SIGNIFICANCE OF BOTANY IN SUSTAINABLE DEVELOPMENT- A HOLIOSTIC APPROACH FOR ACHIEVING SUSTAINABLE DEVELOPMENT GOALS FOR MODERN INDIA.

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ABSTRACT

Botany is the study of plants and plays an important role in achieving United Nations Sustainable Development Goals(SDGs). Brundtland Commission in 1987 described sustainable development as "development that meet the needs of the present without compromising the ability of the future generation to meet their own needs". Developments in the field of agriculture, industry, urbanization, automobiles, textile etc. has resulted in deterioration in the quality of environment and ultimately the whole ecosystem at regional and global level. Human population has invaded the habitats of wild life forcing the millions of species either to become endangered or extinct from the planet earth.

Global rise in earth's average temperature, depletion of ozone layer, Eco-degradation, excessive emission of carbon and other pollutants are imposing immediate threat to life and making the ecosystems unfit for future generations.

Global Action Plan on Education for sustainable development is framed by UNESCO for 2030. 17 interlinked goals are framed. Botany addresses the problems of food security, environmental degradation, poverty and biodiversity loss and thus help in achieving the sustainable Development Goals(SDGs).Participation of students, teachers and common men at all level is required to achieve the framed goals. Education is a tool to improve the Sustainable Development Goals Index. In this paper we will discuss the role and importance of Botany and its allied branches to achieve the sustainability goals.

Keywords: Sustainable Development, Sustainable Development Goal, Sustainable Development Goals Index.

INTRODUCTION

Sustainable Development

Sustainable development is a developmental process aimed at keeping the future generations ecologically sound. It is in fact a learning process of holistic approach towards humanity justifying the Homo sapiens at highest level of biological hierarchy. Our long term survival will depends upon the decision we take not only for self but for the whole ecosystem. Sustainable development is a behavioral concept involving change in thought process of common man, economists, socialists, environmentalists, politicians, teachers and students. These are the pillars

of sustainable development and the development without the coordination between these pillars can never be sustainable. A development is called sustainable if it fulfills the achievement the sustainable development goals. *Sustainability* is often thought of as a long-term goal while sustainable development refers to the many processes and pathways to achieve sustainable development.

Sustainable Development Goals (SDGs)

The whole world is facing crises of food, energy, health, Eco-degradation due to faulty industrial, agriculture, urbanization practices and ongoing wars nuclear tests. There is a threat of human and other species survival which needs to be addressed on priority. Rise on global average temperature, melting of glaciers, floods, thinning of ozone layer, excessive carbon emissions etc has resulted in desertification, shifting of crops and changes in crop patterns. All these changes are directly or indirectly causing food crises globally. Further the COVID 19 pandemic has resulted in economic crises all over the world. At the UN Assembly Summit 2015, the 2030 Agenda for sustainable development was adopted. The 2030 agenda for sustainable development, adopted by all United Nations Member States in 2015, which provides a blueprint for peace and prosperity for people and the planet, now and into the future. The 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing are 1.No poverty 2. Zero hunger, 3. Good health and well-being 4. Quality education, 5. Gender equality, 6. Clean water and sanitation , 7. Affordable and clean energy , 8. Decent work and economic growth , 9. Industry, innovation and infrastructure, 10. Reduced inequalities 11. Sustainable cities and communities 12. Responsible consumption and production, 13. Climate Change , 14. Life below water , 15. Life on land , 16. Peace, justice, and strong institutions and 17. Partnerships for the goals.

Need of Sustainable Development Goals

1. To end hunger and poverty.
2. To ensure equal opportunities for access to health, quality education and energy.
3. To ensure healthy living for all people.
4. To eradicate gender based discrimination and empower the women.
5. To save the planet from degradation , climate change and war impacts.
6. To ensure sustainable use of resources, ecosystem services and to restore the loss caused to habitat and biodiversity.
7. To make the countries responsive and accountable for achieving sustainable development goals.

Role of Botany in Achieving Sustainable Development Goals

For achieving sustainable development goals, Botany and linking of botany to other sectors can play a significant tool. Majority of sustainability development goals out of 17goals framed by UNESCO can be achieved through various branches of Botany. Out of the 17 SDGs, following are addressed by botanical science:

1. SDG 2 (Zero Hunger)

Poverty and Education-Poverty is a condition when the individuals/families lack sufficient money and resources to fulfill the basics needs with dignity.

Zero Hunger, Good Health and Education- Hunger is a condition where the individuals are not able to get sufficient quality food on regular basis. It results in under nutrition and malnutrition. About 790 million people all over the world are not able to get food on regular basis. Food insecurity is another issue. Natural disasters, epidemic of diseases and wars has created a situation of food insecurity. Education at all levels helps the individuals to understand the reasons and consequences of hunger. Better agricultural practices, food processing, food fortification, food storage etc are due special knowledge and training imparted through education.

Botany plays a crucial role in achieving the goal of Zero Hunger by addressing various aspects of food security, sustainable agriculture, and ecosystem health. Here are some key contributions:

Plant breeding and genetic research enhance crop resilience, , nutritional content and yield, helping to meet the food demands of a growing population. **Sustainable Practices** like Promoting agro ecology and organic farming practices helps maintain soil health and reduces reliance on chemical fertilizers. Understanding plant biology allows for the development of sustainable agricultural practices that minimize environmental impact, such as crop rotation, agro forestry, and organic farming.

Diversity and Resilience: Botanical research promotes the conservation of plant diversity, which is vital for resilient food systems. Diverse crops can withstand climate variability and pest pressures better than monocultures.

Nutritional Improvement: Botanists can develop bio fortified crops with higher levels of essential nutrients, addressing malnutrition and enhancing food quality.

Resistant varieties: By studying plant responses to climate change, botanists can identify and develop varieties that thrive in changing conditions, ensuring stable food production.

Ecological Resource Management can contributes to efficient water and soil management techniques that support agriculture, particularly in arid regions where water scarcity is a concern. Botanical principles can solve the problem of resourse management.

Food Systems Innovation: Research into edible plants, including underutilized species, can diversify diets and increase food availability, making communities less dependent on staple crops.

In summary, botany not only aids in enhancing food production but also ensures that food systems are sustainable and resilient, which is essential for achieving Zero Hunger.

2. SDG 3 (Good Health and Well Being)

Sustainable Development Goal 3 (SDG 3) aims to ensure healthy lives and promote well-being for all at all ages. The key targets and aspects related to SDG 3 are Universal Health Coverage: Ensure access to quality essential health services and access to safe, effective, quality, and affordable essential medicines and vaccines. Maternal and Child Health: Reduce the global maternal mortality ratio and end preventable deaths of newborns and children under five. Communicable Diseases: End the epidemics of major communicable diseases, such as HIV/AIDS, tuberculosis, malaria, and neglected tropical diseases, and combat hepatitis and other communicable diseases. Mental Health and Well-Being: Promote mental health and well-being, addressing issues such as substance abuse and mental disorders. Health Promotion: Promote healthy lifestyles and prevent diseases through awareness and education about nutrition, physical activity, and other health-related behaviors. Global Health Security: Strengthen the capacity for early warning, risk reduction, and management of national and global health risks. Access to Essential Health Services: Increase health financing and recruitment, development, training, and retention of the health workforce. Universal Access to Reproductive Health: Ensure universal access to sexual and reproductive health care services. Achieving SDG 3 is vital for fostering a healthier, more equitable world and addressing health disparities across different populations.

Botany can efficiently deal with the challenge of achieving this goal. Some of the ways are as follows:

Medicinal Plants: Many pharmaceuticals are derived from plant compounds. Understanding plant biology helps in discovering new medicines and improving existing ones. Now we can extract active principles from variety of medicinal plants.

Nutrition: Getting better quality food is as necessary as getting food to fill the belly. Botany helps us to understand the nutritional value of different plants, supporting diets rich in fruits, vegetables, and whole grains that are essential for good health. Various crops rich in specific nutrients are developed through genetic engineering and biotechnology.

Mental Health: Exposure to green spaces and plants has been shown to reduce stress, anxiety, and depression. Gardening and interacting with nature can improve mental well-being. Horticultural Therapy approach uses gardening as a therapeutic tool to improve physical and mental health, especially for individuals with disabilities or mental health challenges.

Air Quality: Plants improve air quality by absorbing carbon dioxide and releasing oxygen. They also filter pollutants, contributing to healthier indoor and outdoor environments. Also the knowledge of Pollen Pollution help in preventing pollen allergies.

Biodiversity and Ecosystem Health: A diverse plant life supports healthy ecosystems, which are crucial for providing resources like clean water and food, essential for overall health. Rich biodiversity is also a source of genes needed in crop improvement.

3. SDG 6 (Clean Water and Sanitation)

Sustainable Development Goal 6 target to achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations, to improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally, to increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity, to implement integrated water resources management at all levels, including through transboundary cooperation as appropriate, to protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes, to expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies, to support and strengthen the participation of local communities in improving water and sanitation management

Botany plays a vital role in achieving Sustainable Development Goal 6 (SDG 6),). It aims at ensuring the availability and sustainable management of water and sanitation for all. Some of the contributions of botany in achieving SDG no. 6 are as below:

1. Water Restoration and water Quality: Understanding of the aquatic plants helps to restore wetlands, improving water quality and biodiversity. Aquatic plants and wetlands are vital for filtering of pollutants from water, improving water quality, and maintaining healthy ecosystems.

2. Improvement of Soil Structure: Plants enhance soil structure and texture of soil and promote water retention, reducing runoff and soil erosion. This is essential for sustainable agriculture and water conservation.

3. **Biodiversity Conservation and Ecosystem Services**: Diverse plant species contribute to healthy ecosystems that regulate water cycles and provide habitat for organisms that play roles in water purification.

4. Development of **Drought Resistant Crops**: Research in botany helps develop drought-resistant crops, improving food security and reducing the need for irrigation, thus conserving water resources. It will need less water for crops.

5. **Solutions for Water Management**: Botanical knowledge supports the use of green infrastructure, such as rain gardens and vegetated swales, which help manage storm water and reduce flooding.

6. **Climate Change Mitigation**: Plants sequester carbon and can help mitigate climate change impacts on water resources, thereby supporting sustainable water management practices.

7. Community Education and Involvement: Botany can promote awareness and engagement in water conservation practices through community programs that highlight the importance of native plants and sustainable landscaping.

8. Phytoremediation: Certain plants can absorb heavy metals and other pollutants from contaminated water and soil. This process, known as phytoremediation. It helps to clean up polluted sites in a sustainable way.

9. **Water Cycle Regulation**: Plants play a crucial role in the water cycle by facilitating processes like transpiration, which contributes to local precipitation patterns and overall water availability.

In this way by integrating botanical research and practices into water management strategies, we can work toward achieving SDG 6 effectively.

4. SDG 7 (Affordable and Clean Energy)

Sustainable development Goal no. 7 is aimed at ensuring universal access to affordable, reliable and modern energy services, increase substantially the share of renewable energy in the global energy mix, double the global rate of improvement in energy efficiency, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States.

Botany plays a major and vital role in achieving Sustainable Development Goal 7 (SDG 7), which aims to ensure access to affordable, reliable, sustainable, and modern energy for all. Some of the contributions of Botany in achieving the SDG no. 7 are listed below:

Biofuel Production: Various plants commonly called energy crops like Paddy Straw, and sugarcane waste, can be cultivated for biofuels. These renewable energy sources can help reduce dependence on fossil fuels. Cotton plant residues can be crushed and compacted to use as fuel in industry.

Plant-based Biomass: Biomass from plants can be converted into energy through processes like combustion, gasification, and fermentation. This provides a sustainable energy alternative and can help mitigate climate change.

Sustainable Forestry: Managed forests can produce timber and other products while also serving as a source of renewable energy. Sustainable forestry practices ensure that forest ecosystems remain healthy and can continue to provide energy resources.

Climate Support: Plants absorb carbon dioxide, which can help mitigate climate change impacts on energy systems. Healthy ecosystems contribute to a stable climate, supporting sustainable energy production.

Ecosystem Services: Healthy plant ecosystems provide essential services, such as water regulation and soil stabilization, which support energy infrastructure development and resilience.

Innovative Materials to minimize pollution: Research in botany can lead to the development of biodegradable materials and alternatives to plastic, reducing the environmental impact of energy-related products.

By adhering to the principles of botany, we can enhance the sustainability and reliability of energy systems, contributing to the achievement of SDG 7.

5. SDG 12(Responsible Consumption and Production)

Sustainable Development Goal 12 (SDG 12) focuses on ensuring sustainable consumption and production patterns. A large quantity of food is wasted every year and about 2 million people go hungry or undernourished. Sense of developing responsible consumption is important in achieving this goal. SDG no. 12 aims to promote resource and energy efficiency, reduce waste, and support sustainable practices across various sectors. Key objectives of SDG 12 include Implementation of programmes on sustainable consumption and production, achieve the sustainable management and efficient use of natural resources, to reduce per capita global food wastage at the retail and at consumer levels and reduce food losses along production and supply chains, including post-harvest losses, to achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment, substantially reduce waste generation through prevention, reduction, recycling and reuse, to encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle. Overall, SDG 12 aims to create a more sustainable and equitable world by promoting responsible consumption and production that balances economic growth with environmental sustainability.

Botany plays a vital role in achieving this goal through several key contributions:

Sustainable Agriculture Production: Botany promotes practices such as organic farming, crop rotation, and agroecology, which enhance soil health, reduce chemical use, and promote biodiversity, leading to sustainable food production.

Ecological Resource use Efficiency: Understanding plant biology can help optimize the use of resources like water, nutrients, and energy in agriculture, reducing waste and increasing efficiency.

Development of Biodegradable Materials: Research in plant-based materials can lead to the development of biodegradable alternatives to plastics, promoting a circular economy and reducing environmental impact.

Waste Reduction: Plant-based waste can be repurposed through composting and biogas production, minimizing landfill waste and contributing to nutrient recycling.

Biodiversity Conservation: Protecting and restoring plant biodiversity helps maintain ecosystem services essential for sustainable production, such as pollination and pest control. Biological methods of pest control can be promoted to ensure sustainable production.

Sustainable Forestry: Sustainable management of forest resources ensures that timber and non-timber products are harvested responsibly, balancing ecological health with economic needs.

Innovation in Crop Development: Research in botany can lead to the development of resilient and resource-efficient crop varieties, which can reduce reliance on chemical inputs and enhance food security.

By integrating botanical knowledge and traditional practices, we can promote more sustainable consumption and production patterns, contributing to the achievement of SDG 12.

6. SDG 13 (Climate Action)

Sustainable Development Goal 13 (SDG 13) focuses on combating climate change and its impacts. It emphasizes the need for urgent action to address climate-related challenges. It involves Strengthening Resilience: Promoting resilience and adaptive capacities to climate-related hazards and natural disasters, especially in vulnerable regions, Integrating Climate Measures: Incorporating climate change measures into national policies, strategies, and planning to ensure that development is sustainable, Reducing Greenhouse Gas Emissions: Urging countries to improve education, awareness, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning systems, Funding and Resources: Mobilizing significant resources from various sources, including developed countries, to support climate change mitigation and adaptation in developing countries. It also aimed at Promoting mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.

Botany helps in achieving the SDG no 13 in following ways:

Carbon Sequestration: Plants absorb carbon dioxide during photosynthesis, making forests, wetlands, and grasslands vital for sequestering carbon and mitigating climate change.

Restoration of Ecosystems: Botanical knowledge is essential for the restoration of degraded ecosystems, such as forests and wetlands, which enhance resilience to climate change and improve biodiversity.

Drought and Stress Resistance: Research in botany helps develop crop varieties that are more resilient to climate-related stresses, such as drought, flooding, and extreme temperatures, ensuring food security in changing climates.

Sustainable Agriculture Practices: Botany informs sustainable agricultural practices that reduce greenhouse gas emissions, such as agroforestry, cover cropping, and organic farming, promoting soil health and reducing reliance on chemical inputs.

Biodiversity Conservation: Preserving plant biodiversity is essential for ecosystem stability and resilience, which are critical for adapting to climate change impacts.

Natural Solutions for Climate Adaptation: Vegetation can be used in nature-based solutions, such as green roofs, urban forestry, and wetlands, to mitigate urban heat effects, manage storm water, and enhance climate resilience.

Public Awareness and Education: Botanical education fosters understanding of climate issues and the importance of biodiversity, encouraging community engagement in climate action.

7. SDG 14 (Life Below Water)

Over three billion people worldwide depends on availability of biodiversity under the sea and in fresh water bodies. However, harvesting these recourses beyond the sustainability have exerted huge pressure on the life below the water. Further, oceans can absorb more than 30 % of the carbon dioxide produced due to human activities. SDG target at preventing and significantly reducing the marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution, to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans, to effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices.

Botanical knowledge help in achieving SDG no. 14 in following ways:

Habitat Restoration: Botanical knowledge aids in the restoration of coastal and marine habitats, such as mangroves and coral reefs, which provide vital ecosystem services, including carbon sequestration and shoreline protection.

Sustainable Fisheries: Healthy aquatic plant populations support fish habitats and promote sustainable fisheries, ensuring food security and livelihoods for coastal communities.

Biodiversity Support: Marine and coastal ecosystems are rich in biodiversity, and protecting plant species is crucial for maintaining the balance of these ecosystems.

8. SDG 15 (Life on Land)

SDG no. 15 is aimed to ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and dry lands, in line with obligations under international agreements by 2020.

It promotes the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

To combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strives to achieve a land degradation-neutral world.

To ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development by 2030.

To take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

To promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed

Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products

By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

Conclusion:

Sustainable development is a developmental process aimed at keeping the future generations ecologically sound. Global Action Plan on Education for sustainable development is framed by UNESCO for 2030. 17 interlinked goals are framed. Education is capable of bringing changes in attitude, thoughts, values and help in acquiring the skills and knowledge for achieving the sustainable Development Goals (SDGs) among the people. A development is called sustainable if it fulfills the achievement the sustainable development goals. The whole world is facing crises of food, energy, health, Eco-degradation due to faulty industrial, agriculture, urbanization practices and ongoing wars and nuclear tests. There is a threat of human and other species survival which needs to be addressed on priority.

botany is integral to achieving a sustainable future. Various branches of Botany are directly or indirectly concerned with the achievement of almost all sustainable development goals framed by UNESCO. Botany can address problem of Poverty, hunger, good health and well-being,clean water and sanitation, affordable and clean energy, sustainable cities and communities, responsible consumption and production, climate Change etc. in a very effective manner.

Its application in various sectors not only addresses environmental and economic challenges but also enhances human well-being, healthy ecosystem, climate change, aligning closely with the objectives of the SDGs. Modern developments in botanical science directly address the problem poor quality food, better crops which are less dependent on harmful pesticides and other chemicals. Collaborative efforts among scientists, policymakers, and communities are essential to harness botanical knowledge for sustainable development.

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