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Design and Fabrication of Biogas Brooder System Utilizing Chicken Waste for Sustainable Poultry Farming

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Abstract: *Sustainable agricultural practices are essential for addressing environmental degradation, resource depletion and energy inefficiency in traditional farming methods. One promising solution is integrating biogas technology with poultry farming, particularly in Nigeria, where poultry farming plays a crucial role in livelihoods and economic growth. This approach uses renewable energy sources, such as chicken manure, to generate biogas for heating poultry brooders, offering a sustainable alternative to fossil fuels. The goal of this project is to design and develop an efficient, eco-friendly portable biogas brooder system specifically for poultry farms. The system includes a digester tank to produce biogas from chicken manure, PVC pipes for transporting slurry, a stirrer for mixing and a drainer valve to manage excess liquid. Biogas is transported through a gas pipe to abiogas container for storage, which is then used in a burner to generate heat. The design incorporates seals and gaskets to prevent leaks and utilizes cost-effective materials for construction. The system is estimated to produce enough energy to power the burner for 2 hours daily, demonstrating its potential to improve operational efficiency, reduce costs and promote sustainable practices in poultry farming.*

Keywords: Biogas production, Sustainable agriculture, Poultry farming, Renewable energy, Chicken manure

I. INTRODUCTION

Sustainable agriculture practices have become increasingly imperative in addressing the myriad challenges associated with traditional farming methods, such as environmental degradation, resource depletion and energy inefficiency. In this context, the utilization of renewable energy sources and organic waste management techniques has emerged as a promising solution to foster sustainable agricultural practices. One such innovative approach is the integration of biogas technology with poultry farming, aiming to harness the energy potential of organic waste while enhancing the efficiency and sustainability of poultry operations [1]

In Nigeria, poultry farming serves as a significant source of livelihood for many individuals, contributing significantly to food security and economic growth. However, the sector faces various challenges, including the high cost of energy and environmental sustainability concerns. Addressing these challenges necessitates innovative solutions that promote sustainability and efficiency within poultry farming practices [2]. One promising solution lies in the utilization of biogas technology, which harnesses organic waste materials to generate renewable energy. Among these waste materials, chicken dung stands out as a readily available resource abundant in poultry farming operations across [3].

The generation of biogas from chicken dung offers small to medium-scale poultry farmers with a solution to waste management challenges while providing affordable, environmentally friendly energy for farm operations. This approach enhances energy self-sufficiency, reduces reliance on fossil fuels and mitigates environmental impacts [4]. Integrating biogas technology into poultry farming in Nigeria holds promise for improving operational efficiency, cutting costs and fostering sustainable practices. The portable biogas brooder system's versatility enables adoption across various farming environments, empowering farmers to embrace renewable energy solutions and enhance productivity and resilience.

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II. STATEMENT OF THE PROBLEM

The reliance on traditional methods of using fossil fuels for brooding chickens in Nigeria poses significant challenges. It contributes to environmental degradation and air pollution due to the combustion of fossil fuels, exacerbating climate change and posing health risks to both humans and animals. The high cost of fossil fuels burdens poultry farmers, particularly in rural areas where access to affordable energy sources may be limited. Moreover, the dependence on fossil fuels undermines energy security, as power outages and supply shortages are common in many parts of Nigeria. The traditional method of using fossil fuels for brooding chickens presents a pressing need for sustainable alternatives to ensure environmental protection, economic viability and energy resilience in the poultry industry.

III. OBJECTIVES

The objectives for developing the portable biogas brooder system for poultry farms are as follows:

- To design and develop an efficient, eco-friendly portable biogas brooder system specifically tailored for poultry farms.
- To utilize chicken manure as a renewable feedstock for biogas production, providing a sustainable energy source for heating poultry brooders.
- To offer a sustainable alternative to fossil fuels through biogas technology integration, which reduces the environmental impact and energy costs of traditional heating methods.
- To estimate and optimize the daily energy output of the system, ensuring it provides sufficient heating for poultry brooders for at least 2 hours.

A. Construction and Working Functions


Digester Tank


Chicken Waste


PVC Pipes


Drainer Valve


Gas Pipe



Biogas Container Regulator


Burner

Digester Tank: The primary chamber where anaerobic digestion occurs, breaking down chicken waste into biogas. The tank is constructed from materials such as high-strength steel or reinforced concrete, chosen for their resistance to corrosion and ability to withstand prolonged contact with acidic slurry and biogas. This ensures long-term durability and prevents degradation over time.

Chicken Waste: Consists of a mixture of chicken manure, feathers and bedding material (such as wood shavings or straw). This organic matter serves as the main feedstock in the biogas production process. The waste is mixed with water to create a slurry, which is then introduced into the digester for anaerobic digestion, where microbes break it down to produce methane-rich biogas.

PVC Pipes: These pipes are used for transporting chicken waste slurry from the collection area to the digester tank and for discharging the digested slurry after biogas production. Made from high-density PVC, the pipes are durable, resistant to chemical corrosion and capable of handling both organic material and biogas flow without leakage or degradation. PVC pipes are also utilized in the system for constructing to a **Stirrer**, a mechanical device that continuously mixes the slurry within the digester to ensure an even distribution of microbes and prevent the formation of scum or solid layers. This action helps maintain uniform conditions inside the digester, optimizing the anaerobic digestion process and enhancing biogas yield.

Drainer Valve: Located at the bottom of the digester tank, this valve is used to drain excess liquid or sludge that may accumulate during digestion. Draining helps maintain the proper balance of slurry and prevents the digester from overflowing. Valves made of brass or stainless steel are preferred due to their corrosion resistance and durability when exposed to the aggressive conditions inside the digester.

Gas Pipe: A specially designed pipe that carries the biogas produced in the digester to a storage container or burner. The gas pipe is typically made from flexible, gas-tight materials such as rubber or PVC, ensuring a secure and leak-free transport of biogas. The pipe is also designed to withstand the pressure of the biogas and resist corrosion from the methane and other gases.

Biogas Container: A storage unit that temporarily holds the biogas produced by the digester. Often constructed from flexible materials like reinforced rubber or heavy-duty plastic, the container expands and contracts as biogas is produced and used. The biogas is stored here under low pressure until it is needed for cooking, heating, or power generation.

Regulator: A device that controls the flow and pressure of the biogas coming from the digester or storage container. The regulator maintains safe operating pressure and prevents backflow into the digester. Typically made from brass or high-quality plastic, it ensures consistent gas delivery to the burner while protecting the system from overpressure damage.

Burner: A combustion unit where the biogas is burned for cooking or heating. The burner is designed to handle the high temperatures generated during combustion and is typically made from heat-resistant materials like stainless steel or cast iron. It provides a stable, controlled flame that allows the biogas to be used efficiently as an energy source.

Seals and Gaskets: Made from materials like rubber or silicone, these components are used to create airtight seals at connections between pipes, valves and other parts of the system. They prevent biogas leakage, which is essential for maintaining system efficiency, safety and preventing energy loss.

Elbows: Pipe fittings that allow the gas or slurry pipes to change direction as needed. These fittings are designed to ensure smooth transitions, reducing resistance and ensuring the continuous flow of materials without causing blockages or turbulence in the system.

Gas Tape: A special sealing tape that is used on threaded pipe joints or fittings to ensure an airtight, leak-proof connection. The tape is applied to threaded connections before they are tightened, helping to create a secure seal and prevent biogas leaks in the system.

Concrete Base: A solid foundation made from reinforced concrete that supports the weight of the digester tank and prevents it from shifting or settling over time. The concrete base ensures the stability of the system, especially under the pressure and weight of the digester when filled with slurry and biogas.

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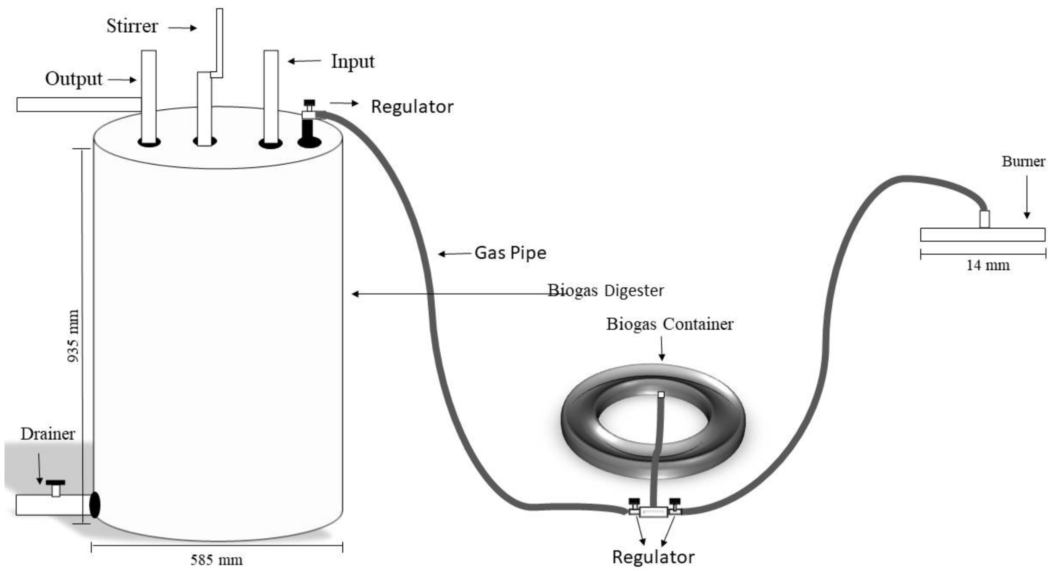

Fig 1. Biogas Brooding System

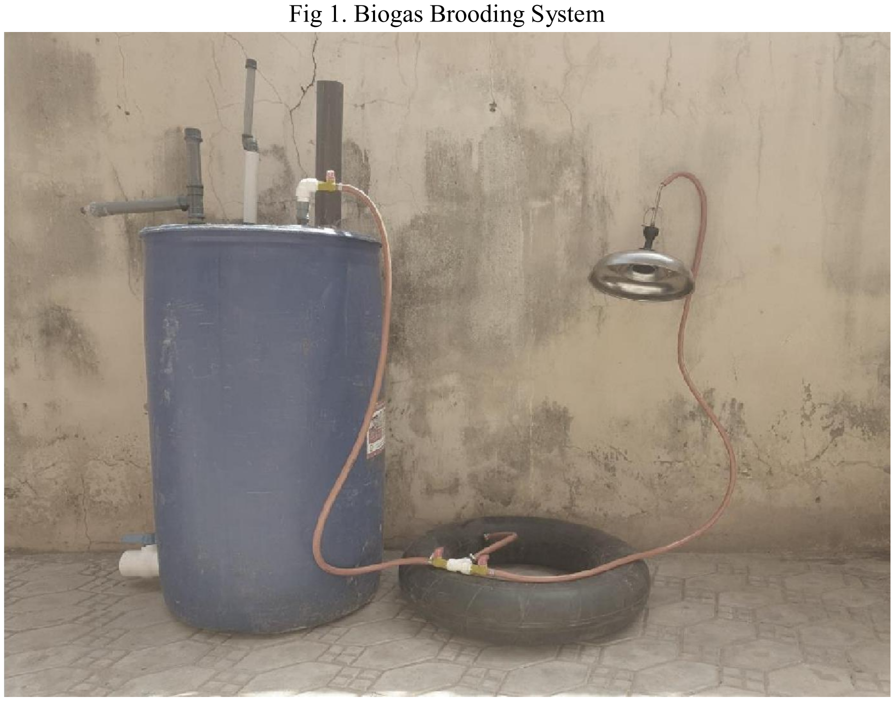

Fig 2. Working model

IV. CONCLUSION

This work has successfully designed and developed a portable biogas brooder system for poultry farms. The project involved applying technical and fabrication skills to create an efficient, eco-friendly system that utilizes chicken manure for biogas production. Key components, including the digester tank, PVC pipes, stirrer, and safety features, were incorporated to ensure optimal performance and safety. The project provided valuable insights into the use of renewable energy in agriculture, particularly in poultry farming. By integrating biogas technology, the system offers a sustainable, cost-effective alternative to traditional heating methods, improving operational efficiency and reducing environmental impact. This work contributes to the development of practical solutions for poultry farming, highlighting the role of biogas systems in promoting sustainable agricultural practices.

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