

TerraGreen

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VOLUME 17 | Issue 5 | August 2024

Circling Back to Water

Safe Reuse of Treated Water (SRTW)

SPECIAL HIGHLIGHTS

Managing Crop Residue

Environmental Fallouts of Gastronomical Apartheid

TERRA YOUTH

Driving the Future

IN CONVERSATION

Sandesh Kadur,
Renowned Wildlife Photographer





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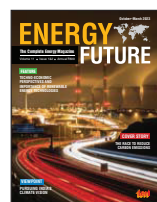
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TerraGreen is India's most respected monthly magazine dedicated to informing and enlightening its readers on issues of environment, energy, and sustainable development. Launched in 2004, TerraGreen has made an indelible impression on the minds of readers, both in India and across the world. Today, it enjoys a readership of over 40,000 and a subscriber base of close to 10,000.

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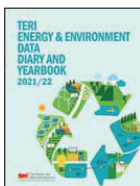
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A TERI Publication

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EDITORIAL



“ At the subnational level, a greater emphasis must be placed on developing state-specific policies and guidelines for an increased uptake of the safe reuse of treated water approach and its enforcement. ”

India, with a rapidly growing population and urbanized landscape, is grappling with an increasing gap between water demand and supply—thereby compounded sewage generation. This water risk is intrinsically linked with climate change that is disrupting the rainfall patterns, and posing serious threats and vulnerabilities for communities across all regions in India. Given this backdrop, it is imperative to re-evaluate India's water resource management scenario. The safe reuse of treated water is emerging as an alternative solution to the growing water stress and associated challenges. It is worth mentioning here that the advanced treatment technologies enable in recycling the wastewater for various non-potable uses, such as irrigation, industrial processes, and toilet flushing.

This month, our cover story on safe reuse of treated water (SRTW) highlights that this sustainable approach has the potential to address multiple issues: (a) the gap between water demand and supply, (b) contamination from untreated sewage discharge, and (c) the unpredictability of water availability due to erratic rainfall. As India faces increasing environmental challenges from climate change and dwindling resources, effective water management is crucial. SRTW decreases our need for freshwater for non-potable purposes, reduces water stress by bridging the gap between water demand and supply, and helps us mitigate the impacts of climate change on water availability.

To support the cause, the Government of India has various flagship programmes to provide technical and financial assistance to state governments. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 scheme offers significant opportunities to promote and implement safe reuse of treated water (SRTW) across India indicating a proactive step ahead for addressing future water needs and envisaging circular economy in water sector.

However, for effective implementation of SRTW in a city, a pre-feasibility assessment should be carried out, which maps the supply and demand of water, identifying multiple roles and responsibilities of various stakeholders, and assessing the wastewater management. At the subnational level, a greater emphasis must be placed on developing state-specific policies and guidelines for an increased uptake of the safe reuse of treated water approach and its enforcement. Transitioning to a circular economy in the water sector and ensuring water security in India calls for large-scale adoption of sustainable approach briefed above. Consequently, this will result in charting out the pathway for self-sustenance of sewage management assets and eventually help in building financial resilience.

I am confident that the articles in this edition of TerraGreen will strongly resonate with our readers. Your insightful suggestions have significantly enhanced the publication, and I encourage you to keep sharing your valuable ideas and feedback.

A handwritten signature in black ink that reads "Vibha Dhawan".

Vibha Dhawan
Director-General, TERI



Apropos the cover story on heatwaves in India published in the June–July 2024 issue of *TerraGreen*, heatwaves are becoming a significant public health crisis that demands immediate and sustained action. By combining government initiatives, community engagement, and climate-adaptive strategies, we can mitigate the impacts of heatwaves and safeguard public health. Continued and consolidated efforts are essential to enhance resilience against the growing threat of heatwaves in India. Working together, we can ensure that India not only endures the summer but also faces the harsh realities of a warming climate. The fight against heatwaves cannot rest solely on the government’s shoulders; it requires a concerted effort from all sectors of society. Communities must adopt and promote sustainable practices, such as rainwater harvesting

and tree planting. Private enterprises can contribute by creating more green buildings and providing heat-resilient cooling spaces for their employees, as well as supporting community cooling initiatives.

Mohit Bhattacharya
Kolkata, West Bengal

I liked reading Special Report published in the June–July 2024 issue of *TerraGreen*. As climate change continues to intensify, its impact on air travel is becoming increasingly concerning. Rising temperatures can lead to more frequent and severe weather events, including thunderstorms, turbulence, and reduced visibility, which pose significant risks to flight safety. Additionally, changing weather patterns can affect airport operations, resulting in delays and increased congestion. Higher temperatures can also reduce aircraft performance, particularly during take-off and landing, leading to longer runways and potential safety hazards. Furthermore, the aviation industry itself contributes to climate change, creating a cycle that exacerbates these challenges. As such, without proactive measures to adapt to and mitigate these risks, climate change could indeed make air travel more disaster-prone in the coming years.

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Delhi's 2023 Floods Linked to Rapid Urbanization, Climate Change

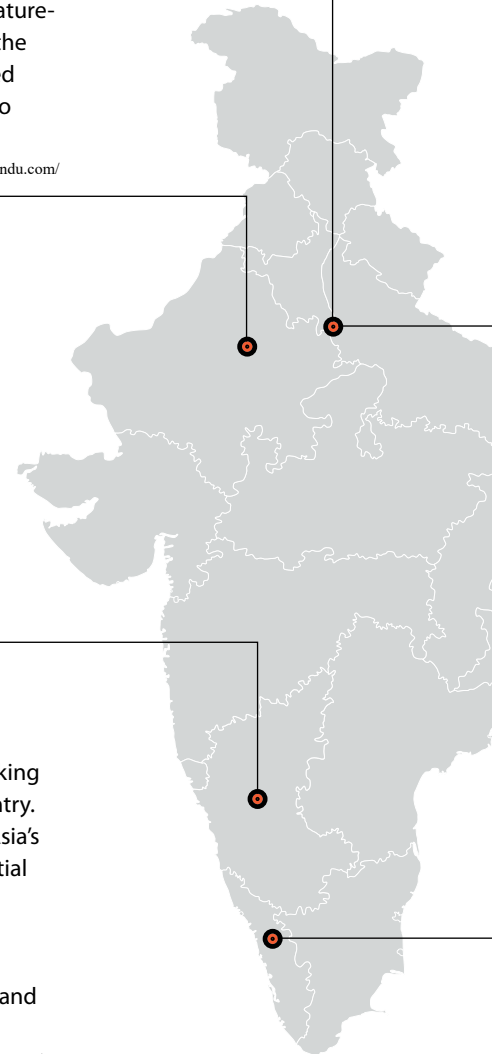
A group of scientists and researchers from IIT Roorkee have raised alarms over the escalating risks of floods tied to rapid urbanization and climatic changes in the floodplains of the Yamuna River in Delhi. By analysing the 2023 deluge, they found a significant rise in built-up areas near the river over the past three decades, particularly in regions such as Shastri Park, Majnu ka Tilla, and Akshardham. This urban growth has led to a drastic reduction in green areas, aggravating the city's susceptibility to heavy rainfall and subsequent flooding. The study highlights the critical intersection between human development and flood-prone zones, stressing the need for immediate and proactive urban planning alongside enhanced flood management strategies to protect communities.

Source: <https://www.indiatoday.in/>

India's First 'Teal Carbon' Study

India's first study on 'teal carbon', undertaken at Keoladeo National Park (KNP) in Rajasthan's Bharatpur district, has highlighted the significance of wetland conservation to address the challenges of climate adaptation and resilience. The pilot project sought to develop holistic nature-based solutions to address climate change. The concept of teal carbon is a recent addition to the environmental science pertaining to organic carbon in inland fresh wetlands. The study, carried out in the form of the KNP's global review, has depicted the potential of teal carbon as a tool to mitigate climate change if the anthropogenic pollution in the wetlands can be controlled.

Source: <https://www.thehindu.com/>



Karnataka to Be a Key Driver of India's Transition to Clean Energy

Karnataka is set to be a major driver in India's low-cost clean energy transformation, while ranking second in green hydrogen production and with the highest wind energy potential in the country. A study published recently by the Council on Energy, Environment and Water (CEEW) one of Asia's leading research institutions and climate think-tanks states that with a green hydrogen potential of 5 MTPA (million tonnes per annum) each, Karnataka and Maharashtra rank second after Gujarat, which has an estimated potential of 8.8 MTPA green hydrogen. India has a renewable energy (RE) potential of over 24,000 GW, but even reaching the 7,000 GW required to achieve net-zero emissions by 2070 will require a "holistic approach to addressing challenges such as land access, climate risks, land conflicts, and population density.

Source: <https://www.newindianexpress.com/>



Pollution in Drains Rises Despite Rain

Pollution levels have spiked in several major city drains that flow into the Yamuna despite the rains in August. According to reports of Delhi Pollution Control Committee (DPCC), chemical oxygen demand (COD) and biochemical oxygen demand (BOD) have spiked in several drains. BOD indicates the power of the river to heat itself up. Higher BOD indicates more oxygen is required, while low BOD means less oxygen is being removed from the water, so it is cleaner. Chemical oxygen demand (COD) is the amount of dissolved oxygen that should be present in the water to oxidize chemical organic material. According to the report, the Najafgarh drain, one of the main polluters, recorded a BOD level of 54 mg/l, against the minimum standard of 30 mg/l.

Source: <https://timesofindia.indiatimes.com/>

Hundred Per Cent Renewable Energy Utilization by Visakhapatnam Port

Visakhapatnam Port Authority (VPA) utilized 100 per cent renewable energy, and this achievement placed it in the first position among all major ports in the country. Under the Green Port initiatives launched by the Ministry of Ports, Shipping, and Waterways, the port established a solar power plant and introduced CNG buses, among others. These efforts are in line with the broader Amrit Kaal Vision 2047, which seeks in reducing carbon emissions in Visakhapatnam City to zero.

Source: <https://www.thehindu.com/>



Wayanad Landslide Largest in India's History, Finds Study

The landslide that devastated a few villages of Wayanad recently is the biggest in India's recorded history, according to a study commissioned by the Kerala State Disaster Management Authority. The July 30 landslide resulted in a debris flow of nearly six million cubic metres—capable of filling 2,400 Olympic-sized swimming pools stretching eight kilometres downhill, the study found. Previously, the 1998 Malpa landslide in Uttarakhand held the record for the largest debris flow in the country. The Wayanad landslide was five times larger than Malpa and 300 times the size of the 2020 Pettimudi landslide in Munnar.

Source: <https://www.newindianexpress.com/>



Climate Change Can Cause Bridges to 'Fall Apart Like Tinkertoys,' Experts Say

On a 95-degree day this summer, New York City's Third Avenue Bridge, connecting the Bronx and Manhattan, got stuck in the open position for hours. As heat and flooding scorched and scoured the Midwest, a steel railroad bridge connecting Iowa with South Dakota collapsed under surging waters. In Lewiston, Maine, a bridge closed after the pavement buckled from fluctuating temperatures. America's bridges, a quarter of which were built before 1960, were already in need of repair. But now, extreme heat and increased flooding linked to climate change are accelerating the disintegration of the nation's bridges, engineers say, essentially causing them to age prematurely.

Source: <https://www.nytimes.com/>



Heat Deaths have Doubled in the US in Recent Decades

As dangerous heat bears down on the central and eastern United States recently, a new study shows heat-related deaths across the country are on the rise. While 2023 was the hottest year on record and led to at least 2,325 heat-related deaths in the US, more than 21,518 people have died from heat since 1999, according to a study published recently in *JAMA*, the journal of the American Medical Association. "It's very likely that we're going to continue to face these kind of extreme heat issues," said Jeffrey Howard, an associate professor in public health at the University of Texas at San Antonio and the lead author of the study. "It's not something that's going to go away."

Source: <https://www.nytimes.com/>

AI is 'Accelerating the Climate Crisis,' Expert Warns

If you care about the environment, think twice about using AI. Generative artificial intelligence uses 30 times more energy than a traditional search engine, warns researcher Sasha Luccioni, on a mission to raise awareness about the environmental impact of the hot new technology.

Instead of simply extracting information, "like a search engine would do to find the capital of a country, for example," AI programmes "generate new information," making the whole thing "much more energy-intensive," she explains. According to the International Energy Agency, the combined AI and the cryptocurrency sectors consumed nearly 460 terawatt hours of electricity in 2022—2 per cent of total global production.

Source: <https://economictimes.indiatimes.com/>

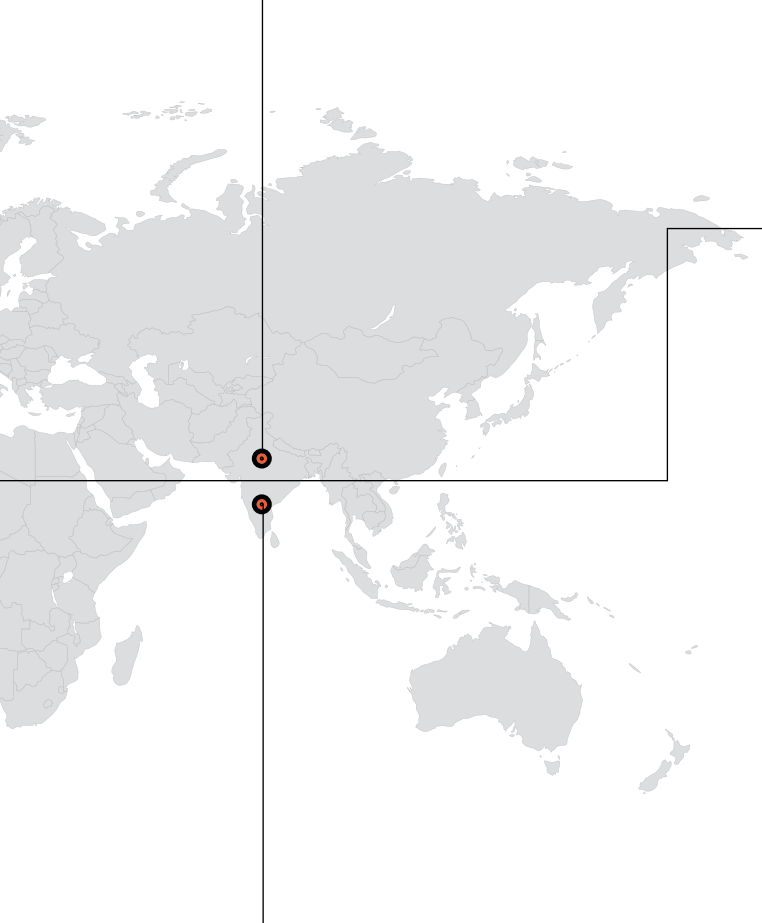




ISA to Launch \$100 Million Solar Facility, Insurance Mechanism to Accelerate Solar Power Projects

The International Solar Alliance (ISA) will launch a \$100 million fund, Global Solar Facility, that will help catalysing up to \$1.5 billion in funding to expand decentralized solar power capacities across the least developed countries in Africa, where more than 700 million people have no access to electricity. ISA Director General, Dr Ajay Mathur, emphasized that through a framework of partnerships and purpose that ties together businesses, colleges, youth, women and communities, ISA aims to unlock the full potential of solar energy, drive significant investments, and pave the way for a sustainable and vibrant future.

Source: <https://www.thehindubusinessline.com/>



Nearly 40 Per Cent of Amazon Rainforest Most Vital to Climate Left Unprotected

Scientists agree that preserving the Amazon rainforest is vital to combating global warming, but new data recently indicate huge swathes of the jungle that are most vital to the world's climate remain unprotected. Nearly 40 per cent of the areas of the Amazon rainforest most critical to curbing climate change have not been granted special government protection, as either nature or indigenous reserves, according to an analysis by non-profit Amazon Conservation. The areas lie in the far southwest of the Amazon in Peru and the far northeast in Brazil, French Guiana, and Suriname, the data show. Those parts of the Amazon have the biggest, densest trees and the most continuous canopy cover, said Matt Finer, who leads Amazon Conservation's Monitoring of the Andean Amazon Project (MAAP).

Source: <https://www.deccanherald.com>

India Unveils Cooling Action Plan to Phase out CFCs by 2037

On the occasion of World Ozone Day, India released its cooling action plan to phase out chlorofluorocarbons (CFCs), a major refrigerant widely used in all cooling equipment like air-conditions, freeze, foam applications, etc. It is a major gas which is contributing to rapid depletion of the ozone layer and warming climate. CFCs are nearly 2,000 times more potent than carbon dioxide in terms of their global warming potential. Because of this, the world has come together to phase out the CFCs by 2040 at their 28th Meeting of the Parties on October 15, 2016 in Kigali, Rwanda under the Montreal Protocol. To phase out CFC, the Indian government has brought the Indian Cooling Action Plan (ICAP) document to phase out demand for refrigerants by 2037–38.

Source: <https://www.newindianexpress.com/>



Entrepreneurship

Bridging the Gap of Research and End Users

In today's dynamic world, where innovation drives progress, research holds the key to unlocking groundbreaking solutions to the world's most pressing challenges. Yet, too often, these groundbreaking discoveries remain restricted to the confines of laboratories, failing to reach the hands of those who need them most—the end users. Bridging this gap requires a concerted effort, and entrepreneurship emerges as a powerful catalyst in this endeavour, a pathway to sustainable progress. Entrepreneurship serves as the vital link between the abstract realms of research and the concrete needs of society. To know more, keep reading this article by **Dr Banwari Lal**.

Oil Spill and Management of Oil Contaminated Waste

Oil spills are a global problem that endangers ecosystems, plants, and wildlife. In 2023, there were 10 oil tanker spills worldwide, leaking more than 700 metric tonnes of oil. Every year, the National Oceanic and Atmospheric Administration (NOAA) respond to more than 150 oil and chemical spills in United States waterways. Oil spills into rivers, bays, and the ocean are typically caused

by incidents involving tankers, barges, pipelines, refineries, drilling rigs, and storage facilities.

Despite the best efforts of the petroleum industry and consumers, oil spills across the country are increasing. Oil spills frequently occur in farmer fields due to the proximity of oil fields. These events often lead to significant financial losses for farmers over multiple crop seasons. Similarly, individuals reliant on fisheries suffer job losses due to oil slicks in rivers and lakes. To compensate for these losses, oil companies typically

provide substantial annual payments. However, these are short-term solutions. Sustainable solutions like treating the oil affected land or water making them useable are imperative for long-term resolution.

Research as a Probable Solution and the Impact it Can Create

In 1992 just after first Gulf war, the Department of Biotechnology, Government of India, initiated a programme on Petroleum Biotechnology. Research institutes like The Energy and Resource Institute (TERI) with the support of Department of Biotechnology, Government of India, took a lead and worked on finding a solution for the same.

After screening over 1000 naturally occurring bacterial strains, four were chosen. Each strain specializes in degrading a specific fraction of oil, with no competition among them. Together, these bacteria can break down over 95 per cent of the various petroleum fractions within 24 hours. The result of the extensive research led to discovery of 'Oilzapper', a cocktail of four bacterial strains to treat crude oil and oily sludge, was eco-friendly and an economical





option. This innovative product could biodegrade crude oil and oily sludge at a very fast rate under laboratory conditions.

Bridging the Gap of Research and End Users

At this stage, one of the primary challenges the researcher faces are the translation of theoretical knowledge into real-world applications. While academic institutions excel in generating knowledge, the practical implementation of this knowledge often requires a different skillset and mindset altogether. Too often, researchers operate within silos, disconnected from the practical realities and needs of end users. Conversely, end users may remain unaware of the latest advancements in research that could address their challenges.

Additionally, research institutes have limited resources to fund such research activities or even scale it up to an industrial level. With focus on research and development, facilitating funds or applying for grants takes a back seat. This is where entrepreneurship steps in. A more sustainable approach for R&D activity is collaboration, where the

technology is transferred to an industry player so that the solution is scaled up to be applied in real life situations.

Meeting Financial Challenges through Creation of Start-Up for Smooth Functioning of R&D Work

The Indian start-ups initiative has been on an amazing journey since the Honourable Prime Minister unveiled the Start-up India Initiative on January 16, 2016. The government's purpose with this programme is to enable businesses to expand through innovation and entrepreneurship in the country, thereby boosting economic growth and creating large-scale jobs. The business entity incorporated by TERI and ONGC, follows a model similar to the Indian Start-up Initiative of 2016. Not only was the revenue generated but was also ploughed back for uninterrupted research and development activities. Additionally, it created a large number of jobs for scientists, field workers, labourers, and contractors. A win-win situation for the Research institute as

much as it is for the oil company.

The product was utilized by major oil companies globally, including ONGC, IOCL, BPCL, HPCL and international entities such as ADNOC and KOC, facilitated successful bioremediation of oil-contaminated sites. Operated by this innovative start-up, this technology efficiently treated over one million metric tonnes of oily sludge and soil. Its promptness in handling oil spills restored contaminated land to farmers, while also cleansing water bodies, benefiting fisheries. This exemplifies science's application for societal welfare, restoring ecological balance and livelihoods, notably in India and abroad.

This is an excellent example of a self-sustainable model of a start-up company which employs the funds back to the development of research and development activities, while also creating job opportunities. Thus, entrepreneurship serves as a powerful bridge between research and end-users, translating scientific discoveries into tangible solutions that address real-world challenges. ■

Dr Banwari Lal, Senior Fellow & Senior Director, Environmental & Industrial Biotechnology division, TERI, New Delhi.

Reasons behind Battery Degradation

Discovery could lead to longer-lasting EV batteries, hasten energy transition

Researchers have discovered why lithium-ion batteries, which power most electronic devices, lose capacity over time. The findings could enable the development of electric vehicles that go far longer without needing a charge.

Batteries lose capacity over time, which is why older cell phones run out of power more quickly. This common phenomenon, however, is not completely understood.

Now, an international team of researchers, led by an engineer at the University of Colorado Boulder, has revealed the underlying mechanism behind such battery degradation. Their discovery could help scientists to develop better batteries, which would allow electric vehicles to run farther and last longer, while also advancing energy storage technologies that would accelerate the transition to clean energy. The findings were published recently in the journal *Science*.

“We are helping to advance lithium-ion batteries by figuring out the molecular level processes involved in their degradation,” said Michael Toney, the paper’s corresponding author and a professor in the Department of Chemical and Biological Engineering. “Having a better battery is very important in shifting our energy infrastructure away from fossil fuels to more renewable energy sources.”

Engineers have been working for years on designing lithium-ion batteries—the most common type of rechargeable batteries—without cobalt. Cobalt is an expensive rare mineral, and its mining process has been linked to grave environmental and human rights

concerns. In the Democratic Republic of Congo, which supplies more than half of the world’s cobalt, many miners are children.

So far, scientists have tried to use other elements such as nickel and magnesium to replace cobalt in lithium-ion batteries. But these batteries have even higher rates of self-discharge, which is when the battery’s internal chemical reactions reduce stored energy and degrade its capacity over time. Because of self-discharge, most EV batteries have a lifespan of seven to 10 years before they need to be replaced.

Toney, who is also a fellow of the Renewable and Sustainable Energy Institute, and his team set out to





investigate the cause of self-discharge. In a typical lithium-ion battery, lithium ions, which carry charges, move from one side of the battery, called the anode, to the other side, called the cathode, through a medium called an electrolyte. During this process, the flow of these charged ions forms an electric current that powers electronic devices. Charging the battery reverses the flow of the charged ions and returns them to the anode.

Previously, scientists thought batteries self-discharge because not all lithium ions return to the anode when charging, reducing the number of charged ions available to form the current and provide power. Using the Advanced Photon Source, a powerful X-ray machine, at the US Department of Energy's Argonne National Laboratory in Illinois, the research team discovered that hydrogen molecules from the battery's electrolyte

would move to cathode and take the spots that lithium ions normally bind to. As a result, lithium ions have fewer places to bind to on the cathode, weakening the electric current and decreasing the battery's capacity.

Transportation is the single largest source of greenhouse gases generated in the US, accounting for 28 per cent of the country's emissions in 2021. In an effort to reduce emissions, many automakers have committed to moving away from developing gasoline cars to produce more EVs instead. But, EV manufacturers face a host of challenges, including limited driving range, higher production costs and shorter battery lifespan than conventional vehicles. In the US market, a typical all-electric car can run about 250 miles in a single charge, about 60 per cent that of a gasoline car. The new study has the potential to address all of these

issues, Toney said.

"All consumers want cars with a large driving range. Some of these low cobalt-containing batteries can potentially provide a higher driving range, but we also need to make sure they don't fall apart in a short period of time," he said, noting that reducing cobalt can also reduce costs and address human rights and energy justice concerns.

With a better understanding of the self-discharge mechanism, engineers can explore a few ways to prevent the process, such as coating the cathode with a special material to block hydrogen molecules or using a different electrolyte. "Now that we understand what is causing batteries to degrade, we can inform the battery chemistry community on what needs to be improved when designing in batteries," Toney said. ■

Source: www.sciencedaily.com



Managing Crop Residue

Improving Soil Health and Reducing Pollution

In this article, **Sarita Brara** highlights that the burning of paddy straw in Punjab and Haryana significantly contributes to rising pollution levels in Delhi each October and November. To combat this issue, the states are implementing various methods, including the use of Super Seeder machines. These advanced agricultural implements not only incorporate paddy residue into the soil but also help manage crop residue more effectively. By reducing the need for stubble burning, Super Seeders play a crucial role in mitigating air pollution and enhancing soil health. They simplify residue incorporation, improve soil structure and fertility, and support microbial activity and nutrient cycling. Additionally, these machines minimize the need for extra tillage, saving both time and fuel for farmers. The adoption of Super Seeders across India is expected to improve soil management practices, promote environmental sustainability, and boost agricultural productivity.





Before 2023 Vikas Singh admits that he and other farmers in Dayalpur village in Kurukshtra district of Haryana used to burn their paddy stubble to clear the their fields before sowing the next crop. That is no longer the case now. Last year their village was

one of the 100 villages selected by an NGO to ensure zero burning of paddy residue. Twenty-seven Super Seeder machines were provided to individual farmers who in turn let other farmers in their village use the machine on payment basis. The multi-tasker Super Seeder

machine attached to a tractor finely cuts the paddy stubble, ploughs it back to the soil and is also used for sowing seeds for the next crop and all this is done fast. This means that there is no need to burn paddy stubble locally referred to as *parali* and hence no air pollution. Secondly, the soil is enriched with nutrients in the residue and most importantly sowing is completed for next crop within the small window of time available after harvesting paddy.

“In Dayalpur village, the panchayat owns nearly 500 acres of land which is given on lease to farmers for growing crops and another 500 acres are privately owned for cultivation,” says Vikas Singh. One of the recipients of the Super Seeder, Singh grows paddy in five acres of land owned by him and charges INR 1500 per acre for use of his machine by other farmers in his village. He says that it takes just 2–2.5 hours per acre to complete the task saving both energy and time.

The main reason for stubble burning in Haryana as well as Punjab is the limited



time available between harvesting of paddy and sowing of wheat. Delaying wheat sowing can negatively impact crop production. Left with only a 2–3-week window between harvesting the paddy crop and sowing the next one, the farmers find burning the crop residue as the most cost-effective way to clear the fields post-harvest, not realizing the harmful effects caused by pollution from the burning.

The NGO SM Sehgal Foundation initiated the project in 2023 to address crop residue burning in northern India starting with villages in Kaithal and Kurukshetra districts of Haryana. Under the CSR supported project being implemented by the Foundation, the farmer has to just pay INR 1,00,000 for the Super Seeder machine that costs about INR 2.5 lakh. The rest that is 60 per cent of the cost is provided under the project.

In addition to providing financial support, the NGO educates villagers about the harmful effects of burning parali and holds workshops and programmes aimed at improving agricultural practices to boost production. The NGO also supplies seeds for various types of paddy that can be harvested in a shorter period. Additionally, it assists farmers with soil testing.

Vikas Singh says that with this variety of seed, paddy is ready for harvesting in 85 days, compared to 120–135 days with the previous variety they were using. Mehma Singh, a farmer in Manjhla village of Kaithal district, owns five acres of land and does farming in 20–25 acres of land that he takes on rent. He used to pay INR 1500–2500 per acre for the use of Super Seeder machine from a farmer in another village. Many a times, the machine was

not available on time and a lot of money and time was wasted in removing the paddy residue from the fields. He like other beneficiaries contributed INR 1,00,000 from his savings as part of his share for the cost of Super Seeder machine that he got from the NGO.

“Not only do I earn from the machine used for other farmers in the villages I am saving money as I have to spend much less on fertilizers as the soil is enriched with paddy residue that has multiple nutrients including nitrogen, zinc, and DAP”

Ranjit Singh, a farmer in his village, is one among 100–125 farmers who is benefitting from Mehma Singh’s Super Seeder machine. He says now he is able sow the next crop on time. “Earlier I used spend INR 5000 on fertilizer and now the cost has come down to INR 2000,” he says.

According to the Principal Lead





Agriculture Development and Extension Department of the Foundation Pawan Kumar, villages which had the highest incidence of parali burning as per the state data were selected under the project. Also, only those villages were chosen where no farmer owned or there was no community-owned Super Seeder. Under the project, Super Seeder

machines were provided to individual entrepreneurs. These machines were also put to use for other farmers in their villages or nearby places on payment basis. According to the Foundation, 5000 farmers have benefitted and 30,000 acres of land were covered under the project for the purpose. The result was that residue from these many acres of land

after harvesting paddy was not burnt reducing pollution levels in the area. "This year another 27 Super Seeder machines will be provided to benefit more farmers," says Pawan Kumar.

The aim of the initiative besides promoting the use of Super Seeder machines for effective paddy residue management was also to develop a



replicable and scalable holistic model and build the capacities of small and marginal farmers across rural India. Workshops were held to sensitize farmers about soil health and organic content through demonstrations and regular capacity-building sessions by experts. The Foundation also supports farmers who already have Super Seeder machines by including those training programmes.

Under the project, farmers in the selected villages in the two districts were given training to make proper use of the machine and also given cues on crop diversification as well as how to grow paddy that is ready for harvesting in a shorter period. Workshops were held as part of the community awareness programmes in which they were also informed and educated about the government schemes under which subsidy is provided for buying machines like the Super Seeder. In order to inculcate leadership qualities in women in the selected villages, Village Development Committees (VDCs) and Women Leadership Schools, WLS were set up.

Sudesh Rani from Kainthal khurd village in Kurukshetra says that initiative by the NGO has brought down the number of people who used to have breathing-related problems due to

A farmer using the super seeder machine



burning of parali. She says that she got seeds from the Foundation to grow vegetables, learnt how to take care of the cattle and more importantly taking part in joint sessions with male counterparts has increased her confidence level.

Maya Kaur, a member of WLS from Manjhla village, received training and seeds to start a kitchen garden. She was also given guidance on caring for domestic animals and their health. Kaur says she is now growing her own vegetables and no longer needs to buy them from the market.

The burning of paddy straw in Punjab

and Haryana is seen as a significant contributor to the rise in pollution levels in Delhi during October and November every year. The use of Super Seeder machines that disposes of the paddy residue by mixing it in the soil and using paddy stubble for production of fuel gas and manure are some of the methods being employed by the two states to reduce the incidence of parali burning and thereby trying to reduce air pollution. ■

Sarita Brara is a Delhi-based senior freelance writer who regularly contributes articles in TerraGreen.



The Spectacular Flyer

The Waved Albatross (*Phoebastria irrorata*)

The intrepid wildlife photographer **Sandesh Kadur**, lives life on the edge, bringing to us high-quality wildlife and conservation documentaries, for globally renowned networks like National Geographic, BBC, and Netflix. When I (**Dr Marianne Furtado de Nazareth**) received his 2024 calendar with a picture of waved albatross (*Phoebastria irrorata*) Galapagos in Ecuador, the picture of the massive birds piqued my interest and I immediately emailed his sister Vydehi to get me inputs for my story. Like Sandesh says—From the Himalayas in India, through the cloud forests of Rwanda, and under the crashing seas of the Galapagos Islands, where there’s a story to be told, a behaviour to be filmed, and incredible species to be discovered, and we’re there.

I had also just read the beautifully illustrated book—“Whale and the Albatross” by Emily Zisman about the bird with the biggest wingspan in the world, so I just had to get his interview and learn more about this bird. Talking to **Sandesh Kadur** he shares his experiences of photographing the birds on the Galapagos Islands and we are lucky to enjoy his unique experience.



Why did you want to photograph the waved albatross? What's so special about them?

I've always been drawn to capturing images of unique and fascinating wildlife. The waved albatross is the largest bird in the Galápagos Islands, and quickly captured my attention given its distinctive appearance. However, it was their behaviour that truly fascinated me. Their elaborate courtship rituals and the stories of their lives at sea are just remarkable.

They look like massive birds. Did they show any aggression during your photoshoot?

Not at all. While they are large birds, the waved albatrosses were not aggressive towards me. Of course, as visitors to their habitat, it's key to be respectful of their space and give them a wide berth.

Have the numbers increased or dwindled over the last decade?

The population on the Galápagos is protected by law, and the island is designated as a World Heritage Site. However, they have faced numerous challenges over the past decade, including habitat disturbances, the consequences of illegal fishing activities and plastic pollution. It is hard to say what their numbers are in comparison but I do know that several conservation efforts are underway as we speak.

What's the primary food for the waved albatross? Is there enough around the islands to keep the population fed?

The waved albatross feeds on fish, squid, and smaller critters like crabs and molluscs. Quantifying if there's enough food around the islands is challenging. Outside protected areas, illegal fishing and pollution significantly affect the availability of prey for the albatross. These birds often need to forage up to 100 km from their nesting sites to find sufficient food. Additionally, plastic pollution in our oceans poses a severe threat to both adult albatrosses and their chicks, impacting their survival rates.

There is an interesting legend that they mate for life. Is that true? Any anecdotal evidence you would like to share?

Many species in the wild are known to mate for life, and this is indeed true for the waved albatross. But it is important to note that they may or may not be strictly monogamous and may sometimes engage in extra-pair copulations.

The 2011 film *Albatross* I recollect shows the birds' amazing wingspan and their spectacular glides. Is that a fact? Being so huge how do they launch themselves?

Yes, waved albatrosses have an impressive wingspan, which can exceed 2 metres, while some albatross species have wingspans of up to 3 metres or



Sandesh Kadur

more. The wingspan helps them ride ocean winds, and gives them the ability to glide for hours without resting or even flapping their wings. This ability is crucial for their survival, given the time they spend out at sea. Launching themselves into flight is equally fascinating to watch. They often run into the headwind to gain lift (much like watching an aircraft take off) or launch off cliff edges.

Any anecdotes you would like to share about your trip to photograph them?

The Galápagos Islands are heavily protected, so you can't just tell the captain of the boat or ship where you'd like to be dropped off and roam freely for the day. There are strict rules about where you can and can't go, when you can be in certain locations, and how many people can be there at a time. Of course, these rules are essential for preserving the unique ecosystem. When I was there, given the time restrictions, it was difficult to decide what to photograph because there was so much incredible wildlife all around me! From prehistoric-looking marine iguanas and playful sea lions to Nazca, blue-footed, and red-footed boobies, vibrant sally lightfoot crabs, giant tortoises, penguins, and frigate birds, the diversity was astounding. Of course, I ended up spending the most time with the waved albatross given that they were going through their mating rituals. The light was perfect too, casting a golden hue over the scene, adding that extra spark. At one point, I was so engrossed that I almost missed my ride back.

Reading up on the net the information about the bird is very interesting for the layperson. The waved albatross (*Phoebastria irrorata*), also known as Galapagos albatross, belongs to the Diomedidae family found in the tropics. When they forage, they follow a straight path to a single site off the coast of Peru, about 1,000 km to the east. During the non-breeding season, these birds are resident on the Ecuadorian and Peruvian coasts.

It gets its name from the wave-like pattern on the feathers of the adult birds. This species is medium-sized, measuring 80–90 cm in length with a wingspan of a massive 220–250 cm. They range between 2.7 and 4.0 kg in weight, with males being significantly heavier than the female. Their long, yellow bill is huge in comparison to its small head and long, slender neck. Interesting to note is that they have weird bluish feet and the lifespan of these birds could be 40 to 45 years.

The waved albatross mainly eats fish, squid, and shellfish, as well as other small birds. Searching for food, the bird will glide over the ocean where fish stay on the surface, making it easy to catch its prey. Sometimes the bird is known to hunt for food, 10 to 100 km away from the place where the chicks are nesting, to feed them.

The nests are built on outcropping of lava with boulders and sparse vegetation, or thick brush. A spectacular sight is the courtship of the waved albatross which is very elusive and photographers wait for



it. The birds engage in rapid bill circling and bowing, beak clacking, and an upraised bill to make a 'whoohoo' sound. Between April and June they lay their eggs and incubate them for two whole months. Later, the chicks are fed up to 2 kg of food a day so the parents forage for hours. The young grow fast and reach adult size by December, finally leaving the parental nest by January.

Waved albatrosses are spectacular fliers, perhaps the most famous in the world. They can fly for hours without needing to rest, thanks to a technique known as dynamic soaring. The wind speed near the sea surface is much lower than it is about 50 feet above it, so the waved albatross takes advantage of this by gliding at high speeds into the wind. As it glides higher it loses most of its ground speed, because it is gliding into a wind of a higher speed. However, its air speed does not fall, enabling it to glide

continuously. But waved albatrosses do have difficulty in landing because of their high stalling speed, and in taking off because of their weight and wingspan. To make it easier they sometimes take off from cliffs that are found inland rather than beside the coast.

What was interesting in my research on the bird was the salt gland that they possess and is situated above the nasal passage, which desalinates their bodies. Obviously needed due to the high amount of seawater that they naturally consume when they hunt for food they excrete a highly saline solution from their nose.

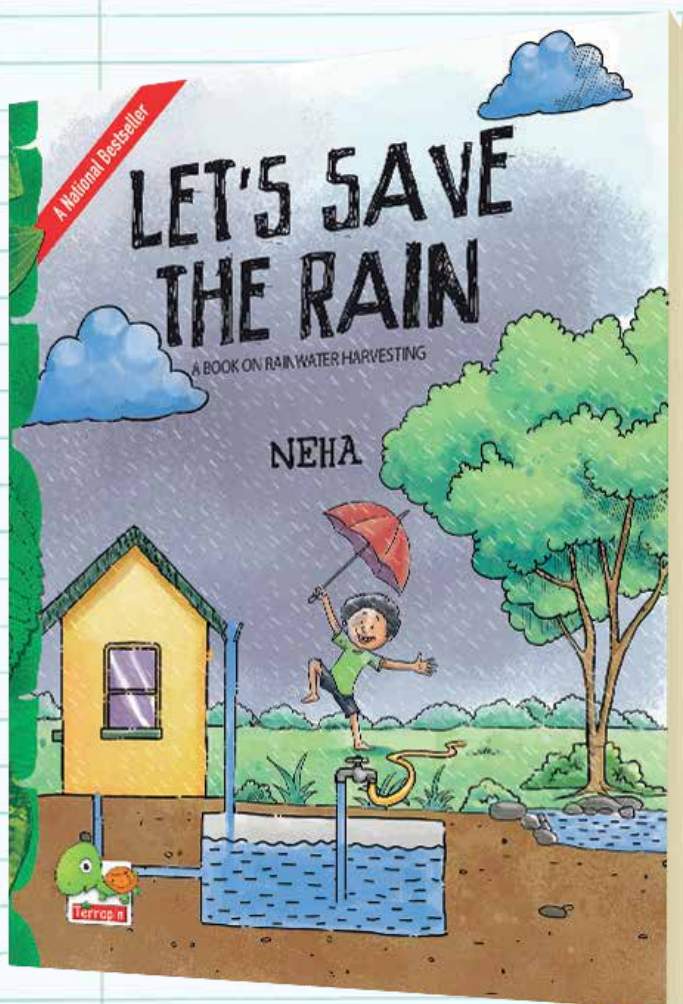
The population of waved albatrosses on the Galápagos is protected, and the island is also categorized as a World Heritage Site. But human intervention in particular seems to be having a severe impact on the species and the conservation status was posted as vulnerable by the IUCN in 2000.

Despite there still being some 34,700 adult birds in 2001, their numbers have apparently started to decrease at an unknown rate. As the current situation makes the population highly vulnerable to a catastrophic collapse to extinction, it was uplisted to critically endangered status in the 2007 IUCN Red List. ■



Dr Marianne Furtado de Nazareth is Freelance Science and Environment Journalist, Former Assistant Editor – The Deccan Herald. All photos by Sandesh Kadur.

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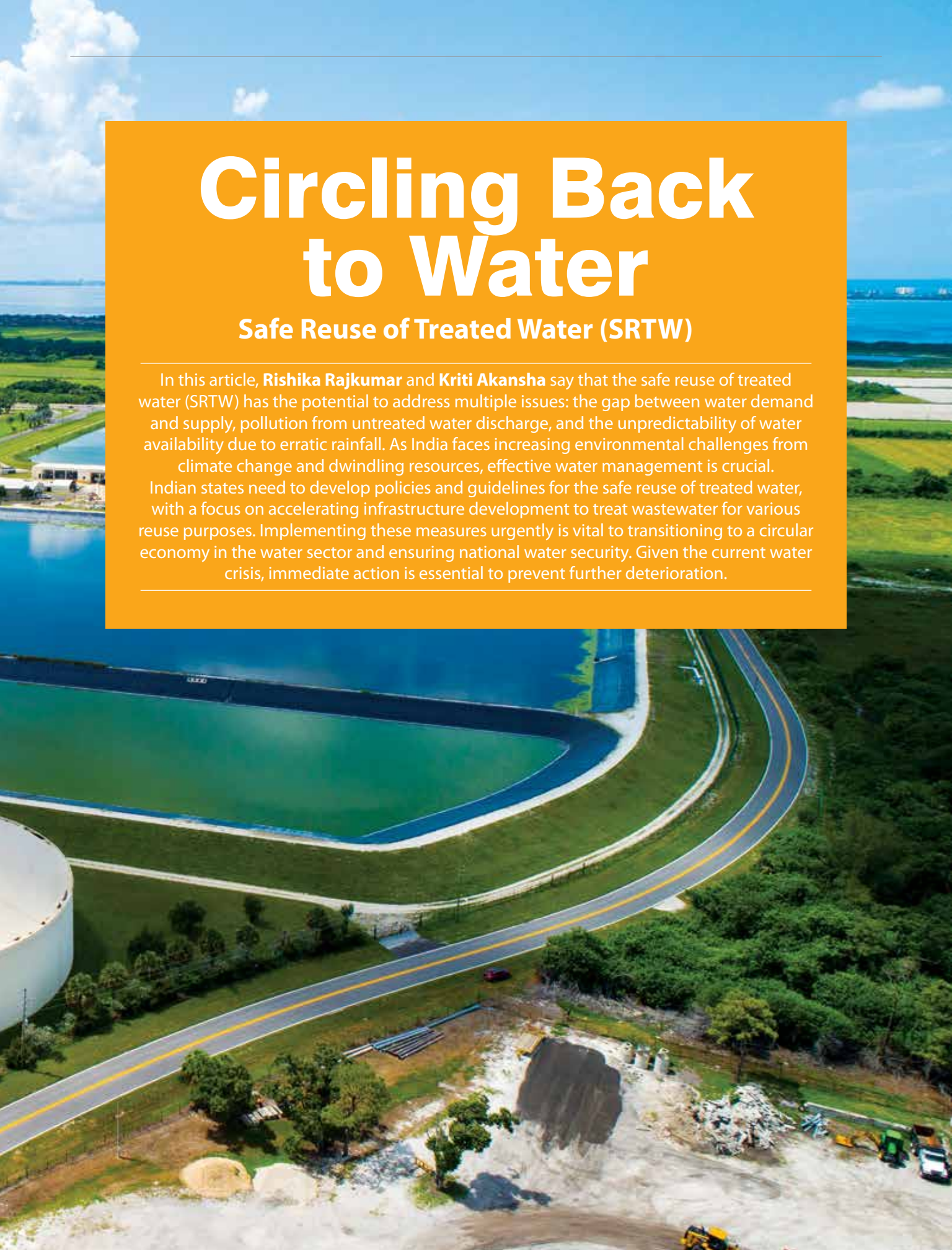
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Circling Back to Water

Safe Reuse of Treated Water (SRTW)

In this article, **Rishika Rajkumar** and **Kriti Akansha** say that the safe reuse of treated water (SRTW) has the potential to address multiple issues: the gap between water demand and supply, pollution from untreated water discharge, and the unpredictability of water availability due to erratic rainfall. As India faces increasing environmental challenges from climate change and dwindling resources, effective water management is crucial. Indian states need to develop policies and guidelines for the safe reuse of treated water, with a focus on accelerating infrastructure development to treat wastewater for various reuse purposes. Implementing these measures urgently is vital to transitioning to a circular economy in the water sector and ensuring national water security. Given the current water crisis, immediate action is essential to prevent further deterioration.





India, with a rapidly growing population and urbanized landscape, is experiencing an increasing gap between water demand and supply. With the additional aspect of climate change disrupting rainfall patterns, it has become imperative to reevaluate India's water resource management.

Predictions show that in the year 2030, the water demand will be 1498 BCM and the water supply will be 744 BCM (Figure 1)¹. This points to a dire scenario with the water demand being around two times the water supply in just a little over five years from now.

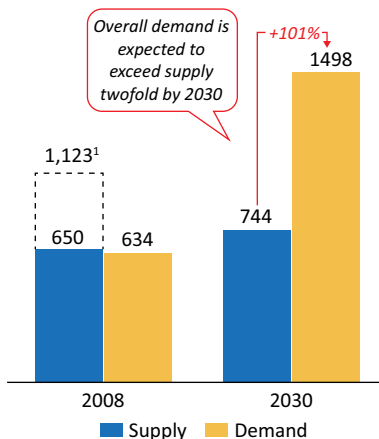


Figure 1: Demand and supply of water in India (forecast) (NITI Aayog, 2018)

¹ NITI Aayog (2018). Composite Water Management Index-A Tool for Water Management. Available online at https://social.niti.gov.in/uploads/sample/water_index_report.pdf

The rising population of India and the decrease in water supply will result in lower per capita water availability in the years to come. The population of India is predicted to reach 166.8 crore by 2050, with the official estimate of the annual per capita water availability in India in 2050 to be 1140 m³/year. This is a significant decrease in per capita water availability in India of nearly 15 per cent from 2025 to 2050 (Figure 2)².

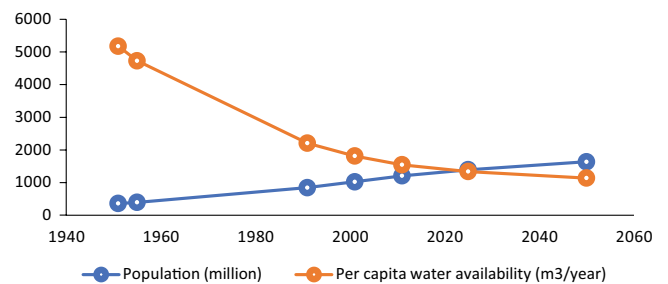


Figure 2: Per capita water availability in India over the years (Bhat, 2014)

Water Shortages and Flooding in Urban India

The year 2024 alone has seen the news of severe water shortages in most Indian cities. Bengaluru faced a water shortage of as much as 300–500 million litres a day in early March. Poor rainfall the previous year and the

² Bhat, T. A. (2014). An analysis of demand and supply of water in India. Journal of Environment and Earth Science, 4 (11), 67–72

depletion of underground water tables were identified as the reasons for this.

With only 10 per cent of usable water stock in the reservoirs of Mumbai this summer due to reduced rainfall the previous year, water cuts began from May 30 onwards to make sure that the supply would last till the rains arrived. This water cut was revoked on July 29 with the monsoon rains replenishing the reservoirs of Mumbai.

In June, Delhi faced an acute water shortage during the heat wave. While there has been the inter-state water dispute between Delhi and Haryana, the other underlying issue appears to be that Delhi has been relying significantly on groundwater reserves to meet the gap between the water demand and water supply. The Delhi Jal Board (DJB) has increased the extraction of water from groundwater reserves from 86 million gallons per day in 2020 to approximately 135 million gallons per day in 2024. The extraction of groundwater was recorded to rise from 98.16 per cent in 2022 to 99.13 per cent in 2023, while the net annual groundwater recharge has declined from 0.41 in 2022 to 0.38 in 2023.³

It is interesting to note that in all three of these cities, the rainfall in the months that followed the periods of severe water shortage resulted in waterlogging and flooding. Urban India seems to be facing conflicting water-related calamities one after the other, reminding one of Chennai, which faced massive flooding in 2015, to later deal with 'Day Zero' in 2019. The need for effective drainage systems and efficient integrated water resource management in Indian urban spaces has become apparent.

Safe Reuse of Treated Water

It is in the midst of contradictory situations with water and the increasing urgency to tackle the widening gap between water demand and supply that the safe reuse of treated water becomes an important topic for discussion. Safe reuse of treated water (SRTW) is exactly what it sounds like. It is the process of water being used, collected, treated, and then reused safely for different purposes, such as industrial processes, gardening, toilet flushing, irrigation, etc.

SRTW decreases our need for freshwater for non-potable purposes, reduces water stress by bridging the gap between water demand and supply, and helps us navigate the impacts of climate change on water availability. The discharge of treated water into water



bodies not only helps avoid the pollution of water bodies but also helps rejuvenate them, as opposed to the discharge of untreated used water.

In many countries of the European Union, treated water is largely reused for irrigation, followed by the industrial and urban sectors. In Brazil, treated water is used in agriculture, aquaculture, and industries. Singapore has gone as far as treating their water for it to be potable, exceeding the standards for drinking water quality set by the World Health Organization (WHO) as well as the United States Environmental Protection Agency (USEPA). Singapore reuses the treated water mainly in water-intensive industries, petrochemical industries, and power plants.

Safe Reuse of Treated Water in India

The beginning of reuse of treated water in independent India dates back to 1964–65, when wastewater from textile industries was reused for purposes such as blanket washing. In the year 1969, blackwater began to be treated and reused as cooling water in the centralized air conditioning system in the Air India building in Mumbai. In the 1970s, Chennai began using wastewater for irrigation.

As of today, 12 Indian states (Figure 3)⁴ have policies for the reuse of treated water, of which most have action plans with set targets and timelines. Meanwhile, three other Indian states include wastewater reuse in their state water policies.

In 2022, the National Framework on SRTW was developed, which provides guidelines for states to develop their respective state policies for the safe reuse of treated water as well as promote its implementation.⁵

Now, with the AMRUT (Atal Mission for Rejuvenation

³ CGWB (2023). Ground Water Year Book National Capital Territory, Delhi 2022–2023

⁴ NITI Aayog (2023). Reuse of Treated Wastewater in Urban/Peri-Urban Agriculture in India.

⁵ Govt. of India (2022). National Framework on Safe Reuse of Treated Water

and Urban Transformation) 2.0 scheme, there is great scope for amplifying the processes and actions required for the promotion and implementation of

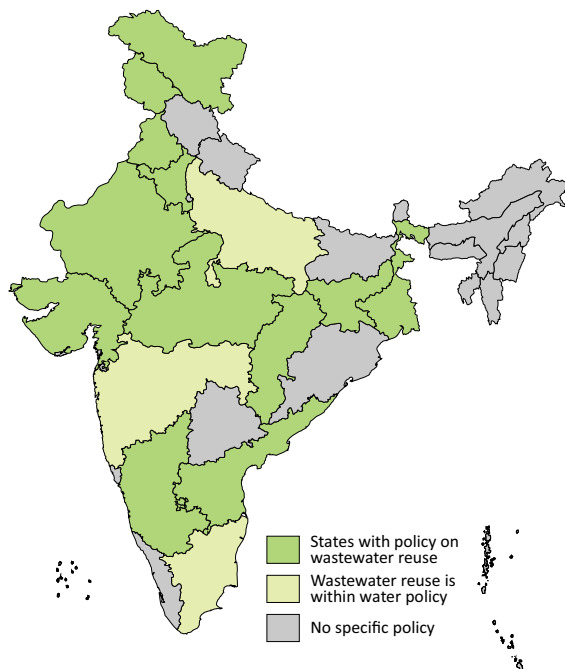


Figure 3 States having policy on reuse of treated water (NITI Aayog, 2023)

SRTW throughout the country. The developments in the direction of reusing treated water safely in India are significant, for they hold much promise for the times to come.

Successful Stories of Safe Reuse of Treated Water in Indian Cities

Chennai

As mentioned earlier, Chennai began reusing wastewater for irrigation in the 1970s. Between 1989 and 1991, secondary treatment plants were set up to treat sewage and reuse the water as cooling water for the industrial processes, and this grew in 1999.

In June 2019, 'Day Zero' was declared by the Chennai city officials due to the drying up of the city's water reservoirs. This was 5 years after the Chennai Floods of 2015 and this scenario prompted the CMWSSB (Chennai Metropolitan Water Supply and Sewerage Board) and the Greater Chennai Corporation to take urgent action. A bylaw mandating the recycling of water was made, applicable to all stakeholders.

This led to the establishment of two tertiary treatment reverse osmosis (TTRO) plants in late 2019,

with a capacity of 45 million litres per day (MLD) each. With 20 sewage treatment plants (STPs) and two TTRO plants, the city of Chennai has the capacity to treat 913 MLD, of which 600 MLD is treated on a daily basis. Around 79.15 MLD treated water is reused on an average day, which has been calculated to generate a net revenue of INR 4.07 crore per month. Chennai is projected to be able to meet half of its water demands with the reuse of treated sewage by the year 2050.

There are two reuse business models in operation in the industries by the CMWSSB, both of which is overseen by the Tamil Nadu Pollution Control Board to ensure the quality of the treated effluent is in compliance with the set standards. The first is the supply of secondary treated used water to petrochemical industries, wherein used water undergoes treatment at STPs and this secondary treated water is sent via a conveyance system funded by the CMWSSB to the industries. Here, the industries invest in and operate tertiary treatment plants themselves and the secondary treated water can undergo further treatment. With these industries, the CMWSSB has committed to provide a specified amount of secondary treated water.

The second is the supply of tertiary treated used water to State Industries Promotion Corporation Tamil Nadu (SIPCOT), in which secondary treated used water is moved from the STPs to the two TTRO plants mentioned above which have been established under a 15 years contract between BGR Energy Systems, the Wabag-IDE consortium and CMWSSB. SIPCOT receives tertiary treated water of specific quantity and quality, as agreed upon with the CMWSSB.

Surat

In 1995, the Surat Municipal Corporation (SMC) created a long-term water supply master plan with counsel





from Tata Consulting Engineers. This was done with the recognition that water supply and availability for the projected population of the city in the year 2021 required to be planned for, well in advance. The effect of seawater intrusion into groundwater reserves as well as the dependence on and unpredictability of River Tapi as the only source of fresh water was also noted as significant reasons to move towards SRTW. The water supply master plan resulted in a water treatment plant with a capacity of 120 million litres per day (MLD) being commissioned, which was later scaled up to 240 MLD in 1999. In 2001, the city's capacity to treat wastewater further increased to 440 MLD. In the year 2009, the Government of Gujarat further promoted the reuse of water under the flagship programme 'Swarnim Jayanti Mukhya Mantri Shehri Vikas Yojna' (SJMMSVY).

Today, there are 11 STPs in Surat with a total capacity of 1726.5 MLD. The total average sewage collected and treated is 1018 MLD, out of which 330 MLD is reused, which is more than 30 per cent. Surat also has three tertiary STPs, which have a total capacity input of 164 MLD and a net output of 115 MLD.

In Surat, industrial estates commit to purchasing a specified quantity of treated used water and this generates an annual revenue of more than INR 120 crore. SMC is working towards the mission of reusing 70 per cent of all treated wastewater by the year 2030 and 100 per cent by the year 2035.

Models to follow

The stories of these two cities show us that the safe reuse of treated water in urban India is viable, reliable, and profitable. With the recognition of the severity of the water shortage at present, that in the future with the projected populations, and the need for urgent measures to be taken now to ensure water security in

the long run, it has been proven that a more sustainable way of managing water resources in cities is, in fact, possible. Both Chennai and Surat serve as fine examples of the viability of the safe reuse of treated water for urban India to follow and improve upon.

Opportunities

The AMRUT 2.0 scheme provides great opportunities to further the development of SRTW projects, for promotion of a circular economy of water. The Swachh Bharat Mission for Urban Areas 2.0 aims at establishing effective grey and black water management in all the Indian cities that are not covered under AMRUT. This furthers the scope of SRTW to be operational in more urban spaces in India.

Safe reuse of treated water can bring about new green jobs, generate a significant amount of revenue, allowing for huge profits and economic growth. Agriculture, the largest contributor to the country's gross domestic product (GDP), can also benefit from the reuse of treated water in irrigation, provided that the water is treated adequately and that the treated water is provided cheaper than freshwater to the farmers. Pushing the agenda for the safe reuse of treated water in turn presents great opportunities for further research and innovation in this direction.

Challenges

Most Indian state policies on SRTW highlight the significant gap between the volume of wastewater generated and the capacity of existing wastewater treatment plants. In all Indian Class I cities and Class II towns combined, this gap is projected to be 22,939 MLD.⁶

In other words, the current sewage treatment infrastructure can only handle 21.3 per cent of the total sewage produced in these areas, and the remaining 78.7 per cent remains untreated.⁷

This presents a major challenge, as the collection and adequate treatment of used water are the essential prerequisites for the safe reuse of treated water. In India, there are states that continue to not have any installed STPs.

There is a need to inspect the working conditions and status of existing STPs in India. Although state policies on SRTW list the number of existing STPs, their installed capacities, and capacity utilization, the

⁶ CPCB (2021). National Inventory of Sewage Treatment Plants. Details available at <https://cpcb.nic.in/status-of-stps/>

⁷ Ibid.

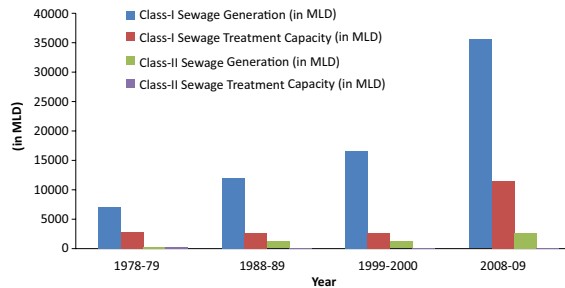


Figure 4 The generation of sewage and capacity for treatment in Class-I cities and Class-II towns (CPCB, 2021)

quality of the treated water/effluent of all wastewater treatment plants in India is not discussed. In 2021, it was found that only 578 STPs complied with the norms as prescribed by the State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) and that only 23 per cent of treatment capacity actually meets the required consented parameters of the SPCBs and PCCs.⁸ There is a need for the treatment plants to ensure proper operation and maintenance.

Efforts are required to disseminate an understanding of the different business models that can be set up to allow for SRTW. While most Indian state policies on SRTW list the different business models to be considered, they do not provide a criteria or guidance for selection. This requirement was met by the National Framework on Safe Reuse of Treated Water and by documentation that supports the same.

For effective implementation of SRTW in a city, a pre-feasibility assessment should be carried out, which maps the supply and demand of water, identifying the roles and responsibilities of the different governing bodies, and assessing of the wastewater treatment infrastructure that exists and is planned for. The second step involves potential reuse options, consisting of listing the possible ways of reuse and identifying the treatment technologies appropriate for the purposes of the reuse of the treated water. The last step involves the feasibility assessment, which identifies the business models that would be best suited for the water reuse options and the technology requirements for the same. These need to be incorporated into state policies too, along with insights from experts, to assist stakeholders in making informed decisions.

Community ownership is vital for the uptake of the safe reuse of treated water. Despite the scientific treatment and quality of the water, the history of water weighs high in the mindset of our population. Efforts

⁸ Ibid.

are required in educating the masses to break social stigma, build trust in the science of treatment, and instill a sense of responsibility in the use and management of water, given the urgency of circumstances. There is potential to bring about change in the behaviour and mindset of the nation's perception of treated water. Involving the public in the building of infrastructure and the assessment of quality is of significant value for it can in turn create accountability and amplify the movement towards the circular economy of water.

Moving Forward

SRTW is an area with scope to solve several issues at once: the current crisis of the gap between water demand and supply, the pollution of water bodies due to the discharge of untreated water, and the unpredictable availability of water due to disruptions in rainfall patterns. As we move towards times of greater environmental distress with climate change and dwindling resources, India is at a crucial point in the management of water as a resource.

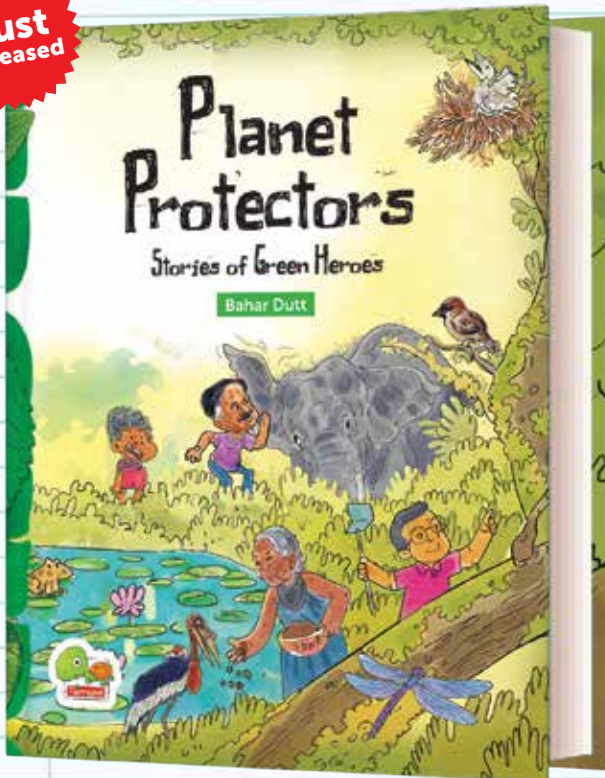
Indian states must develop their respective policies on the safe reuse of treated water and guidelines for increased uptake. There is great urgency for implementation and changes on the ground to transition to a circular economy in the water sector and ensure water security in the nation. It is of utmost importance that the rate of development of infrastructure to treat wastewater to acceptable levels for different purposes of reuse is maintained and accelerated. We already see the problems of the water crisis in the news today, and we must take all the measures possible to avoid the worsening of this situation.

India has a long way to go to be able to collect, treat, and reuse all of the generated wastewater. However, this is a journey that must be met with enthusiasm, energy, and hope for the long vision and the future generations of India. ■

Kriti Akansha, PhD, is a sustainability professional specializing in the impact of industrial pollution on water bodies and the development of effective pollution mitigation strategies. Currently working with Mu Gamma Consultants Pvt. Ltd., she leverages her expertise in various projects dedicated to improving water resource management and mitigating industrial pollution. Rishika Rajkumar is currently pursuing her MSc in Environmental Studies and Resource Management at TERI School of Advanced Studies. With the opportunity to work as a research intern at Mu Gamma Consultants Pvt. Ltd., she has gained insights into water resource management.

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Environmental Fallouts of Gastronomical Apartheid

Central Himalayan Landraces like Black Soybeans

Bethany Mc Lean, an American journalist says, “Choices of right and wrong are not presented to you in black and white. If they were, I am sure most people would choose white.”... And this is true for the central Himalayan landraces like black soybeans, a wide range of millets and pseudo cereals, uncultivated food plants, etc., which despite their nutritional worth and active role in keeping the ecological parameters intact, have for long been denied their due. Indeed, these black edibles have been the unfortunate victims of apartheid in the realm of gastronomy... says **Rajshekhar Pant**.

The strategic location of the Central Himalayas, consequent upon its sharing the border with the twin foreign states of Tibet (China) and Nepal, its inaccessible inner reaches, extreme climatic conditions, abundance of landraces and traditional wisdom gathered over the centuries—(due to an intimate relationship of its inhabitants

with the regional topography, flora & fauna along with a wide range of various other manifestations of nature)—have been instrumental in the gradual development of a cultivation and cuisine pattern which was typically localized and kept on continuing over the generations more or less in its original form. Interestingly, even the regional

variations of different landraces did not undergo any noticeable change and kept on continuing their separate identity.

Over 70 per cent of the population in the rural areas of Kumaon region in the central Himalayas depends on subsistence agriculture. *Agricultural Statistics at a Glance* shows that around 70 per cent of the landholdings here



A poor man's crop, the cultivation of traditional landraces is now confined to such remote pockets.

are marginal while 18 per cent are small. Surabhi Mittal, Gaurav Tripathi and Deepti Seth have found in their field research that in all the districts of Uttarakhand falling in the Central Himalayan region the average landholding is 0.66 hectare. The cultivation scenario here was dominated by traditional subsistence cereals, pseudo-cereals, and millets. A wide range of millets was once grown here in the marginal land under rainfed conditions. The use of uncultivated wild plants, sorrels, seeds, aromatic herbs, roots and tubers, etc., had been the main reason for the regional food being quintessentially straightforward, rustic, and robust.

The trilogy of millets, landraces and uncultivated food items constituting the staple diet in the central Himalayan region had been instrumental in keeping the environmental parameters of the region intact over the centuries. Terraced fields were never furrowed deeply; there was hardly any need of levelling the small slopy terraces cut on the face of the hillocks; use of chemical fertilizers, insecticides, pesticides, etc., was not needed; cultivators happened to have their own seed-banks and invasive species such as parthenium, Crofton weed or pearl grass—which came in due course with exotic seeds—were unheard of.



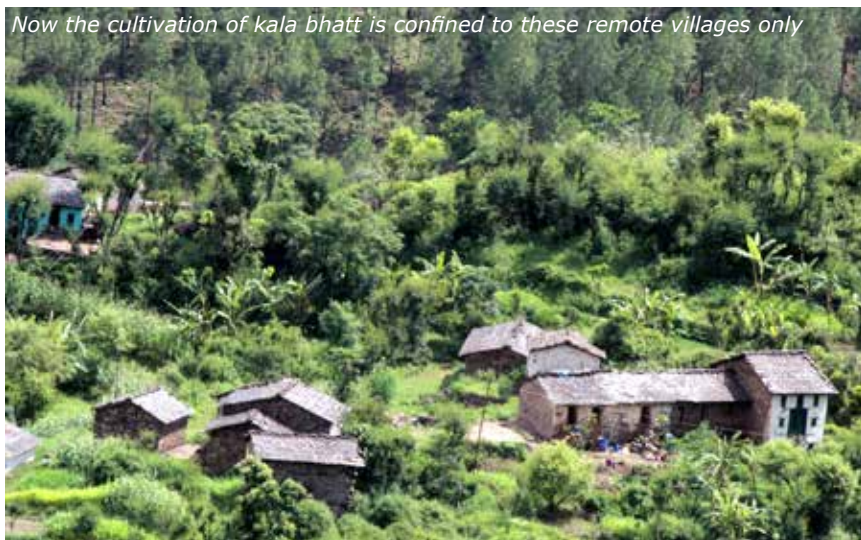
A cultivator in the field of kala bhatt

The area under millets and landraces has drastically been shrinking since 1961. It has declined by 60 per cent. Working paper of the CRIER of July 2008 shows that the total area under cultivation of horse-gram in Almora district, with one of the highest average landholdings in the Kumaon region, has shrunk to just 190 hectares and the same for black soybeans has also dwindled to 1669 hectares. Around 20 years back, the area under the referred landraces happened to be more than double of the stated figures. According to data from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare, finger millet covered 125,000

hectares of agricultural land in the state. By 2015–16, this had dropped to 107,000 hectares. Put another way, in just 4 years, the equivalent of more than 25,000 football fields fell out of finger millet cropping.

This decline in the interest of the local farming communities towards traditional crops, all across the region is randomly attributed to climatic and socioeconomic transformation. Commercial cultivation of off-season veggies, especially cabbage, cauliflower, broccoli, capsicum, etc., in highly subsidized polyhouses is now in vogue. An in-depth probing however reveals that consumption of millets and traditionally grown cereals having black or dark brown shades is now looked down upon as a derogatory practice among the upwardly mobile villagers. The succession of small terraced fields where millets, lentil, horse-gram, buck wheat, amaranth along with other pseudo-cereals were once broadcast with the advent of monsoon, now keep on lying fallow and have mostly been occupied by Mexican Devil, a devastating weed that has assumed the dimension of a pestilence in the Himalayan region up to an altitude of 7000 feet.

It will not be out of place to mention here that *kala bhatt* or black soybeans, with a wide variety of genomes—over 45 in Uttarakhand alone—are famous in the interior hills for their taste and



Now the cultivation of kala bhatt is confined to these remote villages only

Amaranth with millets



fetch comparatively a better price. The yellow variety developed in the USA and cultivated all over the world for soy oil is a genetically improved version of this landrace.

Interestingly, the landraces of *kala bhatt* are very easy to cultivate. They are simply broadcast in the freshly ploughed slipshod fields with the advent of monsoon and don't require application of chemical fertilizer or spray of insecticides, pesticides or herbicides. Even watering is not needed at all. So hard and acclimatised are these genomes that their only requirement is de-weeding and that too if need be. They grow best in

the rocky soil of the lower reaches in the Central Himalayas. As goes the traditional wisdom, if the pebbles are removed from the fields the yield takes a nosedive.

Harvested in the months of October–November and eaten regularly till the next sowing season, i.e., June–July, *kala bhatt* is consumed as *dal* which is quite crunchy and called *chulkani* locally. Sumptuous *dubkas* are also made of the paste of the soaked seeds of *bhatt* and it is the main ingredient in yet another delicacy called *rus*, which is the filtered and highly spicy soup of so many hill pulses. Baked beans of *bhatt* are also eaten as munch with tea, especially when

it is snowing outside.

Grown presently in 5548 hectares of rainfed land in the Central Himalayan region of Uttarakhand as a kharif crop, the total production of black soyabean in hills is around 4981 metric tonnes. Besides being a staple diet of hill folk it has of late acquired the status of cash crop also and is sold for INR 100/kg in local bazaars. Black soybeans and their soy products are among the richest sources of isoflavones in the human diet, such as genistein and daidzein, which have been found to possess antioxidant, anti-tumour, and estrogenic activities. These compounds are also recognized as therapeutic agents for prostate and ovarian cancers. They are also full of Omega-3 and fatty acids. Black soybeans also reduce cholesterol level, inhibit growth of cancerous cells and interestingly, people consuming black soybean in Japan were found less affected by pollution and adverse effects of radiation. *The Journal of Nutrition and Nutrition Reviews* endorsed black soybean's curative powers and its iron and protein content—making it an excellent meat substitute. It is also found of extreme help in managing diseases like jaundice, beriberi, lockjaw, and promotes blood circulation. The disease called kwashiorkor (edematous malnutrition), caused by high carbohydrate and low protein diet and otherwise so common in India, is totally absent in the inner reaches of hills, thanks to the regular consumption of *kala bhatt* by hill people.

Unfortunately, the area under the cultivation of this heirloom crop in the lower Central Himalayan region is also shrinking speedily. Holdings close to the pliable roads are being leased out to the multinational companies in the business of seed culture of a wide range of seasonal flowers and bulbous plants. The climate of this region being highly conducive for such culture the trend of giving short-term lease to multinationals is ever on increase. Rendering the land absolutely unproductive following



Black soybean from Kumaon hills

Traditional crop of buck wheat



the application of the heavy doses of synthetic fertilizers, pesticides and herbicides for 4–5 years the lessee companies move onwards in search of greener pastures.

Himalayan Action Research Centre (HARC) an NGO from Garhwal-Hills

developing technical skill and capacity building could produce 1500 kg of *kala bhatt* for the market involving 200 farmers. This amount was actually the surplus they could spare after storing enough for their annual consumption. Creation of such islands of excellence

by individual organizations with limited resources needs emulation at the level of government's policies and planning.

Uttarakhand Government had once taken a decision to add bhat-ki-dal in the patients' menu of govt. hospitals in the state. It however, has not been done so far. It is unfortunate that the area under this crop has shrunk drastically following the formation of hill state and organized efforts are being made to replace it with a particular variety of pigeon pea developed specially for hill slopes under the name VL Arhar-1. National Bureau of Plant Genetic Research (NBPGR) at Bhowali however, has preserved quite a few acclimatized landraces of *kala bhatt* in its research farm. ■

Genomes of black soybean landraces at NBPGR, Bhowali



Rajshekhar Pant is an amateur filmmaker, photographer, and writer, who has written over a thousand write-ups, reports, etc., published in the leading newspapers and magazines of the country. He can be reached at pant.rajshekhar@gmail.com

Addressing Perennial Flood Menace in Assam

Time for the government to redefine the flood adaptation measures

The perennial flood menace in Assam is a significant and recurring challenge, driven primarily by the Brahmaputra River's immense volume and the state's heavy monsoon rains. Each year, the confluence of these factors results in widespread flooding that disrupts communities, displaces thousands, and causes extensive damage to homes, infrastructure, and agriculture. Despite efforts to mitigate the impacts through infrastructure, early warning systems, and community preparedness, the frequency and intensity of these floods continue to pose a severe threat, necessitating ongoing adaptation and resilience strategies to protect the affected populations and their livelihoods. **Nava Thakuria** assesses the current situation and also highlights government's efforts in this regard.

The perennial floods in Assam remains a common subject of essay writing in the schools and as the flood menace continues to haunt the residents of northeast India and the neighbouring country Bangladesh for decades. The annual natural disaster still creates havoc among the people as hundreds of thousands of residents lose seasonal crops, private properties and often lose their family members. Sometimes, the river bank erosion takes

away their cultivable land to make them more vulnerable to the crisis. Thousands of families also face permanent displacement from their ancestors' villages and virtually displace them permanently. In the post-flood period, various vector-borne diseases strike the villagers and mount their troubles.

Mitigating a natural disaster often emerges as a major challenge for the human race and the perennial flood in Assam continues to be a matter of

serious concern for the region and the nation as well.

Often government schemes are announced and also implemented accordingly but that hardly works. Once we talked about controlling the flood (so the flood control department existed) and now admit we have to adopt the ways to live with the flood. Strict measures to prevent erosion even after inundation of vast areas may emerge as a focal point for discussion and formulation of pragmatic policies. Continuous factual reporting by the mainstream media can enhance government agencies to help the affected villagers in getting adequate relief and rehabilitation on time. After all, flood not only affects the people economically, but it can change the course of lives for many families forever.

The second wave of flood embracing the incessant rainfalls hit over 2.7 million people (out of 33 million population) in 30 districts of Assam, where more than 3500 villages were submerged by the flood water for many days. Thousands of families in the districts of Dhubri, Cachar, Golaghat, Darrang, Goalpara, Lakhimpur, Barpeta, Bongaigaon, Biswanath,





Charaideo, Chirang, Dhemaji, Dibrugarh, Jorhat, Kamrup & Kamrup (metropolitan), Karbi Anglong, Karimganj, Hailakandi, Kokrajhar, Majuli, Morigaon, Nagaon, Hojai, Nalbari, Sivasagar, Sonitpur, Tamulpur, Tinsukia, Udalguri, etc., had taken shelter in 700 relief camps, set up by the administration.

According to the State disaster management authority, the deluge claimed nearly 100 lives across Assam. The muddy flood water from Brahmaputra, Barak, Kushiya, Subansiri, Burhi Dihing, Dikhou, Disang, Dhansiri, Jia-Bharali, Puthimari, Kopili, Beki, Dhaleswari, Pagladiya, Burhadiya, etc., rivers inundated more than 63,000 hectares of crop area and it devastated 10,50,000 domestic animals and poultry in Assam. The disaster also damaged a number of embankments, roads & bridges, buildings, and other infrastructure.

Kaziranga National Park and Tiger Reserve in central Assam also went under flood water from the swollen Brahmaputra River and no less than 174 wild animals including 10 rhinos and 144 deer died due to drowning and other causes. The park

authority also successfully rescued 133 animals including two rhino calves during the flood time and 116 animals were already released after necessary treatments. The field director Sonali Ghosh informed members of the media that most of the forest camps (out of 233) inside the park went under flood water for many days.

The safe habitat for the largest population of single-horn rhinoceros in the world eventually experiences flooding every year and as the core 430 square kilometre area goes under the water the animals take refuge in the highlands erected inside it. Many animals also cross the National Highway-715 on its southern border to climb the hilly areas of Karbi Anglong. While crossing the highway, some precious animals are killed by the speeding vehicles and hence the authorities instruct the drivers to maintain the safe speed limit to avoid any unwanted incidents. Often the vehicles are escorted by the forest officials while crossing the park to prevent accidents with the fleeing animals.

The UNESCO World Heritage Site, which gives shelter to more than 2600 one-horned rhinos along with Asiatic elephants, water buffalo, tigers,

etc., faced a major flood in 2017, when over 350 animals died due to drowning and colliding with moving vehicles on the highway. Otherwise, the number of poaching incidents in Kaziranga has been reduced in the last few years, thanks to the brutal laws against the poachers, strengthening of ground staff inside the protected forest areas and increasing public awareness in the fringe localities.

This year, the highly protected park lost two adult rhinos to poachers in January and both the carcasses were recovered with their precious horns cut away. Last year, Kaziranga and Manas National Park & Tiger Reserve in western Assam, adjacent to Bhutan, lost two rhinos each to poachers, where also the horns, which may fetch a few million dollars in the illegal wildlife market, went missing. Amazingly, Assam enjoyed the credit of zero rhino poaching incidents in 2022 to draw the international media attention. The previous years recorded two rhino poaching incidents each in 2021 and 2020.

Prime Minister Shri Narendra Modi assured full cooperation to the State government to deal with the deluge. Union Home Minister Shri Amit Shah also called Assam Chief Minister Shri Himanta



Biswa Sarma to reassure all possible support from the Centre. Union ministers Shri Sarbananda Sonowal and Shri Pabitra Margherita, assessed the flood situation in various parts and assured the people that the governments in New Delhi and Dispur will look for a permanent solution to the recurring flood problem. Assam Governor Shri Gulab Chand Kataria also visited some flood-ridden areas and took stock of the situation.

CM Sarma personally visited a number of flood devastated areas to review the ground situation and interacted with the displaced families. He also directed the State ministers, legislators and concerned officials to monitor the situation closely and take necessary actions as and when needed. State ministers visited the affected villages and reviewed the rescue and relief operations. Various

social organizations like Rashtriya Swayamsevak Sangh extended support to the flood-affected residents and provided phenyl, bleaching powder, livestock feed, etc., to address the post-flood diseases.

A large part of Guwahati, precisely bowl-shaped lowland, witnessed flash floods for several days. Continued rescue operations were carried out by the National Disaster Response Force, State Disaster Response Force along with military personnel in various parts of the State including in the city. Amidst the chaos, a minor boy was swept away in Bamunimaidan area of Guwahati by the current of flood water and his body was recovered three days later from a drain in Rajgarh locality. The victim, identified as Avinash Sarkar (8), was returning home at Noonmati locality with his father during the evening hours amidst rains when he

fell on a roadside drain. As his parents identified the body at Gauhati medical college hospital morgue, the last rituals followed accordingly.

Assam's neighbouring States namely Manipur, Arunachal Pradesh, Nagaland, Meghalaya, Tripura and Mizoram also experienced relentless rains and subsequent floods. Heavy rains inflated the rivers of Manipur like Imphal, Thoubal, Nambul, Iiril, etc., and submerged a large area of arable land and residential localities. The overpowered Brahmaputra and other rivers inundated a large area of neighbouring Bangladesh, where 40,000 people were forced to take shelter in government run relief camps. Nearly 10 people died of drowning in the last few days.

The flood-prone Brahmaputra valley witnessed a major devastation in 2004, when the deluge affected 12.4 million people and claimed 251 people's lives. Heavy devastation was also witnessed in 1988 and 1998 floods in Assam. Recently, the Union government proposed to create at least 50 large ponds in the State, where the extra volume of Brahmaputra water will be stored temporarily to reduce the intensity of destruction. Many natural lakes on the river banks are also expected to be cleaned up to carry out additional activities such as agriculture, irrigation, pisciculture, and tourism.

Needless to mention that even if the flood cannot be mitigated fully, the devastating impact can be minimized with proper and timely policies. New Delhi should discuss with upper riparian countries like Bhutan and Tibet (China) for receiving timely alerts about unusual high rainfalls and hydropower activities (including damming water resources) in their places. It's also time for the government to redefine the flood adaptation measures so that it can bring some positive outcomes for the common people in the coming days. ■

Nava Thakuria is a northeast India-based journalist.





Terra Youth

Joining Hands
for a Greener
Tomorrow

Driving the Future

BioFuelCircle's Mission to Revolutionize India's Biofuel Market

The biofuel market has witnessed a major transformation globally, from changing energy consumption patterns to a growing emphasis on renewable energy sources. This shift is pushing economies to adopt more sustainable and eco-friendly alternatives.

According to a report by the International Energy Agency (IEA), the total biofuel demand is set to rise by 23 per cent to 200 billion litres by 2028, with renewable diesel and ethanol accounting for two-thirds of this growth. This growth will be led by three developing economies including Brazil, Indonesia, and India. Biofuels like Compressed Biogas (CBG) are emerging as promising alternatives to fossil fuels. This not only helps curb greenhouse gas emissions but also offers economic benefits. Fossil fuel consuming industries are steadily transitioning towards biofuels like briquettes and pellets in their effort to meet sustainability objectives.

A trailblazing firm in India called BioFuelCircle is driving the transition to a cleaner future. Building a strong bioenergy ecosystem that benefits the economy and the environment, BioFuelCircle is tackling the main issues in the biofuel supply chain and encouraging sustainable behaviours.

An estimated 35 million tonnes of crop waste are burned annually in India by farmers, primarily in the states of Punjab, Haryana, and Uttar Pradesh from their wheat and paddy crops. Fields are swiftly cleared using this low-cost straw disposal technique in between the cycles of harvesting and sowing. BioFuelCircle addresses this issue by providing machinery tailored for specific

crop residue types, including slashers, rakers, and balers, to process stubble into transport-ready forms.

BioFuelCircle's innovative approach increases the value of agricultural waste for farmers, integrating them into the industrial supply chain. Stubble must be chopped, gathered, and compressed into conveniently transportable bundles in order to establish a Biomass Bank™. In addition to giving village tractor owners extra earning opportunity, this approach enables rural businesses and Farmer Producer Organizations (FPOs) to grow their operations and boost profits. Biomass Bank presents multiple engagement models of partnering with it—one can become a baler operator, or one can own and operate a baler, while an enterprising individual can put together a team to operate entire collection mechanism. This is backed by financing too.

The seasonal presence of biomass, the disorganized nature of biofuel providers and the adoption of biofuels due to fluctuations are key challenges in the biomass industry. A single Biomass Bank of 10,000 MT quantum can deploy over 50 tractors, generating income for their otherwise unused capacities. It employs over 125 labourers daily and provides employment for 60 days through the season. This initiative generates several full-time jobs and creates opportunities for landowners to earn rent by using their land as warehouses. A tractor owner can





earn as much as INR 6 lakh per annum if deployed for the whole year. The total economic activity generated in a cluster of villages under the Biomass Bank exceeds a crore of rupees.

BioFuelCircle ensures a steady year-round supply of biomass through Biomass Banks™ across various locations. Operated by local rural enterprises, these

banks are responsible for the collection, transportation, and storage of biomass. This network is managed through a cloud-based digital platform, creating a reliable supply chain for biofuels. The digital platform enables traceability right from the farm and the farmer to the end use of the fuel. Farmers register their interest simply through a WhatsApp

bot, interfacing with the platform. The tractors and post-harvest equipment are listed on platforms such as Ola and Uber, and their operators get notifications on their daily schedules for clearing farms or collecting bales. The biomass warehouse is managed digitally, with inwards and outwards deliveries recorded till the last mile, along with quality records.

“Our solution focuses on digitalization alongside a robust and participative framework of rural enterprises. Digitalization is aimed at creating inclusivity, promoting participation, and ensuring simplicity and efficiency. Coupled with a network of rural businesses set up in a franchise mode, the BioFuelCircle solution has created a supply chain that provides reliability and fair pricing.

BioFuelCircle conducts campaigns to raise awareness among farmers about the harmful effects of stubble burning on





air quality and soil health. Additionally, the company highlights the economic benefits of selling agricultural waste and the opportunity for establishing sustainable businesses within villages. These efforts not only raise awareness but also demonstrate the practical aspects of collecting, transporting, and storing biomass for the Biomass Bank™ system,” says Suhas Baxi, Co-Founder and CEO of BioFuelCircle.

“This project requires proactive local involvement. As these activities begin on the ground, the economic advantages become apparent, establishing trust and turning the initiative from a business into a broad movement. A strong supply chain is essential for meeting industrial supply agreements. Businesses are motivated to collaborate with us as we help them achieve their sustainability

goals,” Baxi adds. At the heart of BioFuelCircle’s model are the Biomass Banks, which serve as central collection facilities where farmers can bring their agricultural residues. These materials are weighed and recorded, and in exchange, farmers receive digital payments. This system ensures a stable supply of biomass while empowering farmers to contribute effectively.

The collected biomass is then processed into biogas by CBG plants, providing a renewable energy source that can replace fossil fuels. BioFuelCircle aims to increase international awareness of how a participative, market-based platform model can aid in sustainable energy transition, particularly in developing countries. Bioenergy, as a unique form of green energy, touches the lives of the people who help produce it.

Developing countries like India face similar challenges in transitioning to sustainable energy. In many countries, a large portion of agricultural residue is wasted. If harnessed and processed, this residue could replace coal, gasoline, diesel, and natural gas. An inclusive platform model like the one implemented by BioFuelCircle in India can not only augment farmer income but also increase access to sustainable fuel in these countries. This platform technology is geography-agnostic and can be deployed at scale in partnership with local market expertise, promising a greener and more sustainable future for all. ■

For more information: <https://www.biofuelcircle.com/>

India's First Energy Bars with Compostable Flexible Packaging

The newly launched date energy bars are India's first energy bars with compostable flexible packaging and offer a healthy snack option while addressing the growing problem of packaging waste.

On August 27, 2024, Pakka Limited, a manufacturer of compostable packaging solutions, announced its second collaboration with Brawny Bear, a nutrition company known for its date-based healthy food products. Through this partnership, the brand has launched Date Energy Bars, India's first energy bar with compostable flexible packaging. The new Date Energy Bars, produced by Brawny Bear, are packaged using Pakka Limited's innovative compostable flexible packaging. This innovative product not only offers a healthy snack option but also addresses the growing concern of packaging waste in India.

Pakka Limited's venture into compostable flexible packaging is a natural progression for the company, which has spent four decades producing compostable pulp, paper packaging solutions and moulded tableware. This move into adaptable packaging form reflects the company's response to modern consumer needs for convenience, versatility, and cost-effectiveness.

Containing no added sugars, the energy bars are made with premium dates, aligning with Brawny Bear's commitment to creating nutritious, naturally sweetened products. This launch expands Brawny Bear's existing range of date-based food products, which includes chocolates, chikki, nut butter, milkshake/energy powders, and natural sweeteners.

The latest association comes after Pakka Limited and Brawny Bear

collaborated for the first time in October 2023 to launch the world's first compostable flexible packaging for food products, setting a new standard in the industry for eco-friendly packaging solutions.

Jagdeep Hira, India Business Head, Pakka Limited commented, "Our partnership with Brawny Bear for these date energy bars exemplifies our ongoing commitment to developing sustainable packaging solutions. By combining our compostable flexible packaging with Brawny Bear's healthy snacks, we're not only offering consumers a nutritious option but also taking a significant step towards reducing packaging waste. This product line demonstrates that eco-friendly packaging and convenient, tasty snacks can go hand in hand."

Further, Shivaam Tibrewal, Founder of Brawny Bear, added, "We're delighted to further our collaboration with Pakka Limited through the new product. Our date energy bars, now wrapped in compostable packaging, represent the perfect fusion of health and sustainability. This launch aligns perfectly with our mission to provide delicious, date-based products that are good for both our customers and the environment. We believe this sets a new benchmark for responsible snack manufacturing in India."

Pakka (legal entity known as Pakka Limited) is a company that is revolutionizing the Indian packaging industry with its commitment to sustainability and innovation. Founded in 1981 as Yash Papers Limited, the

company has since evolved to become a global leader in compostable packaging solutions. Its purpose is to leave a cleaner planet for future generations by providing compostable and regenerative alternatives to non-compostable multilayer flexible packaging, single-use plastics and Styrofoam, which can take hundreds of years to degrade. In addition, the main production facility generates its own electricity with an 8.5-MW plant that runs on 100 per cent biomass-based energy. The raw materials and fuel used in the facility are locally sourced, and they recover 95 per cent of the cooking chemicals used in manufacturing. The company has a strong focus on innovation and R&D and is working on path-breaking products and processes for fibre, pulp, paper, biopolymers, moulded products, waste lines, and more. ■



Biofuels and Beyond

Comprehensive Solutions for a Greener Tomorrow

This article explores the critical role of biofuels in our quest for a greener future, emphasizing the integration of waste management, organic fertilizers, and biofuel production as a holistic approach to sustainability.

As the world grapples with the escalating impacts of climate change, the search for sustainable energy solutions has never been more urgent. Traditional fossil fuels, with their high carbon emissions and environmental degradation, are increasingly viewed as unsustainable in the long term. In this context, biofuels emerge as a promising alternative, offering not only a reduction in greenhouse gas (GHG) emissions but also the potential to revolutionize how we manage waste and produce energy.

The Urgent Need for Sustainable Energy Solutions

Climate change presents one of the most pressing challenges of our time. The burning of fossil fuels, including

coal, oil, and natural gas, has led to a significant increase in GHG emissions. In 2022, global CO₂ emissions from fossil fuels and industry reached approximately 36.8 billion metric tonnes, contributing to rising global temperatures and environmental degradation. To combat these impacts, transitioning to sustainable energy sources is imperative. Renewable energy technologies, such as solar, wind, hydro, and geothermal power, are essential for reducing our carbon footprint and promoting environmental sustainability.

Biofuels as a Viable and Eco-Friendly Alternative

Biofuels, derived from biological materials like plant and animal waste, offer a renewable energy source that can significantly reduce GHG emissions. Unlike fossil fuels, which release stored

carbon, biofuels are considered carbon-neutral. This is because the carbon dioxide emitted during their combustion is offset by the carbon dioxide absorbed by the plants used to produce them.

Biofuels come in various forms, including bioethanol, biodiesel, and biogas. In 2021, global bioethanol production was expected to reach approximately 111 billion litres, with major producers including the United States and Brazil. Bioethanol, made from crops such as corn and sugarcane, is used primarily in transportation. Biodiesel, derived from vegetable oils or animal fats, can replace traditional diesel fuels. The global biodiesel market was valued at around \$42.5 billion in 2022 and is expected to grow at a CAGR of 10.8% from 2023 to 2032. Biogas, produced through the anaerobic digestion of organic waste, can be harnessed for electricity generation and heating.

The environmental benefits of biofuels are substantial. They reduce GHG emissions, lower air pollution, and decrease our dependence on fossil fuels. Additionally, biofuels can help stabilize energy prices by diversifying energy sources and reducing reliance on volatile oil markets. Despite these advantages, it is essential to consider the broader context of biofuel production to ensure that it contributes positively to sustainability goals.





Integration of Waste Management, Organic Fertilizers, and Biofuel Production

An important aspect of biofuels is their integration with other sustainable practices. Effective waste management and the production of organic fertilizers can complement biofuel production, addressing multiple environmental challenges simultaneously. Organic waste from households, agriculture, and industry often ends up in landfills, contributing to methane emissions—a potent GHG. By converting this waste into biofuels, we can reduce these emissions and generate valuable energy. The process involves anaerobic digestion to produce biogas, which serves as a renewable energy source.

Additionally, the by-products of biofuel production, such as digestate from anaerobic digestion, can be utilized as organic fertilizers. These fertilizers improve soil health and reduce reliance on synthetic chemicals, promoting more sustainable agricultural practices. Organic fertilizers can increase crop yields by up to 10–25 per cent compared to conventional fertilizers, supporting agricultural productivity and

sustainability. This circular approach to waste management and biofuel production creates a more efficient and environmentally friendly system, minimizing waste and maximizing resource use.

Synergies and Benefits of Combining Sustainable Practices

Combining biofuel production with waste management and organic farming practices creates synergies that enhance their individual benefits. Utilizing waste materials for biofuel production not only reduces landfill use but also lowers GHG emissions. Concurrently, using organic fertilizers from biofuel production supports soil health and reduces the need for chemical fertilizers.

This integrated approach also promotes resource efficiency. By leveraging waste materials for biofuels and organic fertilizers, we reduce the need for raw materials and minimize environmental impacts. This strategy supports sustainability goals and enhances economic efficiency by lowering waste disposal and fertilizer production costs. In addition, the use of renewable biofuels can decrease the overall carbon footprint of energy

systems as compared to fossil fuels.

Furthermore, this holistic approach benefits local economies. Biofuel production can create jobs in rural areas, where agricultural waste is generated. Organic farming improves crop yields and soil health, contributing to food security and sustainability. By fostering local solutions to global challenges, we build more resilient and self-sufficient communities.

Takeaway

As we confront the urgent need for sustainable energy solutions in the face of climate change, biofuels offer a promising path forward. Their ability to reduce GHG emissions, lower air pollution, and provide renewable energy makes them a key component of a greener future. By integrating biofuel production with waste management and organic fertilizers, we can address multiple environmental challenges and maximize benefits. This comprehensive approach not only supports sustainability goals but also enhances resource efficiency and promotes economic development. Embracing and expanding these integrated practices will be crucial in building a more sustainable, resilient world. ■

Article contributed by Mr. Maninder Singh Nayyar, CEO and Founder, CEF Group.



Climate-Change-Triggered 2023 Mega-Landslide Caused Earth to Vibrate for Nine Days

A landslide in a remote part of Greenland caused a mega-tsunami that sloshed back and forth across a fjord for nine days, generating vibrations throughout Earth, according to a new study involving UCL researchers. The study, published in the journal *Science*, concluded that this movement of water was the cause of a mysterious, global seismic signal that lasted for nine days and puzzled seismologists in September 2023.

The initial event, not observed by human eye, was the collapse of a 1.2km-high mountain peak into the remote Dickson Fjord beneath, causing a backslash of water 200 metres in the air, with a wave up to 110 metres high. This wave, extending across 10 km of fjord, reduced to seven metres within a few minutes, the researchers calculated, and would have fallen to a few centimetres in the days after.

Source: <https://www.sciencedaily.com/>

Urban Heating and Cooling to Play Substantial Role in Future Energy Demand

Existing global energy projections underestimate the impact of climate change on urban heating and cooling systems by roughly 50 per cent by 2099 if greenhouse gas emissions remain high, researchers report. This disparity could profoundly affect critical sustainable energy planning for the future.

Existing studies predominantly concentrate on chemical feedback loops, which are large-scale processes involving complex interactions between energy use, greenhouse gas emissions, and the atmosphere. However, a research group led by the University of Illinois Urbana-Champaign focuses on the often-overlooked physical interactions between urban infrastructure and the atmosphere that can contribute to local microclimates and, ultimately, global climate.

Source: <https://www.sciencedaily.com/>



To know more... Read



ISBN: 9788195077687

POLLUTION SOLUTIONS FOR A CLEANER, GREENER EARTH

Urmi A Goswami

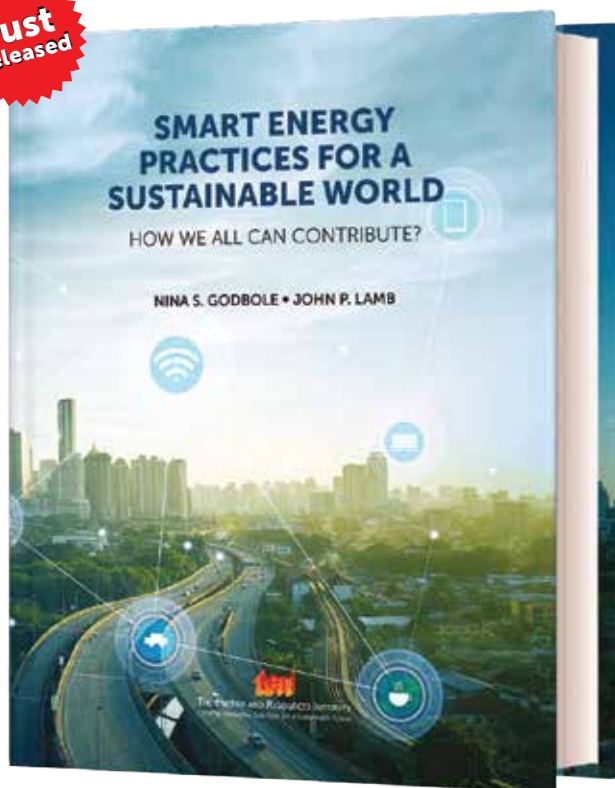
We are living in a fast changing world. Pollution of natural resources, such as air, water, and land is one of the biggest banes of our times. Under such precarious circumstances, it is needed that the young generation is not only made aware about the different kinds of pollution but also about the solutions. This is what this book *Pollution Solutions – For a Cleaner, Greener Earth* is all about.

Filled with eye-opening facts, informative illustrations, and multiple activities, this book is the perfect guide to help the young generation become environmental crusaders.

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This book stresses the need for us to judiciously, sustainably, and smartly harness and use energy techniques in order to effectively combat climate change. The book also gives an in-depth discussion on utilization of artificial intelligence and information technology to realize energy efficiency in various sectors of economy including such as transportation, buildings, infrastructure, health care, and other services.

Text is supplemented by case studies that depict ground-level reality to facilitate comprehension of the subject matter. The appendices serve as an extended learning of the concepts discussed in the chapters. The publication would serve as a valuable reference for both scholars and researchers engaged in the domain, in addition to, being a guide to industry and the academic world.

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Detrimental Impacts of Plastic

On the Biodiversity of Sundarbans

In this article, **Rangeet Mitra** highlights the perils of plastic pollution on the biodiversity of Sundarbans in India and informs us that a high-level committee and specialized task force with members from corporations, research institutes, academic institutions, concerned industries, NGOs and the government will be established to tackle the issue of plastic pollution in the Sundarbans. Stakeholders ought to be aware of how plastics affect biodiversity in the long run.

The people of Sundarbans have been fighting against the climate impacts to sustain their livelihoods. As per the recent media news, plastic pollution is one of the key issues in Sundarbans. Because of poor awareness, policy gaps and lack of willpower of locals, plastic pollution has been destroying the ecosystem and livelihoods. As per the news published by Daily Star,¹ microplastic (plastics less than 5 mm in size) contamination was found in at least 17 species of fish and three species of shellfish from three rivers that pass through the Bangladeshi parts of Sundarbans. As per the researchers, these microplastics have impacted the marine ecosystem and have infected the human food chain.

Sundarbans, the mangrove forest and coastal zone, is known as the habitat of the Royal Bengal Tiger (*Panthera tigris*) and other important flora and fauna. Various types of plastics such as marine litter, plastic debris, meso-plastics, and microplastics² are responsible for



environmental pollution in Sundarbans. As per the researcher's view, the demand for plastics has been increasing rapidly in developing countries like India. As per *The Hindu* newspaper, more than 56 tonnes of plastic waste were observed in Sundarbans after the Amphan cyclone in 2020. Several studies highlighted the presence of microplastics and its long-term impacts on biodiversity.

This delicate ecology is threatened by plastic contamination in several ways:

Habitat destruction: Plastic debris may build up in mangrove roots, water bodies, and forest floors, upsetting the natural environment of animals and plants. Plastic waste can choke off

mangrove roots and obstruct bird and turtle hatching locations.

Marine life threats: Fish, dolphins, and turtles are among the marine creatures that confuse plastic waste for food or become entangled in it. In addition to harming or killing these species, this also upsets the ecosystem's food chain.

Chemical pollution: When plastics break down in the Sundarbans, they can produce harmful compounds that contaminate the land and water. These substances have the potential to go up the food chain and endanger the health of animals and people who rely on the environment for survival.

Economic impact: Tourism and fishing

1 Details available at <https://www.thedailystar.net/opinion/editorial/news/save-sundarbans-plastic-pollution-3232896>

2 Details available at <https://www.frontiersin.org/articles/10.3389/fmars.2021.766876/full>

are two businesses that might be negatively impacted by plastic pollution in the Sundarbans. Local economies and lives are impacted by contaminated waterways and destroyed ecosystems, which also lower fish populations and discourage tourists.

Government regulations governing the use and disposal of plastic, community-led clean-up operations, and awareness campaigns aimed at enlightening the local populace about the value of waste management and conservation are all part of the efforts to combat plastic pollution in the Sundarbans. To tackle this intricate matter, it is necessary to make consistent efforts at regional, national, and global scales to curtail plastic usage, enhance garbage disposal facilities, and safeguard fragile ecosystems such as the Sundarbans.

Mitigation Steps

To mitigate plastic pollution in the Sundarbans, several stakeholders—including local people, companies, NGOs, and governments—must be involved in the process. The following are some methods to lessen the Sundarbans' plastic pollution:

Education and awareness: Inform locals, visitors, and interested parties about the harm that plastic pollution does to the ecosystem of the Sundarbans. Inform them about appropriate waste management techniques, such as the recycling, reuse, and reduction of plastic products.

Community engagement: Involve the neighbourhood in garbage management and clean-up campaigns. Encourage people to take charge of their surroundings by planning frequent clean-up campaigns, setting up neighbourhood recycling initiatives, and endorsing environmentally suitable substitutes for single-use plastics.

Regulation and enforcement: Implement the current laws and rules about the usage, manufacture, and disposal of plastics. Enact severe penalties for inappropriate waste management techniques and unlawful disposal. Implement measures to decrease the manufacturing and usage of single-use plastics, such as imposing tariffs or prohibitions on plastic packaging and bags.

Infrastructure development: Invest in the infrastructure needed for waste management, such as landfills, recycling centres, and garbage collecting systems. To lessen the usage of single-use plastic water bottles and packaging, provide access to clean water and sanitary facilities.

Innovation and Research: Encourage the development of innovative waste management and plastic substitutes research and innovation. Promote the creation of environmentally friendly packaging, biodegradable plastics, and creative recycling techniques that work in the Sundarbans.

Partnerships and collaboration: To combat plastic pollution together, encourage cooperation between local

communities, companies, NGOs, and government authorities. Combine resources, impart knowledge, and synchronize endeavours to optimize outcomes and durability.

Monitoring and evaluation: Establish procedures for monitoring and evaluating success in initiatives to reduce plastic pollution. To help guide future actions and policy decisions, gather statistics on the production of plastic garbage, disposal methods, and environmental implications.

It is feasible to reduce plastic pollution in the Sundarbans and preserve this crucial environment for future generations by implementing a comprehensive strategy that includes education, community participation, regulation, infrastructure development, innovation, and cooperation.

Conclusion

A high-level committee and specialized task force with members from corporations, research institutes, academic institutions, concerned industries, NGOs and the government will be established to tackle the issue of plastic pollution in the Sundarbans. Stakeholders ought to be aware of how plastics affect biodiversity in the long run. Green tribunals ought to compel the relevant government agency and the implementation authority to begin developing a self-sustainable plan for reducing plastic pollution. Organizations must put into practice plastic waste management policies under national and international guidelines. It will encourage residents to take part in this activity. In the Sundarbans, it is advisable to promote the use of biodegradable plastic and organic goods. The government ought to prohibit the use of plastic as soon as possible. If not, the Sundarbans will become a plastic waste dump. ■

Rangeet Mitra is a development professional with 8 years of experience in livelihood development and sustainability in India.



The Benefits of Living Sustainable

Sustainable Revolution in Architecture

As people increasingly invest in the future of our planet and seek an improved quality of living, **Earthenhive**, along with other firms in the sustainable architecture domain, holds significant potential to integrate sustainability into global standards.

In recent years, the term “sustainability” has become increasingly common in our vocabulary. Whether in fashion, food, entertainment or lifestyle choices, people are growing more and more aware regarding the necessity to adopt sustainable alternatives for their benefit, their loved ones and the planet we all call home. Therefore, it comes as no surprise that even in the business of architecture, integrating sustainable measures and practices has opened up new doors of opportunities.

The Three Pillars of Sustainable Architecture

Sustainable or green architecture can be defined as a style or design of architecture that ensures minimal negative impacts caused by humans and construction on the environment, now and into the future. Guided by the principles of people, planet, and profit—termed as the 3 Ps—sustainable architecture focuses on designing and constructing structures that incorporate effective systems such as rainwater harvesting, greywater recycling, solar panels, and maximizing natural lighting and cooling. These practices aim to optimize the use of natural resources for the benefit of inhabitants while minimizing waste, all without imposing



unreasonable costs on the client.

What earlier developed as an afterthought that came after the completion of construction—limited to simple measures such as basic energy saving and waste recycling regimes—has now transformed into a multifaceted field dedicated solely to creating structures that integrate greenery and sustainable mechanisms such as rainwater harvesting and solar panels through advanced technological strategies. The attention and growth achieved by sustainable architecture as a trend over the years manifests as a reflection of the growing awareness and commitment of people to preserving the planet.

Sustainable architecture, similar to

adopting sustainable measures in any other aspect of your life, is fundamentally all about giving back to the planet that sustains us. They play a significant role in reducing the strain on vital resources by adopting innovative techniques and strategies. By making the most out of natural and abundantly available resources such as sun, wind and water for natural lighting, heating, cooling and ventilation, these structures reduce the dependence on limited energy resources, which also helps in controlling waste and toxic emissions from being released. Over time, these small habits add up to notable long-term benefits such as mitigating climate change by lowering carbon emissions.

How Co-living Spaces Embrace Sustainable Practices

The appeal of residing in structures that are open and green is growing more and more apparent through people's preference of hotels, hostels or PG services that are a refreshing change to traditional cement and brick buildings.

One example of this shift in preference is the growing popularity of Zolo Stays.

As a well-established company with over 200 properties including flats, hostels and PGs spread across major cities in India, Zolo Stays grasped the need for a fresh and unique touch to their existing properties that would set them apart from their competition. Seeking to incorporate sustainable measures and green elements into already existing buildings, this request put forth by Zolo Stays posed a challenge since these changes were to be brought into the functioning of their buildings without pausing their business or disrupting the routine of existing residents.

Earthenhive, a sustainable architecture firm based in Bangalore, took up this challenge and worked on providing a concept and model that could be commonly applied to all Zolo properties across cities. \

Youngsters increasingly prefer unconventional living spaces that break away from traditional settings and with that thought in mind Earthenhive worked on a design that would appeal to them. They primarily targeted the reception and dining areas as they are frequented by hostlers. The dining area and other common spaces were to be turned into more open, green spaces incorporating plants and recycled materials such as tyres and wooden boxes painted in vibrant colours as seats and tables. Natural elements such as sunlight and green spaces are natural mood boosters, creating a calm and relaxed environment where people enjoy living and working in harmony. These common areas



turned into lively hubs for meetings and socializing for the residents.

In collaboration with Zolo Stays, the esteemed university Manipal Academy of Higher Education (MAHE) also approached Earthenhive with a similar objective of transforming their existing campus and hostels into more green, sustainable spaces. Earthenhive provided them with suggestions to include open cafes, a tower for valley viewing and other similar concepts which could serve as dynamic gathering spaces for the students, where they could get together and spend their leisure time under the sun, connecting with nature, which benefits their physical and mental well-being rather than staying confined to closed and gloomy rooms.

Innovation in Function and Design

The sustainability subcategory of architecture does not simply implement greenery or eco-friendly measures into buildings, but produces fresh concepts and exotic designs in the process. As in the case of Zolo properties, effective

utilization of available space and resources presents an opportunity to play around with the design and look of buildings, shifting in a direction different from traditional age-old designs. Buildings that are centred around the four natural elements (pillars)—light, water, air and earth pave the way for innovative additions. To cite an example, a roof design could incorporate solar panels that are inclined for maximum capture of energy, coupled with a rainwater harvesting system on the other side. This roof would also double as a skydeck, with a common area or luxurious recreational space underneath.

With people growing and more and more willing to invest in the future of our planet and an improved quality of living for themselves, Earthenhive, along with other firms in the sustainable architecture domain, hold significant potential to integrate sustainability into global standards. ■

Article contributed by Bindu K and Raghunathan Elangovan - Founders and Principal Architects, Earthenhive.

Ramhari Kadam

A Farmer's Successful Journey towards Natural Farming

Jeeva Bhavana is a national environmental non-profit organization headquartered in Pune. In 2020, they introduced their flagship initiative, Urvarasa, aimed at supporting Indian farmers in shifting from animal-based to natural, plant-based farming methods. This transition is designed to foster a self-sufficient and sustainable food system, ensuring fair compensation for farmers' crucial work. Urvarasa collaborates with farmers who choose to follow Jeeva Bhavana's guidelines, cultivating crops for mindful consumers who seek fair trade, sustainably grown, cruelty-free, and nutritious food. Keep reading to know more...

"The shift from chemical to natural farming was born in my soul. I finally listened to what my heart had been telling me to do for so long, and I have never regretted it," says Ramhari, a farmer from Pandharpur, Maharashtra. "I learned so many things at

school and in books, so many techniques and methods to increase productivity and output, to lessen costs and maximize gains, but what really matters is doing what your heart tells you is right."

As a child, Ramhari loved school and he loved studying. He was determined to

complete his class XII, despite carrying a heavy weight of responsibilities at home. "Growing up, I lived with my mother, my younger brother Laxman, and my sister. My father was absent far more often than present, and didn't really take part in raising me. Studying was a dream, both



Ramhari in his fields



Ramhari's brother Laxman with family

for me and my brother. Play was out of the question. From 6th standard on, I worked in the fields every morning from 6 to 9 to make some money: I wanted to help my mom run the household. I managed to complete my class XII, and then went on to pursue my passion by enrolling in college, studying *Vanaspati Shastra* (Botany) and finally obtaining a Diploma in Agriculture.”

In 2005, upon completing his diploma and in the pursuit of getting the best yield from his farm, he adopted chemical-based farming practices, an approach that was rigorously encouraged at college. His enthusiasm for the use of synthetic inputs was so great that in 2012, in addition to running his farm,

he opened a shop selling chemicals to other farmers. By 2016, though, he had a rude awakening when—after ten years following the chemical-based agricultural techniques that had been encouraged at college—he finally recognized the damaging impacts of these inputs on his land, specifically the depletion of the groundwater table and soil degradation. At the same time, he finally acknowledged that productivity on his farm had in fact declined over those years. And he wasn’t and isn’t alone: most smallholder farmers continue to face economic struggles in spite of massive government funding and support for chemical farming.

Ramhari understood that he had

been deceived and even worse: by selling chemical inputs to other farmers, he was deceiving others. He shut shop and transitioned to organic farming techniques that same year. “I believe that everything in life is about karma—giving and receiving. What you give comes back to you in one way or another. Agriculture should be sustainable so that none of the stakeholders involved are drained—be it the soil, water, nutritional value of the output, farmer or any other stakeholder in any other form. If you nourish, that is positive energy, and that comes back to you too. Chemical-based agriculture does not nourish; in fact it does the opposite: it depletes, it damages, and it destroys. My awakening to this reality was very painful,



but it led me to search for farming methods based on sustainability, soil and water conservation and growing food that nourishes the mind, body, and soul.”

“Under colonial rule, two vital systems were targeted to weaken Indian self-rule and strengthen colonial power: agriculture and education. This dealt a severe blow to our country’s environment, public health and economy, from which we are yet to recover. I understood this early on and vowed to strengthen these systems. I understood the need for food security in this complex world. And of course I understood the essential role that food plays in creating a healthy India.”

In 2018, two years after transitioning to organic farming, Ramhari took a final step to true sustainability by adopting natural farming techniques. Natural farming, as the name suggests, follows the law of nature, with minimum human intervention. Organic farming, on the other hand, has set processes to follow and can be carbon intensive, with a reliance on many inputs coming from outside the farm and sometimes sourced from unethical practices.

At the same time, Ramhari learnt the truth (ethics, environment, and health) about the dairy business and decided to forgo dairy farming entirely. (It is important to note that sustainability can only be reached if animal use is kept to a bare minimum, if not completely absent.) And while his farm is a model of sustainability and secures output with high nutritional value, as with most farmers practicing natural farming techniques, reaching financial profitability is taking time. Also, a suitable market needs to be created to promote these ethical practices, and advocacy and outreach are essential.

“Consumers need to know that agricultural prices have stayed nearly constant over the last decade, while the cost of living has increased phenomenally. The paradox is that most of us are willing to pay a premium for many products, but not for agricultural

produce even though it sustains our bodies and forms the very basis of our lives. How can we change this and support farmers? How can we get them out of this entrenched cycle of poverty?"

Above all, Ramhari stresses the importance of public support for natural farming, where community funding and online retail campaigns drive increased public knowledge about how our food is grown and who grows it. He encourages the youth to get involved, as many are technically capable and technology savvy, and could help getting the word out.

Ramhari considers himself extremely fortunate to have come into contact back in 2020 with Urvarasa, a farmers' empowerment programme developed

by Jeeva Bhavana, an environmental non-profit based in Pune. Thanks to Urvarasa, he has obtained the support—technical and commercial—he needed to plan for the future with optimism, and his hope is that other farmers come on board and are finally given their due while providing nutritious food for the population. Ramhari's sustained success as an Urvarasa lead farmer practicing truly sustainable natural farming principles today requires support on many fronts. There's a role for everyone—conscious consumers, social enterprise entrepreneurs, local government bodies and civil society organizations—to create an awakened climate smart world.

Ramhari's journey has been neither easy nor straight, but he now feels a

sense of redemption: he has a clinic where he advises people about the use of different kinds of plants, as well as natural farming. "I have enjoyed many titles like '*Kheti Ka Doctor*' and what not, but I am enjoying this phase of my life the most. Being so close to nature, working with nature to yield the best for everyone is a beautiful journey. I would encourage everyone to embark on this journey. It may not be easy, but it is tremendously rewarding," concludes Ramhari with a smile. ■

Jeeva Bhavana is a pan-Indian, environmental non-profit based in Pune. As a solutions-based organization, in 2020 Jeeva Bhavana launched a flagship project Urvarasa through which they assist Indian farmers in their transition from animal-based agriculture to natural, plant-based agriculture to create a sovereign and sustainable food system so that farmers are well compensated for the important work they are doing. The organization also aims to study the damaging effects of animal agriculture (environmental, health, and economic) in India. The project is based on the principles of Padmashri Subhash Palekar, a name synonymous with natural farming practices in India. Based on the principles recognized by the UN as one of the most effective ways to mitigate climate change, the initiative, Urvarasa has received international recognition and was also nominated for the prestigious Earthshot Prize 2024.

Jeeva Bhavana conducts awareness programmes, workshops and film screenings to inform the public about the importance of adopting a plant-based diet for the environment, health and animals so that the increasing consumer demand creates a market for the natural, ethically grown farm produce.



Toor plantation

Microplastics in Soil

Tomography with neutrons and X-rays shows where particles are deposited

Microplastic particles are everywhere. Now a team from the University of Potsdam and HZB has developed a method that allows it for the first time to precisely localize microplastic particles in the soil. The 3D tomographies show where the particles are deposited and how structures in the soil are changed. The method was validated on prepared samples. The team used a special instrument at the neutron source of the Institut Laue-Langevin in Grenoble, France, to carry out neutron and X-ray analyses simultaneously.

Microplastic particles are a major environmental pollutant today. Road traffic accounts for a particularly large proportion: in Germany alone, tyre wear is said to generate around one hundred thousand tonnes of microplastics every year, in addition to particles from astroturf, cosmetics, washing powders, clothing, disposable masks, plastic bags and other waste that end up in nature. Microplastic particles can now be found everywhere. But what happens to these particles in different soils? Do they break

up into smaller and smaller pieces and how are they relocated and transported, changing the structures in the soil?

Some of these questions are already being analysed: A soil sample is floated in a heavy salt solution, whereupon the individual components separate according to density: Plastic and organic particles float to the top, while mineral particles sink. The mixture of organic material and plastic particles is then treated with hydrogen peroxide, for example, whereby the organic components decompose and the microplastic particles should remain. Although this method makes it possible to determine the quantity and type of microplastic in a soil sample, information is lost as to where exactly these particles accumulate in the soil and whether they change any structures in the soil.

3D Tomography with Neutrons and X-rays

In their new study, Prof. Sascha Oswald (University of Potsdam) and Dr Christian

Tötzke (University of Potsdam and HZB) have now presented a method to answer these questions. They worked closely with the team led by Dr Nikolay Kardjilov, HZB, whose expertise went into setting up a unique instrument at the Institut Laue-Langevin, Grenoble, France: there, samples can be analysed with neutrons and X-rays to create 3D tomographies simultaneously, i.e., without altering the sample. While neutrons visualize organic and synthetic particles, X-ray tomography shows the mineral particles and the structure they form.

Method Tested on Prepared Soil Samples

To test the method, Tötzke prepared a series of soil samples from sand, organic components such as peat or charcoal and artificial microplastic particles. In a further series of measurements, he investigated how the roots of fast-growing lupins penetrate the soil samples and how they react to the presence of microplastics.

In the neutron tomograms, the microplastic particles are clearly identified, as can some of the organic components. X-ray tomography, on the other hand, provides an insight into the arrangement of the sand grains, whereas the organic and plastic particles are shown as diffuse voids. When superimposed, a complete image of the soil sample is obtained. This allows the scientists to estimate the size and shape of the microplastic particles, as well as the changes to the soil structure caused by the embedded microplastics. ■

Source: <https://www.sciencedaily.com/>



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