Acknowledgements

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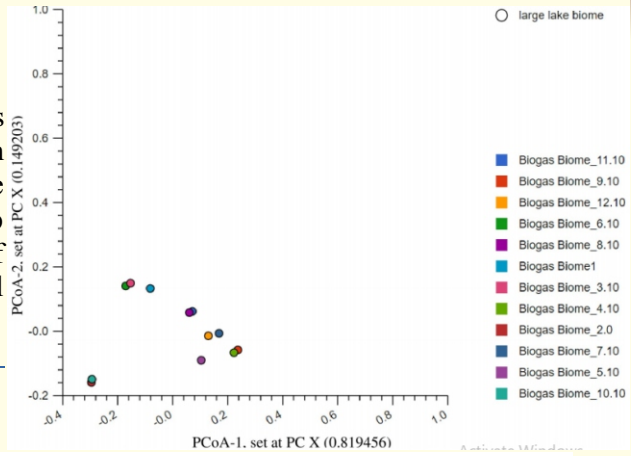

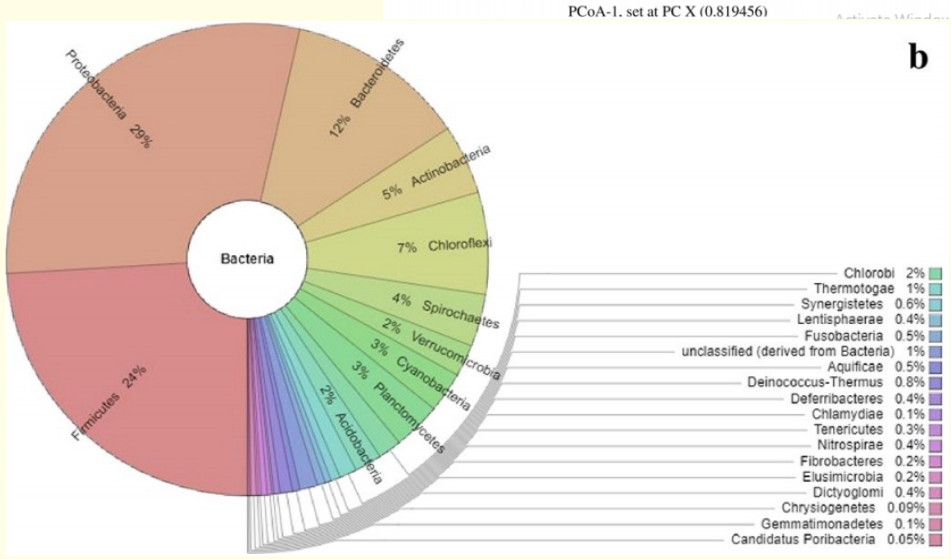

Fig. 6. Showing microorganism variations among the twelve treatments on PCoA analysis (a), and Krona radial space filling display for microbes detection (b)

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Key Messages

- *Poor adoption of biogas technologies globally still persist.*
- *The technology can substitute other non-eco- friendly sources of energy.*
- *High rate of digester failures is the main challenge .*
- *Better understanding of the residing microorganisms can provide solution*

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POLICY BRIEF

March 2021

Enhancing Sustainability of Biogas Production in Kenya

INTRODUCTION

Biogas is essentially a mix of gases and can be produced naturally and artificially. In natural conditions, the gas mainly methane is produced through wastes degradation by microorganisms and enter into the environment. The high amount of methane in biogas is what makes it valuable as an alternative energy source. However, when released into the environment, the gas contributes to global warming. No appropriate policy measures under environment and energy sectors that guide the rural poor on how to dispose of the wastes. The worst is that the policy does not support the existing digesters, further demolarizing the poor communities. Most of the stated policy measures favor the urban richer communities, emphasizing on non-renewable energies; mostly those pollute the environment e.g petroleum. To solve the environmental issues caused by the current huge amount of animal and plant wastes(Fig. 1), that are degraded naturally by the microorganisms, policies on development of better wastes management tools are needed. One such tool is anaerobic digestion of wastes in well designed vessel, so called digester; connected to the kitchen or any power requiring building (Fig. 2)

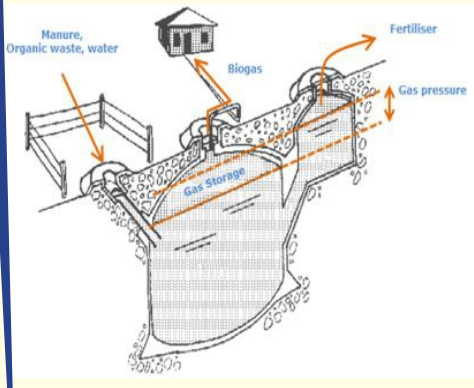

Fig.2. Diagram explaining how biogas can substitute other power sources

Fig. 1. The available huge animal and Plant wastes in the country.

The reason being that biogas can substitute electricity and other form of energy like firewood and charcoal that are also not environmentally friendly (Fig 3). and can lead to respiratory diseases (Fig. 4). To give you a better picture, over 30,000 global industrial installations use digesters to manage the wastes. At the end they produce 10,000 MW of electric power. Unlike other renewable and non-renewable energy sources, $1m^3$ of biogas yields around 5.5-7kWh of energy.

Why not popular?

This is somewhat puzzling scenario that scientists are struggling to understand. One of the reasons is the poisoning of the microorganisms in the digester that are involved in wastes conversion to biogas. This poisoning is what lead to poor digester performance and ultimately complete system shutdown (Fig. 5) and the restoration is costly. Understanding the microorganisms and their roles in our local digesters is key to finding solutions to this problem. In attempt to provide solutions, we conducted a survey on biogas digester installations and characterized the inhabiting microorganisms.

Fig.3 Women and Children from the forest to fetch firewood

Fig.4. Source of the respiratory diseases. The mother and the children in a poorly ventilated kitchen cooking with firewood

Fig. 5. Failed and abandoned digester at Kirinyanga county

Approach and Results

The global diversity of the microbes is one of the main factors, alongside the link between the operating conditions and biogas production, which has to be finely tuned. All these factors are intrinsically linked to one another; thus, steering the one that has the larger repercussions on the system may hold the key to making biogas a more widely used energy source.

Cow dung waste materials derived from different geographical locations in Kenya treatments, as part of our mission of "massively parallel sequencing" . We had hypothesized that environmental and other operating factors caused an ecological drift, simultaneously weakening the microbiomes niche selection ability that introduced 'chaos' effects into the systems

The results provided an insight into the digesters' microbiomes composition richness, abundances, and variations within and among the taxa and the treatments (Fig. 6). Overall the research showed that microbiome composition and richness were similar among the twelve treatments. In total, we identified 37 phyla, 65 classes and 132 orders. Out of these, the largest populations comprised bacterial strains (Fig. 6), while fungi and archaea were almost similar in numbers. All these microorganisms were equally important in Kenyan biogas production systems. Few fungal organisms were also identified in one or two treatments, further confirming that external conditions affected the behavior of the microorganisms in the digesters. The insight can be exploited to formulate stable microbial combinations to solve issues related to high rates of digester failures in the country.

Recommendations

Short Term

- Developing seeding innocula to ensure digester sustainability

Medium Term

- Certify the established private and institutional digesters to ensure best practices are applied in their operation