Sustainable Bioplastic from Wheat Straw: A Solution to Stubble Burning and Plastic Waste Crisis

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***Abstract*—Stubble burning in northern India, particularly in Punjab and Haryana, is a major contributor to seasonal air pollution in Delhi and surrounding regions. At the same time, India is facing a rapidly increasing plastic waste crisis. This study proposes the development of biodegradable bioplastic from wheat straw as a sustainable solution to address both challenges simultaneously. By converting agricultural residue into value-added bioplastic, this approach promotes circular economy principles, reduces environmental pollution, and provides an additional income source for farmers.**

***Index Terms*—Stubble Burning, Biodegradable Plastic, Wheat Straw, Circular Economy.**

I. INTRODUCTION

Punjab generates nearly 20 million tons of agricultural residue every year. Farmers often burn crop residues to quickly prepare their fields for the next crop cycle, as it is the cheapest and fastest option available. However, this practice releases large amounts of pollutants into the atmosphere, significantly worsening air quality in Delhi and nearby regions. Studies suggest that stubble burning contributes nearly 40–50% of Delhi's air pollution during October and November. Pollutants such as carbon monoxide (CO), methane (CH4), volatile organic compounds (VOCs), and carcinogenic polycyclic aromatic hydrocarbons are released into the atmosphere. These pollutants lead to respiratory diseases and thousands of premature deaths each year.

II. ENVIRONMENTAL AND AGRICULTURAL CONSEQUENCES

a. Soil degradation due to destruction of essential nutrients and microbial life.
b. Loss of biodiversity including beneficial insects and microorganisms.
c. Increased greenhouse gas emissions contributing to climate change

III. SUSTAINABLE BIOPLASTIC: AN INNOVATIVE SOLUTION FOR STUBBLE BURNING

Recognizing the dual crises of stubble burning and plastic pollution, this research proposes the development of bioplastic from wheat straw. This biodegradable material offers an eco-friendly alternative to traditional plastics while effectively repurposing agricultural waste.

IV. MATERIALS USED FOR BIOPLASTIC

a. Glycerin
b. Water
c. Wheat Straw
d. Gelatin Powder
e. Vinegar
f. Cornflour

V. PROCESS OF BIOPLASTIC PRODUCTION

a. Preparation of Wheat Straw: The wheat straw is cleaned, dried, and finely ground into a powder to be used as a biopolymer base.
b. Mixing Ingredients: The wheat straw powder is combined with gelatin, glycerin, corn flour, vinegar, and water to create a homogeneous mixture.
c. Heating & Stirring: The mixture is heated at a controlled temperature while being stirred continuously to form a gel-like consistency.

d. Molding & Drying: The bioplastic gel is poured into molds and left to dry, forming a solid material.
e. Testing & Refinement: The final product is tested for durability and strength.

Figure 1Wheat Straw-Based Bioplastic

VI. BENEFITS OF WHEAT-STRAW BASED BIOPLASTIC

a. Reduction in Stubble Burning: Farmers gain an economic incentive to collect and sell wheat straw instead of burning it.
b. Eco-Friendly Alternative: Unlike conventional plastics, wheat straw bioplastic decomposes naturally.
c. Versatile Applications: Can be used in packaging, cutlery, and biodegradable consumer products.
d. Sustainable Production: Low energy consumption and reduced reliance on fossil fuels.

VII. IMPLEMENTATION AND FUTURE SCOPE

a. Raw material collection and processing-
i. Farmers as Suppliers: Establish contracts with farmers to collect wheat straw instead of burning it.
ii. Incentive Programs: Provide government subsidies or financial incentives to encourage wheat straw collection.
iii. Processing Units: Set up processing plants where wheat straw is cleaned, dried, and ground into fine powder.

b. Bioplastic Production Process-
i. Material Mixing: Combine wheat straw powder, glycerin, gelatin, vinegar, water, and corn flour.
ii. Heating & Molding: Heat the mixture to form a plastic-like consistency and mold it into desired shapes.
iii. Drying & Curing: The final product is air-dried or oven-dried for durability.

c. Industrial Adoption & Scaling-
i. Partnerships with Packaging & Consumer Goods Industries.
ii. Government policy integration to promote bioplastics and reduce single-use plastics.

d. Commercialization & Market Adoption-
i. Branding and awareness campaigns- Market wheat straw bioplastic as a luxury sustainable product for eco-conscious consumers. Conduct educational programs for industries and consumers about the benefits of biodegradable alternatives.
ii. Retail and distribution through supermarkets and online platforms- Sell products through supermarkets, online platforms, and government eco-stores. Establish B2B connections with packaging and food industries.

e. Environmental & Economic Impact-
i. Reduces air pollution- Eliminates stubble burning, leading to cleaner air and fewer respiratory diseases.
ii. Sustainable Waste Management- Addresses plastic waste crisis by providing a biodegradable alternative.
iii. Economic Benefits for Farmers- Farmers can sell wheat straw rather than burn it, creating a new revenue stream.
iv. Circular Economy – Encourages recycling, composting, and sustainable business models.

VIII. CONCLUSION

This study highlights the potential of bioplastic derived from wheat straw as a long-term solution to two interconnected environmental issues in India: the growing problem of plastic waste and the burning of crop residues. According to the study, agricultural waste, particularly wheat straw, may be effectively converted into biodegradable bioplastic using simple, environmentally friendly substances like glycerine,

gelatine, vinegar, and cornflour. This technique reduces stubble burning, which reduces air pollution and protects soil health, and offers an environmentally acceptable alternative to conventional petroleum-based plastics. Additionally, the proposed approach advances the concepts of a circular economy by transforming agricultural waste into value-added products and providing farmers with new sources of income.

Additionally, the proposed method advances the concepts of a circular economy by converting agricultural waste into products with additional value and providing farmers with new revenue opportunities. Widespread adoption supported by laws, corporate partnerships, and increased public knowledge can significantly improve sustainable waste management and environmental protection. Therefore, bioplastic derived from wheat straw is a practical way for India to attain long-term sustainable development, reduced plastic pollution, and healthier air.

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