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# A Survey on Bioeconomy: Utilizing Agricultural Waste for Sustainable Organic Farming

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**Abstract:** A sustainable framework for turning agricultural waste into useful resources that improve organic farming methods is provided by the bioeconomy. Agricultural systems can decrease waste and increase productivity by turning harvest leftovers, animal waste and other agricultural residues into nutrient-rich compost, agricultural charcoal, green gas and natural soil enhancers. This method increases soil fertility, water retention and microbial activity while lowering reliance on artificial inputs. The bioeconomy encourages resource efficiency, lowers greenhouse gas emissions and supports rural livelihoods by combining organic farming with waste management. Therefore, using agricultural waste in a bioeconomic model offers a useful and environmentally responsible way to achieve sustainable agriculture and long-term food security.

**Keywords:** The Bioeconomy, Management of agricultural waste, Eco-friendly agriculture, Organic farming, Recycling of resources and Sustainability of the environment.

## I. INTRODUCTION

In order to reduce waste and its negative effects on the environment, the bioeconomy is a sustainable system that emphasizes recycling and reusing biological resources. By turning agricultural waste such as crop residues, animal manure, and other farm by-products into useful products like organic fertilizers, it plays a crucial role in agriculture. By ensuring that nutrients are recycled back into the soil instead of being lost as waste, this procedure aids in dissolving the nutrient loop.

Organic farming can become more environmental friendly and efficient by implementing the bioeconomy approach. Bioeconomy supports microbial activity, increases soil fertility, and improves water retention all of which are critical for crop growth. It also helps mitigate climate change by lowering greenhouse gas emissions and the need for chemical fertilizers.

By giving farmers new opportunities, it promotes agricultural waste resource efficiency, rural development and sustainable farming methods. Figure I shows the bioeconomy which provides a workable and environmental responsible approach to sustainable agriculture and long-term food security through prudent waste management and natural resource management.

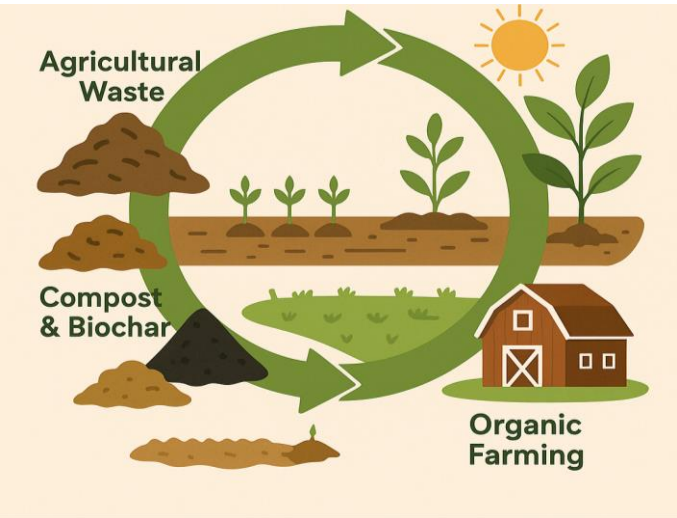


Figure 1: Bioeconomy of Organic Farming

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## II. AGRICULTURAL WASTE AND ITS DIFFICULTIES

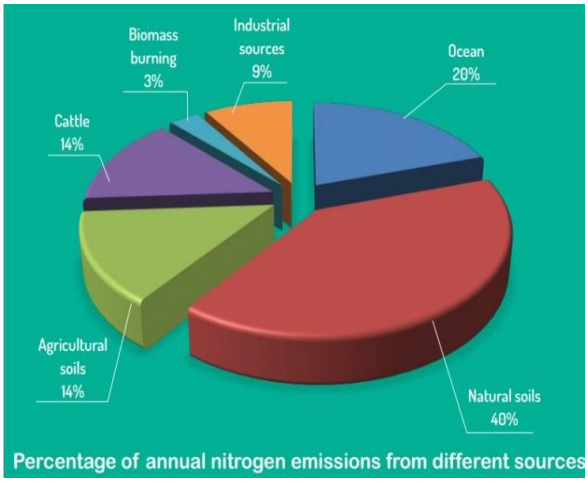


Figure 2: Effects of Agricultural pollutants

Figure 2 shows the effects of agricultural pollutants and large volumes of waste are produced by agricultural activities, including:

1.**Large Volume Generation**: Farming generates a lot of waste, including animal manure, husks and crop residues, which are frequently thrown away.

2. **Improper Disposal**: Burning or disposing of agricultural waste contaminates water, degrades soil and pollutes the air.

3. **Lack of Knowledge**: A lot of farmers don't know how to recycle or reuse agricultural waste in an efficient way.

4**. Limited Infrastructure**: Appropriate waste management is hampered by inadequate facilities for waste collection, biogas production or composting.

5**. High Handling Costs**: Small-scale farmers may find it challenging to afford the expenses associated with waste processing and transportation.

6.**Seasonal Variation**: It can be difficult to manage waste continuously because it varies with crop cycles.

7.**Environmental Impact**: Ineffective waste management raises greenhouse gas emissions and harms the environment. When this waste is improperly disposed from greenhouse it results in gas emissions, soil erosion and air pollution. Sustainable waste management is therefore crucial.

## III. MAKING USE OF AGRICULTURAL WASTE IN THE BIOECONOMY

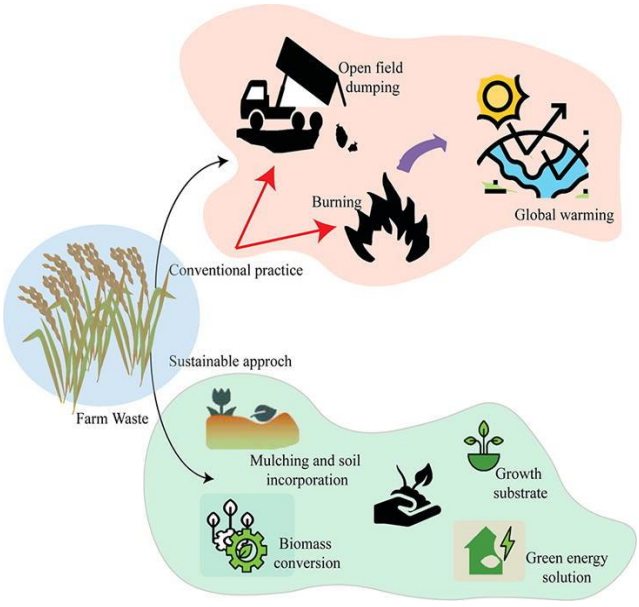


Figure 3: Use of organic waste in Bioeconomy

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Figure 3 shows the use of organic waste in bioeconomy and agricultural waste is transformed into beneficial bio-based products in a circular bioeconomic model, including:

1.**Resource Recovery**: Produces useful goods like compost, biochar, and biogas from crop waste, animal dung and agro-waste.

2.**Waste Reduction**: Lowers environmental pollution and the amount of agricultural waste that is disposed.

3. **Nutrient Recycling** : Restoring vital nutrients to the soil through nutrient recycling increases fertility and yield.

4.**Renewable Energy Production**: Lessens reliance on fossil fuels by turning organic waste into biogas.

5.**Economic Benefits**: Value-added products give farmers new sources of income.

6.**Sustainability**: Encourages environmentally friendly agricultural methods and lowers greenhouse gas emissions.

7.**Improvement of Soil Health**: Promotes microbial activity, water retention and soil structure.

8.**Circular System**: The circular system promotes a dissolve-loop farming model in which waste is turned into a resource.

9.**Food security**: Encourages long-term agricultural resilience and sustainable crop production.

## IV. ADVANTAGES OF ORGANIC AGRICULTURE


Figure 4: Benefits of organic farming.

Figure 4 shows the benefits of organic farming such as:

1.**Enhances Soil Health**: Using natural compost and biofertilizers improves the fertility and structure of the soil.

2.**Environmental Protection**: Prevents pollution by avoiding chemical pesticides and fertilizers.

3. **Healthy Food Production** :Healthy food production creates safer, more nutrient-dense and chemical-free food for consumers.

4. **Biodiversity Conservation**: Conservation of biodiversity promotes natural ecosystems, safeguarding flora, fauna and helpful microbes.

5**. Sustainable Farming**: Sustainable farming preserves the quality of the soil and water to maintain long-term productivity.

6. **Energy Efficiency**: Energy efficiency encourages environmentally friendly behaviour and uses fewer non-renewable resources.

7.**Mitigation of Climate Change**: Enhances soil carbon sequestration and lowers greenhouse gas emissions.

8.**Economic Opportunities**: Offers premium prices for organic produce and supports regional markets.

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## V. ORGANIC FARMING'S DRAWBACKS

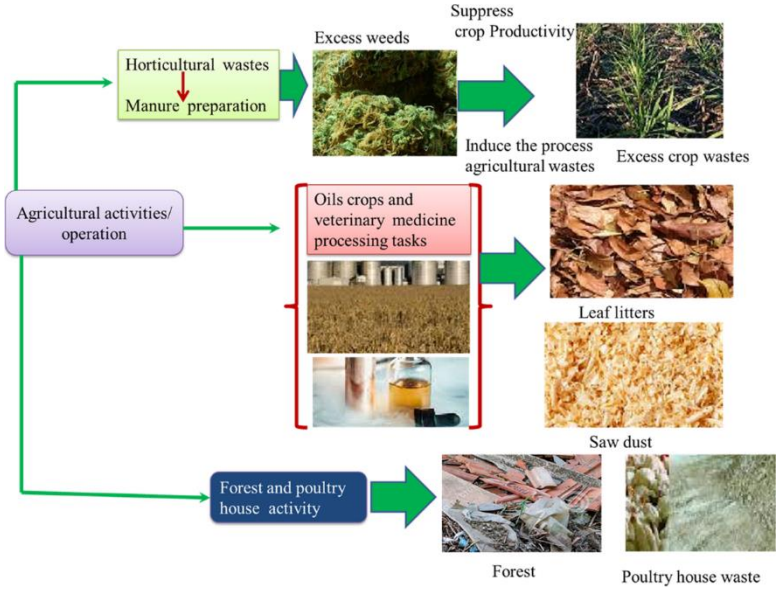


Figure 5: Drawbacks of Organic farming

Figure 5 shows the drawbacks of organic which are as follows,

**1.Reduced Crop Yields**: Compared to conventional farming, organic farming frequently yields lower crop yields.
2.**High Labor Requirement**: Pest control and soil management require more manual labour.
3 .**Expensive Inputs**: Biopesticides and organic fertilizers can be more expensive and harder to find.
4.**Problems with Pest and Disease Control:** Crops may not be completely protected from pests by natural means.
5.**Short Shelf Life**: Without chemical preservatives, organic produce deteriorates more quickly.
6.**Certification Difficulty**: Obtaining organic certification requires financial investment, time and effort.
7.**Market Restrictions**: Organic products may cost more and have fewer markets.

## VI. ECONOMIC AND ENVIRONMENTAL EFFECTS

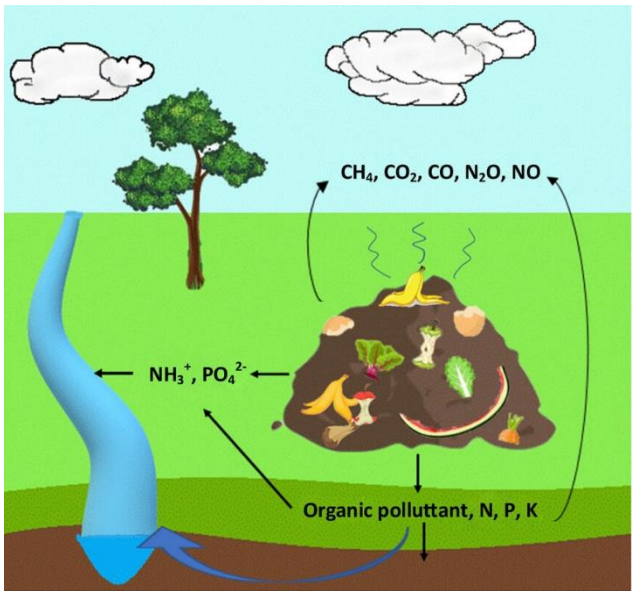


Figure 6: Impact of agricultural waste on the surrounding environment.

Figure 6 shows the impact of agricultural waste on the surrounding environment and economy that includes:

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1.**Economic Growth**: Encourages rural development and generates new employment in bio-based sectors.
2.**Cost-effectiveness**: By reusing waste, costs associated with chemical pesticides and fertilizers are decreased.
3.**Revenue generation**: Produces value-added goods like compost and biogas from agricultural waste.
4**. Resource Conservation**: Resource conservation promotes the economical use of natural resources like soil nutrients and water.
5.**Pollution Reduction**: Recycling organic waste reduces pollution in the air, water and soil.
6.**Mitigation of Climate Change**: Reduces greenhouse gas emissions and boosts soil carbon storage.
7**. Sustainable Development**: For long-term stability, sustainable development strikes a balance between environmental preservation and economic growth.
8.**Energy Savings**: Encourages the use of renewable energy, which lessens reliance on fossil fuels.

## VII. LITERATURE REVIEW

| *SL NO* | *YEAROF PUBLICATION* | *PROJECT TITLE* | *DESCRIPTION* |
|---|---|---|---|
| 1 | 2024 [1] | Smart Composting Solutions for Organic Waste Management and Soil Enrichment in Agriculture with IoT and Gradient Boosting. | Organic waste management is a challenge for modern agriculture since conventional techniques are frequently unsustainable and ineffective. A smart composting system that combines Gradient Boosting algorithms with Internet of Things technology is suggested as a solution. Temperature, moisture, pH, oxygen and other critical composting parameters are continuously monitored by IoT sensors. Gradient Boosting uses real-time data analysis to maximize microbial activity and decomposition. In addition to producing nutrient-rich compost that improves soil fertility and crop yield, this clever system expedites composting and minimizes resource waste. It promotes environmental friendly farming practices and sustainable agriculture by increasing productivity and producing precise forecasts. All things considered, this technology-driven strategy encourages environmentally friendly waste management and helps ensure a more sustainable agricultural future. [1] |
| 2 | 2023 [2] | Sustainable Paths to Food Security from the Perspective of Food Loss and Waste Management. | Events like the Russia-Ukraine war have exacerbated the global food security crisis by upsetting food supply chains and driving up prices. Simultaneously, almost one-third of the food produced globally is lost or wasted annually, impacting not only the availability of food but also the stability of the environment and the economy. Food security, safety, quality and sustainability are all directly related to Food Loss and Waste (FLW).<br>This review emphasizes how governments, organizations and individuals must work together to reduce FLW through better management techniques. It investigates sustainable methods for guaranteeing food security by cutting waste at every level of the food system from production to consumption using secondary research and content analysis. |

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| | | | The results highlight that one of the most important steps toward attaining sustainable food security is lowering food loss and waste. Societies can create a resilient, environmentally friendly, and just food system for the future by encouraging responsible consumer behaviour, effective resource use and improved distribution and storage systems. [2] |
| 3 | 2021 [3] | Smart Garbage Segregator and IoT Based Waste Collection system. | An inventive way to address the expanding waste issue brought on by the fast population growth is the Smart Garbage Segregation System. In addition to automatically separating dry, wet and metallic waste, this system also turns wet waste into compost , which can be utilized in urban agriculture, horticulture and organic farming.<br>By using Internet of Things technology, the system notifies waste management facilities when trash cans are full, preventing overflow and preserving hygienic conditions in public spaces. Despite being more costly than standard bins, it greatly lowers the amount of manual labour and the frequency of collection, improving waste management.<br>The system can be expanded to handle biomedical and industrial waste, which is particularly crucial in health-sensitive situations like COVID-19. The compost generated also encourages sustainability and greenery. All things considered, this clever solution improves resource recovery, urban cleanliness and environmental protection<br>Overall, this system encourages cleanliness, sustainability, and more intelligent urban living [3]. |
| 4 | 2020 [4] | Electrically controlled artificial system for organic waste management using Black Solider File with IoT monitoring. | The two primary categories of waste generated in a nation are inorganic and organic waste. Hazardous gases such as carbon dioxide, methane and hydrogen sulphide are released by untreated organic waste, causing marsh gas and contaminating subterranean water. Composting, biogas production, incineration and the use of Black Soldier Flies (BSF) are some of the methods used to manage this. Because it breaks down organic waste naturally and doesn't produce harmful byproducts, the BSF method is the most environmentally friendly of these.<br>By creating the perfect environment for larvae growth, an Internet of Things-based automated BSF waste management system aids in process control with little human intervention. The larvae can be sold as animal feed and the system yields high-quality organic fertilizer that is high in nitrogen and ammonia. In addition to lowering pollution and global warming, this approach fosters sustainable organic farming and generates income opportunities[4]. |

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| 5 | 2016 [5] | Biogas based chain business: A road to sustainable rural development. | In order to ensure equal participation and mutual benefit, the biogas-based chain business model introduces a bidirectional system in which each participant acts as both a buyer and a seller. A biogas plant receives organic waste from households, including cow dung, chicken manure, and other biodegradable materials. This model is intended for a rural community consisting of approximately 500 families. In exchange, they buy reasonably priced cooking gas, electricity, and biofertilizers made from the same waste.<br>This model provides a creative approach to sustainable development, keeping in mind the circumstances where rural areas frequently lack adequate electrification and access to natural gas. Organic bio-fertilizers lower health risks and pollution in the environment by substituting chemical fertilizers.<br>Overall, the model fosters agricultural productivity, energy self-sufficiency, economic empowerment, and efficient waste management, establishing a closed-loop system that supports long-term rural sustainability and benefits the participating entrepreneurs as well as the community.[5] |
| 6 | 2013 [6] | Management of tropical bio-geo-resources through Integrated Bio-cycle Farming System for healthy food and renewable energy sovereignty. | A sustainable agricultural model called the Integrated Bio-cycle Farming System (IBFS) was created to increase the economic worth of tropical bio-geo-resources with high biomass productivity. With an emphasis on the balanced cycle of energy, water, nutrients, carbon and organic matter, it unifies the agricultural and non-agricultural sectors through landscape ecological management.<br>IBFS encourages effective resource use for the benefit of farmers, communities and the environment by utilizing the 7R principles: reuse, reduce, recycle, refill, replace, repair, and replant. Food, feed, fuel, fibre , fertilizer and even bio-gas energy are all produced by this multipurpose and multiproduct system, which also promotes ecotourism and education.<br>By converting organic waste into high-value renewable products like organic fertilizers and animal feed. IBFS assists farmers of all sizes in producing both short-term and long-term revenue. All things considered, it provides a sustainable strategy that enhances rural development's sociocultural, environmental and economic facets. [6] |
| 7 | 2012 [7] | Biogas production potential in Algeria: Waste to energy opportunities. | Anaerobic digestion of organic materials, including food scraps, manure, and agricultural waste, produces biogas, a renewable energy source. Methane ($CH_4$) and carbon dioxide ($CO_2$) make up the majority of the gas mixture produced when biomass is broken down by this biological process without oxygen. Despite |

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| | | | being a strong greenhouse gas, methane can be captured and converted into clean energy, which lowers pollution in the environment.<br>Large volumes of organic waste from cities, industries, livestock, and agriculture in Algeria present a significant opportunity for the production of biogas. Waste management and energy production are two significant issues that can be resolved by using these wastes through anaerobic digestion. Algeria can improve rural energy access, cut greenhouse gas emissions, decrease landfill waste and generate employment by investing in biogas plants.<br>Government backing, appropriate waste collection systems, technology funding, and public awareness are necessary to realize this potential, though. A cleaner, circular economy and Algeria's renewable energy targets can both be greatly aided by biogas with well-coordinated policies, local involvement and sustainable practices.[7] |
| 8 | 2011 [8] | Comprehensive evaluation on reverse logistics system of city solid wastes. | An important factor in raising the effectiveness and sustainability of urban waste management is the scientific assessment of the reverse logistics system for city solid wastes. It offers strategies to improve the processes of collection, transportation, recycling, and reuse in addition to assisting in identifying weak points that impact system performance. In order to evaluate the efficiency of the municipal solid waste management process, this study creates a comprehensive evaluation index system and a comprehensive logistics flow model from the standpoint of the circular economy.<br>The study provides a solid theoretical foundation for future advancements by scientifically assessing the system's viability and validity using the weights combination method. The results highlight how improved coordination, technology, and management techniques can reduce environmental pollution, increase economic efficiency, turn waste into a valuable resource and support sustainable urban development [8] |
| 9 | 2009 [9] | A sustainable management of treatment plant for dairy wastes with the use of its by-products. | Since many farms in Costa Rica lack proper systems for waste treatment and disposal, the improper management of dairy and pig waste has resulted in significant environmental problems. Due to varying effluent volumes and concentrations, conventional wastewater treatment plants have failed as a result of the unchecked flow of manure, urine, and food residues.<br>The effective Application of Anaerobic Technology (AFBR System) in a dairy farm in Cartago, Costa Rica, offers a cost-effective and environmentally beneficial way to deal with this. In addition to treating dairy wastewater, this |

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| | | | system produces biogas that can be used to power agricultural operations. Additionally, the process produces useful byproducts like reusable water and organic fertilizers.<br>This sustainable management approach transforms waste into useful resources, reduces pollution, and supports clean energy production. It offers a model for environmentally responsible dairy farming that combines economic benefits with ecological protection, promoting cleaner production and sustainable development in the agricultural sector.[9] |

## VIII. CONCLUSION

The bioeconomy encourages organic farming by offering a sustainable and effective method of handling agricultural waste. It contributes to the closure of the nutrient loop and the reduction of environmental pollution by turning waste materials such as crop residues and animal manure into compost, biochar, and biogas. This bioeconomy system supports the production of renewable energy and rural livelihoods in addition this improves the biodiversity, soil fertility and water conservation. Figure 7 shows the organic waste management where bioeconomy promotes a cleaner, greener agricultural sector by reducing reliance on chemical inputs through the reuse and recycling of natural resources. In order to Biodiversity is important to achieve sustainable agriculture, environmental preservation and long-term food security for future generations.

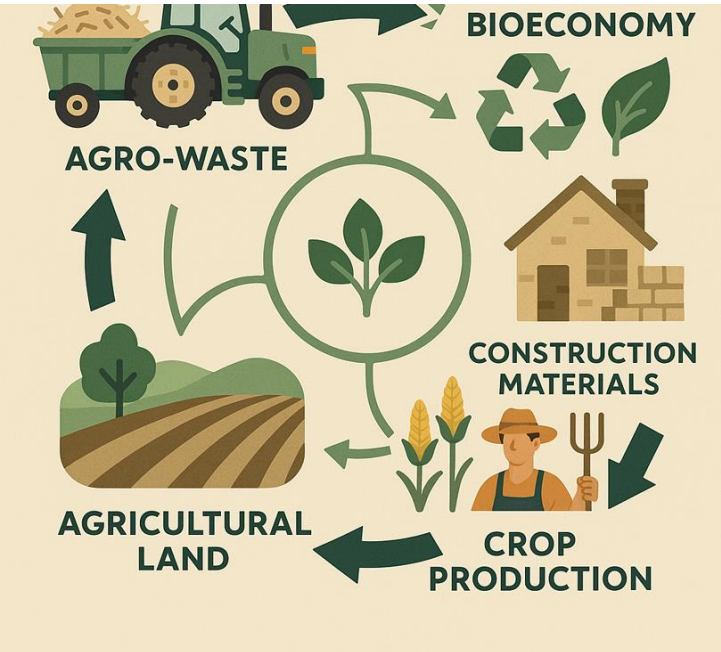


Figure 7: Organic waste management

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