

IoT-Enabled Cow Dung Cake Biofuels: A Comprehensive Review and Entrepreneurial Opportunities

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ABSTRACT

Cow dung, a traditional energy source in India, has gained renewed attention as a sustainable and renewable energy resource. This review paper explores the potential of cow dung cakes as an alternative energy source, focusing on their environmental benefits, technological advancements, and entrepreneurial opportunities in India. The paper highlights the role of cow dung in addressing India's energy needs, reducing greenhouse gas emissions, and promoting rural development. The IoT-enabled prototype reduced production time from 90 seconds (manual) to 30–40 seconds per cake, doubling output to 90 cakes/hour. Energy use was 75 Wh/hour, costing only ₹0.45 per hour, with 95% system uptime. Sensor accuracy: $\pm 2\%$ for moisture and ± 50 g for weight. Field feedback confirmed improved hygiene, reduced drudgery, and strong user acceptance among SHG women operators. The present research work is going on at Gadgebaba Gaurakshan Charitable Trust, Mahuli (Dhande) Tq Daryapur Dist - Amravati under the guidance and supervision of Prof. Gajanan Bharsakle, and the proposed technology is under the patent procedures. The study concludes that cow dung cakes offer a viable solution for sustainable energy production, waste management, and rural entrepreneurship, aligning with India's goals of energy security and environmental sustainability.

Keywords:- IOT Machine,, Sustainability, Energy Conservation, Waste Management

1. INTRODUCTION

Energy security and sustainability are critical issues for India's economic development. With a growing population and increasing energy demands, the need for renewable and alternative energy sources is more pressing than ever. Cow dung, an abundant byproduct of India's large cattle population, presents a viable and eco-friendly solution. Using cow dung cakes in cremation significantly reduces the need for firewood, directly contributing to the conservation of forests and preventing deforestation. Traditional methods of using cow dung as fuel have existed for centuries, but technological advancements now enable its efficient utilization in the form of biogas, biomass briquettes, and organic fertilizers.

2.STATE OF ART ENERGY NEEDS IN INDIA

India is one of the world's largest consumers of energy, with a significant portion of its energy needs met through non-renewable sources such as coal and petroleum. The country faces challenges such as high dependence on fossil fuels, fluctuating energy prices, and increasing carbon emissions. Biomass energy, including cow dung cakes, contributes to India's renewable energy mix and provides an affordable alternative for rural households. The Indian government has introduced several policies and initiatives, like Gobardhan Yojana which aimed at converting cattle waste into bio-energy and promoting a circular economy. National Biogas and Organic Manure Programme (NBOMP) Etc.

3.METHODOLOGY OF MAKING COW DUNG CAKES

Collection: Gather fresh cow dung from the farm. It's important to use dung that is free from any foreign materials to ensure a pure end product.

Mixing: Combine the cow dung with a small amount of water to achieve a pliable consistency. We are mixing water, Cow dung, Nilgiri leaves, Neem leaves & Dammar Gum in the appropriate proportion,

Shaping: Form the mixture into flat, round cakes by hand. The size can vary, but typically they are around the size of an average hand. **Drying:** Place the shaped cakes in a sunny area to dry. This process can take several days, depending on the weather conditions.

Storage: Once dried, the cow dung cakes can be stored in a dry place until they are ready to be used.

Sr. No	Ingredient	Quantity	Approximate Cost
1	Cow Dung	10 Kg	5 Rs/Kg
2	Dry Nilgiri Leaves	20 gm	Free Available
3	Dry Neem Leaves	20 gm	Free Available
4	Dammer Gum	10 gm	16 Rs
5	Camphor	10 gm	17.9 Rs

4.IOT-BASED AUTOMATED COW DUNG CAKE MACHINE PERFORMANCE SYSTEM DESIGN AND METHODOLOGY

The design of the IoT-based automated cow dung cake-making machine is rooted in the need to address the inefficiencies, health risks, and scalability limitations of traditional manual dung cake preparation. The system aims to mechanize key stages of the process—mixing, shaping, drying, and monitoring—while integrating sensor-based intelligence and remote operability to ensure consistency, hygiene, and adaptability in rural contexts.

At the heart of the conceptual framework is a modular machine architecture that combines mechanical components with an IoT-enabled control system. The machine comprises a hopper-based feeding unit for introducing the cow dung mixture, a pressing mold mechanism for shaping the cakes, and an optional drying chamber equipped with embedded heat sources. The entire process is orchestrated by a microcontroller (ESP32), which serves as the central control unit. This microcontroller interfaces with various sensors and actuators to monitor and regulate operational parameters such as moisture content, pressing force, temperature, and weight. Data from these sensors is transmitted via Wi-Fi to a mobile or web-based dashboard, allowing users to track performance, receive alerts, and manage operations remotely.

The mechanical design prioritizes durability, ease of maintenance, and compatibility with rural fabrication capabilities. The frame structure is constructed from mild steel or aluminum, offering both rigidity and corrosion resistance. The dung feeding hopper facilitates manual or semi-automated input of the dung-straw mixture, ensuring a steady supply to the pressing unit. The mold assembly, which may utilize a hydraulic or screw-type mechanism, compresses the mixture into uniform shapes. Once formed, the cakes are ejected using a mechanical arm or slider, and optionally placed on a heated drying plate to initiate moisture reduction before final sun-drying or storage.

The electronic subsystem integrates a suite of low-cost, reliable components. The ESP32 microcontroller provides Wi-Fi connectivity and serves as the main control unit. A load cell paired with an HX711 amplifier measures the pressing force and verifies the weight of each cake, ensuring consistency. A capacitive moisture sensor monitors the water content of the dung mixture, while a DHT11 or DHT22 sensor tracks ambient temperature and humidity—critical variables for drying efficiency. A relay module controls the activation of heaters and motors, and an L298N motor driver regulates the movement of DC motors used in the mold and ejection mechanisms. The system is powered by a dual-voltage supply (12V/5V), calibrated to meet the requirements of the sensors and actuators.

The working principle of the system follows a structured process flow. Initially, the user loads the prepared cow dung mixture into the hopper. The moisture sensor immediately assesses whether the mixture falls within the optimal range (typically 40–50%). If the moisture level is outside this range, a warning is displayed on the user interface, prompting corrective action. Once validated, the mold mechanism is activated to compress the mixture into a standardized shape. The load cell then verifies the weight of the formed cake, ensuring it meets predefined specifications. If power is available, a heated plate initiates preliminary drying to reduce surface moisture. The mold then opens, and the cake is ejected mechanically. Throughout this process, all relevant data—including time stamps, moisture levels, temperature, and weight—is logged and transmitted to the dashboard, providing real-time visibility and historical records for performance analysis.

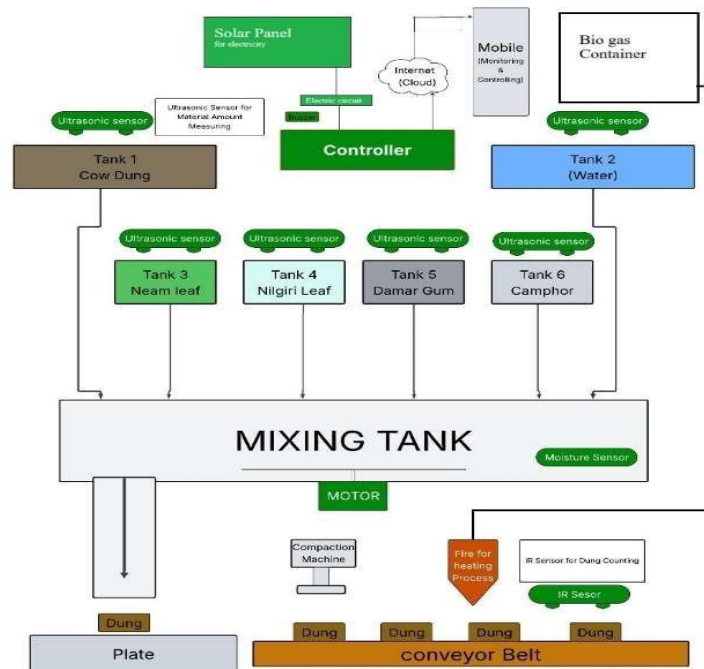


Fig:2 IOT Based Machine Design

5.FABRICATION, SOFTWARE DESIGN, AND TESTING METHODOLOGY

The development of the IoT-based automated cow dung cake-making machine involved a multidisciplinary approach combining mechanical fabrication, embedded programming, interface design, and rigorous testing. The system was built with modularity in mind to ensure ease of maintenance, adaptability to rural conditions, and scalability for future enhancements.

6.FABRICATION AND ASSEMBLY

The machine's physical structure was fabricated using a modular design philosophy, allowing individual components to be replaced or upgraded without disrupting the entire system. The frame was constructed using mild steel or aluminum, selected for its strength, corrosion resistance, and availability in rural fabrication workshops. Welding and precision cutting techniques were employed to assemble the structural framework, ensuring stability and durability under operational loads.

Custom molds for shaping dung cakes were produced using either 3D printing or CNC machining, depending on the required precision and material availability. These molds were designed to accommodate various cake sizes and shapes, with smooth surfaces to facilitate easy ejection and cleaning. The dung feeding hopper was integrated to allow manual or semi-automatic input of the dung-straw mixture, ensuring a consistent supply to the pressing unit.

Electronic components—including sensors, relays, and power systems—were wired and soldered with attention to insulation and layout optimization. A protective enclosure was designed to shield sensitive electronics from moisture, dust, and dung splatter, using locally available materials such as acrylic sheets or repurposed plastic containers. Safety features such as emergency stop buttons, electrical grounding, and overload protection circuits were incorporated to ensure operator safety and system reliability.

7.SOFTWARE DESIGN AND PROGRAMMING

The software architecture was developed using the Arduino IDE for embedded programming of the ESP32 microcontroller. The firmware was designed to perform key functions such as reading sensor data (moisture, temperature, weight), controlling motor and relay operations, transmitting data to the cloud or local dashboard via Wi-Fi, and triggering alerts in case of abnormal readings.

Sensor readings were processed using calibrated thresholds to determine operational decisions. For instance, if the moisture content exceeded the optimal range, the system would pause pressing and notify the user. Similarly, load cell data was used to verify cake weight consistency, and temperature readings informed drying cycle activation.

The user interface was developed using platforms such as Blynk, Firebase, or Node-RED, depending on connectivity and deployment context. The dashboard displayed real-time data including moisture

percentage, cake weight, system temperature, and production count. Users could control machine operations remotely, including start/stop commands, manual overrides, and export of status logs for performance analysis. The interface was designed to be intuitive and accessible via smartphones or web browsers, ensuring usability even in low-literacy environments.

8.SUMMARY

The IoT-based automated system enhanced productivity, hygiene, and rural entrepreneurship. Integration of these subsystems established a functional circular economy model with tangible sustainability outcomes. IoT automation modernizes production, bridging rural labor with digital systems.

9.CONCLUSION

This automation model modernizes rural biomass processing and exemplifies the integration of Industry 4.0 technologies into traditional livelihoods.

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