

Smart Agri Bricks: IOT-Enabled Future Farming (IOT-Enabled Future Farming With Biodegradable Solutions)

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Abstract

The Smart Agri Bricks project presents an innovative solution to environmental and agricultural challenges by transforming waste materials into sustainable, smart-integrated bricks. The project focuses on reducing plastic pollution, managing biodegradable waste, and improving water efficiency in agriculture. Through the collection and separation of mixed waste, including plastics and biodegradable materials, the waste is repurposed into durable bricks. These bricks are embedded with IoT sensors to monitor soil moisture and water levels, enabling precision irrigation and promoting water conservation. The experimental phase includes waste processing, brick production, and field trials to assess the effectiveness of the solution in real-world agricultural settings. Initial results indicate significant improvements in plastic waste management, brick durability, and water efficiency. This approach highlights the potential for integrating sustainable practices into both waste management and agricultural systems, offering a scalable solution to pressing global issues.

Keyword: Smart Agri Bricks, plastic pollution, biodegradable waste, IoT sensors, water efficiency, sustainable agriculture, precision irrigation, waste management, circular economy.

1. INTRODUCTION

The Smart Agri Bricks project is an innovative initiative aimed at tackling pressing environmental and agricultural challenges through the integration of sustainable technology. This project revolves around converting waste materials, such as agricultural residues or biodegradable industrial by-products, into smart-integrated bricks. These bricks not only promote effective waste management but also offer groundbreaking solutions for modern agricultural practices.

The initiative provides an environmentally beneficial alternative to conventional garbage disposal techniques by recycling and reusing materials, therefore tackling the increasing problem of pollution. By converting waste products into useful materials, the transformation process aims to reduce impact on the environment. With the help of Internet of Things (IoT) sensors, these smart bricks can keep tabs on important metrics like soil moisture, temperature, and nutrient levels in real time. Precision farming and efficient use of resources are both made possible by this connection, which provides farmers with data-driven insights.

The project's dual focus on waste reduction and agricultural enhancement reflects a holistic approach to sustainability. By bridging the gap between waste management and smart farming, Smart Agri Bricks create a pathway to sustainable development. They embody a vision of a cleaner environment and smarter, more efficient agriculture, addressing two major global concerns while paving the way for innovative solutions in future farming.

1.1. Objectives of the study

Following are the objectives of the study:

- To reduce plastic pollution by introducing innovative biodegradable solutions.
- To manage biodegradable waste effectively by transforming it into sustainable resources.
- To enhance water efficiency in agriculture through advanced technologies and practices.
- To promote sustainable practices that contribute to environmental and agricultural resilience.
- To educate and raise awareness about the importance of environmental conservation and sustainable development.

1.2. Problem Statement

Plastic waste is a pressing environmental issue, polluting ecosystems and threatening wildlife due to its slow decomposition. Similarly, biodegradable waste in landfills releases methane, a potent greenhouse gas, exacerbating climate change. Effective waste management is crucial to mitigate these impacts.

In agriculture, traditional irrigation methods often waste water, straining limited resources and reducing crop yields [1]. Addressing these inefficiencies is essential for sustainable farming.

The Smart Agri Bricks project aims to resolve these challenges by integrating innovative solutions for waste management and water efficiency, paving the way for a more sustainable future.

1.3. Plastic Pollution

- **Global Plastic Production:** Over 300 million tons annually, with only 9% recycled.
- **Ocean Pollution:** Approximately 8 million tons of plastic waste enter oceans each year. [2]
- **Landfill Impact:** Plastics constitute around 12% of global municipal solid waste. [3]

1.4. Biodegradable Waste

- **Global Waste Generation:** Around 1.3 billion tons of food waste are generated annually.
- **Greenhouse Gas Emissions:** Methane emissions from landfill waste are 25 times more potent than CO₂. [4]
- **Composting Rates:** Only about 5% of food waste in the US is composted.

1.5. Water Management in Agriculture

- **Agricultural Water Use:** Accounts for 70% of global freshwater withdrawals. [5]
- **Water Wastage:** Inefficient irrigation systems can cause up to 60% water loss.
- **Impact on Crop Yields:** Efficient water management can boost yields by 20-30%.

2. LITERATURE REVIEWS

The goal of the study was to provide a comprehensive summary of smart farming's utilisation of IoT technologies. We summarised IoT-based solutions for smart farming by reviewing recent high-quality publications. These solutions consist of four core layers: perception, transport, processing, and application. Optimisation of input resources, conservation of irrigation water, reduction of fertiliser and pesticide amounts, and optimisation of energy resources are just a few of the smart farming challenges that may be addressed with the use of Internet of Things (IoT) technologies. So, the writers went over a few points about sensors, microcontroller systems, communication techniques, and cloud computing. Notably, a collection of inexpensive sensors and several common single-board computers were supplied. For a better understanding of the key factors, we spoke about the Internet of Things communication. [6]

The authors provided a synopsis of the Internet of Things (IoT) and big data as they pertain to smart agriculture in their paper. There has been much discussion on a number of topics pertaining to encouraging the deployment of IoT in the agricultural industry. According to the survey, there have been several attempts to use the internet of things (IoT) for smart agriculture in an effort to increase output while decreasing the need for human labour and increasing the efficiency of production. We spoke about the ways in which the Internet of Things and big data may improve farming. Furthermore, we highlighted the obstacles that must be surmounted in order to expedite the use of the Internet of Things in smart agriculture. But, in order for Internet of Things (IoT) solutions to be within the financial reach of most farmers, especially those operating small and medium-sized farms, certain obstacles must be overcome. Furthermore, security technologies must be upgraded on a constant basis. However, we believe that smart agriculture will inevitably implement IoT solutions, which will increase efficiency, give environmentally friendly food, facilitate food traceability, decrease the need for human labour, and improve productivity. [7]

To tackle the challenges of diminishing arable land and the rising global population's food needs, we require agricultural production approaches that are both smarter and more efficient. In order to practise sustainable agriculture, it is essential that everyone understand the concept of food security. Advances in agricultural technology are attracting creative youth to the field and elevating farming to the status of a respectable occupation. In order to make agriculture smarter and more successful in fulfilling future needs, this study highlighted the importance of numerous technologies utilised for farming, including the IoT. For the benefit of academics and engineers, we have highlighted the present difficulties and potential future developments in the sector. As a result, sustainable Internet of Things (IoT) sensors and communication technologies should be used to every inch of farmland in order to increase agricultural yield. [8]

3. RESEARCH METHODOLOGY

The experimental phase of the project involves several key methods. First, mixed waste, including plastics and biodegradable materials, is collected and separated using air classification and vibrating screens to ensure effective segregation. The separated biodegradable waste is then combined with soil, cocopeat, and seeds, and molded into bricks, which are dried to achieve the desired strength and durability. IoT sensors are integrated into the bricks to monitor real-time soil moisture and water levels, enabling efficient water management for agricultural use. These bricks are then tested in controlled agricultural settings, where their performance in water conservation and soil moisture management is evaluated through real-time data collected by the sensors. Finally, data on plastic separation efficiency, brick quality, and water management effectiveness is collected and analyzed to assess the overall impact of the project on both environmental and agricultural outcomes.

4. CONCEPTUAL FRAMEWORK

1. Garbage Collection and Processing

The project begins with the collection of mixed waste, including plastics and biodegradable materials. This waste undergoes a systematic process of separation, mixing, and molding to transform it into usable components.

2. Plastic Reuse

Separated plastic waste is repurposed into brick frames, reducing environmental plastic pollution and fostering a circular economy by reusing materials that would otherwise contribute to landfill accumulation.

3. Brick Production

Biodegradable waste is combined with soil, seeds, and cocopeat to create a sustainable mixture. This mixture is molded into bricks and dried to ensure strength and durability, making them suitable for agricultural and environmental applications.

4. Smart Features Integration

The bricks are enhanced with IoT technology, incorporating sensors to monitor critical agricultural parameters such as soil moisture and water levels. These smart features enable efficient water management and support precision farming practices, promoting sustainability and resource conservation.

5. SYSTEM COMPONENTS

Efficient waste processing tools, including separators and mixers, transform waste into durable bricks. IoT-enabled brick frames support real-time monitoring for precision water management in agriculture.

- **Trash Container and Screw Conveyor:**

Efficiently collects and transports mixed waste while controlling odor and optimizing storage capacity.

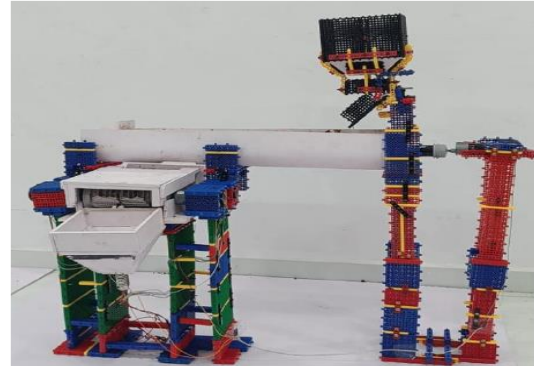


Figure1: Trash Container and Screw Conveyor

- **Plastic Separator:**

Utilizes air classification or vibrating screens to effectively separate plastics from biodegradable materials.

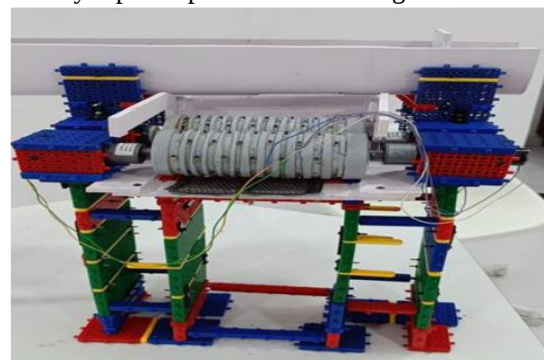


Figure2: Plastic Separator

- **Mixing Mechanism:**

Uniformly blends biodegradable waste with soil, cocopeat, and seeds, ensuring a consistent mixture for brick production.

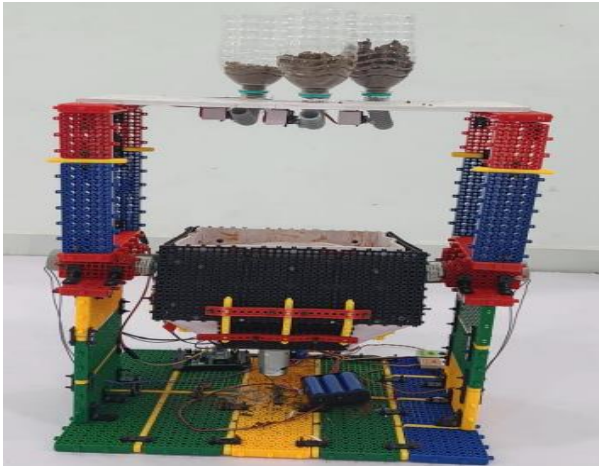


Figure 3: Mixing Mechanism

- **Molding and Drying:**

Shapes the mixture into bricks and dries them to achieve durability and structural integrity.

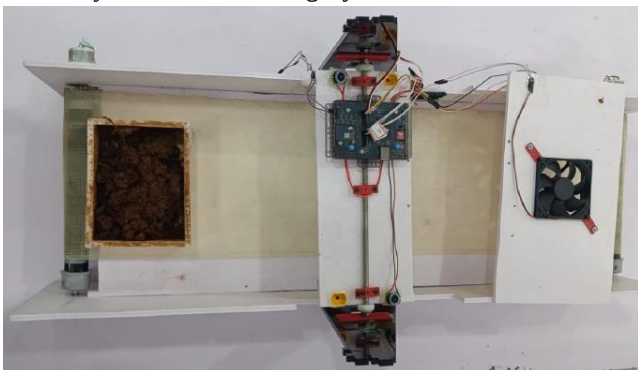


Figure 4: Molding and Drying

- **Brick Frame with IoT Integration:**

Embeds sensors for real-time soil moisture monitoring and precision water management, enhancing agricultural efficiency.

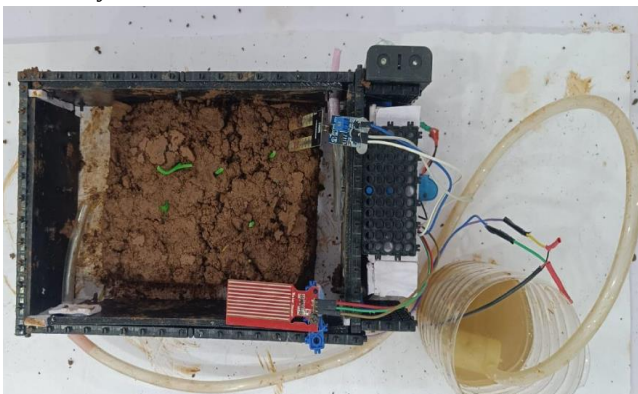


Figure 5: Brick Frame with IoT Integration

Brick Frame: The brick frame houses the molded bricks and incorporates sensors that monitor soil moisture and water levels in real time. This integration allows for precise tracking of soil conditions, enabling better irrigation management.

Water Management System: Integrated with the sensors in the brick frame, this system controls water flow based on the real-time data collected. It ensures efficient irrigation by adjusting water levels to maintain optimal soil moisture, thereby conserving water and improving agricultural productivity.

In essence, the system collects and processes garbage, recycles plastic, creates bricks, and uses smart technology to optimize water usage in agriculture.

6. IMPLEMENTATION

The project follows a streamlined process from waste collection to smart brick integration. Each step incorporates advanced technologies to optimize waste management and enhance agricultural water efficiency.

Process Flow:

- Garbage Collection
- Plastic Separation
- Plastic Reuse
- Mixing and Molding
- Drying
- Smart Brick Integration

Functionality:

Each step uses specialized processes and technologies to meet the project's goals, from waste sorting to integrating smart systems for effective water management in agriculture.

6.1. Performance Metrics

Efficiency of Plastic Separation: Evaluates the success of the plastic separator in removing contaminants from biodegradable waste.

Brick Quality and Durability: Assesses the strength and longevity of the molded bricks under various environmental conditions.

Accuracy of Smart Systems: Tests the precision of IoT sensors in monitoring soil moisture and water levels in real-time.

Effectiveness of Water Management: Measures the impact of the smart bricks on reducing water consumption and improving irrigation efficiency in agricultural applications.

7. RESULTS AND DISCUSSION

The testing and validation phase focuses on four key performance metrics: plastic separation efficiency, brick quality and durability, smart system accuracy, and water management effectiveness. First, the plastic separation process is assessed for its ability to efficiently remove contaminants, ensuring clean and usable materials for brick production. The durability and strength of the bricks are then tested, ensuring they meet the required standards for long-term use in agricultural settings. The smart system's accuracy is evaluated by testing the real-time monitoring of soil moisture and water levels through IoT sensors. Finally, the effectiveness of the integrated water management system is measured by assessing its impact on water conservation and irrigation efficiency, demonstrating its potential to reduce water wastage and improve crop yields. The results show high efficiency in waste separation, production of durable bricks, precise monitoring, and significant improvements in water management for sustainable agriculture.

8. CONCLUSION

The Smart Agri Bricks project successfully addresses critical environmental and agricultural challenges by transforming waste materials into sustainable solutions. By repurposing plastics and biodegradable waste into durable, smart-integrated bricks, the project not only reduces pollution but also promotes a circular economy. The integration of IoT technology in the bricks enables efficient water management, optimizing irrigation practices and conserving valuable water resources in agriculture. The project's testing phase demonstrated significant success in waste separation, brick durability, and water efficiency, highlighting its potential to enhance sustainable farming practices. Ultimately, the Smart Agri Bricks initiative paves the way for a greener, more resource-efficient future,

offering a promising solution to the pressing issues of plastic waste, waste management, and water scarcity in agriculture.

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