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Benefits of Nigeria Grazing Bill to Biogas Industry

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Abstract— Nigeria is well endowed with good soil and weather conditions for high quantity of forage production.The prolonged period of rainfall in the south predisposes the south to production of forage for a prolongedperiod of the year. It is noted that the annual rain fall of the south is above 2,000mm (78.7 in) while the eastern part annual rainfall is between 2,000 – 3,000 mm (118.1in). The Fulanis of the Northern Nigeria breed cattle. The Fulanis' drive their cattle to the South especially with shortage of the forage in the North and in so doing invade the farm and destroy farmer's crops. This engenders quarrels and fights between the crop farmers and the Fulani herdsmen.Establishing ranches should be considered rather than free grazing in order to solve the problem of conflicts between the crop farmers of the South and the Northern cattle herdsmen. This work studied the economic values that could be harnessed by establishing ranches as it relates to Agroindustry. The study shows that the projected amount of biogas that could be produced by 50 cows in a year isto be 57713 m^3. The 50 cows were also able to generate 675.25 tons of manure per year based on calculations. It equally shows that the annual manure production increases at an average percentage of 12% which is sufficient enough to sustain a biogas industry.

Index Terms—Biogas, Combined Heat & power, Cow manure, Electricity, Grazing bill,

1 INTRODUCTION

BEFORE the discovery of crude oil at OloibirinNiger Delta in the year 1956 [1], agriculture had been the lifeline of Nigeria. The Agriculture was then focused on cash and food crops [2]. There were no related issues of indiscriminate grazing of livestock. Grazing reserves were only created in the northern part of Nigeria mostly used by the Fulani herdsmen [3]. Shortly after the discovery of crude oil Nigeria's economy shifted from agriculture to oil, hence there was little or no attention on agriculture until recently. The Fulani herdsmen started intensive drive of their cattle and livestock from the northern part of Nigeria to other parts of the country in search for cow pastures. They migrate from the North to the South where there is predominantly crop farming. During the migration of the Fulani herdsmen and their cattle, in avertedlyinvade farmland of local farmers and destroy the crops. This situation has degenerated to unfortunate fights between the herdsmen and the local farmers, and many casualties have been recorded since the clash started [4].

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A B

Fig.1. (A) Armed Fulani and his cattle [5].
(B) Farmland devastated

With the recent discussion across the nation and beyond on how to curb this menace between Fulani herdsmen and farmers, provision of graze land by each state across the nation has been trending as a lasting solution. On this account, it could be needful and impactful to highlight the importance of siting agroindustry especially biogas plant in close proximity to the graze land/ranches. Cattle ranches will be convenient for collecting cow dungs and wastes for feeding biogas plants.

2 LITERATURE REVIEW

Waste that emanates from livestock is an integral source of greenhouse gas emissions and more emphatically, it occurs often in developed countries where a reasonable large number of livestock are kept in the house. Due to global climate change campaign [6], it is impactful to be conscious of the waste that litter our environment and equally seek for environmental friendly ways to properly dispose such wastes. Production of biogas from waste is considereda practicable solution which converts waste to wealth. Biogas describes a mixture of different gases obtained as a result of conversion of volatile solids through the action of anaerobic process [7]. Anaerobic process occurs in little or no presence of oxygen by the activities of micro-organisms to act on waste and decompose it [8]. It is a technology that has been proven

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relatively best for the process of extracting biogas, mainly methane, from organic material wastes. However, production of biogas is oftenlimited by the quantity of volatile solids added to the digester. Solid volatile wastes contain about 50% and above of methane gas (CH_4) and other gases in relatively low quantity such as CO_2, H_2 , N_2 , and O_2 including other halogen gases [9]. A good number of studies have been carried out in order to extract and increase biogas yield in anaerobic process. Some processes that have been used and still exist for improving biomass conversion efficiency and biogas yield are pretreatment of manure by separating solids from digested materials [10]; improving substrate composition by co-digesting with other substrate [11]; improving contact between bacteria and substrate using stirring [12] and improving nutritional requirements of the bacterial population in the biodigester [13]. Okeh et al [14] did a study on biogas production from rice husks which were generated from different rice mills. They used cow rumen liquor as a means of inoculum. The ratio of feedstock to water that was used was 1:6 w/v. At start with pH of 7, two maximum quantities of biogas yield of 382 mL/day and 357 mL/day were recorded. It was observed that the maximum values of biogas production rate were 30mL/day and 69 mL/day for the control and poultry dropping. In [15], Mashad and Zhang studied the biogas production potential of various mixtures of unscreened dairy and food waste. They compared it with yield from manure obtained from either manure or food waste individually. They recorded that the methane yield of screened and unscreened manure after time duration of 30 days were 302, 228 and 241 L/Kg, respectively. An approximated possible yield percentage of biogas of the following 69%, 87% and 90% were recorded respectively after 20 days of digestion. About 69%, 57% and 66% of average contents of methane in the biogas were recorded respectively.

3 METHODOLOGY AND ANALYSIS

Parameter Specifications:

- **Feed stocks:** Cow Manure
- **Weight of manure:** 1 beef Cow produces 37kg/day (0.037 tons/day) **[16]**
- **Contaminants Level**: 5%
- **pH level**: 6.0 – 6.5
- **Digester Type:** Wet
- **Biogas usage:** CHP (Combined Head and Power)
- **Digestate Usage:** Directly to Land
- **Solid Content Before Digestion:** 25%TS (solid content should be adjusted for the digester type)
- **Percentage of Volatile Solid**: 80% VS
- **Bio Methane Potential (BMP)**: 450
- **Plant type**: Agricultural

4 PROCEDURE

The presumed number of cow in a given grazing land and the possible quantity of manures that could be generated by them are as given in **Table 1**. The cow manure is to be collected after each hour of everyday from the grazing land and transported to the wet biogas plant using manure van as shown in **Figure 2**. The arrived manure will be pretreated to remove some contaminants. The removed contaminants will be used for landfilling. To ensure that the manure can be pumped (25% TS), it will be diluted reasonably with water. Afterward, the mixture will be sent to the digester. In the digester, microorganisms will consume majority of the volatile solids (VS) in the sent mixture in little or no presence of oxygen for the conversion of the mixture into biogas. After the conversion and evacuation of the biogas, the liquid digestate will be applied to land directly as bio-fertilizer or in a reservoir tank where it could undergo further treatment so that it could be used again in the system process or elsewhere. The whole process is as shown in **Figure 2**. The process was tested for 10 different numbers of times as the number of cow in the grazing land increases.

TABLE 1
QUANTITY OF MANURE FOR A GRAZING LAND

S/N	Feedstock Type	Number of cows	Quantity of wet manure produced in a day (Kg/day)	Annual total (ton/year)
1	Cow Manure	50	1850	675.25
2		100	3700	1350.5
3		200	7400	2701
4		250	9250	3376.25
5		300	11100	4051.5
6		350	12950	4726.75
7		400	14800	5402
8		450	16650	6077.25
9		500	18500	6752.5
10		550	20350	7427.75

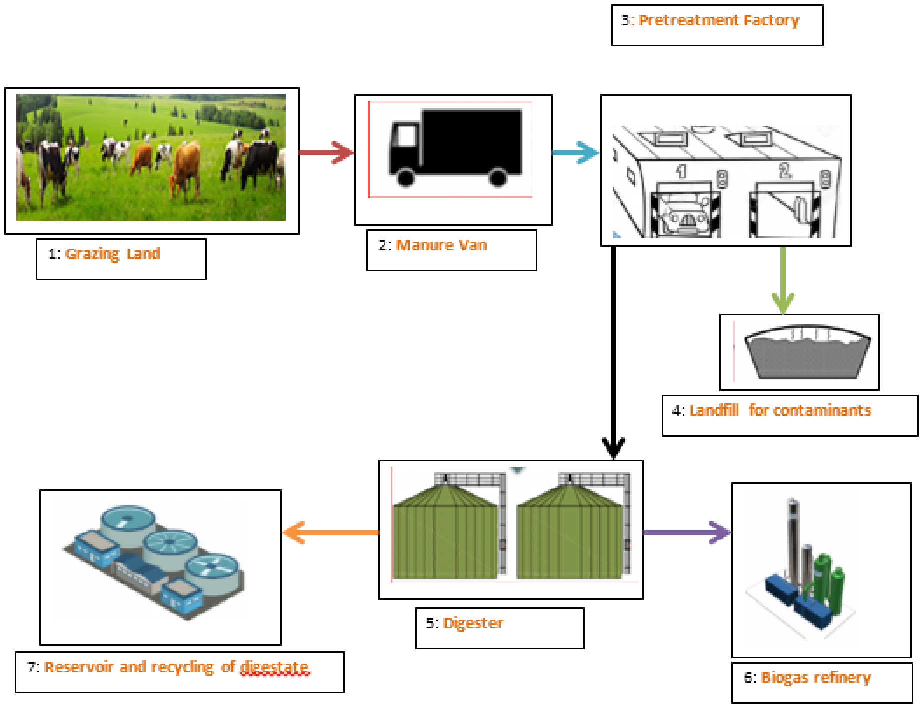

Fig. 2. The procedural stages

4.1 RESULTS

By using the service provided by biogas world [17], the results in Table 2 were obtained.

RESULTS

TABLE 2

RESULT OF THE BIOGAS PLANT CALCULATION

S/N	Biogas Production (m^3/hour)	Biogas Production (m^3/year)	Electricity Production	CHP	Thermal Energy Productio (GJ per year)	Total Digestate (tons/year)	Contaminants to Landfill (tons/year)	Greenhouse Gas (GHG) reduction for landfill diversion (CO2 eq./yr)	reduction for renewable energy production (CO2 eq./yr)	Potential Revenue Per Year (From Electricity Sales)	Plant Cost Estimation (±30%)
1	7	57 713	113 880 KWh	13 KWe	491 GJ	571	34	106	25	$ 10 249	$ 130 000
2	13	115 425	227 760 KWh	26 KWe	982 GJ	1 143	68	213	49	$ 20 498	$ 260 000
3	26	230 936	455 520 KWh	52 KWe	1 964 GJ	2 287	135	426	98	$ 40 997	$ 520 000
4	33	288 648	569 400 KWh	65 KWe	2 455 GJ	2 858	169	532	123	$ 51 246	$ 650 000
5	40	346 446	683 280 KWh	78 KWe	2 947 GJ	3 430	203	639	147	$ 61 495	$ 780 000
6	46	404 159	797 160 KWh	91 KWe	3 438 GJ	4 002	236	745	172	$ 71 744	$ 910 000
7	53	461 871	911 040 KWh	104 KWe	3 929 GJ	4 573	270	851	196	$ 81 994	$ 1 040 000
8	59	519 584	1 024 920 KWh	117 KWe	4 419 GJ	5 144	304	958	221	$ 92 243	$ 1 170 000
9	66	577 382	1 138 800 KWh	130 KWe	4 911 GJ	5 716	338	1 064	246	$ 102 492	$ 1 300 000
10	72	635 094	1 252 680 KWh	143 KWe	5 402 GJ	6 289	371	1 171	270	$ 112 741	$ 1 430 000

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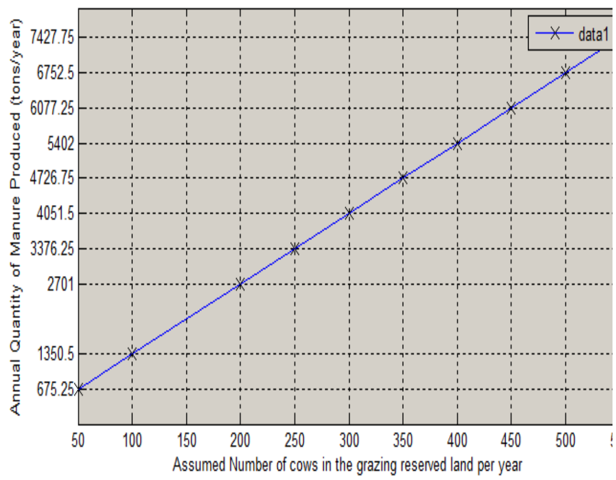

Fig. 3. Annual manure production against assumed Number of cows.

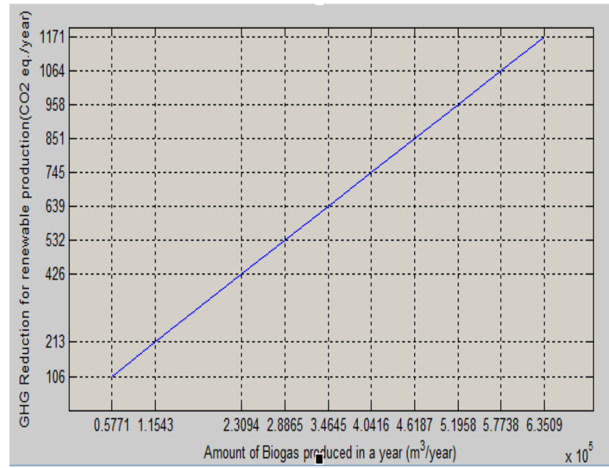

Fig.5. GHG reduction for using biogas against annual production of biogas.

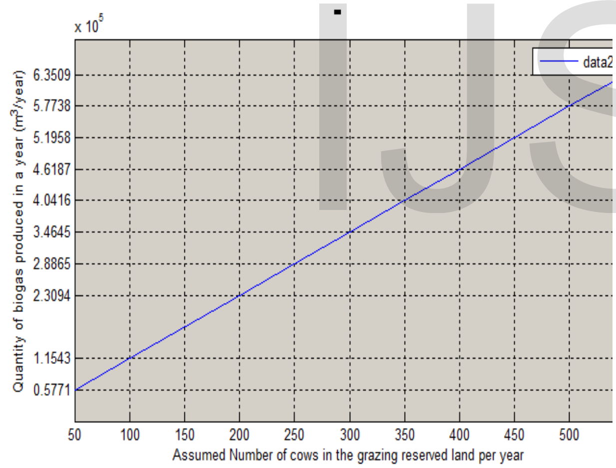

Fig. 4. Annual biogas production against assumed number of cows per year.

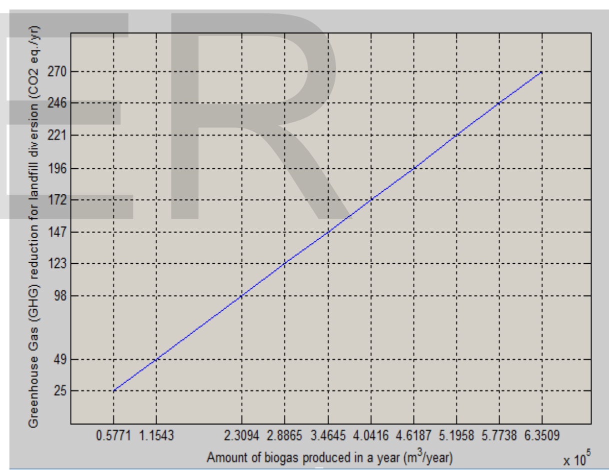

Fig. 6. Annual GHG reduction against biogas production in a year.

5 DISCUSSION AND CONCLUSION

Table 2shows that the projected amount of biogas that could be produced by 50 cows in a year to be 57713 m^3. The 50 cows were also able to generate 675.25 tons of manure per year based on calculations(Table 1). This calculated quantity of biogas obtained was good enough to generate about 113 MWh of electricity.Figure 3 shows that the annual manure production increases at an average percentage of 12%. This rate is sufficient enough to sustain the biogas industry. Based on the current bill of diesel ($0.6/L) and electricity bill rate ($0.09/ KWh) in Nigeria, it was estimated that the biogas so produced has a potential revenue of about $10,249 per annual while the cost of constructing such biogas production plant is about $130, 000. However, from **Figure 4**, the annual biogas production equally increases at an average rate of 12% after the initial high production. The system shows possible economic benefits while there is also reduction in greenhouse gasof about 25% of CO_2 equivalents per year which could still be reduced by the use of some latest technology (Carbon Capture and Storage, CCS). From **Figures 5**and **6**, it was observed that average reduction of GHG per annual is about 12%. The study showed that it is lucrative to site and implement biogas plant in the proximity of graze land. The electricity so generated will be sufficient enough to light up the graze land vicinity and all the street lights close by and equally service nearby communities in the areas of heating application. It will equally help in keeping the environment in hygienic condition as well as provide possible employment opportunities to the host community. The cow dung waste can now be put in to a better economic use.

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