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Entrepreneurship in the Production of Green Electricity from Livestock Waste Gases in Livestock Farms with an Approach to Attrition Entrepreneurship Theory and the United Nations Sustainable Development Goals

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ABSTRACT
Increasing global emphasis on sustainable energy has driven heightened attention toward renewable electricity generation from livestock waste gases, particularly through biogas systems based on anaerobic digestion. This review investigates the entrepreneurial dimensions of green electricity production on livestock farms, drawing on sustainable and attrition-focused entrepreneurship perspectives and situating the discussion within the framework of the United Nations Sustainable Development Goals (SDGs). By integrating insights from relevant scientific studies, the paper examines the technological basis of biogas-powered electricity generation, emerging entrepreneurial models, and the associated economic, social, and environmental outcomes. The analysis illustrates how green energy entrepreneurship supports several SDGs, notably affordable and clean energy (SDG 7), climate action (SDG 13), responsible production and consumption (SDG 12), and inclusive economic growth and employment (SDG 8). Special emphasis is placed on the constraints encountered by rural and farm-based entrepreneurs, including substantial upfront capital requirements, technological challenges, market volatility, and the risk of business failure. The review emphasizes the importance of enabling policies, financial mechanisms, and innovation-supporting ecosystems in minimizing entrepreneurial attrition and strengthening the long-term sustainability of livestock waste-to-energy initiatives. Overall, the paper highlights green electricity entrepreneurship from livestock waste gases as a vital mechanism for linking renewable energy advancement with rural development and broader sustainability goals.
Keywords: Livestock, Waste, Entrepreneurship, Sustainable Development Goals

I. INTRODUCTION

Animal husbandry has traditionally been a vital force behind human civilization, serving as a major source of food, fuel, employment, as well as promoting rural development. Thus, the research conducted so far in this field is largely focused on the management, breeding, health, and nutrition of animals to increase their productivity. Although this research has contributed vastly to the productivity of animals, the underlying aspects of animal

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husbandry are not taken into consideration. In the face of worsening global issues such as climate change, resource depletion, and the need to achieve sustainability, it is being realized that the need to view animal agriculture from a holistic perspective is many-fold. By reframing animal agriculture in ways that shift away from traditional production goals, innovative avenues related to green energy, waste utilization, and the circular economy can be explored. Additionally, animal husbandry practices should be made part of global policies and strategies, especially those of the United Nations on sustainable development, identified as the Sustainable Development Goals (SDGs). This can greatly improve the robustness and sustainability of agricultural resources so that they can play an enhanced role in long-term and sustainable development (Khorshidi et al., 2008; Taslimi et al., 2021; Rosen et al., 2025; Kioumarsi et al., 2026).The path toward developing sustainable energy systems forms a fundamental aspect of the United Nations' Sustainable Development Goals, particularly goal 7: Affordable and Clean Energy, and goal 13: Climate Action. Green electricity from livestock wastes, particularly gases, offers an innovative technology and entrepreneurial opportunity which aligns notably with the achievement of the United Nations' Sustainable Development Goals. Livestock wastes, particularly gases, have been historically considered an environmental pollutant because of the greenhouse effect. However, these wastes can be utilized as a means of harvesting electricity, thus both combating the greenhouse effect and creating entrepreneurial opportunities in the farming sector of rural communities, particularly in developing nations, as discussed in Ariyanto&Soedarto (2025).

II. CONCEPTUAL FRAMEWORK

Livestock Waste and Renewable Energy

The anaerobic digestion (AD) process harnesses microorganisms to break down organic material (e.g., manure, slurry) in oxygen-free conditions, producing biogas composed largely of methane and carbon dioxide. This biogas can be used on-site for heat and electricity generation or upgraded to biomethane, a renewable substitute for natural gas. Capturing methane from livestock waste not only produces energy but also prevents methane release into the atmospherewhere it has more than 25 times the global warming potential of carbon dioxidethus contributing to climate mitigation efforts (U.S. Environmental Protection Agency, 2026).

Sustainable and Green Entrepreneurship Theory

Sustainable entrepreneurship, also known as ecopreneurship, refers to entrepreneurial activities that prioritize environmental and social outcomes along with economic returns, and emphasizes triple bottom line value creation (economic, ecological, and social). Existing entrepreneurship research in renewable energy underscores the need for innovative business models that integrate decarbonization technologies with sustainable market strategies (Bendig, 2025).

Although literature specifically on attrition entrepreneurship theory is sparse, the essence of this ideafocusing on sustainability-driven enterprise development under resource constraints typical of rural livestock farmsaligns with principles in sustainable entrepreneurship and green innovation research emphasizing entry, survival, and growth in sectors with environmental objectives

Technical Foundations of Biogas and Electricity Generation

Anaerobic Digestion Technologies

Anaerobic digestion technology, for instance, has developed over time to include small-scale farm digesters and biorefinery models. HimarkBioGas has developed an Integrated Manure Utilization System (IMUS) that combines the digestion of manure waste with power and nutrient production. The importance of such systems ranges from combating pollution to generating renewable power and organic fertilizers, all aimed at bio-refining farm activities. Studies have used operational research to inform that the optimization of pretreatment systems, such as solar thermal treatment, has the potential to increase the amount of methane produced from cattle manure significantly (Business Wire, 2026; Lansing and Smith, 2008).

Green Electricity Harnessing and Distribution

Biogas produced through AD can be utilized to drive generators to produce power that can be utilized for local requirements and/or utility supply. Real-life examples include the Lusakert Biogas Plant in Armenia, which uses poultry waste to produce heat and power for the utilities as a clean and sustainable alternative to greenhouse gases. In addition to producing electricity, it is possible to upgrade the quality of the biogas to produce a combustible mixture similar to natural gas to exploit existing infrastructure.

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Entrepreneurial Dimensions

Value Creation and Business Models

Harnessing green electricity from animal waste gases presents an exciting combination of technological advancement and business start-up entrepreneurial opportunities. Researchersidentify how renewable energy start-ups create business strategies where economic success and sustainability are combined, causing disruptions in conventional industries, promoting economic advancement, and reducing ecological degradation. Such business strategies may include rural farm energy companies that produce power for surrounding rural off-grid areas, services for maintaining biogas plant facilities, as well as business enterprises in producing digestate-based organic fertilizer materials, among many others (Lu, 2023; Tolessa, 2023; Brahmi et al., 2024).

Enabling Rural Entrepreneurship

Rural and livestock farmers often face constraints including capital access, technical knowledge, and market integration. Studies focusing on community empowerment in biogas utilization demonstrate that participation and planning significantly influence the long-term sustainability of biogas adoption, suggesting that community engagement and capacity building are critical entrepreneurial enablers.Entrepreneurial development in this context requires ecosystem supportpolicy, finance, and technical trainingto ensure that farms can pivot from traditional livestock operations to green energy enterprises (Sari et al., 2022).

Sustainable Development Goals Alignment

Renewable energy development through the harnessing of livestock wastes specifically contributes to achieving the United Nations Sustainable Development Goals in the following ways: First, renewable energy production from these wastes ensures increased and decentralized access to clean and affordable energy for all (SDG 7), simultaneously creating new employment and growth opportunities in the process (SDG 8). Bioelectricity production from organic wastes also supports the UN SDGs on the preservation of a clean and healthy environment through the production of organic fertilizers, hence the reduction of consumption and production inefficiencies (SDG 12). Third, the harnessing of methane gases from the wastes of these animals reduces the emission of these gases into the atmosphere, hence the promotion and preservation of the climate and our environment (SDG 13). Consequently, proper handling and harnessing of the wastes also preserve and conserve the environment (SDG 15).

Challenges and Opportunities

The viability and scalability of green electricity obtainability through livestock waste face several challenges, including high costs of initial investment, technical complexity, variability and expertise needs locally, which might deter green entrepreneurship ventures. Other reasons include differences and variability in renewable energy markets, policies, and incentives across regional territories, which might affect small rural entrepreneurship ventures. The lack of entrepreneurial and business networks among smallholder farmers on one hand, and scarcity of resources among smallholder farmers on another, might pose challenges to green entrepreneurship on a larger scale, especially for rural smallholder farmers. The entrepreneurship theory also claims that green businesses, including new social ventures, are more likely to face deterioration and economic attrition failures due to limited resources, which might deter entrepreneurship ventures. In spite of all these challenges and barriers, significant green entrepreneurship venture opportunities lie ahead, especially in growing markets like Africa and Asia, where green electricity production through livestock waste can improve rural entrepreneurship ventures through innovations and developments like co-digestion and biorefinery businesses, where livestock bio-waste can be used as a resource for green electricity production and sustainable rural entrepreneurship ventures.

III. CONCLUSION

Farzpourmachiani et al.'s study stressed further that although not all business ventures are guaranteed to produce profit (Farzpourmachiani and Farzpourmachiani, 2024), the production of green electricity utilizing the waste gases from the livestock on the farm must be recognized as being able to achieve profitability through serious pursuit. The issue of green electricity production involving livestock waste gas is a classic case where technological innovation meets sustainable entrepreneurship and the attainment of universal and global development objectives. The production of electricity and added products out of livestock waste gases is a strategy in line with universal development objectives such as the SDGs on clean energy, waste management, climate change, and economic development, among others. Entrepreneurial ventures involving this aspect of

electricity and product production out of wasteand particularly encouraged by a sustainable entrepreneurship approach known as ecopreneurshipare capable of changing issues of waste management to SME business opportunities. Future research could seek to advance theories on attrition entrepreneurship for ventures involving specific technological innovations in sustainable entrepreneurship, as well as continuing to advance empirical models on biogas/energy ventures in line with socio-economic and ecological objectives.

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