TITLE: **BIOGAS UTILIZATION AND IT'S AGRICULTURAL IMPLICATIONS IN GHANA**

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ABSTRACT

The use of conventional forms of energy in Ghana has compounded problems for the Ghanaian economy due to unaffordability by both urban and rural poor, insufficiency or limitations due to the possible drastic fall of the water level of the Akosomo Dam.
The Ghana Government Integrated Rural Energy and Environmental Project of the Ministry of Energy and Mines seeks to resolve these problems with the introduction of biogas generation in Ghana, as one of the alternative renewable energy sources to eliminate the problems in the forceable future.

The anaerobic digestion of waste which yields biogas, is being utilised in Ghana for the following purposes:

1.generation of electricity for villages far from the National Grid;
2.Generation of gas for cooking as a better substitute for fuel wood;
3.Solving of sanitation problems;
4.Positive environmental measures, and
5.The prevention of massive loss of soil fertility and promotion of high yield of crops through the application of it's by product ,"slurry", as an excellent,treated organic fertiliser.

To talk of biogas is to talk of agriculture, since biogas generation starts with agricultural waste produce, such as cow dung, husk, straw etc. and ends with agricultural produce,- use of slurry on crops.
Slurry is one of the most environmentally sound organic fertilisers in use today. It does not pollute the atmosphere during it's application and does not pose health hazards to the user and animals around.
The paper presents the result of the study on the slurry.

1. **INTRODUCTION:**

The biogas utilization in the form of electricity generation for street and household lighting, heating, gas for cooking, sanitation and agriculture commenced in 1987 at Appolonia in Ghana. The pilot project, fully utilizes all the benefits of the biogas technology.

The project has ten (10) 50m^3 digesters for electricity generation which has drastically improved the social, economic and political activities of the rural forks. The inhabitants of Appolonia are predominantly cattle rearing and crop producing peasants, located far from the national electricity grid. The expensive nature of the conventional form of energy and it's limitations in Ghana makes this alternative source of energy more attractive. This model village benefited from pipe-borne water sent to the village purposely to feed the biogas digesters and to serve as a potable water source which the village before the biogas project did not have.

The biogas generation for gas for cooking serves as a substitute for fuel wood. There are 19 biogas digesters attached to kitchens for direct gas for cooking. This aspect of the project has drastically reduced the use of fuel wood which led to deforestation, desertification and health risks of women and children, who walked long distances in search of fuel wood, they inhaled a lot of smoke during cooking with fuel wood. Untidy surroundings from ashes, sparking from fire which cause a lot of domestic accidents.

To solve of sanitation problems,public latrines (KVIP), constructed in the village have been directly connected to the biogas digesters for electricity generation. Human faeces from the nearby urban towns and, abundant cow-dung produced daily by cattle in the village are the main source of raw materials feeding the digesters. The domestic digesters are only fed with cow-dung because the rural folks resent the idea of using gas from human faeces for cooking food.

One of the exciting points about biogas generation is the use of the by-product "slurry" as a soil conditioner and an organic fertiliser. The farmers realise the multi-purpose function of the technology. It has been established locally that one of the possible ways of increasing food production and cutting food production costs is by applying slurry on crops. This way the farmers avoid wasting money on chemical fertilisers, which involves travelling to towns. The toxic nature of some of these chemical fertilisers and the risk involve when misapplied.

Slurry is the most environmentally sound fertiliser at their disposal. It has no smell, does not attract flies, does not pollute the atmosphere during it's application, increases yield, does not pose health hazards to the user and animals around. Most harmful bacterial and parasites in the organic feed are either killed or considerably reduced in number by biogas production process. Slurry has been applied on different vegetables in both liquid and solid state in this project, with it's characteristics as an organic fertiliser, large quantities are needed to get an adequate volume of fertiliser for a particular vegetable crop. Nitrogen leach is drastic when drying liquid slurry. It is difficult to transport in it's liquid state which contains more nutrient.

2. **MATERIALS AND METHODS**

The study on the effects of biogas slurry on cucumber production was conducted in June 1994 at Appolonia near the biogas project site. It was conducted here because of nearness of slurry source. Ploughing was done by power-tiller which is the main transport for conveying cow-dung from the near-by kraals for charging the digesters.

Soil samples were tested by the Department of Soil Science of University of Ghana, Legon. The samples were tested to ascertain the initial nutrient content of the experimental plots. Though liquid slurry was used different slurry samples were also taken to compare the nutritive value, pH and micro organic content. Randomized complete block design was used in setting up the experiment.

The experimental plots were made into beds of sizes 3.6m x 3.0m, each bed had three replications. The treatments ranged from 20kg, 40kg, 60kg, 80kg and 100kg of liquid slurry from outlet chambers.

The slurry was applied the same day as the seeds were sown. All the quantities of slurry were applied as starter. The spacing between rows was 1m because of the variety of cucumber planted (Ashley). Germination occurred within four days. Weeds were controlled twice by hand picking before harvesting. Maturation occurred within four weeks and harvesting was done by hand picking. Records on fruit count, weight, length of fruits and diameter of fruits were taken.

FIG. 1 **FIELD LAY-OUT**

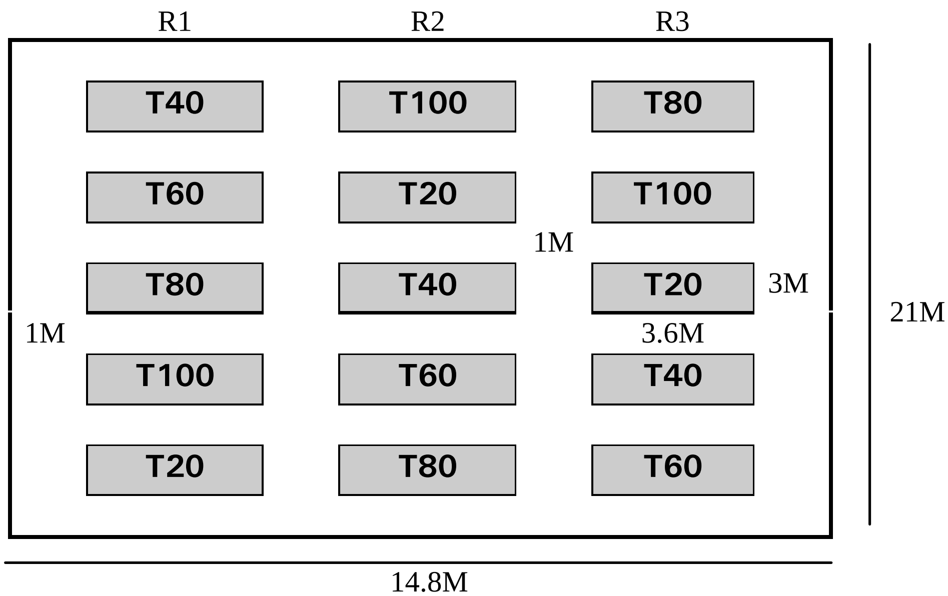

Figure 1. above is the field lay-out of the experiment. The R1,R2 and R3 are the various Replications. T represent the treatments, with access roads of 1m and a total field size of 310.8M.

3. **INTERPRETATION OF EXPERIMENTAL RESULTS**

TABLE A1:
The results in table A1 show that 3 were three harvests for each replication. From the data collected treatment 80kg produced fruits with the highest weight, length and diameter in all the 3 harvest from second replication. There were inconsistencies in the results gathered with varying weights, lengths and diameters of all the harvest from the 3 replications of the 5 treatments.The highest data recorded were seen in the second replication, first and second harvests of treatment 80kg. The lowest values were recorded in treatment 100kg, the third replication which had weight of 7.085kg and diameter of 6.97m.

TABLE A2:
Data for analysis of variance were taken from table A2. The analysis of variance carried out was for randomized complete block design. The results show that slurry treatments have high significant effect on cucumber fruit weight, length and diameter.

The increase in the quantity of slurry caused significant increase in weight, length and diameter of cucumber fruits. Both the weight and length were significant at 5% and 1% level. The diameter of cucumber fruits was only significant at 5% level, at 1% level the diameter of cucumber fruits was not significant. There was significant difference in yield.

TABLE A3:
As table A3 indicates, the treatments ranged from 20kg -100kg of liquid slurry. The table gives quantitative attributes of the experiment.The treatments from 20kg to 80kg showed consistently high total number of fruits, total weight, total length and total diameter. there was a decline in these values when the treatment was increased to 100kg. The total number of fruits countered in treatment 100kg were even lower than that of treatment 20kg. The total weight of all the fruits harvest was 653.69kg with total length and diameter as 621.29kg and 537kg respectively. Out of these treatment 80kg had the highest total weight, length and diameter of 167.3kg, 153.3m and 121.75m respectively. Refer to Fig. graph.1. The second highest values recorded were for treatment 60kg with a weight of 143.1kg, length of 138.3m and diameter of 114.7m. The difference in weight of the highest and second highest is 24kg. The difference in the lowest recorded values (treatment 100kg) and the highest (treatment 80kg) are weight 46.6kg, length 47.3m, diameter 4.94m. The difference between the lowest treatment (20kg) and the highest treatment (100kg) is 80kg of liquid slurry, but the difference in the fruits weight, length and diameter are 17,21kg, 5.01m and 31.73m respectively. Though treatment 20kg had the lowest values in yield the difference between treatment 20kg and treatment 100kg is low.

TABLE A6:
The results in table A6 has been computed to draw the regression graph below. This illustrate the association between response and treatment which has been indicated in the graph. The results were gathered from field experiment with all other environmental factors except the treatments were constant. It is logical to conclude that the treatment is the cause of variation in crop yield, length and diameter. The crop response represented by cucumber yield is the dependent variable and the treatment as independent variable.

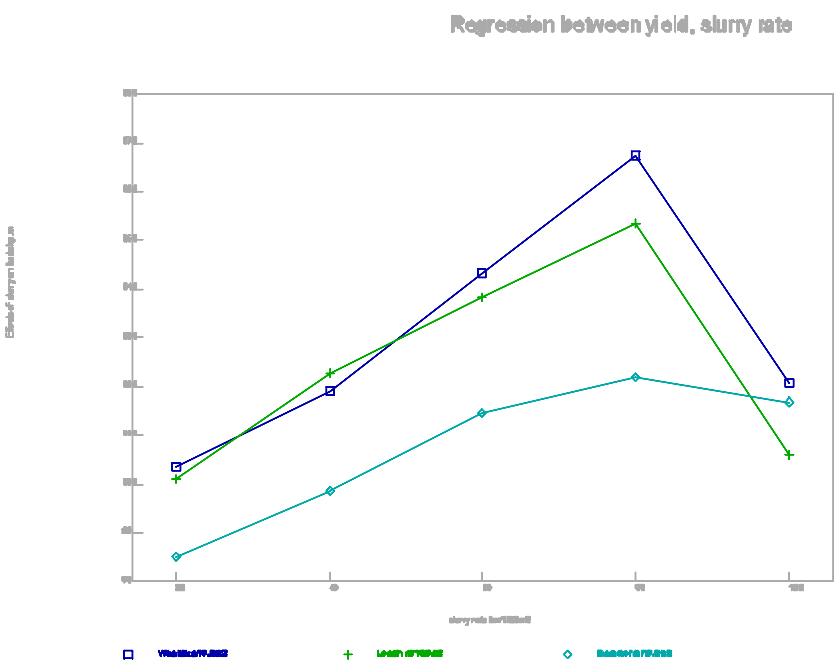

TABLE A4: **SLURRY SAMPLES TESTED**

Sample No.	pH H_2O	pH $CaCl_2$	Total N	Org.M %	Total p	Total K
DSP	7.3	-	1.01	45.12	0.16	0.27
DSM	7.1	-	0.56	27.52	0.12	0.21
DSH	8.5	-	1.05	74.84	0.34	0.94
LSD	6.8	-	1.26	48.15	0.83	0.57
LSC	7.5	-	1.05	47.19	2.18	1.43

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DSP - Dried slurry from project site taken from the surface
DSM - Dried slurry from project site taken from the middle of heap
DSH - Dried slurry from domestic digester
LSD - Liquid slurry from digester (outlet chamber)
LSC - Liquid slurry from compost pit

The slurry samples in table A4 shows that liquid slurry from the outlet chambers (LSD) has the highest total nitrogen which increases the vegetative part of the plant and also increase the protein content of the fruits. LSD also showed acidity range and relatively high Org.M, second highest total phosphorous content of 0.83% and third highest in total K of 0.57. Both dried slurry showed low nitrogen content because of the ability of the nitrogen to leach away when exposed.The Org.M in DSM was the lowest.
When the slurry moves from the outlet chamber to the compost pit there is a lost of nitrogen of 0.21% which is quit high. The DSH, which is only cow-dung has high neutrality and very high Org.M content. This table shows the type of slurry needed depends on the type of vegetable being cultivated. Slurry should be turned constantly when being dried to avoid the state of DSM.

TABLE A5: **ANALYTICAL DATA- SOIL SAMPLES**

Sample	pH H_2O	pH CaCI	Total N %	Org. M %	Available P ppm	Exch.K c.mol/kg
1o	5.7	5.3	0.10	1.48	4.48	0.15
1o	5.7	5.3	0.07	1.21	3.80	0.15
1o	5.5	5.3	0.07	1.65	4.39	0.27
2o	5.8	5.4	0.10	1.65	4.61	0.20
2o	5.7	5.3	0.11	1.87	12.84	0.31
2o	5.3	4.9	0.07	1.10	3.33	0.13
3o	5.8	5.3	0.10	1.60	5.98	0.14
3o	5.7	5.3	0.07	1.48	3.10	0.10
3o	6.2	5.9	0.08	1.65	6.80	0.32
4o	5.7	5.3	0.10	1.65	5.05	0.13
4o	6.3	5.9	0.11	2.75	2.82	0.12
4o	5.7	5.3	0.10	1.65	5.28	0.21
5o	5.3	5.0	0.06	1.54	4.44	0.22
5o	5.5	5.2	0.10	1.48	4.71	0.30
5o	5.4	5.1	0.13	2.81	9.05	0.34

Table A5 above indicates the initial nutrient content of the plots on which the experiment was conducted. The only lapse in the results above this the value of phosphorous of 12.84ppm in soil sample 2o. This soil sample is for treatment 40kg, the second replication. The table shows that the soil is heterogenous. The increase in yield there could only come from the slurry applied because the NPK content of the soil is low. The soil had a high acidity content.

CONCLUSION:

From the experience the farmers from Appolonia had to their credit from the biogas utilization, slurry application and the case study above the following conclusions can be drawn:

1. Farmers are aware of the fact that organic waste can:
i. be applied raw as an organic fertiliser
ii. be processed by anaerobic reaction to generate gas for cooking and electricity for lighting.
iii. still maintains it's quality as soil conditioner and a good fertiliser.

2. Slurry has an advantage over other organic and chemical fertilisers:
i. since most bacterial and parasitic substances are destroyed during biogas generation, it does not pose health hazards to both animals and man.
ii. it can be applied the same day as sowing or transplanting is being done.
iii. the life of villagers is enhanced because waste is easily disposed of to improve sanitation problems, and enhance the economic prosperity of the community through the introduction of electricity from biogas generation.

3. Increase in slurry quantity shows increase in cucumber yield till an optimum dose is attained.

4. When slurry is exposed for a long time during drying it losses it's nutrient content. Especially Nitrogen is leach off.

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