GREEN TECHNOLOGY FOR SUSTAINABLE ENERGY PROCUTION FROM AGRICULTURE SECTOR

Abstract

Green technology, also known as sustainable technology, has emerged as a crucial driver for achieving sustainable development in various sectors. This paper presents an abstract on the significance of green technology in promoting environmental conservation, resource efficiency, and social well-being. By integrating eco-friendly practices, renewable energy sources, advanced materials, and data-driven solutions, green technology contributes to mitigating climate change, preserving biodiversity, and enhancing the resilience of societies. The abstract emphasizes the role of green technology in fostering a circular economy, reducing greenhouse gas emissions, and empowering communities, particularly in the context of urbanization and agriculture. Furthermore, it highlights the importance of collaborative efforts from governments, industries, and individuals in promoting the adoption and diffusion of green technology for a sustainable and equitable future. The abstract concludes with a call to action for policymakers, researchers, and stakeholders to prioritize and invest in green technology solutions to address pressing global challenges and pave the way for a more sustainable and resilient world.

Keywords: Green technology, Resource efficiency, Sustainable Technology, Crucial Driver.

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I. INTRODUCTION

Agriculture serves as a vital means of providing sustainable food for both current and future generations. In the pursuit of environmental preservation and reducing our carbon footprint, green energy has emerged as a promising alternative to conventional energy sources. Nevertheless, a disparity exists between the potential of renewable energy and its practical implementation, often referred to as execution obstacles (White and Walsh, 2008). The Rio Declaration underscores the fundamental rights to a healthy and productive life, ecological protection, as well as the promotion of sustainable agriculture and green technology. Through strategic partnerships and collaborations, we can harness natural resources effectively, while also ensuring farmers have a reliable and viable income source.

Through extensive utilization of green technology, firms generate surplus derivatives that disrupt the Earth's ecosystem, leading to environmental hazards and depletion of natural resources. The introduction of pioneering technology raises ethical conundrums concerning its impact on morality and society. Common practice involves comparing the current societal configuration to a hypothetical system referred to as an "idyllic system." Scientists continually refine pragmatic gadget attributes over time to enhance performance while keeping these conceived devices in consideration. According to Aithal *et al*. (2016), ideal technology possesses renewable characteristics and emits no greenhouse gases into the atmosphere, earning its designation as "green technology."

1. Content of Green Technology

What is Green Technology?

Green technology encompasses a comprehensive array of scientific disciplines aimed at mitigating human impacts on the natural environment. It involves diverse fields such as energy, atmospheric science, agriculture, material science, and hydrology. Green technology is closely related to environmental science, green chemistry, environmental monitoring, and electronic devices used for resource conservation and minimizing human-induced environmental harm. Its primary objective is to reduce hazardous waste and pollutants generated during various mechanized processes and product utilization. Commonly known as "environmentally-friendly technology" or "clean technology," its focus is on promoting sustainability and ecological preservation. (Munn,R.E.,1992).

2. **The Evolution of Green Technology**: Scientists started to perceive the ecological effects of coal-burning industrialized plants in the early 19th century, and manufacturers have tried to diminish these effects by changing production techniques to create less grunge or waste byproducts. The Second World War marked a pivotal moment in American history, with over 400,000 volunteers assembling supplies to reduce consumption and waste. Rachel Carson warned about chemical pesticide dangers, whereas doctors described strange ailments linked to nuclear radiation. This epoch is considered the birthplace of the ecology movement, aiming to protect ecosystems and resources whilst educating the public about rogue technology. Through the conception of the Environmental Protection Agency in the 1970s, the government renowned the value of the environment and promoted curbside recycling whereas setting stringent regulations for waste management and pollution.

II. OBJECTIVES OF GREEN TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

The objectives of green technology for sustainable development are aligned with promoting environmentally friendly and socially responsible practices while fostering economic growth and prosperity. These objectives aim to achieve a balance between meeting current needs and ensuring the well-being of future generations. Some key objectives of green technology for sustainable development include:

1. **Environmental Protection:** The primary objective is to protect and preserve the natural environment, including air, water, land, and ecosystems, by reducing pollution, conserving resources, and mitigating climate change.

2. **Resource Efficiency:** Green technology aims to optimize the use of natural resources, such as energy, water, and materials, to minimize waste and increase resource sustainability.

3. **Renewable Energy Transition:** Promoting the widespread adoption of renewable energy sources, like solar, wind, and hydro, to replace fossil fuels and reduce greenhouse gas emissions.

4. **Energy and Waste Management:** Implementing energy-efficient technologies and waste management strategies to reduce energy consumption and minimize waste generation.

5. **Sustainable Agriculture and Food Security:** Advancing sustainable agricultural practices that promote soil health, biodiversity conservation, and food security for present and future generations.

6. **Green Building and Infrastructure:** Developing sustainable buildings and infrastructure that are energy-efficient, environmentally friendly, and contribute to the overall well-being of occupants

7. **Circular Economy:** Encouraging a circular economy model, where resources are reused, recycled, and repurposed, reducing waste and extending the life cycle of products.

8. **Economic Growth and Green Jobs:** Green technology aims to drive economic growth and create green job opportunities in sectors such as renewable energy, energy efficiency, and sustainable agriculture.

9. **Climate Change Mitigation:** Green technology plays a crucial role in mitigating climate change by reducing greenhouse gas emissions and promoting climate-resilient practices.

10. **Biodiversity Conservation:** Green technology supports efforts to protect and conserve biodiversity, essential for maintaining ecological balance and ecosystem services.

11. **Innovation and Research:** Supporting research and development of new and innovative green technologies to continually improve sustainability efforts.

III. PILLARS OF GREEN TECHNOLOGY

The pillars of green technology delineate fundamental principles and targeted domains directing the conception and application of ecologically sound and sustainable technologies. These pillars are indispensable for tackling environmental predicaments, mitigating ecological footprints, and fostering a more sustainable and environmentally-conscious future. The primary pillars of green technology encompass the following:

1. **Renewable Energy:** Advocating the utilization of renewable energy sources such as solar, wind, hydro, geothermal, and biomass, which possess low environmental impact and perpetually replenish, as alternatives to finite fossil fuels.

2. **Energy Efficiency:** Enhancing energy efficiency across diverse sectors, including buildings, transportation, and industrial processes, to minimize energy consumption and curb greenhouse gas emissions.

3. **Sustainable Materials:** Encouraging the adoption of eco-friendly and sustainable materials in product design and construction to curtail resource depletion and waste generation.

4. **Waste Reduction and Recycling:** Implementing strategies for waste reduction and fostering recycling and up cycling practices to alleviate pressure on landfills and foster a circular economy.

5. **Green Infrastructure:** Integrating green infrastructure solutions into urban planning and construction, such as green buildings, green spaces, and sustainable transportation systems, to foster environmentally-friendly and resilient cities.

6. **Water Management:** Emphasizing sustainable water management practices, including water conservation, water recycling, and efficient irrigation systems, to preserve this invaluable natural resource.

7. **Sustainable Agriculture:** Promoting agricultural practices that minimize the use of harmful chemicals, conserve soil health, and support biodiversity preservation.

8. **Environmental Monitoring and Conservation:** Utilizing advanced monitoring technologies to assess environmental impacts and support conservation endeavors aimed at safeguarding natural resources and ecosystems.

9. **Green Transportation:** Advancing green transportation options, such as electric vehicles, public transportation systems, and alternative fuel technologies, to reduce emissions from the transportation sector.

10. **Eco-friendly Products and Services:** Encouraging the development and adoption of products and services that exhibit minimal environmental impacts throughout their life cycles.

IV. 7R CONCEPT IN GREEN TECHNOLOGY

The 7 R concepts in green technology comprise a series of principles that advocate for sustainable practices and resource efficiency. Each "R" denotes a distinct action or approach, targeting waste reduction, resource conservation, and the mitigation of technology and human activities' environmental impact.

1. **Rethink:** This involves questioning and reevaluating traditional practices and methods to identify more sustainable alternatives. It encourages a shift in mindset towards adopting greener and more eco-friendly approaches.

2. **Reduce:** The principle of reducing emphasizes the need to decrease the consumption of resources and materials to the minimum necessary. By using less, we can reduce waste and environmental burdens.

3. **Reuse:** The reuse principle encourages finding ways to extend the life cycle of products or materials by using them again for the same or different purposes. This helps reduce the demand for new resources and minimizes waste generation.

4. **Repair:** Repairing products instead of discarding them and buying new ones can extend their useful life, reducing the need for additional resource extraction and production.

5. **Refurbish:** Similar to repair, refurbishing involves restoring products to a like-new condition, ensuring they remain functional and useful for a more extended period.

6. **Remanufacture:** Remanufacturing involves disassembling and reassembling products to meet original specifications, making them as good as new. This process reduces the need for manufacturing new products from scratch.

7. **Recycle:** Recycling is the process of converting waste materials into new products or raw materials, reducing the demand for virgin resources and diverting waste from landfills.

V. INNOVATIONS IN GREEN TECHNOLOGY

Innovations in green technology encompass a wide array of advancements and developments aimed at creating more sustainable and eco-friendly solutions. These innovations seek to address environmental challenges, reduce resource consumption, and minimize the ecological footprint of various industries and human activities. Some notable innovations in green technology include renewable energy technologies (such as more efficient solar panels and advanced wind turbines), energy storage solutions, electric and autonomous vehicles, sustainable building materials, smart grid technologies, waste-to-energy processes, water purification and desalination technologies, eco-friendly packaging materials, and advancements in green chemistry and biotechnology. These innovations continuously evolve to meet the growing demand for sustainable solutions and contribute to a more environmentally conscious and resilient future.

VI. GREEN TECHNOLOGY STRATEGIES

1. **Green Product Strategy:** Companies have made significant changes to their products based on consumer needs and requirements, aiming to produce environmentally friendly products. Environmentally friendly products conserve natural resources and reduce atmospheric pollution. These green products are often manufactured through recycling and reusing previously used materials. Marketers play a crucial role in understanding and communicating consumer preferences for green products, such as those made from organic and reusable materials, energy-saving technologies, and less harmful chemicals in cosmetic and personal care products (Sharma and Joshi, 2016).

2. **Green pricing Strategy:** These strategies are regarded as a highly sensitive and critical aspect of the green marketing mix. Consumer behavior demonstrates significant responsiveness to changes in product pricing, promptly influencing their purchasing decisions (Davari and Strutton, 2014). Many consumers exhibit a willingness to pay a premium for green products due to the perceived additional value compared to conventional alternatives. Green technology must prioritize visual appeal, flavor, design, and performance while implementing premium pricing strategies for clients (Sharma and Joshi, 2016).

3. **Availability of Green Product:** The availability of green products is a critical component of the green technology mix, focusing on the distribution channels used by marketers to make environmentally friendly products accessible to consumers. The distribution system for green products comprises two distinct aspects: the inner and outer viewpoints. The inner aspect pertains to the internal environment of the company, where positive and satisfactory behavior of the workforce influences consumers due to their perception of the company's commitment to sustainability. On the other hand, the outer aspect refers to the physical availability of green products, technologies, and services to consumers (Bisoyi and Das, 2015; Sudhalakshmi and Chinnadorai, 2014). This aspect involves ensuring that green products are readily accessible to consumers in the market, thereby encouraging greater adoption and consumption of environmentally friendly alternatives.

VII. EFFECT OF GREEN TECHNOLOGY IN VARIOUS SECTORS

1. **Green Technology in Agriculture and Food:** Green technology in agriculture and food faces significant challenges, including identifying a viable methodology for capital production while ensuring sustainability, researching the consequences of adopting such technologies, and establishing national standards for technology approvals. These obstacles hinder the widespread adoption of green technology, which holds the promise of addressing food-related difficulties and boosting agronomic production. Key innovations in farming based on sustainable green technologies, such as precise cultivation, nano-pesticides, and low-cost decentralized water decontamination, can play a crucial role in meeting the growing demand for food and proper nourishment.

   Agricultural practices that are economically viable while being environmentally friendly are essential for the long-term sustainability of the sector. This requires conducting extensive research and collaborating with experts in the field to identify and implement practices that strike the right balance between productivity and resource conservation. Research is a fundamental aspect of understanding the consequences of adopting green technologies in agriculture and food production. Studies evaluating the environmental, economic, and social impacts of specific innovations, such as nano-pesticides and decentralized water decontamination, are essential for informed decision-making. Close cooperation between scientific researchers, government agencies, and industry players can facilitate the collection of empirical data and the evaluation of the

long-term effects of green technology implementation (Khan *et al.,* 2019). To accelerate the expansion of suitable green technologies in agriculture and food, developing and implementing national standards and regulations is crucial. Governments can play a vital role in incentivizing the adoption of green practices through policies, subsidies, and tax benefits. Collaborative efforts with international organizations can also contribute to creating globally recognized standards, promoting trade in sustainable agricultural products, and supporting technology transfer to developing countries (FAO, 2020).

2. **Green Technology for Drinkable Water:** Green technology innovations in low-cost water decontamination hold the potential to tackle the world's growing potable water problem and ensure access to sustainable drinkable water for all. The increasing global demand for water, projected to grow by 60% by 2030 to accommodate an additional 2 billion people, raises concerns about potential scarcities impacting two-thirds of the world's economy by 2050. To mitigate these challenges, green technology offers cost-effective solutions, including localized water decontamination, molecular-level toxin identification, and significantly improved purification systems. Such advancements enable the reprocessing of rainwater into uncontaminated drinkable water and large-scale desalination of seawater at a reduced cost.

- **Cost-Effective Localized Water Decontamination:** Green technologies are revolutionizing water decontamination processes, making them more cost-effective and accessible. Utilizing natural filtration systems, such as biochar filters (Huang *et al.,* 2017), and eco-friendly adsorbents, like graphene oxide composites (Yang *et al.,* 2021), these localized decontamination methods efficiently remove pollutants from water sources, ensuring safe and drinkable water for local communities.

- **Molecular-Level Toxin Identification:** Advanced green technology tools, such as nano-sensors and spectroscopy techniques, enable the identification and detection of toxins at the molecular level in water (Morales-Narvaez & Merkoci, 2020). This high level of sensitivity and precision allows for early warning systems and real-time monitoring of water quality, ensuring swift responses to potential contamination events.

- **Dramatically Improved Purification Systems:** Green technology has facilitated the development of highly efficient and environmentally friendly water purification systems. For instance, solar-powered water purification using photo catalytic materials (Chen *et al.,* 2017) and forward osmosis membrane systems (Yang *et al.,* 2018) significantly reduce energy consumption and chemical usage, resulting in a more sustainable approach to producing drinkable water.

- **Reprocessing Rainwater and Desalination of Seawater:** Green technologies have enabled the scaling up of rainwater harvesting and purification systems (Cervantes *et al.,* 2018). Through the implementation of low-cost rainwater collection systems and advanced filtration methods, rainwater can be reprocessed into potable water, particularly in regions facing water scarcity. Additionally, advancements in desalination technologies, such as solar-powered desalination (Gude, 2016) and membrane distillation (Wang *et al.,* 2021), have made large-scale desalination of

seawater more energy-efficient and cost-effective, further expanding the availability of drinkable water in coastal areas.

3. **Green Technology in Food and the Food Processing:** Achieving a sustainable balance between food quantity and demand is paramount for the long-term survival of the human species. Green technologies in the food and food handling industry are essential to address the challenge of reducing the generation of process-induced contaminants, requiring specialized expertise. Among the available technologies are biological conservation, non-thermal techniques, electronic and magnetic wave warming, and the application of electrical and magnetic fields. Additionally, nanotechnology and biotechnology offer promising prospects for mitigating process-induced toxins in foodstuffs and minimizing the environmental impacts of food production and storage.

4. **Green Technology in Healthcare and Medication:** Green nanotechnology research has emerged as a promising field with significant implications for human well-being. This scientific pursuit offers numerous opportunities for innovation in the medical industry, encompassing fair and simple diagnostics, novel drug delivery technologies, and expedited drug production. In the long term, green nanotechnology breakthroughs hold the potential to address DNA and cellular impairments, revolutionize drug therapies, and even extend human lifespan. Proposed rejuvenation therapies may enable people to live up to 1,000 years, and future advancements in microscopic machines could lead to intrabody interventions, replacing damaged cells and tissues to effectively combat diseases.

   - **Green Nanotechnology in Medical Diagnostics:** Green nanotechnology facilitates the development of fair and simple diagnostic tools, harnessing nano materials to enhance sensitivity and accuracy. Nano sensors and Nano probes offer high precision for detecting biomarkers and early signs of diseases, enabling early diagnosis and intervention (Yin *et al.,* 2020). These advancements hold great potential for improving medical diagnostics and monitoring various health conditions.

   - **Innovative Drug Delivery Technologies:** The application of green nanotechnology in drug delivery is a key focus of research. Nano particles and nano carriers can transport therapeutic agents precisely to target sites, improving drug efficacy and reducing side effects (Tansi *et al.,* 2019). Controlled release systems, enabled by nanotechnology, ensure sustained drug delivery, optimizing treatment outcomes and patient comfort.

   - **Accelerated Drug Production:** Green nanotechnology facilitates faster drug production processes, expediting the development of new pharmaceuticals. Nano particle-based drug formulations offer enhanced solubility and bioavailability, streamlining drug development and regulatory approval (Dhar *et al.,* 2019). This efficiency translates into timely availability of advanced medications for various medical conditions.

   - **Addressing DNA and Cellular Impairments:** Long-term green nanotechnology advancements are envisioned to restore DNA and cellular impairments, paving the way for transformative therapies. Nano material-based gene editing technologies,

such as CRISPR-Cas9, hold the potential to correct genetic mutations and treat hereditary disorders (Ma *et al.,* 2020). These interventions may revolutionize the landscape of personalized medicine and inherited disease treatments.

- **Prolonging Human Lifespan:** Proposed rejuvenation therapies, leveraging green nanotechnology, offer the tantalizing possibility of extending human lifespan. By targeting age-related cellular damage and senescence, nanotechnology-based interventions aim to rejuvenate tissues and organs, potentially slowing down the aging process (Jung *et al.,* 2019). While these concepts are still in early stages, they present intriguing prospects for longevity research.

- **Future of Microscopic Machines:** Anticipated advancements in nanotechnology could lead to the development of microscopic machines with intra-body capabilities. These nano-robots could enter the human body, repairing damaged cells and tissues, and eradicating diseases (Doshi & Mitragotri, 2010). Such interventions hold immense potential for transforming medical treatments and combating complex health challenges.

5. **Green Technology in Aircrafts and Space Travelling:** Space exploration offers numerous benefits, serving as a means of monitoring Earth's well-being, providing an energy source, and offering a blank canvas for human creativity. Embracing green technologies enables humans to live sustainably in space, addressing challenges such as propulsion systems, protective coatings, essential textiles, intelligent garments, sensors, and life-supporting environments. Green nanotechnology, in particular, holds immense potential to yield more efficient, durable, self-repairing, and lightweight materials, surpassing the capabilities of current technologies.
   - Environmental Monitoring and Sustainability
   - Energy Resources from Space
   - Innovation and Creativity
   - Sustainable Space Living with Green Technologies
   - Advanced Space Textiles and Garments

6. **Green Nanotechnology Advancements:** Green nanotechnology holds great promise for space exploration. By designing nano-materials with superior strength, resilience, and lightweight properties, we can enhance spacecraft construction and improve performance in space missions. Self-assembling nano-materials may enable transformative manufacturing processes in space, reducing costs and resource consumption.

7. **Green technology for drone in Agriculture:** Agricultural drones, also known as UAVs (Unmanned Aerial Vehicles) or UAS (Unmanned Aerial Systems), equipped with green technology, have emerged as a powerful tool in modern farming practices. These drones utilize various green technologies to enhance precision agriculture, reduce chemical usage, monitor crop health, and promote sustainable farming practices.

   - **Precision Agriculture and Crop Monitoring:** Agricultural drones equipped with advanced sensors, such as multispectral and thermal cameras, LiDAR, and GPS, enable precision agriculture and crop monitoring. These sensors collect real-time data on crop health, soil moisture, and other essential parameters, allowing farmers to

make data-driven decisions on irrigation, fertilization, and pest control (Qin *et al.,* 2019).

- **Reduced Chemical Usage:** With the aid of sophisticated imaging and mapping technology, agricultural drones create detailed crop health maps. By pinpointing areas that require intervention, farmers can apply pesticides and fertilizers only where necessary, reducing overall chemical usage and minimizing environmental impact (Joshi *et al.,* 2020).

- **Precision Planting and Seeding:** Green technology-equipped drones can facilitate precision planting and seeding. By releasing seeds at optimal locations and densities, farmers can achieve better crop establishment and minimize seed wastage, resulting in improved crop yields and resource efficiency (Thorp *et al.,* 2019).

- **Soil Health and Erosion Monitoring:** Agricultural drones equipped with sensors and cameras can monitor soil health and erosion levels. This data assists farmers in implementing erosion control measures, managing soil nutrient levels, and promoting sustainable land management practices (Yuan *et al.,* 2019).

- **Solar-Powered Drones:** Advancements in drone power sources include the use of solar energy to power agricultural drones. Solar-powered drones reduce reliance on traditional fossil fuels and lower greenhouse gas emissions, making them more environmentally friendly (Hoffacker *et al.,* 2017).

- **Improved Logistics and Efficiency**: Agricultural drones with advanced flight planning and autonomous navigation systems optimize flight paths, saving time, energy, and resources. This improved efficiency allows farmers to cover larger areas and gather more data in a shorter time, making drone-assisted farming practices more practical and effective (Sanchez *et al.,* 2019).

VIII. CONCLUSION

The integration of green technology into agriculture offers a pathway to a more sustainable and resilient food system. As the world faces environmental challenges and the need to feed a growing population, embracing green technology in agriculture becomes essential for securing food security, protecting ecosystems, and mitigating climate change effects. Collaborative efforts from governments, farmers, researchers, and industries are vital to drive the adoption and development of green technology for a sustainable agricultural future. Green technology applications for drones in agriculture have revolutionized farming practices by promoting precision agriculture, reducing chemical usage, and optimizing resource management. With the integration of advanced sensors, autonomous navigation, and renewable energy sources, agricultural drones have become a valuable tool in sustainable farming, contributing to environmental protection and improved agricultural productivity.

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