Bio Vet Innovator Magazine
(Fueling The Future of Science…)
Volume 3 (Issue 10) OCTOBER 2026
OPEN ACCESS World Animal Day – 04th October 2026 Popular Article

# From Dung to Energy: Sustainable Livestock Waste Management and Biogas in India

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DOI: https://doi.org/10.5281/zenodo.23645177

Received: October 09, 2026
Published: October 17, 2026
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**Abstract:**

Indian agriculture and rural livelihoods heavily rely on livestock output, however the growing number of animals in dairy farms, poultry farms, pig farms, sheep and goat units, and gaushalas also produces significant amounts of manure and other organic wastes. Livestock manure can cause Odors, contamination of the air and water, greenhouse gas emissions, nutrient loss, and the spread of infections and antibiotic resistance factors if it is not properly managed. However, livestock waste is also a valuable biological resource containing organic matter and plant nutrients. Appropriate management can therefore convert livestock waste into useful products such as compost, vermicompost, biogas, compressed biogas (CBG), biofertilizer and biochar. Recent research emphasizes a shift from a conventional "waste disposal" approach towards resource recovery and circular livestock farming.

**Keywords:** Livestock waste management, animal manure, cattle dung, dairy waste, anaerobic digestion, biogas, CBG, composting, biochar, sustainable livestock farming.

## Introduction:

Livestock waste is a natural and inevitable part of animal husbandry. Animals such as cattle, buffaloes, sheep, goats, pigs and poultry produce manure on a daily basis. Dairy farms and large-scale livestock operations, in particular, often generate considerable amounts of waste within limited areas. Traditionally, farmers have utilized animal manure as farmyard manure to improve soil fertility or as a source of fuel for household energy needs.

However, increasing livestock density and commercialization of animal farming require more systematic approaches to collection, storage, treatment and utilization. Improper management of livestock manure can create serious environmental and public health concerns, including the release of ammonia and greenhouse gases, contamination of surface water and groundwater, unpleasant odours, and the spread of harmful microorganisms and antimicrobial resistance determinants. These challenges highlight

the need for sustainable manure management practices that not only reduce environmental pollution but also convert livestock waste into useful resources. **Biogas production offers a practical solution to these concerns**, as it allows animal manure to be converted into renewable energy through anaerobic digestion. This process produces biogas, which can be used for cooking, heating and electricity generation, along with nutrient-rich digestate that can be utilized as organic manure. (Sadeghpour and Afshar, 2024, Qi *et al.*, 2023).

## What is Livestock Waste?

Livestock waste includes materials generated during animal production, housing and farm operations.




**Figure 1- Categories of Livestock Waste**

## Why is Livestock Waste Management Important?

### A. Environmental Protection:

When livestock waste is not properly managed, it can pollute the soil, water and air. Rainwater can carry nutrients from animal dung into nearby ponds, lakes and rivers, causing excessive growth of algae and reducing the oxygen available for aquatic life. Similarly, when manure is left to decompose or stored without proper care, it can release harmful greenhouse gases such as methane and nitrous oxide, which contribute to global warming. Wavhal *et al.,* 2025 highlighted that improper management of livestock manure can lead to several problems, including water pollution from nutrient runoff, the release of greenhouse gases, the spread of disease-causing

microorganisms, and the presence of genes that can make bacteria resistant to antibiotics.

**B. Odour Control:**

When animal manure is not stored properly, it can release gases such as ammonia and hydrogen sulphide, along with other substances that produce strong, unpleasant smells and affect the surrounding environment.

**C. Nutrient Conservation:**

Animal manure contains valuable nutrients that come from the feed consumed by livestock. When manure is properly treated and applied to agricultural fields, these nutrients are returned to the soil, helping improve soil fertility and support crop growth. In this way, livestock waste can be reused as a useful resource, completing the natural cycle of nutrients between animals, soil and crops.

**D. Energy Recovery:**

Organic waste from livestock farms, such as animal dung and leftover feed, can be used to produce biogas. In this process, microorganisms break down the waste in the absence of oxygen, producing a renewable source of energy that can be used for cooking, heating and electricity generation.

## Livestock Waste Management in India:

Ahmed and Vijay (2026) estimated that India's theoretical annual biogas production potential from livestock manure increased from approximately 31,602 million cubic metres in 2012 to 33,686 million cubic metres in 2019. Their findings highlight the considerable opportunities for converting animal waste into renewable energy. However, turning this potential into reality is not easy. Simply having large quantities of animal dung does not guarantee successful biogas production. Proper dung collection, transportation, financial support, plant maintenance and reliable markets for the final products are equally important.

Sekhon *et al.* (2026) also highlighted these challenges, pointing out that the success of livestock waste management depends on organized dung collection, maintaining product quality and finding suitable markets for organic fertilizers. Proper use of digestate, the nutrient-rich material left after biogas production, is another important factor.

Thus, India's main challenge is not just producing energy from livestock waste but developing practical and affordable systems that can benefit farmers and rural communities.

## Major Approaches to Livestock Waste Management:




**Figure 2. Main pathways for recovering useful products from livestock waste (author-developed schematic).**

### 1. Composting:

Composting is an easy and economical way to turn animal dung, used bedding and other farm waste into valuable organic manure. In this process, microorganisms break down organic materials in the presence of oxygen. As decomposition takes place, heat is generated, which can help destroy many harmful microorganisms under suitable conditions. The prepared compost can then be added to agricultural fields to improve soil fertility, provide nutrients and promote healthy crop growth (Sadeghpour and Afshar, 2024).

### 2. Vermicomposting:

Vermicomposting is a natural method in which earthworms, along with microorganisms, break down livestock dung and other biodegradable waste into nutrient-rich organic manure called vermicompost. Before adding earthworms, animal dung should be allowed to decompose partially and cool down, as fresh manure may produce excessive heat and ammonia that can harm the worms. The finished vermicompost can improve soil quality, increase nutrient availability and support better plant growth (Raza *et al.,* 2022).

### 3. Biochar Production:

Animal manure can also be converted into a useful material known as biochar. It is prepared by heating dried organic waste at high temperatures with little or no oxygen through a process called pyrolysis. Biochar can be added to agricultural soil to improve certain soil properties and support

sustainable farming. However, manure-based biochar should be properly tested before use, as it may contain unwanted substances or harmful contaminants depending on the raw material and production conditions (Rathnayake *et al.,* 2023).

**4. Biogas:**

Biogas commonly contains methane and carbon dioxide, with small amounts of other gases. The methane allows it to burn. According to Ministry of New and Renewable Energy gas can be piped to suitable cooking stoves or, in larger systems with the necessary equipment, used for heat and electricity. Steady feedstock supply, suitable moisture and temperature, and regular maintenance all influence gas output.

***How Biogas Is Produced?***

Biogas forms when microorganisms break down organic matter in a closed tank without oxygen. On a typical dung-based farm, collected manure is mixed with water, fed into an airtight digester and allowed to decompose. Microbial groups, including methane-producing archaea, gradually produce methane-rich gas. The leftover material is known as digestate (Kadam *et al.,* 2024, Pandey *et al.,* 2021;).

**Typical Composition of Biogas**

| Compound | Molecular Formula | Percentage |
|---|---|---|
| Methane | $CH_4$ | 50-75 |
| Carbon Dioxide | $CO_2$ | 25-50 |
| Nitrogen | $N_2$ | 0-10 |
| Hydrogen | $H_2$ | 0-1 |
| Hydrogen Sulphide | $H_2S$ | 0-3 |
| Oxygen | $O_2$ | 0 |

**Figure 3 – Source: Prepared by the author based on MNRE**

***Biogas Applications:***

During this process, methane-producing microorganisms help convert the waste into biogas, which can be used for cooking, heating and electricity generation (Kumar *et al.,*2021). As a renewable source of energy, biogas offers a useful way to manage organic waste while reducing dependence on conventional fuels. This is particularly important in livestock farming, where large quantities of manure are generated daily and improper waste management can cause serious environmental pollution.

ISSN: 3048-8397

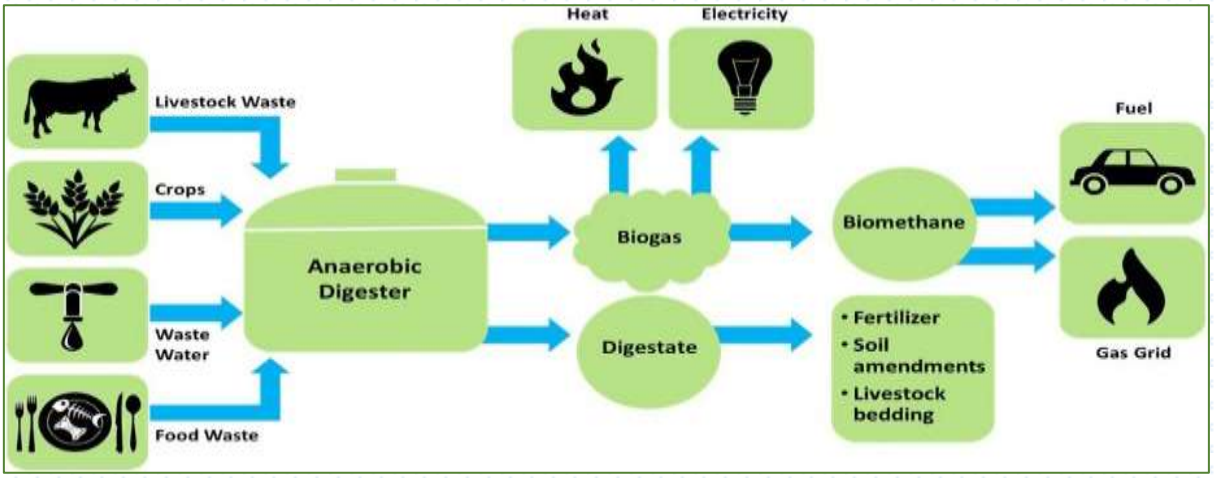



**Figure 4. Schematic of biogas production and optimization.**

## Future Prospects of Biogas in India:

Government programmes have encouraged biogas and organic-waste recovery. The Ministry of New and Renewable Energy's Biogas Programme supported household and medium-size plants during its stated 2021–22 to 2025–26 phase, while GOBARdhan promotes conversion of dung and other organic waste into useful products (Ministry of New and Renewable Energy, n.d.; Department of Drinking Water and Sanitation, n.d.). Current assistance, eligibility and application windows should be confirmed from official portals before making an investment.

Future progress will require reliable dung supply, trained technicians, affordable operation, control of gas leakage and safe digestate use. Community participation matters as much as plant technology. Successful projects should be assessed through actual energy output, operating costs and environmental performance rather than only the number of plants installed (International Energy Agency, 2025; Sekhon *et al.,* 2026).

## Conclusion:

Livestock dung should no longer be viewed only as a disposal problem. With suitable collection and treatment, it can support cleaner farms, provide renewable energy and return valuable nutrients to fields. Biogas is especially relevant to Indian livestock systems, but its benefits depend on sound day-to-day management. The goal is not simply to build more plants; it is to keep workable plants running and ensure that both gas and digestate are put to good use.

Livestock dung should therefore be viewed not merely as a waste product, but as a valuable resource that can provide energy, enrich agricultural soil and contribute to a cleaner and more sustainable rural environment.

## References:

Ahmed B, Vijay VK. (2026). Biogas generation potential and greenhouse gas emission saving potential from livestock manure: A state-level analysis for India. *Energy for Sustainable Development*, 92, 101960. DOI:https://doi.org/10.1016/j.esd.2026.101960

Alengebawy A, Ran Y, Osman AI, et al. (2024). Anaerobic digestion of agricultural waste for biogas production and sustainable bioenergy recovery: a review. *Environmental Chemistry Letters*, 22, 2641–2668. DOI: https://doi.org/10.1007/s10311-024-01789-1

Department of Drinking Water and Sanitation. (n.d.). About GOBARdhan Initiative. Ministry of Jal Shakti, Government of India.

International Energy Agency. (2025). Outlook for Biogas and Biomethane: A Global Geospatial Assessment. IEA, Paris.

Kadam R, Jo S, Lee J, Khanthong K, Jang H, Park J. (2024). A Review on the Anaerobic Co-Digestion of Livestock Manures in the Context of Sustainable Waste Management. *Energies*, 17(3), 546. DOI: https://doi.org/10.3390/en17030546

Kumar N, Gupta H. Methane: risk assessment, environmental, and health hazard. In: Singh J, Kaushik RD, Chawla M (eds), Hazardous Gases. London: Academic Press, 2021, 225–38. DOI: https://doi.org/10.1016/B978-0-323-89857-7.00009-8

Ministry of New and Renewable Energy. (n.d.). Biogas Programme (Phase-I) for FY 2021–22 to 2025–26. Government of India.

Pandey P, Pandey A, Yan L, Wang D, Pandey V, Meikap BC, Huo J, Zhang R, Pandey PK. (2021). Dairy Waste and Potential of Small-Scale Biogas Digester for Rural Energy in India. *Applied Sciences*, 11(22), 10671. DOI: https://doi.org/10.3390/app112210671

Qi J, Yang H, Wang X, Zhu H, Wang Z, Zhao C, Li B, Liu Z. (2023). State-of-the-art on animal manure pollution control and resource utilization. *Journal of Environmental Chemical Engineering*, 11(5),110462.DOI: https://doi.org/10.1016/j.jece.2023.110462

Rathnayake, D., Schmidt, H.-P., Leifeld, J., Mayer, J., Epper, C. A., Bucheli, T. D., & Hagemann, N. (2023). Biochar from animal manure: A critical assessment on technical feasibility, economic viability, and ecological impact. GCB Bioenergy, 15(9), 1078–1104. DOI: https://doi.org/10.1111/gcbb.13082

Raza, S. T., Wu, J., Rene, E. R., Ali, Z., & Chen, Z. (2022). Reuse of agricultural wastes, manure, and biochar as an organic amendment: A review on its implications for vermicomposting technology. Journal of Cleaner Production, 360, 132200.

Sadeghpour A, Afshar RK. (2024). Livestock manure: From waste to resource in a circular economy. *Journal of Agriculture and Food Research*, 17, 101255. DOI: https://doi.org/10.1016/j.jafr.2024.101255

Sekhon SS, Kasrija R, Dhaliwal PS, Garg V, Sharma RK. (2026). Livestock Waste Valorisation in India: A Critical Appraisal of Conversion Technologies, Policy Instruments and Implementation Practice. *Archives of Current Research International*, 26(9), 709–730.

Wavhal, N., Dhaka, P., Kaur, S. and Wakchaure, N. (2025). Manure management in dairy cattle: Insights into regional variability and sustainable approaches. Environmental Quality Management. 35(2): e70221. DOI: https://doi.org/10.1002/tqem.70221