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From the Editor's

Dear Readers,

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

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

Your suggestions are always welcomed for improvement.

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WORLD ENVIRONMENT DAY 2025 IS #BEATPLASTICPOLLUTION

Dr. R. S. Tomar
Editor-in-Chief

Plastic Pollution: An Introduction

Plastic pollution is one of the most pervasive and pressing environmental challenges of the 21st century. Characterized by the accumulation of plastic objects and microplastics in the Earth's environment, it severely impacts wildlife, ecosystems, and human health. With over 400 million tonnes of plastic produced annually, a significant portion ends up in landfills, oceans, and rivers, taking hundreds of years to decompose.

The durability and lightweight nature of plastic, once considered its greatest strength, have now become its biggest threat. Single-use plastics such as packaging, bottles, straws, and bags make up a large portion of plastic waste and are often used for mere minutes but persist in the environment for centuries. Marine life is especially vulnerable, with millions of animals ingesting or becoming entangled in plastic debris every year. These pollutants can also enter the food chain in the form of microplastics, posing health risks to humans.

Combatting plastic pollution requires urgent and collective global action. This includes reducing plastic production, banning single-use plastics, enhancing recycling infrastructure, and encouraging innovations in biodegradable alternatives. Public awareness campaigns, such as those spearheaded on World Environment Day under the theme #BeatPlasticPollution, play a vital role in shifting consumer behavior and pressuring industries and governments to act.

World Environment Day 2025 continues to highlight one of the most urgent environmental challenges of our time with

its theme: #BeatPlasticPollution. This theme, though not new, remains highly relevant and deeply necessary. It underscores the persistent and escalating global crisis caused by plastic waste, particularly single-use plastics, and calls for decisive action from governments, industries, communities, and individuals to curb plastic pollution at the source.

A Global Call to Action

Plastic pollution affects every corner of the planet from the deepest oceans to the highest mountains, and even within the human body. The theme #BeatPlasticPollution reinforces the call for systemic changes in how we produce, use, and dispose of plastic. The United Nations Environment Programme (UNEP) and its partners aim to catalyze policy changes, promote circular economy principles, and support innovations in sustainable alternatives.

Relevance in 2025

As we approach the halfway point to the 2030 Sustainable Development Goals (SDGs), this year's theme is a timely reminder that tackling plastic pollution is integral to achieving SDG targets related to clean water, life below water, sustainable cities, and responsible consumption. Despite growing awareness, the production and mismanagement of plastic waste continue to rise. World Environment Day 2025 calls for accelerating efforts, from phasing out harmful polymers to building robust waste management infrastructures globally.

Role of Citizens and Youth

This year's campaign also heavily emphasizes individual responsibility and youth-led movements. Social media, community clean-ups, art installations, and eco-conscious innovations are being used as powerful tools to inspire behavioural change. The #BeatPlasticPollution hash tag is not just a slogan; it's a digital rallying cry that empowers people to rethink their plastic footprint.

Policies to Combat Plastic Pollution

To effectively combat plastic pollution, a range of policies have been introduced at national and international levels. One of the most widely adopted strategies is the ban or restriction on single-use plastics, including items like bags, straws, cutlery, and packaging materials, which are often discarded after a single use and persist in the environment for centuries. Countries like India and many in the European Union have enforced such bans to curb plastic waste at its source. Another key policy is Extended Producer Responsibility (EPR), which mandates that manufacturers take responsibility for the entire lifecycle of their plastic products, including post-consumer waste collection, recycling, and environmentally sound disposal. This encourages industries to design more sustainable and recyclable products.

Plastic Waste Management Rules have also been implemented in various countries to regulate the segregation, collection, and processing of plastic waste. These rules often include mandates for using recycled content in packaging and setting targets for plastic waste reduction. Deposit Return Schemes (DRS) are another effective approach, wherein consumers pay a small deposit when purchasing plastic-bottled beverages, which are refunded when the bottle is returned, encouraging high return and recycling rates. Countries like Germany have successfully adopted this system, achieving return rates of over 90%.

At the global level, international agreements such as the United Nations Global Plastic Treaty, currently under negotiation, aim to establish a legally binding framework to end plastic pollution by 2040. The Basel Convention also plays a role in regulating the transboundary movement of plastic waste, especially hazardous varieties. In addition to regulatory measures, many governments are investing in research and innovation to promote biodegradable and sustainable alternatives to conventional plastic. Financial incentives such as tax rebates and subsidies are provided to industries that adopt eco-friendly packaging.

Public awareness campaigns and environmental education initiatives are crucial in changing consumer behavior and encouraging responsible consumption. Programs like the United Nations Environment Programme's "Beat Plastic Pollution" campaign highlight the role of individuals and communities in addressing this crisis. Governments are also adopting circular economy policies, which focus on reducing plastic use, promoting reuse and recycling, and keeping plastic materials in use for as long as possible. Environmental taxes on virgin plastic and non-recyclable products further discourage excessive use and promote sustainability. Lastly, public-private partnerships play a vital role in developing waste management infrastructure, boosting recycling rates, and supporting community-level initiatives.

Conclusion

World Environment Day 2025's theme #BeatPlastic Pollution is more than a celebration; it is a global reminder of the pressing need to act collectively and urgently. While some progress has been made in banning certain plastic products and improving waste collection systems, much more remains to be done. The theme challenges every stakeholder, governments, industries, and citizens to move beyond promises and adopt real, scalable, and sustainable solutions. Only then can we hope to secure a cleaner, greener, and healthier planet for future generations.

HONEY BUZZARDS: A NATURE'S MIRACLE

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Honey buzzards are fascinating birds of prey known for their unique diet and behavior. Here's a breakdown of what they are, what they eat, and where they're found:

What Are Honey Buzzards?
Honey buzzards belong to the genus *Pernis*, and they are medium-sized raptors. Despite the name, they are not true buzzards (*Buteo* species); they are more closely related to kites and other birds in the family Accipitridae. The most well-known species are:

European honey buzzard (*Pernis apivorus*)

Oriental honey buzzard (*Pernis ptilorhynchus*)

Primary Diet:
Honey buzzards are specialized feeders, and their diet is quite unusual for raptors:

Main diet: Wasp and bee larvae — they raid nests of wasps, hornets, and bees.

They are well-adapted for this:

Tough, scale-like feathers to protect from stings.

Nostrils that are narrow and slit-like to block stings.

They also eat:

Adult wasps and bees

Honey and wax

Other insects, small reptiles, amphibians, and occasionally bird eggs or nestlings.

Distribution:
European honey buzzard:

Breeding: Europe and parts of western Asia.

Migration: Winters in sub-Saharan Africa.

Oriental honey buzzard:
Resident and migrant populations across South and Southeast Asia, including India, China, the Philippines, and Indonesia.

They are migratory in temperate zones, but more sedentary in tropical regions.

How does honey buzzard bird prey upon bees and bee hives
Honey buzzards are fascinating raptors with a unique taste for wasp and bee larvae, especially the European honey buzzard (Pernis apivorus). Here's how they go about raiding bee and wasp nests:

1. **Specialized Diet and Adaptations**
   Honey buzzards don't primarily eat honey — they mainly target larvae inside wasp and bee nests.

   Their heads and faces are covered in dense, scale-like feathers, protecting them from stings.

   Their nostrils are narrow and slit-like, reducing the risk of getting stung inside the nasal passages.

   Their skin is relatively tough and resistant to stings.

2. **Locating the Nest**
   They use a keen sense of smell (unusual for raptors) and visual clues to locate underground or tree-based hives.

   They watch the flight patterns of bees or wasps to trace the direction of their nests.

3. **Raiding the Hive**
   For ground nests, they dig into the soil with strong talons to access the hive.

   For tree hives, they tear apart the nest using their beak and claws.

   They ignore the adult bees or wasps (though they may eat some), focusing on the nutritious larvae and pupae.

4. **Dealing with Defenders**
   Their feather armor and tough skin help withstand stings.

They also tend to move deliberately and precisely, minimizing disturbance to avoid provoking too many defenders.

In short, honey buzzards are like the armored robbers of the natural world — equipped with natural defenses and clever tactics to get to the good stuff inside the hive.

Photo credit: *Shera Photography & Saikat Kumar Basu*

NOTES TO NAMES-BIRDSONG AND TAXONOMY

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Vocalization refers to the sounds produced by animals using their respiratory and vocal apparatus, such as vocal folds in mammals, syrinx in birds, enabling communication for various purposes. These vocal sounds vary widely across animal taxa, reflecting adaptations to social needs. Vocalization patterns also contribute to animal taxonomy by helping distinguish species and understanding evolutionary relationships since vocal traits often reflect genetic and ecological divergence. Vocalizations through features like call structure, frequency and learnt dialects help taxonomists identify species boundaries, social groups and evolutionary relationships by providing acoustic signatures unique to taxa. This is especially useful in cryptic species. Vocal learning and convergence add complexity but also valuable markers for taxonomy across the animal kingdom (1,2,3)

Bird vocalization plays a significant role in bird taxonomy by providing species-specific acoustic signatures that aid in identification and classification. Bird vocalizations are classified into calls and songs, where songs are usually complex and serve functions like mate attraction and territory defence, while calls are simple and used for alarming or contact. Similar to human speech learning, vocal learning in birds, particularly song birds, involves intricate neural pathways that enable them to learn and alter songs. This characteristic offers insights into taxonomy and evolutionary biology. As a result, bird vocalization serves as a taxonomic tool and a behavioural characteristic that represents ecological adaptations and evolutionary relationships among bird species.

In the fascinating world of ornithology, plumage and physical traits often steal the spotlight. However, vocalizations- songs and calls play an equally vital role in distinguishing bird species, particularly those that are visually similar. A few examples are mentioned, although Bronzed Drongo (*Dicrurus paradiseus*) may share similar dark plumage and overlapping habitats but can be readily distinguished by their vocalizations. Bronzed Drongo typically produces sharp metallic notes while Racket tailed Drongo is known for it's rich, varied calls and remarkable ability to mimic sounds of other bird species [4]. Eastern Meadowlarks *(Sturnella magna)* and Western Meadowlarks *(Sturnella neglecta)* appear nearly identical but are easily distinguished by their vocal differences. The Eastern Meadowlark has a clear, flute-like song with simple, melodious phrases, whereas the Western Meadowlark produces a more complex, gurgling and varied tune [5]. Another compelling case comes from the Plain Tailed Wren *(Pheugopedius euophryus)* and Canebrake Wren *(Cantorchilus zeledoni),* despite overlapping geographic ranges and sharing morphological traits, they were found to have markedly different vocal behaviours. The plain-tailed wren is renowned for its coordinated duets, and the canebrake wren has a different song structure, tempo and duet pattern [5]. These vocal distinctions, coupled with genetic data, prompted taxonomists to recognise them as separate species.

PHARMACEUTICAL NANOTECHNOLOGY: FROM INNOVATION TO PATIENT

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Introduction

From the time when first modern medicine was made in 1804 to now 2025, time has evolved and so the diseases. To tackle this enormous change in disease causing agents & environment, pharmaceutics change it's form too. From biopharmaceuticals to genomic medicines incorporating technology with medicine becomes the future healing of mankind. CAR-T therapy, personalized medicines, early diagnostics, stem cell therapies, regenerative medicines are some of the examples of pharmaceutical advancement happens over a small period of time where conventional ways takes years to manufacture and launch a medicine, modern advancement such as use of biotechnology do miracles and one of those miraculous advancement is nanotechnology. Nanotechnology involves the engineering

of materials at the nanoscale, typically between 1 to 100 nanometers. In the Pharmaceutical domain, this technology unlocks groundbreaking potential & give hope to several patients with incurable diseases.

Fig. 1 : Designing a nanomaterial.

Understanding nanotech in pharmaceutical

Nanotechnology is basically the understanding of both organic & inorganic matter, molecule, structure, system at a nanoscale of 1 to 100 where unique properties revealed. Particles fall under 1 to 100 nanometers in diameter are nanoparticles, these nanoparticles are used and embodied with medicinal compounds which collectively called naomedicine. Nanoparticles have a significant surface-area-to-volume ratio due to their nanoscale size, which allows them to absorb vast amounts of medications and move quickly throughout the bloodstream, also, demonstrating uncomplicated excretion of undigested or remaining particles. Inorganic nanoparticles are non toxic and biocompatible such as elemental metal, metal oxides. The organic nanoparticles such as polymeric nanoparticles, liposomes are biocompatible and biodegradable which makes them ideal for therapeutic use. There is also a third form of nanoparticles which is carbon based NPs which are also biocompatible such as graphene, carbon quantum dots (CQDs), they are known for their high electrical and thermal conductivity & strength. Pharmaceutical Nanotechnology focuses on procedures and advances in the drug delivery systems at the nanoscale with increased success chances and reduced side effects unlike conventional treatments with adverse side effects. Well everything in this world have both positive and negative side and so nanotechnology. Starting with positive side, the advantages of nanotech in pharmaceutical:

- **Targeted Therapy and Drug Delivery**
  One of the main advantages of nanomedicine could be its ability to deliver drugs at the targeted site. For instance, a nanoscale drug delivery system can specifically target cancer cells, preventing healthy cells from being eliminated.
- **Improved Drug Absorption:**
  Nanoparticles can enhance the absorption of drugs into the bloodstream, particularly for drugs that are poorly soluble or have low bioavailability overcoming biomolecular barriers.

Fig. 2: Drug delivery, an encapsulated drug with nanomaterial.

- **In Diagnostics and imaging**
  By developing new diagnostic tools for early disease detection. Such as producing more powerful contrast agents for almost all imaging techniques, as nanomaterials exhibit lower toxicity, and enhanced permeability and retention effects in tissues.

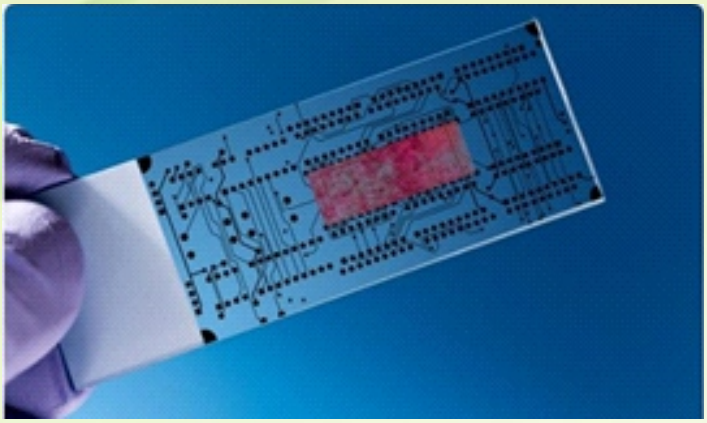

Fig. 3 : A nano biochip used for diagnostic testing.

- **Wound Treatment**
  Nanoparticles incorporated into biopolymer composites, can accelerate healing by removing dead tissue and acting as a barrier, potentially reducing the need for additional dressings. Also, Nanofibers, known for their ability to mimic the extracellular matrix of human tissue, play a crucial role in facilitating cell growth and wound repair.
- **Nanobots**
  The most significant breakthrough of nanomedicine is nanobots. Nanobots can be employed to fix damaged cells and replace whole intracellular components. They can also be used for DNA repair a genetic defect or replace a DNA molecule for disease eradication.

Pharmaceutical nanotechnology, while promising future, has several potential disadvantages, including regulatory hurdles, safety concerns, high development costs, and potential environmental impacts. These include the possibility of nanoparticles inducing toxicity, causing

Fig. 4: A nanobot repairing DNA.

bioaccumulation, interfering with the immune system, and potentially harming the environment. Along with this, we also have kind of limited knowledge of nanotech and didn't know what could be one of the several anticipated outcomes of combining or using a new technology with human body systems.

Conclusion

Ultimately, pharmaceutical nanotechnology shows promising and have the potential of becoming the greatest human advancement of 21st century helping several patients, changing lives, curing the incurable but need to be thoroughly researched in every aspect and once gets passed from clinical testing, ensuring smooth, undisputed market availability should also be done because this is not just innovation in pharmaceutical but hope to million patients. So we need to deliver best of the best with utmost care and love.

CHEMICAL FREE FARMING WITH BIO-FERTILIZER

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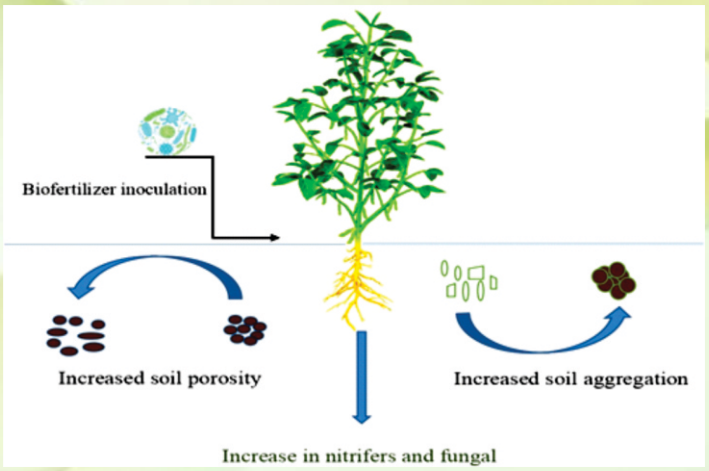
As we all know India has largest area of lands specifically used for cultivating crops as per data India has approximately 169.46 million hectors of croplands but due to stress factors (biotic-pathogens, bacteria, fungi, viruses) (abiotic-drought, nutrient deficiency) it can cause change in gene expression in plants and hormone imbalance resulting reduced growth and yield, change in colour of leaves and also dry the leaves. In modern agriculture, we have a significant use of chemical fertilizer which can increase the yield of crop but on other hand it gives severe problem for environment like air pollution water pollution & very important reason for green house gas emission (CH_4, CO_2, Nitrous oxide) that can cause climate change & global warming also they decrease the fertility of soil by their excessive use . & also decrease the pH level of soil cause increase the acidity of soil. In order to restore them the Bio-fertilizer can be used, which enhance the fertility of soil. They're basically microinnoculants (friends of soil), that types of product were use microorganisms (bacteria, fungi, archea) to degrade the environmental problems & give long term sustainability of agriculture, they all are self replicating in nature if they're given favorable condition's.



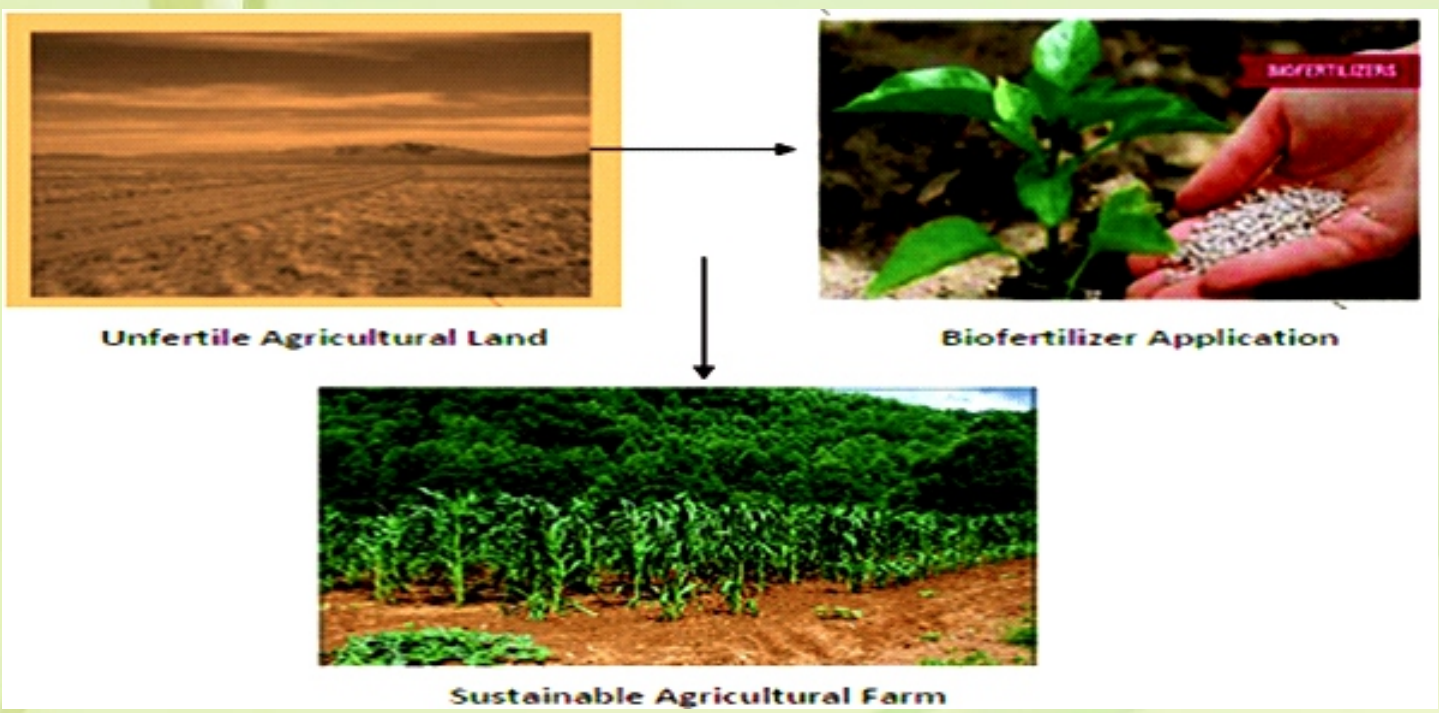
Types of bio-fertilizer

1. **Nitrogen fixers:** That types of microorganisms which can change the nitrogen present in air for plant (because they require ammonia and nitrate) use . also known as Nitrogen fixers present in root nodules of legumes - pea, sprouts
2. **Phosphate-Solubilizing Bio-fertilizers:** Change Insoluble phosphorus into soluble form for plant use.
3. **Potassium-Mobilizing Bio-fertilizers:** change potassium which can present in soil in form for plants

Fig: Types of microbes act as bio-fertilizer.

Importance in agriculture

In present time, We all know about the raising concerns for our environment because of excessive use of fertilizers in agriculture. It can give negative impacts in our health (Inhealtion, Skin problems like rashes) also it reduced nutritional value of food, change in their taste and texture . To preserve them now we can introduce a new type of fertilizer in agriculture BIOFERTILIZER because of its natural properties it play crucial roles like maintaing the soil health , environment protection because it is chemical free in nature , also cheap for farmers that's should be beneficial for them , they provide essential nutrients to plants also increase their stress tolerance from environmental factors and it decrease the green house gas emission and promote the sustainable agriculture that's resulting reduction in carbon footprints.



Advantages

- Gives natural nutreint supply like nitrogen fixation, phosphorus solibilty, micronutreint availability
- Improving soil health by adding soil molecules resulting increase in their aeration and water retention
- Eco-friendly by using living microorganisms that's good for environment
- Increase the crop yield and its quality because of better growth
- Cost effective and reduced the dependency of chemicals in agriculture

Disadvantages

It have some limitations also:

- It have slower action and less immediate effect because it use living microorganisms
- Storage and shelf life problems due to use of living organisms they should survive only a right temperature and conditions
- Need for specific condition for their life because they require a certain pH , temperature & moisture level for survive
- Large scale production in remote areas

Some companies that leading bio-fertilizer in India and international level

- Indian Farmers Fertiliser Cooperative Limited (IFFCO)
- Rashtriya Chemicals and Fertilizers Limited (RCF)
- Chambal Fertilisers and Chemicals Ltd
- Gujarat State Fertilizers & Chemicals Ltd. (GSFC)
- IPL Biologicals Limited
- Biostadt India Limited

Fig. 8: bio-fertilizer products.

Conclusion

As we see how it is different from chemical fertilizer. bio-fertilizer are not increasing the crop yield rather than it also enhance soil fertility and their health for long period of time. And because of their eco-friendly in nature and their cost effectiveness farmers can afford easily and reduce their dependency on chemical fertilizers. this not only brings down the cost of cultivation but also mitigates the risk of chemical pollution in soil and water. When farmers achieve good yields at a lower cost which is supreme for farmers. So Bio-fertilizers help farmers earn more and keep their land healthy for a long time. Using them widely is key for our country's farming future.Bio-fertilizers are good for our planet, prevent pollution in water and air, and help us farm in a way that protects nature for everyone.so that's how much it is important for organic farming and for healthy lifestyle.

YAMUNA CLEANUP AND AWARENESS CAMPAIGN – RECLAIMING DELHI'S LIFELINE

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Ecological and Cultural Significance of the Yamuna River

The Yamuna River serves as a critical freshwater resource for the National Capital Region, supporting Delhi's domestic water supply, agriculture, urban biodiversity, and spiritual activities. Functioning as both a hydrological and socio-cultural lifeline, the river has historically played a central role in sustaining livelihoods and traditions. However, unchecked anthropogenic activities—ranging from direct discharge of untreated sewage and industrial effluents to religious immersion practices and riverfront encroachments—have severely degraded its water quality. As a result, the Yamuna is now ranked among the most polluted rivers globally, necessitating urgent multi-stakeholder intervention to restore its ecological integrity.

Campaign Launch and Scope of Intervention

To address this critical environmental crisis, *Paryavaran Sanrakshan Gatividhi* initiated a large-scale "Yamuna Safai evam Jagrukta Abhiyan (Cleanup and Awareness Campaign)" on 8th June 2025, targeting 11 high-impact ghats across Delhi. These included ITO Ghat, Mayur Vihar (Yamuna Khadar), Nizamuddin Bridge Ghat, Geeta Colony (Chhath Puja Ghat), Pantoon Bridge, Signature Bridge, Loha Pul (Chhath Ghat), as well as Zero Pusta, Dhai Pusta, Chautha Pusta in Sonia Vihar, and spiritual hubs like Preetam Dham and Anandateet Yoga Sadhana Kendra. The simultaneous multi-site operations ensured widespread public engagement and high spatial coverage of critical riverfront zones.

Quantifiable Outcomes and Waste Management.

The campaign witnessed an impressive turnout of over 2,100 participants, including more than 200 women and over 158 youth volunteers, reflecting strong community engagement across diverse groups. Their united efforts led to the collection of 12.41 metric tons of waste, which was meticulously segregated into categories such as plastic, religious waste, biomedical items, and broken idols. This waste was then consciously disposed of, with proper documentation to ensure recycling and reuse. The plastic waste collected during the campaign will be handed over to IPCA for recycling, where it will be transformed into various useful products. This initiative not only ensures proper waste management but also promotes a circular economy by giving discarded plastic a new purpose.

Participation.
The overwhelming response and organized action highlighted a growing environmental awareness and a collective sense of responsibility among Delhi's citizens toward restoring and preserving the Yamuna River. Doctors from the Indian Medical Association (IMA) and college professors actively participated in the drive, showcasing strong community support from both the medical and academic sectors. Their involvement not only added credibility to the campaign but also inspired students, residents, and other professionals to join the cause. By taking part in the initiative, these respected figures emphasized the importance of collective responsibility in addressing environmental and social challenges, reinforcing the message that change begins with active participation from all walks of life.

Behavioral Science Model – Harit Ghar (Green Home) Initiative.
A central educational pillar of the campaign was the Harit Ghar (Green Home) initiative, which promotes sustainable domestic practices using a scientifically designed 5-4-3-2-1 Formula:

- **5 Plants**: Households are encouraged to plant and maintain five plants to enhance green cover and improve air quality.
- **4 Waste Streams**: Waste is to be segregated into four scientifically categorized streams—organic (wet), dry recyclables (paper, plastic, metal), e-waste, and sanitary waste—to optimize recycling efficiency.
- **3Rs Principle**: The reduce, reuse, and recycle framework is emphasized for minimizing ecological footprints.
- **2-Bucket System**: A dual-compartment system is promoted for the separation and reuse of greywater, enhancing water-use efficiency at the household level.
- **1 Hour of Volunteering**: Each citizen is encouraged to dedicate at least one hour per week to environmental service activities such as clean-ups, plantation drives, or awareness campaigns.

This framework integrates environmental science, behavioral change, and civic responsibility into an accessible model for sustainable living.

The 3P Formula – Ped, Pani, Polythene The campaign also popularized the 3P environmental model, structured to convey essential ecological messages through simple, culturally resonant concepts:

- **Ped (Trees)**: Advocates afforestation, conservation, and biodiversity enhancement to combat urban heat and air pollution.
- **Pani (Water)**: Emphasizes judicious water usage, prevention of aquatic pollution, and revival of indigenous water conservation methods.
- **Polythene (Plastic)**: Promotes the complete elimination of single-use plastics, advocating for biodegradable and reusable alternatives such as cloth bags and metal containers.

Volunteer Coordination and Institutional Partnerships.
The success of the campaign is attributed to the tireless efforts of the volunteers and coordinators of *Paryavaran Sanrakshan Gatividhi*. Key contributors—including Mr. Jai Kumar Goel, Mr. Mahendra Aggrawal, Mr. Puneet Sood, Dr. Juhi Saraswat, Mr. Rahul Arora, Dr. Jalaj Saxena, among many others—played instrumental roles in operational planning, site execution, logistics, and media outreach. Their collective dedication ensured a seamless translation of strategy into impact. Furthermore, partnerships with over 100 institutions, including schools, RWAs (Resident Welfare Associations), NGOs, and youth collectives, significantly expanded the campaign's outreach, demonstrating the power of collaborative, decentralized environmental governance.

Conclusion – Scientific Stewardship for a Sustainable Future.
The Yamuna Cleanup and Awareness Campaign serves as a robust example of science-based, community-driven environmental restoration. By integrating public participation, waste science, sustainable living models, and educational outreach, the initiative not only addressed immediate pollution concerns but also laid the

groundwork for long-term ecological stewardship. The campaign reinforced the Yamuna's identity not just as a river but as a hydro-ecological and cultural heritage system that must be preserved through collective action and informed intervention.

"*If we want a clean, green, and livable Delhi, we must begin with our Yamuna.*"

BIOENERGY PRODUCTION FROM ALGAL BIOMASS

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DEFINITION: Bioenergy from algal biomass refers to the utilization of algal biomass as a renewable resource to produce various forms of energy

EXAMPLES: Biodiesel, bioethanol, biohydrogen, and biomethane

CULTIVATION METHODS

1. Open Ponds-The simplest and most cost-effective method, using natural or artificial ponds for cultivation.
2. Closed Photobioreactors (PBRs)-Enclosed systems that offer precise control over environmental conditions like temperature, light, and nutrient availability.
3. Hybrid Systems-Combine aspects of both open ponds and closed PBRs, aiming to optimize production while reducing costs and environmental impact.
4. Vertical Growing-Algae are placed in clear plastic bags exposed to sunlight on two sides, which are then stacked high and protected from rain.

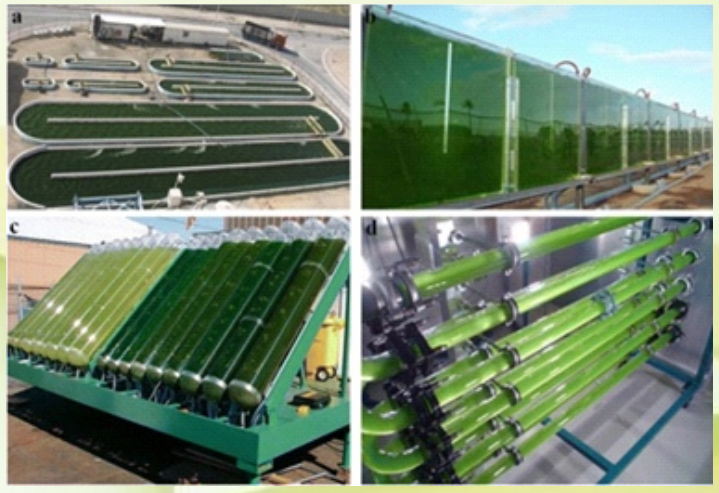

Fig. 1: Different types of microalgae cultivation symicro. (A) Raceway Ponds (B) Flat Panel Photobioreactors (C) and (D) Tubular Photobioreactors

FACTORS AFFECTING ALGAL GROWTH

1. **Light:** Algae require light for photosynthesis, and the type and intensity of light can influence growth rate.
2. **Nutrients:** Algae need specific nutrients, such as nitrogen, phosphorus, and trace elements, for optimal growth.
3. **Water:** Water quality and availability are essential for algal cultivation.
4. **Carbon Source:** Algae require a source of carbon dioxide for photosynthesis.
5. **Temperature:** Algae have specific temperature ranges for optimal growth.
6. **pH:** The pH of the growth medium can affect algal growth.

BIOLOGICAL AND BIOCHEMICAL POTENTIAL-

Algae, particularly microalgae, possess high photosynthetic efficiency and can accumulate significant amounts of lipids, carbohydrates, and proteins, depending on the strain and growth conditions. Some strains, such as Chlorella vulgaris, Nannochloropsis sp., and Spirulina, have demonstrated lipid contents exceeding 50% of their dry weight. These lipids are particularly suitable for biodiesel production through transesterification.

In addition, algae can be cultivated in diverse environments, including freshwater, marine, and wastewater systems, thereby reducing freshwater demand and allowing integration with wastewater treatment. Their ability to sequester CO2 from industrial emissions further enhances their environmental benefits.

CONVERSION TECHNOLOGIES-

1. **Transesterification** – Using alcohol and a catalyst lipids extracted from algal cells are converted into biodiesel. This is the most studied and commercially relevant pathway.
2. **Anaerobic Digestion** – Biogas (mainly methane) is produced by digestion of algal biomass by anaerobic bacteria in absence of oxygen.
3. **Hydrothermal Liquefaction (HTL)** – Under high pressure and moderate temperature wet algal biomass is converted into bio-crude oil without any drying.
4. **Fermentation** – Algal carbohydrate is fermented to produce bioethanol that can be blended with gasoline or used as a fuel source. This is less efficient than lipid-based methods.
5. **Pyrolysis**-Heating algal biomass in the absence of oxygen to produce bio-oil, bio-char, and syngas.
6. **Gasification**-Similar to pyrolysis, but with the addition of an oxidizing agent to produce syngas, a versatile fuel source

7. **Hydrogen Production**-Certain algal species can produce hydrogen gas under specific growth conditions, offering another pathway for bioenergy generation.

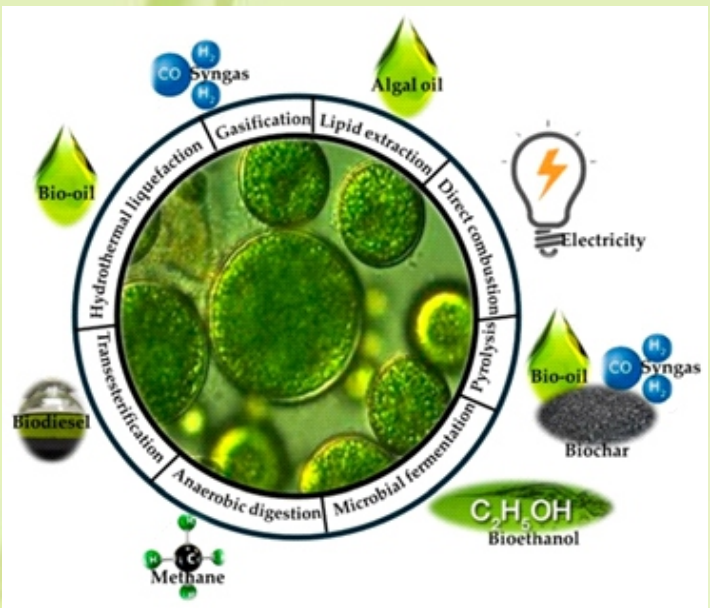

FIG. 2: Different conversion Technologies used for bioenergy production from algal biomass and their respective end products.

RECENT ADVANCEMENTS AND INNOVATIONS

1. **Genetic Engineering** – Techniques like CRISPR-Cas9 are being used to improve lipid accumulation, stress tolerance, and growth rates.
2. **Photobioreactor Design** – Innovative designs now allow better light penetration, gas exchange, and scalability.
3. **Integrated Systems** – Algae cultivation combined with wastewater treatment and CO2 capture is being explored to enhance overall sustainability.

ADVANTAGES

1. Offer lower greenhouse gas emissions compared to fossil fuels and some first-generation biofuels
2. High Productivity and Rapid Growth
3. Algae can be grown on non-arable land, including saltwater and brackish water, without competing with food crops.
4. Algae can be grown in wastewater, potentially reducing pollution and utilizing resources
5. They absorb atmospheric CO2 during growth, potentially contributing to a reduction in greenhouse gas emissions.
6. This flexibility allows for scalable and sustainable production, reducing the risk of monoculture dependence and environmental impacts.

CHALLENGES AND FUTURE DIRECTIONS-

1. **Economic Viability** – High production costs, especially for harvesting and lipid extraction, remain major bottlenecks.
2. **Strain Selection and Cultivation** – Finding robust strains that perform well under varying outdoor conditions is critical.
3. **Policy and Incentives** – Supportive regulations and subsidies are needed to stimulate investment and commercialization.

Future research should focus on system-level optimization, coupling bioenergy production with valuable co-products (e.g., pigments, proteins), and scaling up pilot studies. Cross-disciplinary collaboration and public-private partnerships will play a crucial role in transitioning algal bioenergy from research labs to industrial reality.

CONCLUSION-

Algal biomass represents a scientifically and environmentally promising route for sustainable bioenergy production. With continued innovation in biology, engineering, and systems integration, algae could play a pivotal role in the global transition to a low-carbon energy future.

WASTE TO WEALTH: TRANSFORMATION OF AGRICULTURAL WASTE INTO VALUABLE ALTERNATIVE PRODUCT

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Waste is anything which does not have any use value in it's current form or a material which gets generated after it's primary use. Likewise, Agricultural waste can be described as a material which gets generated from different agricultural activities (*i.e.,* manure, oil, silage plastics, fertilizer, pesticides and herbicides, wastes from farms, poultry houses and slaughterhouses; veterinary medicines, or horticultural plastics) and is unwanted in it's present form. In a nutshell the waste which get generated from both livestock and crop is characterized as agricultural waste. The surprising fact is that, each year India generates 350 MT of agricultural waste and improper processing, disposal and management of agricultural waste causes huge problems to environment.

The Problem of Agricultural Waste

As Paul McCartney once said, "There must be a better way

to make the things we want, a way that doesn't spoil the sky, or the rain or the land". This sentiment is particularly relevant in India, where agriculture is a crucial sector, with rice-wheat cropping systems, horticulture, fisheries, and animal husbandry contributing significantly to food security and economic growth. However, the generation of approximately 350 million tons of agricultural waste annually poses a significant environmental challenge, leading to alarming levels of air, soil, and water pollution, and highlighting the need for more sustainable agricultural practices. Globally, agriculture generates vast quantities of waste, including crop residues, husks, straw, and livestock manure. Improper disposal of this waste through burning or dumping contributes to air pollution, greenhouse gas emissions and soil degradation. This waste is often underutilized, despite its potential to be converted into valuable products.

The practice of straw burning releases significant quantities of harmful GHG emissions, including methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), nitrogen oxides (NOx), sulfur dioxide (SO_2), hydrocarbons, and particulate matter. According to Jenkins and Bhatnagar (2003), burning one ton of straw emits approximately 3 kg of particulate matter, 60 kg of CO, 1460 kg of CO_2, 199 kg of ash, and 2 kg of SO_2. These emissions not only contribute to air pollution and climate change but also adversely affect human health, causing issues such as eye irritation, asthma, respiratory diseases, cough, and cold.

Key Sources of Agricultural Waste

Agricultural solid wastes mainly get generated from farming activities. But it is extended up to all sorts of activities associated with farming and food chain. Each detailed stages involved in agricultural production generates significant types and amounts of agricultural wastes. The broad classification of agricultural solid wastes includes the following:

- Field crop based solid waste
- Live stock based solid wastes
- Food processing based solid wastes
- Horticultural crop based solid wastes
- Aqua-culture activity based waste
- Industrial agricultural solid wastes
- Chemical wastes related to agricultural activities

Emerging solutions

This agricultural waste can be effectively utilized through Principal Biomass Conversion Pathways, which transform agricultural by-products into useful energy, materials, and products. Some prominent methods include:

1. Biochemical conversion Techniques such as aerobic and anaerobic fermentation are used to convert organic waste into bioenergy or compost. Anaerobic fermentation, for example, produces biogas that can serve as a renewable energy source.
2. Composting Livestock manure and plant residues are being processed into organic fertilizers, enhancing soil fertility and reducing dependence on chemical inputs. This method is both eco-friendly and economically viable for smallholder farmers. Such an example is instead of burning of rice straws, in-situ composting through addition of different microbes; adds huge nutrients to soil and additionally improves soil health.
3. Thermo-chemical conversion Processes like combustion and pyrolysis convert agricultural residues into energy and by-products. Pyrolysis, in particular, breaks down organic material in the absence of oxygen to produce biochar, oil, and syngas.
4. Waste up-cycling: In many regions, crop residues are creatively upcycled into handicrafts, furniture, and packaging materials, offering additional income streams to rural households.
5. Producer gas utilization Producer gas, generated through biomass gasification, is a versatile energy source that can be used for electricity generation or as an industrial fuel.

Established technologies for waste to wealth generation in Agriculture scetor: Glimpses of case studies

1. Lac Dye from effluent of stick lac washing: Recovery of lac dye, a byproduct of the lac industry, can be done from the effluent of lac washing, reducing waste and generating additional income.
2. Lac mud as organic manure: Lac mud, a waste product of lac processing industries, can be utilized as organic manure, reducing pollution hazards and promoting sustainable agriculture.
3. Family Net Vessel Compost (FNVC) Technology: FNVC technology utilizes epigeic earthworm species to recycle kitchen waste into valuable compost, mitigating odor problems and greenhouse gas emissions.
4. Utilization of Okara for development of Soy-based food products: Okara, a food by-product from tofu and soy milk production, can be used to prepare bakery based soy products and fermented products rich in protein.
5. Cotton stalks for Oyster mushroom cultivation: Cotton stalks, a lignocellulosic biomass, can be used as a substrate for oyster mushroom cultivation, generating additional income for farmers.
6. Tamarind seed husk reduces enteric methane emission: Tamarind seed husk, an agricultural waste, contains tannins that can modulate rumen fermentation, reducing enteric methane emission.

7. Alcoholic beverage with nutraceutical properties from kinnow Peels: Kinnow peel beverage with nutraceutical properties can be developed using a simple, low-cost, indigenous technology.
8. Animal feed from potato waste: Potato waste can be processed into animal feed, replacing up to 30% of grain components, reducing disposal problems and generating value-added products.
9. Banana fiber from pseudostem sheath: Banana pseudo-stem, a waste material, can be utilized to extract banana fiber, which has multifaceted uses in preparing value-added products.
10. Enrichment of cookies by using grape pomace powder: Grape pomace powder, a waste material from wineries, can be used to enrich cookies with phenolic compounds, radical scavenging activity, and dietary fibers.
11. Jackfruit seed powder and mushroom powder-based biscuits / cookies: Jackfruit seed powder, a waste material, has antioxidant and anti-microbial properties, making it suitable for development of specialties products like diabetic foods.
12. Pomegranate rind powder as a natural antimicrobial agent: Pomegranate rind powder, a waste material, has antimicrobial properties, making it suitable for use as a natural preservative in food products.
13. Sugarcane bagasse for production of biodegradable plastic: Sugarcane bagasse, a waste material, can be used to produce biodegradable plastic, reducing plastic waste and promoting sustainable development.
14. Tea waste as a natural Dye: Tea waste, a waste material, can be used as a natural dye for textiles, reducing the environmental impact of synthetic dyes.
15. Value-added products from mango waste: Mango waste, a waste material, can be used to develop value-added products like mango powder, mango juice, and mango kernel oil, reducing waste and generating additional income
16. Rice husk alternative uses: Can be used for extraction of silica, for paper production, for construction purpose, for generating energy, using as growing medium for plants. There are many such uses of rice husk which can transform it as 'trash to treasure'.
17. Rice Husk Ash (RHA) based alternative products/applications: Rice husk ash which gets generated in huge quantity in rice mills after the boiling of the rice. This huge amount of ash faces trouble in disposal issue. But, there are many alternative uses of it! Using RHA in construction material, making insulating material, refractory bricks making, using in soil properties improvement, and conversion into K-rich organic fertilizer.

Conclusion

"Whatever I dig from thee, may that have quick recovery again. O purifier may we not injure the vitals of thy heart". This quote from the Rig Veda, an ancient Indian Vedic scripture, reflects the deep understanding and reverence of the seers for the natural world and the principle of replenishment of the earth. In essence, the quote embodies the concept of sustainability, where human activities are balanced with the earth's ability to replenish itself. It highlights the importance of living in harmony with nature, recognizing the interconnectedness of all living beings, and adopting practices that promote the well-being of both humans and the planet.

In this context, "waste to wealth" initiatives offer a transformative approach to waste management, aligning seamlessly with Sustainable Development Goal (SDG) 12: Responsible Consumption and Production. By converting waste into valuable resources, these initiatives promote recycling, reuse, and sustainable consumption practices, thereby minimizing environmental impact. As a core principle of a circular economy, "waste to wealth" contributes to waste reduction, generates economic opportunities, and promotes sustainable livelihoods.

Furthermore, these initiatives have a ripple effect on other SDGs, including SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 15 (Life on Land), underscoring their potential to drive holistic sustainable development. As the world navigates the complexities of environmental conservation, economic growth, and social equity, "waste to wealth" initiatives emerge as a beacon of hope, illuminating a pathway towards a more circular, sustainable, and responsible future

ARTICLES INVITED

NESA members are requested to share articles on any scientific / research / innovation activities in Newsletter. Article to be sent by mail to: ***nesapublications@gmail.com***

WHEN HUMANS MARRY ANIMALS: RITUALS, BELIEFS, AND STORIES FROM AROUND THE WORLD

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Throughout history, humans have looked to animals not just for food or labor, but for something deeper, a spiritual connection, cosmic meaning, and sometimes, strange solutions to problems we can't fully understand. Across cultures, especially in places where tradition still breathes in everyday life, there are stories that blur the boundaries between species. Among the most curious are those where humans marry animals, not for love, as one might first assume, but as acts of ritual, protection, or protest. Whether it's to summon rain, prevent misfortune, or uphold ancestral customs, these unusual unions aren't merely odd news pieces. They often reflect the hopes, fears, and spiritual frameworks of communities passed down through generations. These symbolic marriages, however surreal they may seem, are full of intention. They are heartfelt gestures of devotion to tradition, of faith in the unseen, or of quiet resistance against modern rules. Sometimes, when rational solutions fail, people turn to symbolic acts, hoping to restore balance between the human world and nature.

When the Rain Won't Come, Frogs Say “I Do”: It might sound like something from folklore, but in several parts of India, frog marriages are a time-honored tradition used to call upon the skies for rain. In rural areas like Bhopal and Assam, where agriculture heavily relies on monsoon rains, communities often come together during dry spells to catch two frogs and conduct a full wedding ceremony. These aren't small affairs. The frogs are dressed up, rituals are followed, mantras are chanted, and they're even paraded like newlyweds. The belief is that their symbolic union pleases Indra, the Hindu god of rain, encouraging him to bless the land with showers.

In one recent case from Bhopal, the frog wedding seemingly worked too well. After the ritual, the region experienced unusually heavy rain and flooding. Concerned, the same local group that organized the marriage, Om Shiva Sewa Shakti Mandal, decided to conduct a symbolic frog "divorce" to stop the deluge. The ceremony, carried out at a Shiva temple, was both solemn and sincere, highlighting just how deeply these beliefs are held. Elsewhere, like in Karnataka, similar rituals are performed using frogs or even donkeys. In villages like Kurubaraboodihaal, farmers conducted ceremonial animal marriages during droughts, hoping to appease the rain god. These ceremonies blend ancient myth with modern desperation, and though they may seem peculiar to outsiders, they're rooted in centuries of faith, collective memory, and survival instinct. The croaking of frogs is traditionally seen as nature's call to the monsoon, and so, uniting two frogs becomes an emotional plea to nature itself, an attempt to reawaken a disrupted cycle.

Beyond the Monsoon: Marriages Born of Belief, Emotion, and Tradition. While frog weddings are deeply connected to weather and agriculture, not all human-animal unions are about rain. In some cultures, animal marriages or relationships serve different symbolic or social purposes, from maintaining harmony to addressing deeply personal needs or ancient customs. One notable example comes from Mexico, where the mayor of San Pedro Huamelula, a town of the Chontal people, marries a female alligator every year. The reptile, dressed in a bridal gown, is considered a representation of a Huave princess, and the ceremony symbolizes the centuries-old peace treaty between two Indigenous groups. This marriage is more than just performance; it's a cultural reaffirmation of identity, history, and harmony with nature.

Then there are the more personal and unconventional stories. In 2006, Sharon Tendler, a British woman, married a dolphin named Cindy in Israel after years of emotional attachment. Though not legally recognized, she claimed the bond was real, emotional, and meaningful. In London, Deborah Hodge married her pet cat, India, in a ceremony to protest housing policies that prevented pet ownership. Her message was clear: this wasn't about romance, but about affirming her cat as an

irreplaceable part of her life. Other instances are tied to tribal beliefs and protective rituals. In Odisha, India, among the Ho tribal community, symbolic marriages between children and dogs are sometimes performed when children develop their upper teeth first, considered a bad omen. By marrying them off to a dog in a traditional ceremony, the misfortune is believed to be transferred, sparing the child from future harm. Though symbolic and temporary, these rituals are taken seriously, often accompanied by community-wide celebrations and feasts.

Further examples of sacred human-animal relationships can be found in places like New Guinea and Sarawak, Malaysia, where totemic traditions thrive. Among the Nor-Papua people and the Iban community, individuals or clans are linked to specific animals, often fish, birds, or mammals, believed to be ancestors or protective spirits. These aren't marriages in the literal sense, but the connection is lifelong, often sacred, and surrounded by rituals, taboos, and myths. Animals in these cultures are more than creatures; they are family, guides, and protectors. These stories may seem strange, humorous, or even unsettling depending on one's perspective. But to the people who practice them, they hold power, meaning, and reassurance. They reflect a complex relationship with the natural world, one where animals are not just background beings, but active participants in human spiritual life. And these are just a few of the many human-animal unions, symbolic or otherwise, that continue to be practiced in corners of the world where tradition still dances hand in hand with belief.

EUTROPHICATION: CAUSES, MANIFESTATIONS, IMPACTS, AND MITIGATION STRATEGIES

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'Eutrophos', which means well-nourished or enriched, is the Greek word for eutrophication, a natural phenomenon. This enrichment causes further gradual processes that are known as lakes' natural ageing. In order to identify the flora of German peat bogs as eutrophe, mesotrophe, and oligotrophe, C.H. Weber defined eutrophication as nutrient-rich conditions. This phenomenon is the transformation of a nutrient-rich bog in a shallow depression into a nutrient-deficient leached bog. Based on the amount of phosphate, nitrogen, and calcium, Einar Naumann classified springs, streams, bogs, or lakes as oligotrophic (barren), mesotrophic, or eutrophic. Eutrophication is the process where water bodies become nutrient rich, primarily nitrogen and phosphorus, leading to excessive plant and algae growth. Water bodies are classified as oligotrophic, mesotrophic, or eutrophic based on their nutrient levels and productivity. Oligotrophic lakes have low productivity, eutrophic lakes have high productivity, and mesotrophic lakes have moderate productivity (Fig.1).

Sources of Nutrients:
Excessive nutrients, particularly nitrogen and phosphorus, enter water bodies from agricultural runoff, untreated sewage, industrial discharge, and livestock and aquaculture operations. These sources include agricultural fertilizers, untreated sewage from homes and industries, industrial discharge, and animal waste from farms and aquaculture operations. When excessively high levels of nutrients from fertilizers, household and industrial wastes, urban drainage, detergents, animal wastes, and sediments enter water streams, eutrophication quickly worsens.

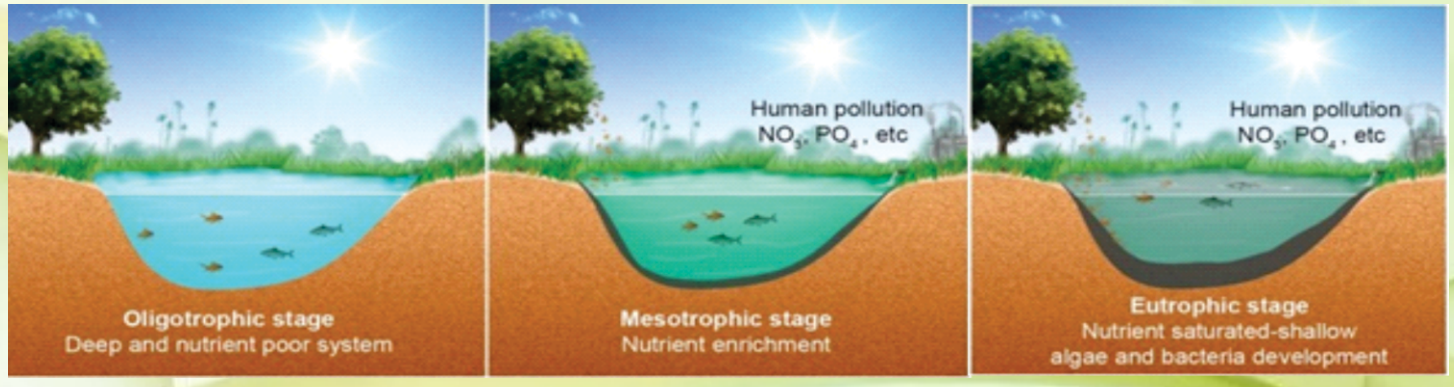

Fig. 1: Stages of Eutrophication.

Types of eutrophication: Eutrophication is mainly of two types such as natural and cultural eutrophication.

a. Natural eutrophication:
Natural eutrophication is the ageing process of lakes that is marked by nutrient enrichment. An oligotrophic lake becomes a eutrophic lake during this procedure. Ample food for fish and herbivorous zooplankton is made possible by the formation of phytoplankton, algal blooms, and aquatic vegetation such as water hyacinth, aquatic weeds, water fern, and water lettuce.

b. Cultural eutrophication:
This process is generally enhanced by human activities; which are responsible for adding 80% nitrogen and 75% phosphorus to lakes and streams.

Due to human activities, this process accelerates natural eutrophication. Because of land clearing, the construction of towns and cities, runoff water, fertilisers, treatment facilities, and farms, lakes, ponds, and rivers receive nutrients, phosphate, and nitrates. Algal bloom is a plant growth induced by these nutrients. One type of water contamination is cultural eutrophication. Additionally, cultural eutrophication happens when too much fertiliser enters lakes and rivers, promoting algal and plant blooms. After that, there is overpopulation and competition between plants for oxygen, sunlight, and space. Additionally, an overabundance of water plants obstructs sunlight and oxygen, endangering aquatic life.

Marine Eutrophication:
When chemicals, particles, and garbage from industry, agriculture, and homes enter the water or when invasive creatures proliferate, it can have detrimental impacts. This is known as marine pollution. The majority of maritime pollution originates on land. Nonpoint sources including wind-blown debris and agricultural runoff are frequently the source of the contamination. Many potentially harmful substances stick to microscopic particles, which plankton and benthos animals, the majority of which are deposit or filter feeders, then absorb. Toxins are thus concentrated higher up in aquatic food chains. Estuaries become anoxic as a result of many particles combining chemically in a way that significantly reduces oxygen levels. Pesticides are rapidly absorbed by marine food webs once they are integrated into the marine ecosystem. These pesticides have the potential to affect humans and the food chain as a whole by causing diseases and mutations once they enter the food network (Fig.2). Marine food webs may also be exposed to toxic metals. These have the potential to alter marine life's tissue matter, biochemistry, behaviour, reproduction, and growth. Marine pollutants have the ability to spread to terrestrial animals and subsequently show up in meat and dairy products.

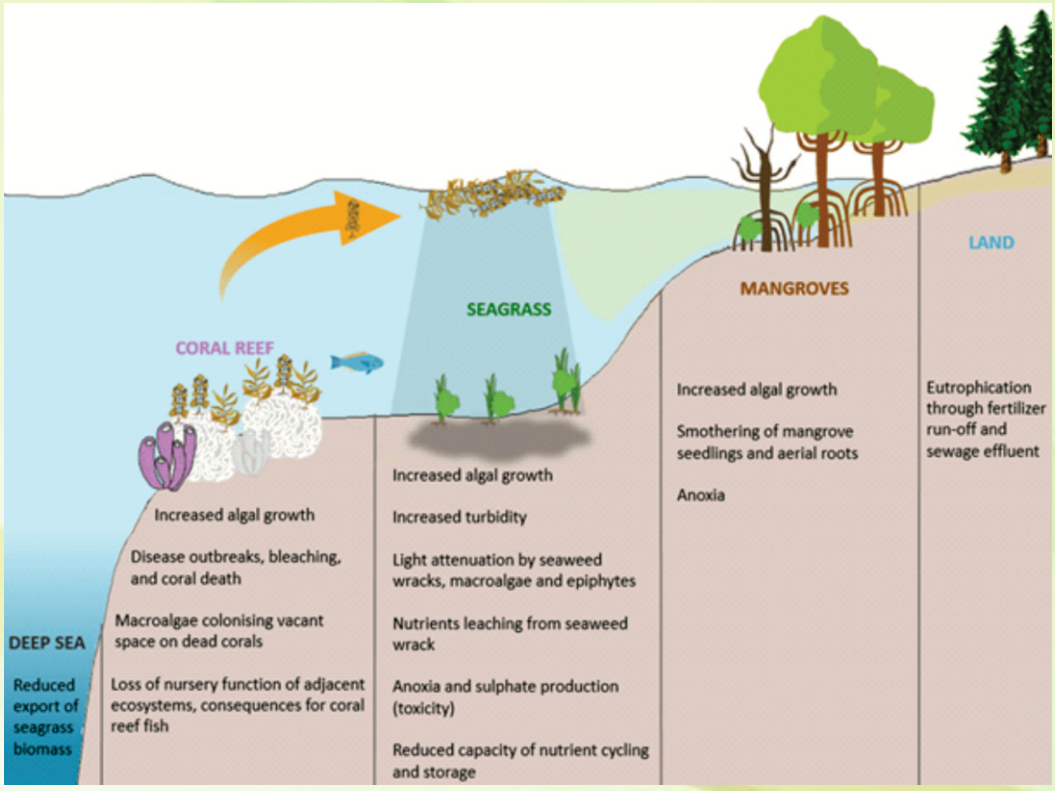

Fig. 2: Eutrophication affects aquatic ecosystem.

Impact of eutrophication on marine benthic life:
An ecosystem experiences eutrophication when its chemical nutrients, usually those that contain phosphorus or nitrogen increase. The primary productivity of the ecosystem may rise as a result, and other consequences may include oxygen deprivation and sharp declines in fish, other animal, and water quality. The largest offenders are rivers that flow into the ocean, carrying with them human and animal waste as well as a variety of chemicals used as fertilisers in agriculture. Chemicals in water that deplete oxygen can cause hypoxia and the formation of a dead zone. Because runoff concentrates nutrients from the land where it enters the marine environment, estuaries are typically naturally eutrophic. There are 375 hypoxic coastal zones in the world, according to the World Resources Institute. Frequent red tide algae blooms in the ocean harm fish and marine mammals and, when they get close to shore, cause respiratory issues in people.

Anthropogenic fixed nitrogen from the atmosphere can enter the open ocean in addition to land drainage. According to a 2008 study, this could be responsible for up to 3% of the yearly new marine biological production and around one-third of the ocean's external (non-recycled) nitrogen supply. According to some theories, the effects of releasing reactive nitrogen into the atmosphere could be just as detrimental as those of releasing carbon dioxide.

Effects of eutrophication:

Eutrophication's effects include a number of physical, chemical, and biological alterations that significantly lower the quality of the water. The following significant consequences are produced by it:

- When eutrophication occurs, poisonous chemicals released by algal blooms kill fish, birds, and other aquatic life, causing the water to drop.
- Water loses oxygen due to a decomposed algae bloom. The biota dies as a result of high CO2 levels and inadequate oxygen delivery, turning pure water into a foul drain.
- Certain bacteria obtain oxygen by reducing nitrates when the oxygen level drops to zero (anaerobic zone). When all nitrate has been used, oxygen may be extracted as a last resort by reducing sulphate, which produces hydrogen sulphide and gives water a putrid taste and a bad odour.
- Under anaerobic conditions, sewage products are home to a variety of harmful microorganisms, including bacteria, viruses, and protozoa. It causes the spread of deadly water-borne illnesses like dysentery, polio, diarrhoea, typhoid and viral hepatitis.
- Because of overfertilization, algae and diatoms achieve a high degree of dominance. Water works and water quality are impacted by algae and rooted weeds, which also block filters, slow down water flow, and interfere with hydroelectric production.
- Shore and shallow areas are unsuitable for any function due to the large population densities of macrophytes such as *Hydrilla, Potamogeton, Ceratophyllum*, and *Myriophyllum*.
- *Chironomous plumosus* and tubificid worms proliferate during eutrophication, causing anaesthetic and financial issues in water bodies.
- Communities of phytoplankton are particularly vulnerable to eutrophication. Eutrophic lakes have a smaller phytopopulation than oligotrophic ones, according to a study on Lake Wisconsin.
- A lake experiencing eutrophication may have an oxygen shortage, which would ruin fish habitats and result in the extinction of a number of beneficial aquatic species.
- Dystrophic states result from prolonged eutrophic environments. Dystrophic lakes are those that receive massive volumes of organic matter from allocthonous sources. These lakes have significant levels of humic acid and bog vegetation, but their planktonic productivity is quite poor.

Control of eutrophication:

In 1974, during the 9th International Congress of Theoretical and Applied Limnology, an international resolution was ratified due to the dominant influence that nitrogen and phosphorus play in eutrophication. To manage eutrophication, a number of technological tools have been employed in conjunction with measures to stop additional wastewater flow. For instance,

- To limit the nutritional value, the wastewater must be treated before being released into streams.
- Harvesting allows for the verification of nutrient recycling.
- By separating nutrient-rich streams from receiving bodies, dilution of these components, and removal of nitrogen and phosphorus at the source, eutrophication can be reduced.
- After algae blooms die and decompose, they should be removed.
- The disruption of the algae food chain is necessary to promote the growth of bacteria.
- By reducing the amount of dissolved nutrients, algae growth can be managed. More phosphorus can be precipitated using chemicals. Alum, lime, iron, and sodium aluminate are examples of these precipitants.
- Dissolved nutrients can be eliminated using physico-chemical techniques. For instance, nitrogen can be eliminated by nitrification or denitrification, electrodialysis, reverse osmosis, and ion exchange techniques, while phosphorus can be eliminated by precipitation.
- Directly killing aquatic plants can temporarily reduce eutrophication. Sodium arsenite and copper sulphate are used to destroy rooted plants and algae.
- Improved wastewater treatment, sustainable agriculture practices, buffer zones, and industrial discharge control are strategies to reduce nutrient input, minimize agricultural runoff, and control industrial discharges, promoting precision farming, reduced fertilizer use, and conservation tillage.
- Eutrophication can also be control through various methods, including dredging, hypolimnetic aeration, chemical treatments, biological methods like biomanipulation and macrophyte planting, and public awareness and education. These methods aim to remove nutrient-rich sediments, add oxygen to water layers, control algal populations, and promote responsible practices to prevent eutrophication.

PROBLEMS OF RED TIDES AND FISH KILLS IN AQUATIC ENVIRONMENT

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Algal blooms, which occur when freshwater, marine, or estuary algae rapidly build up in the water column, are commonly referred to as red tides. Phytoplankton, a type of algae, are single-celled protists that resemble plants and can create thick, noticeable patches close to the water's surface. Photosynthetic pigments found in some phytoplankton species range in colour from green to brown to red. High quantities of algae cause the water to seem murky or discoloured, with a tint that ranges from purple to nearly pink, usually red or green.

Some red tides are referred to as harmful algal blooms and are linked to the creation of natural toxins, the loss of dissolved oxygen, or other detrimental effects. The linked mortality rates of fish, birds, marine mammals, and other organisms among marine and coastal species are the most noticeable consequences of red tides (Fig.1). These deaths in Florida red tides are brought on by exposure to brevetoxin, a strong neurotoxin that is naturally produced by the marine algae *Karenia brevis*. HAB is also caused by the other dinoflagellate species, *Alexandrium fundyense*. The filter-feeding shellfish contains saxitoxin, which is toxic to humans.

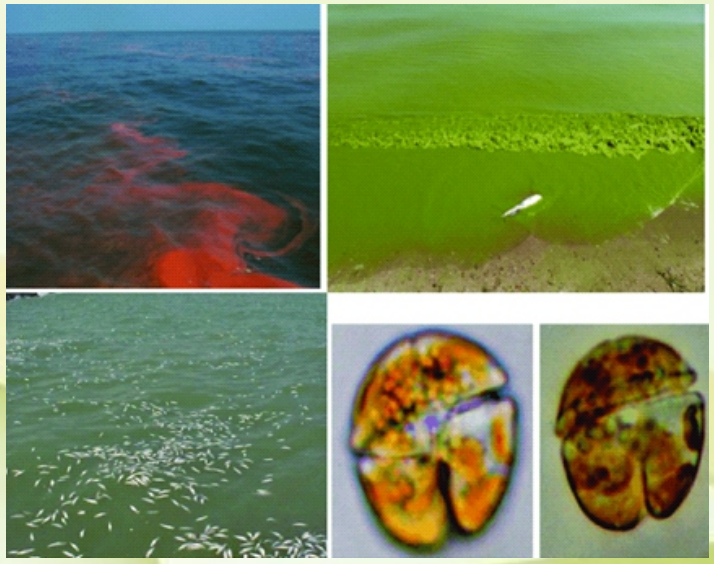

Fig. 1: Red tides and fish kill.

Causes of red tide:
The cause of red tides is unknown, however in some places they seem to be completely natural, while in others they seem to be caused by human activity. Increased nutrient loading from human activity has been connected to the frequency and intensity of algal blooms in several regions of the world. In some places, coastal upwelling, a natural outcome of the movement of specific ocean currents, causes algal blooms, which are a seasonal phenomenon. The availability of nitrates and phosphates, which can be plentiful in coastal upwelling zones and agricultural runoff, typically limits the growth of marine phytoplankton. Additionally, red tides have been linked to human-caused coastal water pollution and a systematic rise in seawater temperature. Red tides are believed to be caused by a number of other variables, including the influx of iron-rich dust from vast arid regions like the Sahara Desert. El Niño events and other large-scale climate oscillations have also been connected to some algae blooms on the Pacific coast. Since the earliest explorers like Cabeza de Vaca, red tides have been happening in the Gulf of Mexico. Numerous coral species are symbiotic with the dinoflagellates. According to biologist Tyler Campbell, they might be "moving," or departing from their mutualistic host coral community, seeking better living conditions or on a yearly basis.

Related diseases:
HAB can harm co-occurring creatures and change the dynamics of the food web by producing poisons or by accumulating biomass. Fisheries and economic losses in coastal areas, human disease and mortality after ingesting or indirectly being exposed to HAB toxins, and fish, bird, and animal mortality linked to HAB are among the effects. Depending on the algae species, the water environment, and the organism concentration, blooms might seem greenish, brown, or even reddish-orange to the naked eye.

Red tide bloom location, timing, and information retrieval:
Florida red tide has not been linked to any human fatalities; however, when the organism (*Karenia brevis*) is present along a coast and winds bring its toxic aerosol onshore, people may experience respiratory irritation (coughing, sneezing, and tearing).

In 1972, *Alexandrium* (*Gonyaulax*) *tamarense*, a toxic dinoflagellate, generated a red tide in New England. A ship named The Oceanus discovered in 2005 that the Canadian red tide had moved further south than it had in previous years, closing shellfish beds in Massachusetts and Maine and warning officials as far south as Montauk (Long Island, NY) to inspect their beds. The reproductive cysts were found in the seabed by experts.

To offer frequently updated updates on the current red tide occurrence, Texas Parks & Wildlife has added a menu item to its primary toll-free information line. Press 4 for fishing and 9 for red tide information when you call 800-792-1112, begin of the skype highlighting, and end of the skype highlighting. Every time biologists submit an update; it will also be displayed on this website's current status section.

Algal blooms in the Indian maritime environment:
The red tide is a well-known occurrence in India's marine environment. *Noctiluca scintilans*, *Trichodesmium erythraeum*, *Rhizosolenia* sp., and other sporadic blooms were observed until 1973, but none of them were of the

HAB type. However, since 1981, there have been reports of paralytic shellfish poisoning (PSP) cases from coastal Maharashtra, Karnataka, and Tamil Nadu, with negative outcomes. In 1981, PSP caused three fatalities and 85 hospitalizations in Tamil Nadu as a result of eating the bloom-affected mussel *Meretrix casta*. A comparable incident occurred in Mangalore in 1983, but the causal species was not found in either instance. *Gymnodinium catenatum*, a powerful PSP species that can form planktonic cells and cysts in sediment, was discovered in 1996 in Karnataka's coastal waters (off Mangalore); nonetheless, the small number of cells had no harmful effects. After consuming *Perna indica* mussels, an outbreak of PSP was documented in three Keralan villages in September 1997, which led to the hospitalization of more than 500 people and the deaths of seven people. The NIO team discovered a harmful algal bloom caused by the hitherto unknown dinoflagellate *Cochlodinium polykrikoides* on a reconnaissance trip on the coastal vessel Sagar Shakti in 2001.

The reason of the fish death observed off Goa was not confirmed, despite the fact that this species is known to kill fish in Korea. These few instances highlight the bloom's unpredictability and may provide an answer to the question of whether India should be concerned about the blooms at all.

Warning for shellfish and oyster consumers:
Red tide poisons can build up in the tissues of oysters and other shellfish, including clams, mussels, whelks, and scallops. Neurotoxic shellfish poisoning (NSP) is a dangerous illness that can strike anyone who consume oysters or other shellfish that contain red tide toxins. However, bacteria and other pollutants in raw oysters pose additional dangers. Shellfish poisoning can result from various HAB organisms in seawater, including neurotoxic (Brevetoxins) caused by marine dinoflagellates (*Gymnodinium breve, Ptychodiscus breve*) and molluscan shellfish, paralytic (Saxitoxins) caused by marine dinoflagellates (*Gonyalux, Alexandrium, Gymnodinium, Pyrodinium*) and freshwater cyanobacteria, diarrhetic (Dinophysis) caused by dinoflagellates and microscopic algae, it also caused due to Okadaic acid which comes from marine sponge, *Halichondria okadai* and also in mussels. Dinophysistoxins-1 (DTX-1), Pectenotoxin-6 and Yessotoxin found in Scallops. Amnesic (Domoic acid) poisoning caused by the consumption of shellfish containing the marine biotoxin domoic acid from diatoms (*Pseudonitschia* species). These poisons can be caused by consuming clams, oysters, mussels, snails, and filter feeder animals, as well as by ingesting shellfish containing the marine biotoxin.

Fish Kill:
Fish kills, or mass die-offs, are primarily caused by environmental factors or disease, including low dissolved oxygen, temperature extremes, harmful algal blooms, toxins, and disease outbreaks, often exacerbated by human activities. When dead fish are seen, it's called a fish kill. The public may perceive certain fish kills as detrimental to the fish population because they are so obvious. Nevertheless, despite their outward manifestation, most lake fish deaths typically impact a small portion of the fish population. Fish kills can happen for a number of causes. It is often caused by low dissolved oxygen, extreme temperatures, harmful algae blooms, toxins from industrial discharges, agricultural runoff, and natural sources, diseases from crowded conditions like aquaculture ponds, and natural events like spawning stress, sudden storms, and drought. These factors can lead to stress, disease, and death in fish populations. Fish kills are most frequently caused by oxygen loss in shallow water basins. There are several ways that oxygen deficiency might occur. The following are the three most frequent causes of fish death:

1. Oxygen is drawn from the water column and used in the decomposition process whenever aquatic creatures die. In this method, oxygen can be severely depleted, particularly in aquatic basins with a high algal population. Fish deaths are likely to result from oxygen deprivation in water bodies where the concentration of total chlorophyll surpasses 100μg/L, suggesting a high level of algae. This is due to the fact that a large portion of the algal population is naturally dying, and as a result, the breakdown of this population can utilize a lot of oxygen.
2. In a similar vein, a large number of aquatic plants dying quickly can also result in oxygen depletion. To avoid this, herbicide applicators frequently apply herbicides that cause plants to die slowly or treat sections of aquatic plants at separate times.
3. Several days of cloudy skies, particularly in hot weather, might potentially cause a fish kill because of oxygen deprivation. This is possible because photosynthesis requires enough sunshine for aquatic plants and algae to supply oxygen to the water. However, as part of their regular metabolic functions, they constantly use oxygen. Because the plants are consuming more oxygen than they are generating, oxygen levels may drop if cloudy skies continue for several days. Because warmer water initially contains less oxygen than cooler water, high temperatures make water especially sensitive. An oxygen issue could be indicated by fish "gulping" at the surface.

Low dissolved oxygen levels can cause fish to gasp for air, indicating respiratory distress. Skin lesions and ulcers may indicate parasitic or bacterial infections. Swollen gills may indicate gill damage. Lethargy and loss of appetite may occur, and abnormal behaviours like erratic swimming may indicate illness or stress.

Large numbers of certain fish species naturally perish after spawning or when they are under stress from harsh or unexpected weather. There may be detectable levels of

hydrogen sulphide (perhaps from an artesian well or sulfur-spring water).

Prevention and control measures:
To prevent and mitigate water quality issues, monitor water quality regularly, reduce nutrient pollution by controlling runoff from agriculture and wastewater treatment, manage algal blooms using dyes or herbicides, provide supplemental oxygen to ponds and lakes, and promptly respond to fish kills to mitigate further losses.

Dr. Panjab Singh, Former Director General ICAR, Former Vice Chancellor BHU, Varanasi, Chancellor RLBCAU, Jhansi was awarded with **Lifetime Achievement Award 2024** by NESA, New Delhi for his contributions in Indian Agriculture. In this august gathering **Prof. Altaf Ahmad,** NESA Working President, Aligarh Muslim University, **Dr. Kavita Shah,** Vice Chancellor, Siddharth University, Uttar Pradesh, **Prof. Anil Kumar Singh**, Convener & HoD, Dept. of Dravyaguna, BHI, Varanasi and **Dr RS Tomar**, RLBCAU, Jhansi were present.

APPLICATIONS ARE INVITED FOR NESA ANNUAL AWARDS – 2025

This is to notify that applications are invited for the **NESA Annual Awards 2025** from the Life Members of the Academy. Separate applications should be submitted for independent awards. For detailed guidelines the website of NESA may be approached by log in to website:
https://nesa-india.org/nesa-annual-awards-2025/

The last date for all the categories of awards is 30th September, 2025.
The categories of Awards are given as under:

(1) NESA FELLOWSHIP AWARD-2025
(2) NESA EMINENT SCIENTIST AWARD-2025
(3) NESA DISTINGUISHED SCIENTIST AWARD-2025
(4) NESA SCIENTIST OF THE YEAR AWARD-2025
(5) NESA ENVIRONMENTALIST AWARD-2025
(6) NESA GREEN TECHNOLOGY INNOVATIVE AWARD-2025
(7) WOMEN EXCELLENCE AWARD-2025
(8) NESA YOUNG SCIENTIST AWARD-2025
(9) NESA JUNIOR SCIENTIST AWARD-2025

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