



ONLY NEWS PAPER PUBLISHED IN INDIA FOR SCIENTIFIC COMMUNITIES

NESA NEWSLETTER

NATIONAL ENVIRONMENTAL SCIENCE ACADEMY

Vol. 27 Issue-10 (MONTHLY)

October 2024

From the Editor's

Dear Readers,

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

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

Your suggestions are always welcome for improvement.

Dr. R. S. Tomar

Editor-in-Chief

Dr. Sushma Tiwari

Co-Editor

Editorial Board Members

Dr. S.K. Basu

PS, Lethbridge AB Canada

E-mail: saikat.basu@alumni.uleth.ca

Dr Syed Shabih Hassan

Scientist (Fisheries) & NSS Programme Officer, Department of Fisheries Resource Management, College of Fisheries, GADVASU, Ludhiana (Punjab)

E-mail: fish_ab@rediffmail.com

Dr. Ashok K. Dhakad

Scientist (Tree Breeding), Dept. of Forestry & Natural Resources Punjab Agricultural University, Ludhiana, Punjab

E-mail: ashokdbakad@pau.edu

Dr. Pavan Kumar

Assistant Professor, College of Horticulture and Forestry Rani Lakshmi Bai Central Agricultural University, Jhansi, India

E-mail: pawan2607@gmail.com

Dr. Deeksha Dave

Assistant Professor (Environmental Studies) School of Inter Disciplinary and Trans Disciplinary Studies IGNOU, New Delhi

E-mail: deekshadave@ignou.ac.in

Dr. Namita Das Saha

Senior Scientist, CTRI-RS Dinhat, Cooch Behar, West Bengal-736135

Dr. Sanjay Singh

Associate Professor and HoD Faculty of Agriculture Medicaps University Indore Madhya Pradesh

E-mail: sanjaydbtster@gmail.com

Mr. Mohd. Tasleem

Senior Research Fellow ICAR-NIPB, Pusa Campus, New Delhi

E-mail: mohdtasleem99@gmail.com

INTEGRATED CONSERVATION OF BEES AND MEDICINAL PLANTS

Saikat Kumar Basu

PFS, Lethbridge, Alberta, Canada

E-mail: saikat.basu@alumni.uleth.ca

Natural Biological Pollinators

Pollinators, such as bees, butterflies, birds, and bats, are crucial for both ecosystems and economies for several reasons:

Ecological Importance:

Plant Reproduction: Pollinators are essential for the reproduction of many plants. They transfer pollen from the male parts of flowers

to the female parts, enabling fertilization and the production of seeds and fruits.

Biodiversity: Many plants depend on pollinators for reproduction, contributing to plant diversity. This, in turn, supports a wide range of other organisms, maintaining ecological balance and resilience.

Food Web Support: Pollinators support the food web by enabling the growth of plants that serve as food for herbivores, which are then prey for carnivores. This sustains various levels of the ecosystem.

Habitat Creation: By helping plants reproduce, pollinators contribute to the creation and maintenance of habitats that provide shelter and food for numerous other species.

Economic Importance:

Agriculture: Pollinators are vital for the production of many crops. Around 85% of the world's food crops depend on pollinators to some extent. This includes fruits, vegetables, nuts, and seeds, which are essential for human nutrition.

Economic Value: The global economic value of pollination is estimated to be in the hundreds of billions of dollars annually. Crop yields and quality improve significantly with effective pollination, supporting farmers' incomes and economies.





Product Diversity: Many products, including coffee, chocolate, and almonds, rely on pollination. Without pollinators, the availability and variety of these products would decline, affecting markets and consumer choices.

Jobs and Livelihoods: The agricultural sector, which employs millions of people worldwide, depends on pollinators. Reduced pollination can lead to lower yields, affecting jobs and livelihoods in farming communities.

In summary, pollinators play a critical role in sustaining ecosystems and supporting agricultural productivity and economic stability. Their decline would have significant adverse effects on biodiversity, food security, and the economy.

Medicinal Plants

Medicinal plants are also crucial for both ecology and economy for several reasons:

Ecological Importance:

Biodiversity: They contribute to the diversity of plant species, which supports healthy ecosystems and provides habitats for various organisms.

Ecosystem Services: Many medicinal plants play roles in ecosystem functions such as soil fertility, water purification, and carbon sequestration.

Conservation: Protection of medicinal plants often involves preserving their habitats, which helps conserve biodiversity.

Economic Significance

Pharmaceutical Industry: Medicinal plants are a vital source of ingredients for medicines, contributing significantly to the pharmaceutical industry.

Traditional Medicine: They are essential in traditional and alternative medicine systems worldwide, supporting healthcare practices that are often more accessible and affordable.

Economic Growth: Cultivation, harvesting, processing, and trade of medicinal plants provide livelihoods for millions of people globally, particularly in rural areas.

Preserving and sustainably managing medicinal plant resources is essential for maintaining ecological balance

and supporting economic development and public health initiatives globally.

Decline of pollinators & medicinal plants

The decline of natural pollinators and medicinal plants globally is attributed to several interrelated factors:

Habitat Loss: Urbanization, deforestation, and agricultural expansion destroy and fragment habitats necessary for pollinators and medicinal plants.

Pesticides and Chemicals: The widespread use of pesticides, herbicides, and other chemicals in agriculture harms pollinators and reduces the availability of wild plants.

Climate Change: Changes in temperature and precipitation patterns disrupt the life cycles of pollinators and the growth of medicinal plants.

Invasive Species: Non-native plants and animals can outcompete or prey on native species, including pollinators and medicinal plants.

Pollution: Air, water, and soil pollution negatively impact both pollinators and plant health.

Disease and Parasites: Increased prevalence of diseases and parasites, partly due to weakened ecosystems, affects pollinator populations.

Monoculture Farming: Large-scale monoculture farming reduces biodiversity, limiting the variety of plants available for pollinators and decreasing the presence of medicinal plants.

These factors are often interconnected, amplifying their overall impact on natural pollinators and medicinal plants. Addressing these issues requires integrated conservation strategies and sustainable practices.

Urgent need for Integrated Conservation

Developing an integrated pollinator and medicinal plant conservation model is crucial for several reasons:

Ecosystem Health: Pollinators play a vital role in maintaining biodiversity and ecosystem stability. By conserving pollinators, we support the health of entire ecosystems.

Food Security: Many crops depend on pollinators for reproduction. Conserving pollinators ensures stable food production and supports agriculture.

Medicinal Resources: Medicinal plants often rely on pollinators for reproduction and are crucial for traditional and modern medicine. Conserving both pollinators and medicinal plants ensures sustainable access to medicinal resources.

Cultural Importance: Pollinators and medicinal plants are often deeply embedded in cultural practices and traditions worldwide. Conservation efforts preserve cultural heritage associated with these species.

Climate Resilience: Healthy ecosystems with diverse pollinator populations are more resilient to climate change impacts. Conserving these species helps mitigate environmental changes.

Economic Benefits: Pollinators contribute significantly to global economies through agriculture and ecotourism. Conservation efforts can enhance economic opportunities related to pollination services and medicinal plant markets.

Therefore, integrating conservation efforts for pollinators and medicinal plants is essential for the well-being of ecosystems, human health, and sustainable development.

How to develop a bee garden or pollinator garden ?

Creating a bee garden or a pollinator garden is a wonderful way to support local ecosystems and encourage biodiversity. Here are some steps to develop one:

Choose the Right Location: Select a spot that receives plenty of sunlight, as most flowering plants favored by bees thrive in sunny areas.

Select Plants Wisely: Opt for a variety of flowering plants that provide pollen and nectar throughout the seasons. Choose native plants whenever possible, as they are best suited to the local climate and soil conditions. Plants like lavender, coneflowers, bee balm, and sunflowers are excellent choices.

Plant in Clumps: Bees prefer to forage in patches of the same flower species, so plant your chosen flowers in clusters or clumps rather than scattered individually.

Provide Water: Bees need water, so include a shallow water source like a bird bath or a shallow dish filled with pebbles where they can land safely and drink.

Avoid Pesticides: Minimize or eliminate the use of pesticides and herbicides in your garden, as these chemicals can harm bees and other pollinators.

Include Shelter: Some bee species nest in the ground or in hollow stems. Leave some areas of bare soil or provide bee houses or bundles of hollow plant stems to provide shelter.

Maintain Year-Round Interest: Choose plants that bloom at different times of the year to provide food for bees throughout the seasons. Include a variety of colors and flower shapes to attract a diversity of pollinators.

Educate Yourself: Learn about the bees and other pollinators native to your area so you can better understand their needs and preferences.

By following these steps, you can create a beautiful and functional bee garden or pollinator garden that not only attracts bees but also supports a healthy and thriving ecosystem.

How to develop a medicinal plant garden ?

Developing a medicinal plant garden can be a rewarding project. Here are some steps to guide you:

Research and Plan: Identify medicinal plants that grow well in your climate and soil type. Research their growth requirements, such as sunlight, water, and soil pH.

Choose a Location: Select a suitable location with adequate sunlight for most of the day. Ensure the soil is well-draining and amend it if necessary.

Design the Layout: Plan the layout of your garden based on the space available and the types of plants you want to grow. Consider grouping plants with similar needs together.

Prepare the Soil: Prepare the soil by loosening it and adding organic matter like compost or aged manure to improve fertility and drainage.

Select Plants: Choose a variety of medicinal plants based on your needs and preferences. Consider factors like plant size, growth habits, and whether they are annuals, perennials, or biennials.

Planting: Follow planting instructions specific to each plant, considering spacing and depth requirements. Water thoroughly after planting.

Maintenance: Regularly water your plants, especially during dry periods. Mulch around plants to retain moisture and suppress weeds. Monitor for pests and diseases, and take appropriate action if needed.

Harvesting: Learn the proper techniques and timing for harvesting each medicinal plant to maximize their therapeutic benefits.

Storage and Usage: After harvesting, properly dry and store herbs to preserve their potency. Research how to use each herb for medicinal purposes safely and effectively.

Continuous Learning: Stay informed about each plant's medicinal properties and uses. Gardening and herbal medicine are continuous learning processes.

By following these steps, we can easily create beautiful and functional medicinal plant gardens that provides us with a sustainable source of natural remedies and jointly conserve both natural biological pollinators like bees and medicinal plants as they are both interdependent. This program is suitable for execution in schools and colleges ; even with small available land or space. Cost per garden establishment is minimal as we will provide plants, seeds and seedlings from our own nurseries. The most important support needed from the host Institute is land/space and maintenance following our directions. The program will include education and awareness lectures for maintaining such gardens and also sensitize them about our responsibility to protect and conserve our ecosystem.

Photo credits: Saikat Kumar Basu

AGRO-TECHNOLOGY IS THE TOOL FOR DEALING WITH CLIMATE CHANGE

Saikat Kumar Basu

PFS, Lethbridge, Alberta, Canada;
email: saikat.basu@alumni.uleth.ca

Agro-technology, or agricultural technology, refers to the application of advanced techniques, tools, and innovations in farming to increase the efficiency, productivity, and sustainability of agricultural practices. It encompasses a wide range of technologies, including machinery, biotechnology, information technology, and data-driven approaches that help farmers optimize their yields, reduce resource usage, and enhance the overall quality of agricultural products.

Keywords: aspects of agro-technology include:

Precision Agriculture: Using GPS, sensors, drones, and satellite imagery to monitor crop conditions, soil health, and weather patterns, allowing farmers to apply water, fertilizers, and pesticides more accurately and efficiently.

Biotechnology: Genetic modification and breeding techniques to produce crops that are more resistant to pests, diseases, droughts, and other environmental stressors.

Smart Farming Equipment: Autonomous tractors, irrigation systems, and harvesting machines that reduce labor and improve productivity.

Data Analytics and AI: Using big data and artificial intelligence to make informed decisions on planting times, crop selection, and market trends.

Vertical and Urban Farming: Growing crops in controlled environments within cities or indoor vertical farms to maximize space, reduce water usage, and grow food year-round.

Importance of Agro-Technology:

Increased Efficiency: By automating and optimizing farming practices, agro-technology helps farmers produce more food with fewer inputs like water, fertilizers, and labor.



Sustainability: Many agro-technologies promote eco-friendly practices by minimizing waste, reducing greenhouse gas emissions, and conserving natural resources.

Food Security: As the global population grows, agro-technology is crucial for ensuring that food production can keep pace with demand, especially in regions facing challenges like climate change and limited arable land.

Climate Resilience: Advanced techniques help farmers adapt to changing climate conditions, mitigating the impact of droughts, floods, and unpredictable weather.

Economic Benefits: By improving crop yields and reducing costs, agro-technology increases profitability for farmers, leading to stronger agricultural economies.

Agro-technology, food security, and food safety are interlinked areas that are crucial in addressing the challenges posed by climate variability. As climate change continues to affect agricultural production, these fields become essential to ensure a sustainable, safe, and adequate food supply. Here's why each of these aspects is important under climate variables:

1. Agro-technology

Agro-technology refers to the application of modern technology in agriculture to enhance productivity, sustainability, and efficiency. Under climate change, agro-technology plays a critical role in adapting farming systems to new environmental conditions.

Innovation for resilience: Technologies like precision agriculture, drought-resistant seeds, and improved

irrigation systems help farmers adapt to erratic rainfall patterns, heatwaves, and other climate-induced stresses.

Sustainable practices: Agro-tech promotes sustainable farming by reducing the use of resources like water and energy, minimizing greenhouse gas emissions, and supporting soil health. For example, technologies like sensor-based irrigation systems optimize water use.

Climate-smart agriculture: By integrating advanced technologies, farmers can adopt climate-smart agriculture practices, such as better forecasting, automated monitoring, and data-driven decisions, to boost yields and reduce the risk of crop failure.

2. Food Security

Food security, defined as having consistent access to sufficient, safe, and nutritious food, is heavily threatened by climate change. Changes in temperature, precipitation patterns, and the frequency of extreme weather events can disrupt agricultural production, leading to food shortages and price spikes.

Adaptation strategies: Agro-technologies provide critical adaptation strategies for maintaining food production despite changing climate conditions. This includes crop diversification, early-warning systems for climate events, and improved supply chains.

Increased productivity: To ensure food security for a growing global population, productivity needs to be maintained or even increased under challenging climate conditions. Agro-tech innovations like vertical farming, genetically modified crops, and mechanization are key to achieving this.

Resilience to disruptions: Climate-induced shocks (e.g., floods, droughts) can destabilize food systems. By incorporating resilient technologies and practices, farmers and food producers can withstand these shocks, ensuring a stable food supply.

3. Food Safety

Climate change also influences food safety by altering the environmental conditions that affect foodborne pathogens, pesticide residues, and other contaminants. It can lead to increased risks of contamination during food production, processing, and distribution.

Impact on pathogens and toxins: Warmer temperatures and humidity favor the growth of harmful pathogens like bacteria and fungi, which can contaminate crops, livestock, and stored food. Agro-technology can help monitor and mitigate these risks through enhanced detection systems and improved storage technologies.

Chemical safety: The changing climate may increase the use of pesticides, herbicides, and fertilizers, which could

lead to higher chemical residues in food. Technologies that enable more precise application of these inputs can reduce contamination risks.

Supply chain traceability: Climate variability can disrupt food supply chains, making it harder to maintain food safety standards. Advanced tracking technologies (e.g., blockchain, RFID) ensure the traceability of food products, reducing the risk of contamination across the supply chain.

Conclusion

Agro-technology is critical for safeguarding food security and safety in the face of climate change. Through innovation, adaptation, and sustainable practices, modern agriculture can mitigate the risks associated with climate variability, ensuring the availability, accessibility, and safety of food for future generations. Agro-technology plays a vital role in modern agriculture by improving productivity, sustainability, and resilience, making it essential for addressing global food security challenges and environmental concerns.

CULTIVATING HEALTH: UNVEILING THE POWER OF PREBIOTICS

Priya Sutaoney¹, Dhananjay Pandey^{2*},
Priyambada Singh³ and Renu Tripathi⁴

¹School of Studies in Life Sciences,

Pt. Ravishankar Shukla University,

Raipur-492010, Chhattisgarh

²Department of Botany, Govt. Naveen Girls College,

Surajpur-497229, Chhattisgarh

³Department of Microbiology, Kalinga University,

Raipur-492101, Chhattisgarh

⁴Department of Home Science, Govt. Kamladevi Rathi

Mahila P.G. Mahavidyalaya, Rajnandgaon-491441,

Chhattisgarh

*Corresponding author email:

pandey.dhananjay333@gmail.com

Introduction:

Prebiotics are indigestible materials, usually dietary fiber or specific kinds of carbohydrates, that nourishes intestinal good bacteria. In order to maintain a properly functioning gut microbiome, these drugs encourage the growth and activity of helpful microorganisms, such as different strains of probiotic bacteria^[1]. Prebiotics are not digested or absorbed by the human body but instead reach the colon, where they provide a substrate for the growth and metabolic activity of intestinal microflora. Consequently, this may benefit gut health and general wellbeing. Common examples of prebiotics include inulin, fructooligosaccharides (FOS), and various types of soluble fiber found in foods like leeks, garlic and onions, as well as few cereals and grains^[2]. Propionic acid, lactic acid and butyric acid, are among the short-chain fatty acids (SCFAs)

that are produced when the gut microbiota ferments prebiotics. The body may react to these products in different ways. For instance, SCFAs lower the pH of the colon and propionate influences the function of T helper cells in the airways, macrophages, and bone marrow dendritic cells. Microorganisms' breakdown products of prebiotics mediate their impact on human health. Butyrate, for instance, affects the formation of intestinal epithelium. Prebiotics can influence remote site organs in addition to the gastrointestinal tract because SCFAs can permeate to the bloodstream through enterocytes^[3]. This article elaborates different sources of prebiotics, production and their potential applications.

Sources of Prebiotics:

Prebiotics are naturally occurring in a variety of foods, and they can also be found in some commercial products. Some common sources of prebiotics, are chicory root, onions, asparagus, bananas, dandelion greens, oats, barley, legumes, wheat bran, microalgae, mushrooms, and seaweeds^[3]. Chicory root is one of the richest sources of inulin, a well-known prebiotic and is frequently used to extract inulin, which is then used in a variety of food products. One kind of soluble fiber that is frequently added to foods and supplements to support gut health is inulin. Fructooligosaccharides (FOS), a kind of prebiotic, are found in garlic^[4]. Garlic's distinctive smell is caused by FOS, which also offers a number of health benefits. Red onions in particular are a rich source of FOS, which benefits the gut as a prebiotic. Additionally, asparagus naturally possess FOS, therefore being a vegetable high in prebiotics^[5]. The resistant starch found in underripe bananas serves as a prebiotic. This starch is transformed

into simple sugars as bananas ripen. A great source of inulin, Jerusalem artichokes can be added to soups, salads, or served as a side dish. Another vegetable that contains inulin is dandelion greens, which can be cooked or added to salads. Beta-glucan, a soluble fiber found in oats, has prebiotic qualities. Beta-glucan may promote the growth of beneficial gut microbiota. Beta-glucans are also found in barley, which can be utilised in a variety of recipes, including stews and soups^[6]. Another class of prebiotics are galacto-oligosaccharides (GOS), which are made up of small chains of galactose subunits. Foods include legumes, some whole grains, and dairy products contain them. GOS is also included in infant formulas to mimic the prebiotic content of breast milk. Prebiotic fiber can also be found in wheat bran, which is commonly added to cereals or baked goods to increase dietary fiber content. Prebiotic fibers and resistant starch can be found in legumes such as chickpeas and lentils. Some microalgae, such as Chlorella and Spirulina, are accessible as supplements and include prebiotic components. Seaweed kinds like nori and wakame contain prebiotic fibers, while certain mushroom varieties, such as shiitake and maitake, include beta-glucans that may have prebiotic benefits^[7]. There are prebiotic supplements on the market that offer a practical means of increasing prebiotic intake; these supplements are frequently in the type of powdered substances, capsule-like structures, or syrups. Including a variety of these prebiotic-rich foods in your diet can help maintain a healthy gut microbiota and overall digestive health. Since the efficiency of prebiotics varies based on the source, eating a range of foods that contain prebiotics is a great way to get the most advantages^[2].

Production of Prebiotics:

Prebiotics are frequently extracted or synthesised from natural sources and can be made in a variety of ways. Here are several typical processes for making prebiotics, including using plant-based substances like garlic (a natural source of FOS) and chicory root (a producer of inulin)^[1]. Several techniques, including ethanol extraction, enzymatic hydrolysis, and hot water extraction, can be used to extract these prebiotics from these sources. Chemical techniques are used to create prebiotics like lactulose. For instance, lactose, a sugar present in milk, is isomerised under controlled conditions to form lactulose^[6]. For example, lactose can be fermented using certain enzymes and microbes to produce galacto-oligosaccharides (GOS). The manufacture of prebiotics also involves enzymatic techniques; for example, they are employed to alter the starch or various polysaccharides in order to create resistant starch or another prebiotic substance. The starch is broken down into smaller, fewer digestible fragments that can function as prebiotics with the application of biocatalysts. Prebiotic substances are

also made by chemically modifying natural sugars or carbs. For instance, modified citrus pectin (MCP), which possesses prebiotic qualities, can be created by chemically altering pectin^[5]. The particular prebiotic being produced and its intended usage determine which production process is best. It is noteworthy that the commercial manufacturing of prebiotics frequently entails stringent quality control measures to guarantee their safety and purity, particularly when they are utilised as components in food and nutritional supplements. In order to guarantee that the end results are harmless for consumers and have the intended prebiotic qualities for enhancing gut health, prebiotic manufacture must also comply with safety and regulatory requirements^[7].

Applications of Prebiotics:

The capacity of prebiotics to promote the development and activity of advantageous gut bacteria is the main factor contributing to their many uses and advantages. They aid to keep the gut microbiota in an ideal state by feeding the colon's helpful bacteria^[3]. This helps lessen gastrointestinal discomfort, enhance digestion, and avoid diseases like irritable bowel disorder^[2]. Prebiotics can improve the ability to survive and function of these helpful gut microbes when taken with probiotics. Synbiotics are a type of probiotic and prebiotic combination that may be used to enhance gut health. A robust immune system is intimately associated with a healthy gut flora^[4]. By keeping the gut microbiota in balance, prebiotics can strengthen the immune system and lower the probability of infections and several inflammatory diseases. According to some research, prebiotics might help with weight management. By altering gut hormones, they can affect hunger and satiety and potentially lower the risk of obesity^[5]. By increasing insulin sensitivity, decreasing inflammatory processes, and reducing the possibility of metabolic diseases including type 2 diabetes, prebiotics may benefit metabolic health. Inulin and other prebiotics may improve the gut's ability to absorb certain minerals, such as calcium and magnesium^[6]. This may improve bone health and lower the chance of developing osteoporosis. The relationship among intestinal health and mental health is being investigated by new study. Prebiotics may affect mood, mental health, and cognitive performance via influencing the gut-brain axis. By affecting the growth of good bacteria and preventing the growth of dangerous microorganisms, prebiotics aid in sustaining an ideal gut environment and potentially reduce the risk of colorectal cancer^[7]. Prebiotics are being researched as a possible treatment for a number of gastrointestinal disorders, including IBS and inflammatory bowel disease (IBD). They might aid in symptom relief and enhance the general well-being of those who suffer from these ailments. Prebiotics may help maintain healthy skin by regulating the gut

microbiota and lowering skin inflammation, according to research on the gut-skin relationship ^[3]. Some infant formulae contain prebiotics, especially oligosaccharides from human milk (HMOs), to replicate the prebiotic amount found in breast milk and encourage the development of healthy gut bacteria in babies. Prebiotics are utilised in diets to improve the digestive health of pets

and animals, which benefits their growth and general well-being. It's crucial to remember that prebiotic efficacy might change based on a number of variables, including the kind of prebiotic taken, individual variances, and general dietary practices. These numerous health advantages can be attributed to a balanced diet that includes foods and supplements high in prebiotics ^[4] (Fig 1).



(a) Wheat Grass



(b) Onion



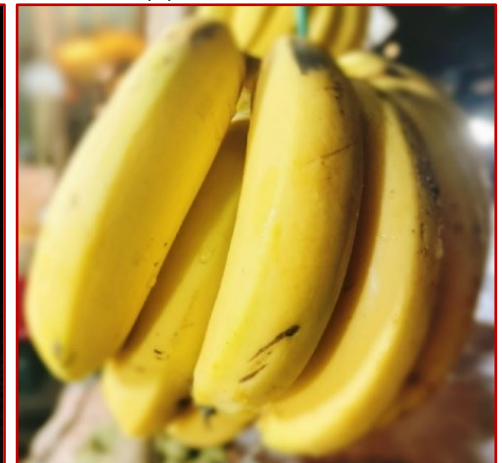
(c) Mushroom



(d) Lentils



(e) Garlic



(f) Banana

Fig. 1: The Prebiotics Symphony in Fruits and Vegetables

Conclusions:

Prebiotics have a significant impact on human health, making them appealing and desirable agents to enhance human well-being against conditions including cancer, vascular disease, being overweight, and mental illnesses. Numerous research studies have demonstrated the benefits of prebiotics on human well-being; however, to validate the health claims, carefully planned, long-term testing and genetic investigations are required. Research on prebiotics has also shown how important they are for preserving gut health. Prebiotics are probably going to become more and more significant in clinical and preventative approaches to nutrition and health as our knowledge of the gut flora advances. However, this field is continuously advancing, it's important to stay updated on the latest findings and recommendations. Understanding the basic workings of

prebiotics would enable researchers to create improved dietary supplements that would improve human health. In the management and recovery of some of the most common illnesses, the capacity of prebiotic dietary ingredients to restore the gut microbiota's composition is an enticing process. If scientists had a greater grasp of how prebiotics work, they could create better food additives that would improve human health. In the treatment and resolution of many of the most common illnesses, the capacity of prebiotic food elements to restore the gut microbiota's composition is an intriguing process.

REFERENCES:

1. **Cummings JH, Macfarlane GT.** Gastrointestinal effects of prebiotics. *Braz J Nutr.* 2002; 87:145-151.
2. **Bindels LB, Delzenne NM, Cani, PD, Walter J.** Towards

- a more comprehensive concept for prebiotics. *Nat Rev Gastroenterol Hepatol*. 2015; 12:303-310.
3. Singla V, Chakkaravarthi S. Applications of prebiotics in the food industry: A review. *Food Sci Technol Int*. 2017; 23:649-667.
 4. Davani-Davari D, Negahdaripour M, Karimzadeh I, Seifan M, Mohkam M, Masoumi SJ, Berenjian A, Ghasemi, Y. Prebiotics: definition, types, sources, mechanisms, and clinical applications. *Foods*. 2019; 8:1-27.
 5. Cardoso BB, Amorim C, Silverio SC, Rodrigues LR. Novel and emerging prebiotics: Advances and opportunities. *Adv Food Nutr Res*. 2021; 95:41-95.
 6. Fei Y, Chen Z, Han S, Zhang S, Zhang T, Lu Y, Berglund B, Xiao H, Yao, M. Role of prebiotics in enhancing the function of next-generation probiotics in gut microbiota. *Crit Rev Food Sci Nutr*. 2023; 63:1037-1054.
 7. Ballini A, Charitos IA, Cantore S, Topi S, Bottalico L, Santacroce L. About Functional Foods: The Probiotics and Prebiotics State of Art. *Antibiotics*. 2023; 2:1-22.

CLIMATE CHANGE IMPACT AND PLANTS' ADAPTATIONS

Monika Kundu, Ananta Vashist, Achhelal Yadav and P Krishnan

^{1,2,3}Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi
E-mail: *mkkundu07@gmail.com

Climate change, driven by rising greenhouse gas emissions, is one of the most pressing global challenges today. It is altering ecosystems and the dynamics of plant life. Plants are essential to life on Earth, acting as the foundation of terrestrial ecosystems and playing critical roles in carbon sequestration, oxygen production, and food security. However, the impacts of climate change, including temperature increases, changes in precipitation patterns, extreme weather events, and shifts in atmospheric CO₂ levels, are posing significant challenges to plant survival and adaptation.

Impacts of Climate Change on Plants

1. Temperature Stress

Rising global temperatures are directly impacting plant physiology and growth. High temperatures can inhibit photosynthesis, reduce water-use efficiency, and alter reproductive cycles. For example, in regions experiencing prolonged heatwaves, crops such as wheat and rice are seeing reduced yields due to heat stress during flowering



Fig 1: Visual representation of the effects of temperature stress on plants.

1. Changing Precipitation Patterns

Alterations in rainfall patterns, including droughts and floods, are affecting water availability. Drought reduces soil moisture, impairing plant growth and productivity. Conversely, excessive rainfall can lead to waterlogging, which suffocates roots and limits nutrient uptake.

2. Increased CO₂ Levels

While higher atmospheric CO₂ concentrations can enhance photosynthesis (a phenomenon known as CO₂ fertilization), this benefit is often offset by other climate stressors. Furthermore, increased CO₂ can favor the growth of invasive species and weeds over native plants, disrupting ecosystems.

3. Extreme Weather Events

Events such as hurricanes, wildfires, and frost are becoming more frequent and intense due to climate change. These events can destroy entire plant populations and alter ecosystems permanently. For example, wildfires in forests can cause loss of biodiversity and hinder regeneration for decades.

Plants' Adaptations to Climate Change

Despite these challenges, plants exhibit remarkable adaptability. They have evolved mechanisms to survive under changing environmental conditions. Some of these adaptations occur naturally, while others are supported by human intervention.

1. Physiological Adaptations

- **Altered Water Use:** Some plants develop deeper root systems to access groundwater during droughts. Others, like cacti, reduce water loss through structural features like thickened cuticles or reduced leaf surfaces.
- **Photosynthetic Pathways:** Plants like maize and sugarcane use C₄ photosynthesis, which is more efficient in high-temperature, low-water environments compared to the C₃ pathway used by most plants.

2. Phenological Changes

Plants are adjusting their life cycles in response to

Table 1: Climate change effects on plant health and crop productivity

| Climate Change Factor | Effects on Plant Health | Impact on Crop Productivity |
|----------------------------------|--|--|
| Temperature Stress | <ul style="list-style-type: none"> - Heat stress damages leaves and reduces photosynthesis. - Cold stress inhibits germination and growth. | <ul style="list-style-type: none"> - Lower crop yields due to impaired flowering and seed formation. - Increased crop failures in frost-prone regions. |
| Drought | <ul style="list-style-type: none"> - Reduced water availability leads to wilting. - Root systems shrink, limiting nutrient uptake. | <ul style="list-style-type: none"> - Decline in crop yields and quality. - Reduced area of cultivation in arid regions. |
| Excessive Rainfall/ Waterlogging | <ul style="list-style-type: none"> - Root suffocation and fungal infections. - Increased susceptibility to diseases. | <ul style="list-style-type: none"> - Stunted growth and reduced productivity. - Loss of harvestable crops in flooded areas. |
| Increased CO ₂ Levels | <ul style="list-style-type: none"> - Altered plant metabolism and photosynthesis rates. | <ul style="list-style-type: none"> - Boosted growth in some crops (e.g., C3 plants) but reduced quality (lower protein content). |
| Extreme Weather Events | <ul style="list-style-type: none"> - Damage to plants from hurricanes, storms, and wildfires. | <ul style="list-style-type: none"> - Destruction of crops and infrastructure, reducing food supply. |
| Soil Degradation | <ul style="list-style-type: none"> - Loss of soil fertility due to erosion and salinity. | <ul style="list-style-type: none"> - Reduced crop yields and long-term productivity. |
| Pest and Disease Proliferation | <ul style="list-style-type: none"> - Increased pest populations due to warmer temperatures. | <ul style="list-style-type: none"> - Higher crop losses and increased dependency on pesticides |

climate change. For example, many species are flowering or fruiting earlier in the season to align with shifting climatic conditions. This phenological shift helps them maintain reproductive success, although it may disrupt interactions with pollinators and other organisms.

3. Migration and Range Shifts

As temperatures rise, some plants are migrating to cooler regions, such as higher altitudes or latitudes. This migration is facilitated by seed dispersal mechanisms and human activities like reforestation in new areas. However, not all plants can migrate quickly enough to keep pace with rapid climate change.

4. Genetic Adaptation

Over generations, plants can undergo genetic changes that enhance their resilience. For example, some populations of Arctic plants are developing traits to withstand shorter, warmer growing seasons. Additionally, human-led efforts in genetic engineering and selective breeding are creating

crop varieties that are drought-resistant, salt-tolerant, or heat-resilient.

5. Symbiotic Relationships

Plants are increasingly relying on symbiotic relationships to adapt. For instance, certain fungi enhance a plant's ability to absorb water and nutrients, while bacteria can fix atmospheric nitrogen to enrich soil fertility.

Conclusion

The interplay between climate change and plants highlights the importance of understanding and mitigating environmental impacts. While plants display impressive resilience through natural and engineered adaptations, the pace of climate change poses a significant threat to their survival and the ecosystems they support. Addressing these challenges requires a combination of conservation efforts, sustainable agricultural practices, and policies to limit global warming. By fostering adaptation and resilience, humanity can help ensure the survival of plant life in a rapidly changing world.

THE COST OF THE DREADED IVORY TRADE

S. K. Basu

PFS, Lethbridge, Alberta, Canada

email: saikat.basu@alumni.uleth.ca

Introduction

Elephants are considered a keystone species because they play a crucial role in maintaining the balance of ecosystems. Elephants eat a variety of fruits and plants, and their digestion helps disperse seeds over large distances. This supports plant biodiversity and forest regeneration. They successfully modify their environment by knocking down trees, digging waterholes, and creating paths through dense vegetation. These actions create habitats for other species, such as birds, insects, and smaller mammals. During dry seasons, elephants dig into the ground to access water, creating waterholes that benefit other animals and plants in arid areas.

Elephant dung enriches the soil with nutrients, promoting the growth of plants. Their waste also supports insect populations, such as dung beetles. By trampling and grazing, elephants prevent grasslands from becoming overgrown with woody plants, ensuring that open savannas thrive and support grazing species like antelopes and zebras. Elephants are a symbol of biodiversity conservation and attract ecotourism, which provides economic benefits to local communities and supports conservation efforts. By maintaining the balance of ecosystems, elephants indirectly support humans, ensuring clean air, water, and food resources for people and wildlife alike. Protecting elephants, therefore, has a ripple effect on the overall health of our planet.

Link between global elephant poaching and ivory trade

Elephants are central to the ivory trade because their tusks are made of ivory, a highly valued material used to make ornaments, jewelry, and other decorative objects. Elephants are the primary source of ivory, harvested from their tusks. This demand has led to widespread poaching of elephants, especially in Africa. Despite international bans on ivory trade (e.g., CITES), illegal poaching persists due to high market demand, primarily in Asia. In some cultures, ivory is seen as a status symbol or has religious significance, driving the trade. Additionally, poverty in some regions pushes individuals into poaching for financial gain.

Consequences of the Ivory Trade

Decline in Elephant Populations

The African elephant population has dramatically declined due to poaching. Some regions have seen local extinction of elephants. Elephants are keystone species, meaning their loss disrupts ecosystems. They help maintain biodiversity by spreading seeds and shaping landscapes. Tourism-dependent economies suffer when elephant populations dwindle. Wildlife tourism often provides significant revenue to countries. The ivory trade fuels corruption, organized crime, and sometimes even armed conflicts, as criminal networks profit from illegal ivory trafficking. Efforts to stop poaching and trade require significant

resources, collaboration between nations, and stricter enforcement of bans. Killing elephants for their tusks raises moral and ethical issues about human responsibility toward other species. Addressing the ivory trade involves enforcing bans, reducing demand, providing alternative livelihoods for communities, and supporting conservation initiatives.

Decimation of global elephant populations

The global elephant population has significantly declined over the past century, primarily due to the ivory trade. Elephants have been hunted for their tusks, which are highly valued in the production of ornaments, jewelry, and other decorative items. Here's an overview of the impact of the ivory trade on elephant populations:

- 1. Historical Decline:** In the early 20th century, there were an estimated 10 million elephants in Africa alone. The rise in the ivory trade caused drastic declines. Between 1979 and 1989, Africa's elephant population halved, dropping from approximately 1.3 million to 600,000. Today, estimates suggest fewer than 415,000 African elephants remain in the wild, and the Asian elephant population is critically endangered, with fewer than 50,000 individuals.
- 2. Impact of the Ivory Trade:** The demand for ivory surged in the mid-20th century, particularly in Asia, where ivory is used for traditional carvings and ornaments. Despite international bans, illegal poaching remains rampant. It's estimated that tens of thousands of elephants are killed annually for their tusks. Forest elephants in Central Africa have seen population declines of over 60% in just the past decade due to poaching. Savanna elephants, typically in Southern and East Africa, have also suffered population losses.
- 3. Conservation Efforts and Challenges:** In 1989, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) banned the international trade in ivory. However, demand persists, fueling illegal markets. In addition to poaching, habitat loss due to human expansion and climate change exacerbates the problem. Governments, NGOs, and local communities have implemented patrols, tracking systems, and awareness campaigns to combat poaching, but enforcement remains uneven.
- 4. Future Outlook:** Without strict enforcement of anti-poaching laws, continued education about ivory alternatives, and sustainable conservation efforts, the survival of elephants remains at risk. While some countries have reported stable or slightly increasing populations, the overall global trend points to a decline.

Current global status of illegal ivory trade

The illegal ivory trade remains a critical issue globally, fueled by demand for ivory in markets across Asia, despite international efforts to curb it. The Convention on International Trade in Endangered Species (CITES) bans international trade in elephant ivory, yet enforcement challenges persist due to weak regulations, corruption, and demand loopholes. Several advancements and strategies are being implemented to combat this trade:



Recent developments, such as the use of Raman spectroscopy, enable rapid, non-invasive identification of illegal ivory. This technology can differentiate between elephant ivory (illegal) and mammoth ivory (legal), a distinction often exploited by traffickers. The EU and other regions have introduced stricter rules to close domestic ivory markets. While some progress has been made, legal ivory markets in countries like Japan and parts of Asia provide cover for laundering illegal ivory.

The illegal ivory trade contributes to an annual loss of around 8% of the world's elephant population, endangering species survival. Poaching continues to thrive in regions with weak governance and high poverty levels. Although global attention and enforcement efforts have increased, challenges like high demand, legal loopholes, and insufficient funding for enforcement highlight the need for a more unified international approach.

Future of the elephants from the context of ivory trade

The future of elephants in the context of the ivory trade is complex, tied closely to global conservation efforts, government policies, and public awareness. The demand for ivory has led to widespread poaching, particularly in Africa. Estimates suggest that tens of thousands of elephants are killed annually for their tusks, severely threatening the animals. African elephants (both savanna and forest species) have seen significant population declines. Forest elephants, in particular, have suffered an 86% decline in some regions over 30 years due to poaching. In some regions, such as parts of Asia, ivory remains a status symbol or is used in traditional crafts, fueling demand.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) banned international ivory trade in 1989. While this helped reduce trade, enforcement gaps and legal loopholes remain.

Countries like China, the U.S., and the U.K. have implemented domestic ivory bans, reducing demand. However, some countries, such as Japan, still allow domestic trade. Many nations have increased anti-poaching efforts, using technology like drones and GPS tracking, as well as better-equipped ranger teams.

Challenges of elephant conservation

In some regions, corruption and limited resources hinder anti-poaching and trafficking enforcement. In communities near elephant habitats, poverty can push people toward poaching as a source of income. Beyond poaching, elephants face threats from habitat loss due to agriculture, mining, and infrastructure development. If current trends in ivory bans and conservation continue, elephant populations could stabilize and even recover in some regions.

Continued investment in education, tourism, and community development programs could provide sustainable alternatives to poaching. Without stronger international cooperation, enforcement, and habitat protection, elephants could face localized extinctions, especially in areas heavily affected by poaching and habitat loss. Increasing awareness and advocacy have proven effective in reducing demand for ivory. Campaigns showing the ecological importance of elephants and their suffering due to the trade have shifted public attitudes, particularly in consumer countries.

Conclusion

The future of elephants depends heavily on the success of coordinated global efforts to combat the ivory trade, protect habitats, and involve local communities in conservation. While progress has been made, sustained action and vigilance are essential to ensure these iconic animals survive and thrive.

PHOTO CREDIT: SAIKAT KUMAR BASU