavier's College students attended the Seminar in large numbers



Gandhi Smarak is situated at the highest point of the nature trail



Towering trees shaded the walk in the forests of SGNP, Borivali



Sanjay Gandhi National Park constitutes a green lung for Mumbai



Roots hold the soil, preventing erosion by monsoon rain



• NATURE TRAIL AT SANJAY GANDHI
• NATIONAL PARK, KRISHNAGIRI STATION
• TO GANDHI TEKDI,
• 1ST MARCH, 2020



Happy to reach Gandhi Tekdi, the destination



The trees in the Park harbour a vast biodiversity



The National Park is a living laboratory for nature lovers



Yellow Caesalpinia attracts insects and birds



Water lilies bloom in the pond at the Gandhi Smarak



Members exchanged knowledge and experiences during the trail



A bonsai Ficus from Dr Saraswathy Unnithan's collection



Dr Saraswathy Unnithan, ornithologist and bonsai expert, host of Breakfast with Bonsai, demonstrates a technique for FoT members



Years of dedicated effort go into developing a prize specimen of bonsai



• GARDEN VISIT AND
• BREAKFAST WITH
• BONSAI AT JAL VAYU
• VIHAR, POWAI
• 8TH MARCH, 2020





Mr Bharat Godambe with FoT members at the lecture-demonstration



Ms Priyanka Kumari gave a tremendously successful lecture-demonstration on "Kitchen Gardening and Composting"



LECTURE-DEMONSTRATIONS
ON KOKEDAMA AND KITCHEN
GARDENING & COMPOSTING,
14TH MARCH, 2020



Mr Bharat Godambe explaining the finer points of "How to make Kokedama"



Climbing down a rocky path in search of nature's wonders



VISIT TO GREENWAY
HOMES AND
RESORT, WADA,
15TH MARCH, 2020



FoT members assemble at Greenway Resort, Wada



A massive beehive of almost frightening proportions above the path



Acalypha and other greenery fascinates visitors at Greenway Resort



TREES ARE OUR FRIENDS



HORTICULTURE SERVICES, GODREJ CONSTRUCTION

Ficus religiosa or Peepul is among the commonest trees in India, and a blessing for the shade it provides to tired travellers, and all the insects, birds and other animals that reside in it.

IN MEMORIAM



AJIT D. JOSHI

Dr Surendra Jaywant

To all those involved in the Annual Vegetable, Fruit and Flower Show of the National Society of the Friends of the Trees, one of the most respected judges was Dr Surendra Jaywant, a versatile, lovable, and highly learned person who shared his vast knowledge with all, without any reservation.

Born in 1933, Dr Surendra Jaywant spent his childhood in Kalyan, in Thane district. His father Shri Dwarkanath was a forest contractor, and young Surendra was fortunate to have the opportunity to visit the vicinity of Tansa Lake and the dense forests of Murbad along with his father. Sometimes he would stay overnight at Tansa Sanctuary along with his father; at such times the staff would take him along for jungle trails. It was there that he gained first-hand knowledge about plants and animals, their names and their habits. He started enjoying these outings and thus began his passion for nature and the natural world.

In 1947, Surendra Jaywant passed the Matriculation examination and was admitted into St Xavier's College, Mumbai, to study science. During the two years he spent in St Xavier's, he came into contact with Professor Munshi and Professor P.V. Bole. This turned out for the best, as the association developed his love for nature studies. After passing the Intermediate examination, he decided to pursue a medical profession. He obtained admission into G.B. Medical College, Mumbai, and completed his MBBS degree in 1955.

In 1960, Dr Surendra Jaywant joined Bhabha Atomic Research Centre (BARC) as Medical Officer. Being in the 300-acre BARC campus, in natural surroundings, stimulated his childhood hobby. He took special permission from the authorities to move about alone

in the campus in pursuit of his nature studies. Here, he was introduced to Shri Shripad Vaidya, the Chief of the BARC Botanical Garden. This acquaintance helped Dr Jaywant to pursue his interest in nature to the fullest capacity. He came into contact with Shri V.A. Rode and Dr V.K. Ogale. He knew almost all the plants, birds, and butterflies of BARC campus. During his tenure as Medical Officer, in his leisure hours, he inculcated his own passion in many others, and developed a good number of followers. He became dear to all, due to his good nature and helpfulness. He served BARC till his superannuation in 1992.

After retirement, Dr Jaywant kept himself busy guiding people in general and graduate students in particular, creating in them a love for nature and natural surroundings. He used to educate students through his lectures and nature trails. His narration used to be informative and attractive. He wrote popular articles on the subjects dear to him, in Marathi and English periodicals. He also delivered radio talks emphasizing the importance of conserving nature. Dr Jaywant was interested in Indian classical music, and in stamps and coins, of which he had a large collection. He was attached to many organizations, among them were Marathi Vidnyan Parishad, Holiday Hikers, and BARC Marathi Mandal.

Such a versatile and lovable person, who was always keen on sharing his vast knowledge with all, with no reservation, and always advocating the need for nature conservation, with interests that were learned and valuable, passed away on April 4, 2021, at the age of 88.

CHANDRAKANT S. LATTOO

Contributors

Amit Lahiri, PhD, is Chief Sustainability Officer, O.P. Jindal Global University. As Professor of International Business (Graduate Program) Centennial College School of Business, Toronto, he helped develop the graduate certificate program in International Business Management and a course in Corporate Social Responsibility. He received the Board of Governors Award of Excellence in Community Partnerships (2015). He held senior managerial positions at Sanofi Pasteur (Diagnostics) & Boehringer Mannheim (Biochemicals). He has a Master's in Life Sciences, and in Environmental Studies (Sustainable Development) from York University, and Graduate Diploma in Business and The Environment, Schulich School of Business, Canada.

Bhushan Shigwan is a doctoral student of the Biodiversity & Paleobiology Group, Agharkar Research Institute, Pune. His research includes flowering plant taxonomy, biodiversity, and ecology. He collaborated on a study “Endemic Vascular Plants of the Northern Western Ghats.” He studies forest ecology, tree diversity, and anthropogenic disturbances in the forest fragments of the Northern Western Ghats. He has co-published four research papers.

Mandar Datar, PhD, studied at Pune University. His research interests include systematics and ecology of flowering plants. He was conferred the K.L. Mehra Memorial Award for Best Paper (2015) from the Asian Agri-History Foundation. His current projects are “Taxonomy, ecology and molecular phylogeny of *Ischaemum* (Poaceae)” and “Vascular plant endemism of Northern Western Ghats”. He has co-authored five books, contributed 20 chapters, and numerous research papers.

Hari Shanker Singh, PhD, had an illustrious career in the Indian Forest Service. He was a Member of the Gujarat State Board for Wildlife (2015–17) and Gujarat Biodiversity Board (2016–18). Presently, he is a Member of the National Board of Wild Life, Gujarat Coastal Zone Management Authority, Society for Wildlife Institute of India, Dehradun, and is on the Board of Governors, GEER Foundation, Gandhinagar. He served as Director, GEER Foundation, Gandhinagar; Chief Conservator of Forests, and Head, Gujarat Forestry Research & Training Centre, Gandhinagar. His professional focus is mammalian biodiversity, Mangroves, and Protected Area management. He is a member of IUCN-World Commission on Protected Areas, International Bird Conservation Society, GEER, and Bombay Natural History Society. He has authored 23 books and 42 research papers.

Vijaya Chakravarty is an ecologist and landscape designer and is associated with several leading corporate houses in India. She specializes in ecological gardens (Biodiversity, Native Plants, Wildlife) and children's gardens for learning, natural play, and wellbeing.

Hashim Mirza, a CA by profession, looks after his family business in wholesaling greeting cards, over the past 30 years. Travel, food, and reading are his enduring passions. Recently, he has been exploring the nooks and corners of Mumbai city. He writes about issues that interest him, starting a daily blog from the first day of the lockdown. He believes in living life to the fullest, and taking each day as it comes.

Behnaz B. Patel, PhD, is a Life Member of Friends of the Trees. She is presently Invited Faculty in Botany at Ramnarain Ruia Autonomous College and R. Jhunjhunwala Autonomous College, Mumbai University, after retiring as Associate Professor and Head, Dept of Botany and In-charge, Dept of Biological Sciences, Ruia College, Mumbai. She studied Botanical Cytogenetics and Cytohistochemistry at Mumbai University. She was Vice Principal of Ruia College (2000–2006), and served on various august committees of her University. She received The Principal's Appreciation Award (2009), and other awards for excellence in academic and administrative affairs. Dr Patel co-authored college textbooks, and published 25 papers. Her research projects related to medicinal uses of plants, medical mycology, and agriculture extension projects for students, were highly lauded. She has vast experience of extension education in Mumbai University and affiliated colleges.

Shobha Ramana Pakala is an educationist, avid gardener, and life skills trainer. She is a trained career counsellor and has conducted workshops in Mumbai schools on adolescent problems, addiction, and memory management. She conducts gardening classes for children and adults. She is passionately fond of trees.

V.M. Meher-Homji has had an illustrious career in environment related research. His publications cover diverse subjects ranging from the phytogeography of South Indian hill stations to the repercussions of deforestation on rainfall precipitation in Karnataka. His book “Bioclimatology and Plant Geography of Peninsular India” is a benchmark, and he has numerous scientific papers to his credit. He also writes popular scientific articles.

Nikunj & Jyoti Parekh founded the Bonsai Study Group of The Indo-Japanese Association in 1979. They have co-authored three books on bonsai. They have given demonstrations at conventions in USA, UK, Germany, Hong Kong, Italy, Taiwan, Sri Lanka, Sultanate of Oman, Kenya, and Japan. Together they publish the quarterly *Nichin Bonsai*, since 1985. Recipients of national and international awards, they were honoured with a Gold Medal at the World Bonsai Convention in Puerto Rico (2009). Nikunj Parekh was awarded ‘The Rising Sun with Silver and Gold Rays’ (2015) by the Government of Japan. 🌿

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