BIOGAS PRODUCTION: A PATH TO PROSPERITY FOR AGRICULTURE AND ANIMAL HUSBANDRY

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Abstract

By processing organic waste into biogas composed primarily of CH4 (55–65%) and CO2 (35–45%) farmers can mitigate the impact of volatile LPG markets while producing a high-potency liquid digestate rich in Nitrogen, Phosphorus, and Potassium. Technical analysis confirms that maintaining a 1:1 feedstock-to-water ratio and ensuring anaerobic stability optimizes gas yield (0.037 m3/kg of dung) and improves thermal efficiency from 11% in traditional combustion to 60%. Ultimately, the integration of biogas systems facilitates a circular bio-economy, enhancing soil health through organic fertigation and providing a scalable model for rural energy self-sufficiency and carbon footprint reduction.

Introduction

India is an agrarian country, and animal husbandry is the lifeline of our farmers. Generally, farmers view animal dung only as traditional manure; however, from a scientific perspective, this 'waste' is truly as valuable as 'gold.' Currently, the prices of Liquefied Petroleum Gas (LPG) are consistently rising. In Gujarat, the price of a domestic gas cylinder has reached approximately ₹920 to ₹940. Due to ongoing conflicts in Iran and West Asia, there have been significant disruptions in the global supply of crude oil and gas. India imports about 65-70% of its LPG requirements, which primarily pass through the 'Strait of Hormuz.' As this route is affected by war, there are fears of severe gas shortages and further price hikes in the coming days. In such a time of 'crisis,' biogas plants provide an 'opportunity' by making farmers self-reliant. India possesses one of the largest livestock populations in the world. According to the 20th Livestock Census, the total livestock population in India is approximately 535.78 million. Every day, millions of tonnes of dung and kitchen food waste are produced. If this waste is utilized for biogas production, a significant portion of India's rural energy needs can be generated locally at home, while also ensuring effective waste management.

What is Biogas?

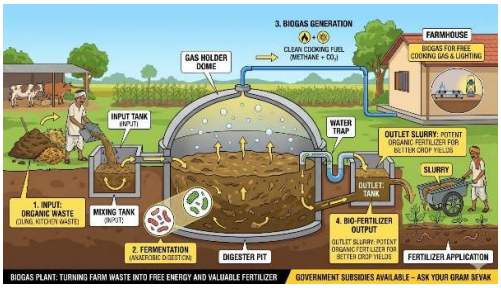
Biogas is a gas produced through the decomposition of organic waste (such as cattle dung, agricultural residue, kitchen waste, human excreta, pig manure, and poultry droppings) in the absence of oxygen (anaerobic digestion) (Akinola and Olanrewaju, 2025). It primarily consists of Methane (CH_4), about 55-65%, and Carbon Dioxide (CO_2), about 35-45%. Biogas also contains trace amounts of gases like Nitrogen and Hydrogen Sulfide (H_2S). This gas is smoke-free and serves as an excellent fuel for cooking. By removing impurities like CO_2 and H_2S from biogas and compressing it, Bio-CNG (Compressed Biogas) can also be produced.

Structure and Working Mechanism of a Biogas Plant

A biogas plant is primarily divided into three main components:

1. **Inlet Tank:** This is where the mixture of dung, organic kitchen waste, and water (known as slurry) is prepared. Generally, it is mixed in a 1:1 ratio (1 kg of dung per 1 litre of water).

2. **Digester:** This is an airtight underground tank or chamber. Here, anaerobic bacteria decompose the dung and other organic waste through a biological process, which results in the generation of biogas.
3. **Outlet Tank:** Once the gas is produced, the processed liquid residue (digested slurry) flows out through this



tank. This leftover slurry serves as a high-quality organic fertilizer.

Multiple Benefits of Biogas

1. Free Cooking Gas and Energy

- **Cost Savings:** Domestic cooking gas can be obtained virtually for free, significantly reducing the monthly expenditure on LPG cylinders.
- **Versatility:** This gas is not limited to cooking; it can also be used for lighting (via biogas lamps) or to power modified internal combustion engines for farm machinery.
- **Environmental Impact:** It reduces the dependency on traditional firewood. By switching to biogas, the labor required to collect wood, the hassle of storing it during the monsoon, and the health hazards associated with smoke are eliminated, thereby reducing indoor air pollution.

2. Superior Organic Fertilizer

- The slurry obtained from the outlet is richer in nitrogen, phosphorus, and potassium compared to raw dung dried in the sun.
- It improves soil structure and promotes sustainable organic farming.

'Slurry' (Liquid Fertilizer): A Nectar for Crops

The slurry discharged from the biogas plant is essentially "liquid gold" for farmers. It is nearly **10 times more potent** than traditional farmyard manure (FYM).

- **Nutrient Rich:** It contains high concentrations of Nitrogen (N), Phosphorus (P), and Potassium (K) in a form that plants can absorb easily (Kumar and Sharma, 2025).
- **Direct Application:** It can be applied directly to the fields along with irrigation water (fertigation).
- **Soil Health:** It significantly enhances soil fertility and encourages the growth of **earthworms**, which naturally aerate the soil and improve its texture.

Operational Guidelines for Daily Maintenance

To ensure the longevity and efficiency of the biogas plant, the following steps should be followed:

a. Quality of Input: Use only **fresh and clean cattle dung** regularly. Avoid using old, dried-out dung as it reduces gas production.

b. Precise Mixing: Maintain a 1:1 ratio of dung to water. Ensure they are mixed thoroughly to create a uniform slurry and feed it into the plant at the same time every day for consistency.

c. Steady Supply: To ensure a constant supply of gas without shortages, the required amount of input must be fed daily. This maintains the bacterial equilibrium inside the digester.

d. Slurry Preparation & Cleaning:

- **Eliminate Clumps:** While mixing, ensure there are no hard lumps of dung. The mixture should be homogeneous (consistent).
- **Sedimentation:** After mixing in the inlet tank, let the slurry sit for 10–15 minutes. This allows heavy inorganic particles (like sand or stones) to settle at the bottom, preventing them from entering and clogging the digester.

- **Hygiene:** Once the slurry is fed into the digester, wash the mixing tank thoroughly with water to remove dust and debris.
- **Initial Charging:** When filling the digester for the first time, ensure the slurry is poured evenly from both sides to maintain structural balance.

Protection of Environment and Health

- **Sanitation:** Biogas plants reduce the accumulation of open dung heaps, which in turn decreases filth and the breeding of mosquitoes and flies.
- **Women's Health:** Since biogas is a clean, smokeless fuel, it prevents eye irritation and respiratory (lung) diseases among rural women, which are common when cooking with traditional firewood or dung cakes (Vasco-Correa *et al.*, 2024).

Economic Gains for Farmers: The Mathematics of Prosperity

When dung is processed through a biogas plant, the farmer gets dual benefits: clean fuel and superior manure. Without a plant, dung is typically used as "Dung Cakes" (Chhana), which is inefficient.

- **Efficiency Gap:** The thermal efficiency of dung cakes is only 11%, whereas Biogas has a high efficiency of **60%** (Ahammad and Sreekrishnan, 2024).
- **Daily Dung Production (Average):**
  - **Buffalo:** 15 kg
  - **Cow:** 10 kg
  - **Calf:** 5 kg
- **Gas Yield:**
  - **1 kg Dung:** 0.037 m3 (approx. 1.3 ft^3) of gas.
  - **Human Excreta (per person):** 0.028 m3 (approx. 1 ft^3) of gas.

Consumption Requirements:

Purpose	Requirement (m^3)	Requirement (ft^3)
Cooking	0.227 per person/day	8 ft^3 per person/day
Lighting	0.127 per hour/lamp	4.5 ft^3 per hour (100 candle power)

Hypothetical Example (Farmer with 5 Cattle):

1. **Savings:** Saves approximately ₹1,000 - ₹1,100 per month on LPG cylinders.
2. **Manure Wealth:** Produces 20 to 30 trolleys of high-quality organic fertilizer annually, reducing chemical fertilizer costs by nearly 50%.
3. **Better Yield:** Shifting toward organic farming fetches higher market prices for crops.

Government Assistance and Schemes

Farmers can avail of significant financial help to install these plants:

- **GEDA (Gujarat Energy Development Agency):** Provides substantial subsidies for biogas plants in Gujarat.
- **GOBARdhan Scheme:** The Central Government's "Galvanizing Organic Bio-Agro Resources Dhan**"** scheme offers incentives to convert waste into wealth (Ministry of Jal Shakti, 2026).
- **Contact:** Farmers can reach out to the District Panchayat Agriculture Department or their local Gram Sevak to apply for these benefits.

Conclusion

- Biogas is not just a source of fuel; it is the first step toward a farmer's financial independence. While rising pollution and inflation are "crises," adopting a biogas plant transforms them into an "opportunity." Every livestock-owning farmer should move in this direction today.

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"Cattle dung brings prosperity to the farm—Biogas strengthens the nation's charm."

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