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RESEARCH ARTICLE

Potentials for Biogas Production in Anambra State of Nigeria Using Cow Dung and Poultry Droppings

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ABSTRACT

Preliminary investigation of the major abattoirs and poultry farms in Anambra State was undertaken to determine the quantity of cow dung and poultry dropping generation with respect to biogas production. The study showed that about 15563 kg (15.6 tons) of fresh cow manure and about 2012 kg (2.01 tons) are produced daily in the state. These are sufficient to support biogas production in the state. Investigation shows that most of these manures are not properly managed resulting to environmental pollution. Result shows that only negligible proportion of these manures are used as manure for vegetable crops and feed stock for fish farming. Thus, there is need to popularize biogas technology which is a cheap and renewable source of energy whose effluent is a good fertilizer for crop growing.

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INTRODUCTION

Biogas typically refers to gasses produced by the biological breakdown of organic matter in the absence of oxygen. Ghosh *et al*. (2000) stated that biogas originated from biogenic materials, and it is produced by anaerobic digestion or fermentation of biodegradable materials such as biomass, manure or sewage, municipal wastes, green wastes and energy crops (Shelef *et al*., 1981).

Biogas is a mixture of gasses that is composed chiefly of 40-60 percent methane (CH_4), 20-60 percent carbon dioxide (CO_2), 1-5 percent other gasses including (0-1 %) hydrogen (H_2), Q-32 hydrogen Sulphide (H_2S), Biogas technology is based on the phenomenon that when organic matter containing cellulose is fermented in the absence of air (anaerobically), combustible gasses (chiefly methane) are emitted (Ghosh *et al*., 2000). Production of biogas allows for the controlled management of large waters and plant residues, and the safe production of gas for cooking, lighting or power generation. The effluent of this process is a residue rich in essential inorganic elements needed for healthy plant growth known as bio-fertilizer. Bio-fertilizer is environmental friendly, in that; it enriches the soil with no detrimental effects on the environment (Energy Commission, 1998). Anaerobic digestion plays a dual role in waste management by converting organic waste into stable organic soil conditioner.

Energy status in contemporary Nigeria

A country's economic growth and developmental aspirations is highly dependent on the cost of its energy supply. An investor makes maximum profit when all the economic indices point to low cost of production. Since Nigerian independence in 1960, energy supply (mainly electricity generation, transmission and distribution) has witnessed frequent and persistent outrages which have adversely affected the country's economic growth. This scenario has scared both local and foreign investors away from the country. Efforts by successive governments to break the jinx are yet to be applauded. With the persistent astronomically increase in Nigeria population, there is need to reduce the energy cost cum cost of production in the country in order to attract investors through provision of quality and dependable power supply to the economy. Moreover, Aneke (2012) stated that Nigeria becoming one of the 20 largest economies by the year 2020 as predicted

by Energy Commission of Nigeria (1998) and the International Atomic Energy Agency (2006) would require the country to generate about 40,000 mega watts (mw) of electricity necessary to drive the economy. However, power generation in the country fluctuates presently between 3,800-4,400 mw.

Nigeria is blessed with petroleum deposits being the sixth largest producer in the world. But reports have shown that mismanagement of the energy sector is the country's number one problems. Secondly, petroleum is non-renewable energy source and its deposit is continuously being depleted. Presently, Nigeria produces over 2.4 million barrels of crude oil daily with estimated crude oil reserve of over 40 billion barrels and over 176 trillion cubic feet of gas reserves (Nwokorji, 2012). Despite the huge deposits of crude oil in the country, the nation is experiencing enormous scarcity of petroleum products. Kerosene which is domestically used for cooking and lighting is hard to come by. The prices of fuel for automobiles have sky rocketed hence, pushing the cost of transportation of goods, human and services at high side. Also high cost of diesel fuel has forced many industries to close thereby pushing more hands into the unemployment market. Prices of some petroleum products in the country are shown in Table 1.

Table 1: Domestic prices of some petroleum products

Companies	PMS/L	AGO/L	DPK/L
African Petroleum	N97.00	N155.00	N50.00
Total Plc	"	"	"
Oando	"	"	"
Mobil	"	"	"
Texaco	"	"	"
NNPC	"	"	"

Sources: The Nation Newspaper. April 17, 2012 Page 44; Note: 1dollar= N156

Table 2: Domestic prices of some petroleum products in Nigeria at indigenous petrol selling stations

Companies	PMS/L	AGO/L	DPK/L
Okacha Oils Ltd	105.00	160.00	130.00
Avenco Oils Ltd	100.00	155.00	135.00
Ausco Oils Ltd	105.00	155.00	135.00
Molpets Oils Ltd	105.00	155.00	140.00
Ejezi Oils Ltd	105,00	160.00	140.00

Nigeria must invest in alternative and renewable fuels, and improve its automobile fuel efficiency, because expanded oil production by way of the existing refineries and upgrade of the existing ones will not cut down the country's dependence on oil, will not create the mix, and not create the employment envisioned by the year 2020, and will not be cheap (Bamikole, 2012).

Nigeria is an agrarian country with more than 70 percent of her workforce employed in agricultural sector resulting in production of millions of tons of biomass which is the raw material for biogas production. These biomasses are usually plentiful in rural areas where they are treated as wastes.

Interest in biogas as a viable energy resource has spread throughout the globe in the past three decades. Biogas digesters operate throughout Asia, with more than 100,000 reported in India, about 30,000 in Korea and several millions in China (Mattocks, 1984; Tatom, 1980; Mc Grarry and Stainforth, 1978; Ghosh *et al.*, 2000) many more are operating now in the Middle East, Africa, Europe and the Americas.

Agricultural wastes and biogas production

Historically, anaerobic digestion has mainly been associated with the treatment of animal manure and sewage sludge from aerobic waste water treatment plants. However, in the 1970s increased environmental consciousness, added to the demand for new waste management strategies and renewable energy forms, broadened the field of applications for anaerobic digestion and hence introduced industrial and municipal wastes as well (Steffen *at al.*, 1998; Budiyono *et al*., 2010).

The excrements of pigs, cow dung, poultry droppings, industrial waste water, municipal wastes, energy crops and other agricultural wastes are sources of eligible substrates for biogas production. Often, co-digestion of two or more substrates is carried out so as to enhance biogas production (Larzor *et al*., 2010). Chukwuma (2012) and Jagadish *et al.* (2011) reported that co-digestion strategies are widely applied in order to enhance the methane production in agricultural biogas plants.

Until recently anaerobic digestion was a single substrate, single purpose treatment. Manures used to be digested to produce energy; sewage sludge was anaerobically stabilized and industrial waste water was pretreated before final treatment in a wastewater treatment plant. Numerous studies show that the sensitivity of the anaerobic digestion powers may be improved by combining several waste streams (Mladenovska *et al.*, 2003). The mixing of several waste types has positive effect both on the anaerobic digestion itself and on the treatment economy. Co-digestion of substrates has become a standard technology (Ezeoha and Idike, 2007). They reported that co-digestion usually improve the biogas yields from anaerobic digester due to positive synergisms established in the digestion medium and the supply of missing nutrients by the co-substrates. However, it should be noted that the digestion of manure and the biogas produced is variable depending on the types of manure (liquid vs solid), animal species, age and the type of feed the animals are fed with. Other variability of which anaerobic process is dependent upon are temperature, pH and alkalinity, hydraulic retention time, presence of toxic materials, solids retention time, concentration of the substrates, digester loading rate, the nature of waste being digested.

Potentials of biogas technology in Nigeria

Akinbami *et al*. (1996) estimated that about 227,500 tons of fresh animal waste is produced daily in Nigeria. Since 1 kilogram of fresh animal waste produces about $0.03m^3$ of biogas, it then follows that Nigeria has the potential of producing about 6.8million m^3 of biogas daily from animal waste alone. Yusuf *et al.* (2011) in his research on biogas production reported that from five batch digesters containing varying ratio of mix of horse and cow dung for a retention time of 30 days at ambient temperature, biogas production was optimized when worse and cow dung was mixed in a ratio of 3:1.

Investigations on biogas production at the National Centre for Energy Research and Development at University of Nigeria, Nsukka, on the comparative study of biogas production using cassava peels treated with various chemicals and locally available potash. The result showed that the biogas yield from cassava peels can be enhanced by chemical treatment and that locally available potash is a better treatment to be employed in the biogas yield from cassava peel. Some researchers at the University of Port Harcourt studied the effect of waste paper on biogas production from the co-digestion of fixed amount of cow dung (CD) and water hyacinth (WH) at room temperature with retention time of 60 days. They reported that an optimum waste paper amount of 17.5 g needs to combine with 5 g of CD and 5 g of WH in 250 ml of water for optimum biogas production. Numerous researchers have investigated biogas production in Nigeria using various agricultural wastes as substrates with varied results.

MATERIALS AND METHODS

The study area

Major poultry farms and abattoirs in Anambra State were visited during the field survey trip for primary and secondary data collection. Anambra State is one of the 36 states of Nigeria, and is located in the South East geo-political zone of the country. The national population census of 2006 gave the population of Anambra State as 4.06 million with a population density of 1,500 to 2,000 persons living within every square kilometer. Anambra State occupies a land area of about 4,844 square kilometer and is bounded in the east by Enugu State, in the north by Kogi State, in the south by Rivers and Imo States, and in the west by Delta State. The State is divided into 21 local government areas with Awka as its state capital.

Geographically, Anambra State is located between latitude $5^0 37^{'} 60$N and longitude $7^0 10^{'} 0$E. It has equatorial type of climate with two main seasons viz. the rainy season which is often characterized by heavy thunderstorm and lasts from April to October. At times, the wet season arrives as early as March and lasts till November. The mean annual rainfall varies between 1500 mm and 2250 mm, with a bimodal rainfall pattern with brief drop in rainfall known as the August Break. Dry season starts from November and lasts till March. Average maximum temperature range of 32 ^{0}C and average annual mean temperature of about 27 ^{0}C have been recorded. At rainy season however, the temperature is about 33 ^{0}C and high Relative Humidity (RH) of about 85 % is also recorded.

Over 70 percent of the population of the state is farmers who grow various agricultural crops such as yam, rice, cassava and maize. Tree crops are not given much attention. Livestock such as poultry, goats, and sheep under free range system are kept. However, poultry keeping in confirmed system is becoming popular with numerous well established large poultry farms in the state. The state's location in equatorial climatic region with average maximum temperature range of 32 ^{0}C is ideal for anaerobic digestion of biomass. Temperature is an important factor to consider in designing digesters among other factors such as pH (range of between 6.2 and 7.8), retention time, loading rate, and agitation.

Method of Data Collection

Survey visit was made to nineteen large-scale poultry farmers for on the spot assessment and personal interviews. A structured questionnaires was administered on each poultry farmer visited containing such question as, name of the poultry farm, size of the farm in terms of number of birds (layers, broilers, and day-old chicks), quantity of daily egg production, and poultry waste generations, method of poultry waste management, production system, and knowledge of biogas production using poultry dropping.

RESULTS AND DISCUSSION

Simple descriptive statistics was used in analysis of data generated during the course of the study. The data

Table 3: Farm locations and size

Name of Farm	Location	No of layers	No of broilers	No. of Chicks	Total
Ausco farms	Awka	20,0000	60,000	120,000	200,000
Chika Ebele farms	Ogbunike	5,000	-	-	5,000
Labour farm	Urum	6,000	1,500	1,000	8,500
Ozubulu Monastry	Ozubulu	750	200	-	950
Umuoji Monastry	Umuoji	2,000	1,000	-	3,000
Ugogburu farms	Nnobi	1,500	500	-	2,000
Chidera farms	Agulu	1,000	500	-	1,500
Ifeukwu farms	Nnewi	1,000	-	-	1,000
Aroma farms	Awka	4,000	3,200	2,000	9,200
Michael farms	Obosi	2,000	500	800	3,300
F.C. Muonwem	Uke	2,000	500	1,000	3,500
Ekwesiobi farms	Ojoto	3,000	1,000	1,000	5,000
Ekene farms	Anaku	30,000	20,000	50,000	100,000
Ugo farms	Nanka	6,500	500	500	7,500
Indigenious farms	Ihiala	9,000	10,000	5,000	24,000
Freedom farms	Umunachi	2,000	900	2,500	5,400
Chinyaka farms	Ifite Ogwali	1,500	1,500	2,500	4,750
Emeka farms	Enugu Ukwu	6,000	7,000	3,500	16,500
Young farms	Onitsha	1,500	2,000	1,000	4,500
	Total	102050	120800	179050	402600

Table 4: Approximate monthly production of poultry wastes in kilogrammes.

Name of Farm	Location	Monthly production (kg)
Ausco farms	Awka	15,000
Chika	Ogbunike	425
Labour	Urum	1,000
Ozubulu	Ozubulu	500
Umuoji	Umuoji	950
Ugogbuzue	Nnobi	700
Chidera	Agulu	500
Ifeukwu	Nnewi	2,120
Aroma	Awka	5,000
Michael	Obosi	3,750
F.C. Muonwem	Uke	2,800
Ekwesiobi	Ojoto	3,000
Ekene	Anaku	18,000
Ugo	Nanka	2,200
Indigenious	Ihiala	750
Freedom	Umunachi	1,500
Chinyaka	Ifite Ogwali	670
Emeka	Enugu Ukwu	1,000
Young	Onitsha	500
	Total	60,365kg

Table 5: Showing number of cows slaughtered in major abattoirs in Anambra State

Location of	No of Cows Slaughtered			
Slaughter House	Daily	Weekly	Monthly	Annually
Awka	70	490	1,960	2,350
Onitsha (Ose)	65	455	1,820	2,184
Onitsha (Ochanja)	56	392	1,568	18,816
Nnewi	60	420	1,680	20,160
Nnobi	20	140	560	6,720
Awka Etiti	40	280	1,120	13,440
Umuoji	10	70	280	3,360
Ekwulobia	30	210	840	10,080
Ihiala	16	112	448	5,376
Ogidi	15	105	420	5,040
Ogbunike	26	182	728	8,736
Nteje	100	700	2,800	33,440
Nkpor	30	210	840	10,080
Umunya	10	70	280	33,660
Total	548	3,836	15,344	184,128

obtained are presented in Tables 3 to 6. Table 3 shows the distribution of each poultry types (layers, broilers, and day-old chicks) with respect to the total number of a particular poultry type. The estimated that production of poultry in the study area is 402600 birds comprising of 102750 layers, 120800 broilers, and 179050 day-old-chicks. The number of birds differed remarkably. The study revealed that the major aim of poultry farming in the state is for meat and egg production. It is also shown that the level of mechanization in poultry industry in the state is at low ebb. The method employed in feeding the birds, brooding, egg collection and waste collection and management are still performed manually by the employees of the poultry farms.

Table 4 shows that the quantity of poultry waste generated monthly in each farm. The study shows that a total of about 60,363kg (about 60.4 tons) of poultry waste is generated in the state monthly amounting to about 724.8 tons of poultry waste annually.

These large quantities of poultry waste generated in the state often constitute pollution to the environment. The study reveals that only small proportion of this manure is used by farmers as fertilizer and as feedstock for fish farming.

During the field survey of the abattoirs in the state, it was revealed that about 548 cows are slaughtered daily in the state with minor shift upwards in number during festivities. Thus about 184128 cows are slaughtered annually in the state. Table 5 shows the number of cows slaughtered in major abattoirs in the state.

Table 6 shows the quantity of fresh cow manure generated in Anambra State. It further reveals that about 5,229,235kg (5,229 tons) of fresh cow manure is generated from major slaughter houses in the state.

Table 6: Quantity of fresh cow manure generation in Anambra State

Location of Slaughter House	Quantity of fresh manure generated in kilogram				
	Daily	Weekly	Monthly	Annually	% generation of cow manure
Awka	1,988	13,916	5,564	667,968	12.8
Onitsha (Ose)	1,846	12,922	51,688	6,206,256	11.9
Onitsha (Ochanja)	1,590	11,133	44,531	534,374	10.3
Nnewi	1,704	11,928	47,712	542,544	10.9
Nnobi	568	3,976	15,104	190,848	3.6
Awka Etiti	1,136	7,952	31,808	381,696	7.3
Umuoji	284	1,988	7,952	95,424	1.8
Ekwulobia	852	5,964	23,856	286,272	5.6
Ihiala	454	3,181	12,723	152,678	2.9
Ogidi	426	2,182	11,928	143,136	2.7
Ogbunike	738	5,169	20,675	248,104	4.7
Nteje	2,840	19,880	79,520	954,240	18.2
Nkpor	852	5,964	23,856	286,272	5.5
Umunya	284	1,988	7,952	95,424	1.8
Total	15,563	108,943	435,770	5,229,235	100

Conclusion

Fossil fuels are natural resources that are non-renewable and their prices are not reliable. The countries that use oil in large quantities have started to realize the fact that apart from the problems such as environmental issues, other problems associated with the use and burning of fossil fuels are enormous and the oil itself is not there in abundance as the world continue to witness oil depletion.

Bio-fuel as energy source has come to the rescue especially for the poor resource people in the rural areas who can not keep up to the price fluctuations of petroleum products.

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