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SAFE DISPOSAL OF ANIMAL WASTE TO PRODUCE BIOGAS AND ORGANIC FERTILIZERS USING BIOLOGICAL TREATMENTS: A PRELIMINARY RESEARCH NOTE

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ABSTRACT: In accordance with the state's vision 2030, which aims to bring about sustainable development, especially in the rural sector, and the President of the Republic launched a decent life initiative, the university administration has supported some development and applied projects that can be implemented at the university, provided that the outputs of these projects can be concomitant with the State's strategies for confronting climate changes and reducing the intensity of pollution, as well as providing some applied models for the people of Menoufia Governorate by which they can implement themselves, and then increases job creation and also constructive participation with those in charge of scientific research at the University.

In this context, the Faculty of Agriculture, Menoufia University, has implemented an important project for biogas production from animal waste on the farm, as well as extracting organic fertilizers. The first steps of the project were initially completed, and a number of Menoufia governorate residents and young graduates were invited to attend a workshop in which audiences were given an adequate explanation of the project so that they could implement it without any obstacles at their home.

In the following preliminary research note we will throw some light on the practical steps of the project, how to implement it and its practical objectives, as well as future studies that will be conducted in the future to ensure the sustainability of the project.

Key words: Animal waste, Biogas, Composting, sustainable development, Menoufyia University.

INTRODUCTION

Egypt as one of the developing countries has been suffering from some of major obstacles such as Overpopulation, Demographic imbalances, Shortage of agricultural area, Water scarcity *et al*., which mainly affects livelihood of peoples, particularly who are living in the rural sector. This mean that we have to benefit the different resources that prevailing to mitigate and alleviate such constraints.

The utilization of agricultural waste residues have emerged as one of the most important environmental considerations. As the methods of its use and its relationship to the environment emphasize give the necessity of placing it in an advanced position in the priorities of sustainable agricultural development issues. The amount of agricultural waste is increasing annually at high rates, especially with the horizontal agricultural expansion. The amount of plant waste, according to the latest report issued by the Egyptian Ministry of Environment (EME, 2019), was estimated at 40-50 million tons, with an average of 44 million tons annually. In addition to the residues of various animal and fish activities, which may reach half of this number. The total quantities that we benefit from are 20 million tons. This mean that what is not utilized is 24 million tons, which will double the size of the waste accumulation problem if researchers do not join efforts to devise new appropriate ways to benefit from this agricultural waste.

Animal waste prevailing under Egyptian environment must be maximized by converting it into biogas as a clean energy (El-Hadidi and Seufert, 1997) and then protect the environment from pollution, improve agricultural products, providing employment opportunities in the agricultural sector, thus improving the economic

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and environmental situation and raising the health and social level in our country (Table 1).

In the following preliminary research note we will throw some lights on the importance of biogas production from the animal waste as a tool for biogas production and organic fertilizers through using some of biological treatments. Biogas process, factors affecting biogas production, biogas process and its importance under rural sector development as a tool for sustainable development will be taken into consideration.

The state's efforts to produce biogas and organic fertilizers from animal waste:

During the past two years, the role of the environmental dimension has emerged strongly as one of the most important dimensions of Egypt's sustainable development strategy 2030. Egypt's plan aims to transform into a green economy, through integrated waste management programs of all kinds, which are among the most important pollution control mechanisms. In order to emphasize that, law regulating waste and integrating the informal sector, integrating the private sector into the waste system, beside the infrastructure projects were established by the state. A number of 103 intermediate stations, 57 factories, and more than 70 landfills nationwide, cost more than 10 billion pounds were constructed (Yasmine F.,2021).

The produced biogas from anaerobic digestion (AD) can contribute to about 13% of the Egypt's total natural gas production; meanwhile, compost will increase the total production of fertilizers in Egypt at more than 60%. This suggests that decision makers, researchers, and engineers should draw more attention to bioconversion as an efficient management tool for resolving the growing problem of agricultural wastes in rural areas (Elfeki *et al.,* 2017).

Fundamentals of Biogas production and Technology:

Methane gas can be produced from agricultural wastes, particularly manures in an anaerobic digestion process in which the anaerobic digestion of agricultural waste to form methane-rich gas is a two-step microbial fermentation. Initially, acid-forming bacteria break down the volatile solids to organic acids which are then utilized by methan-ogenic organisms to yield methane-rich gas (Khidr *et al.,* 2021).

Biogas is a sustainable alternative solution to natural gas, it is extracted from bio-waste which may be food or agricultural wastes, animal manure. Biogas is a sustainable alternative solution to natural gas. Biogas technology aims to reuse organic waste, such as crop residues and livestock manure, to produce new renewable energy and as an alternative to traditional energy with the production of good organic fertilizer and to protect the environment from pollution with these wastes. The system consists of three main parts; mixing tank, digester with gas collecting roof and outlet tank. The mixing tank mixes the waste with water before feeding it to the digester which contains the bacteria that digests the waste. This is done through breaking complex carbon bonds producing biogas that will be collected at the top part of the digester. And as the gas produced increases, it applies pressure on the slurry in the digester forcing it to the outlet tank. The solids collected at the outlet tank are used as fertilizers (El-Haggar *et al.,* 2004).

Biogas production has enjoyed support in developing countries, by both local authorities and international organizations (Thu *et al.,* 2012). Biogas technology could address handling problems of industrial, agricultural, and domestic wastes, and at the same time produce renewable electricity, heat, and fertilizer (Lijo et al., 2014). Biogas production can help Egypt to sustainably manage biomass waste and produce renewable energy, in order to enact positive change both locally and globally. To this end, household digesters can play an important role and be a useful manure management tool, provided that they are well-designed and operate appropriately (Hou *et al.,* 2017).

Table (1): Daily production of manure in Egypt

Type	average body weight (kg)	Amount of dry waste (kg/day)	Total daily production (tons)
Cattle	400	4	36445
Equine family	350	5	370
Sheep	40	0.48	2606
Goats	30	0.24	1033
The Camels	400	2	283
Total	-	-	40737

Kewan and Khattab (2016).

Applied steps of Biogas production technology from the Egyptian state:

A large number of fermenters were implemented to produce biogas, especially from animal manure. Practical experiments started in a large number of Egyptian universities and research centers. Then these techniques were spread to many beneficiaries and farmers. These executive techniques depend on the following: The digester which designed according to the Indian model which consists of a two-chamber, Fig. (1). The digester consist of one cylindrical tank with 9.42m^3 volume (height 3m, diameter 2m) and gas tank with 6m^3 (height 1m) and inlet tube and outlet tube. The production of biogas from fermentation time during the 30 days amounted to 48m^3. The highest production was in the thirteenth day with 4.5m^3. The smell of waste in the farm has become weak, also after investing in the fermenter; the farm was distinguished by its cleanliness and lack of insects. However, the fermenter that used in our project is illustrated below.

Test the fermenter before work:

The fermenter was tested to ensure that there is no leakage and free movement of water and its exit from the exit hole at the required level for the fermenter, as the tank was filled with water through the inlet hole until it came out of the exit hole and left the water in the fermenter for 72 hours, and no decrease in the water level was observed. This is evidence that the water does not leak through invisible holes or cracks, then all the water is withdrawn from the fermenter, so that the fermenter is ready for use. However, Among hundreds types of traditional anaerobic digesters, three of them are most efficient; namely, floating dome, fixed dome and plug flow (tubular) digester (Bond and Tempeleton, 2011). The floating dome digester or the Indian style is the popular type in Egypt due to its simplicity in repair and maintenance.

Supplying the fermenter with animals manure:

Before placing the residues in the fermenter, it is diluted with water in a ratio of 1:1 and mixed well in a plastic barrel, so that the mixture becomes easy to move, then the mixture is placed in the fermenter through the input tank, and thus the fermenter is filled with residues, and while the fermenter is filled with the mixture, the fermentation starter is added which was previously prepared by placing an expanded mixture in a completely closed barrel, and leaving it for three months, and this time is sufficient to activate the bacteria needed to ferment or digest the waste and produce gas. Biogas production varied from day to day during the fermentation period, which was 33 days.

Fig. (1): The Fermenter at project region, Fac. Of Agric., Menoufyia Univ.

Factors affecting Biogas Production:

The biogas production is influenced by many factors, of which the temperature of the anaerobic digester process and of the sublayer is the most important. Depending on the reaction medium temperature, certain groups of microorganisms are stimulated, while others are inhibited mesophilic bacteria require an optimal temperature around 35°C, and the thermophilic bacteria require an optimal temperature around 55°C) (Paul et al. 2014). Retention Period is also another factor affecting biogas production as it represents the time period for which the fermentable material remains inside the digester. This period ranges from 35 days to 50 days depending upon the climatic conditions and location of the digester. The longer retention period needs larger size digester and it allows more complete digestion of feed (Harilal *et al.*, 2012).

Hydrogen Ion Concentration pH value is also an important factor which indicates the degree of acidity or alkalinity of a solution. The pH value is represented as the logarithm of the reciprocal of the hydrogen ion concentration in gm equivalent per liter of solution. pH value in the range 0-7 represents acidic solution and in the range 7-14 indicates the alkaline solution. The micro-organisms require a neutral or mildly alkaline environment.

During methane formation stage the pH value higher than 7.0 is maintained since methane formers are sensitive to acidity. Moreover, the pH value depends on the ratio of acidity and alkalinity and the carbon dioxide content in the digester, the determining factor being the density

of the acids. For the normal process of fermentation.

The concentration of volatile acid measured by acetic acid should be below 2000 parts per million too high a concentration will greatly inhibit the action of the methanogenic microorganisms. It was reported also that the major nutrients required by the bacteria in the digester are N2, P, S, C, H2, and O2 to accelerate the anaerobic digestion rate.

It is worth to note that the major nutrients are supplied in correct chemical form and concentrations. The carbon in carbohydrates supplies, the energy and the nitrogen in proteins is needed for building of growth of bacteria. The bacteria responsible for the anaerobic process require both elements nitrogen and carbon, as do all living organisms, but they consume carbon roughly 30 times faster than nitrogen.

Assuming all other conditions are favorable for biogas production, a carbon-nitrogen ration of about 30:1 is ideal for the raw materials fed into a biogas plant with 2% phosphorous for maximum biological activity. A higher ratio will leave carbon still available after the nitrogen has been consumed, starving some of the bacteria of this element. These will in turn die, returning nitrogen to the mixture, but slowing the process. Too much nitrogen will cause this to be left over at the end of digestion (which stops when the carbon has been consumed) and reduce the quality of the fertilizer produced by the biogas plant. The correct ratio of carbon to nitrogen will prevent loss of either fertilizer quality or methane content. Therefore, for acceleration fermentation and production of biogas nutrients like C, P and N2 are maintaining within the optimum range. Oil cakes and animal urine are found to be suitable nutrients for this purpose ((Harilal *et al.*, 2012).

However, the stability of the anaerobic fermentation process within the digester is highly affected by many factors such as the presence of oxygen, pH of slurry, temperature, type of feedstock, stirring as well as the amount of inhibitors (Al Seadi *et al.*, 2008).

Biogas Production and Sustainable development in rural sector of Egypt:

Biogas produced from animal waste is widely used as a renewable bio-fuel source. This source of energy is regarded as cheap and clean and is also known to produce a residue with a high fertilizer value for crop production (Albihn and Vinneas, 2007 and Lantz *et al.*, 2007). An increase in population densities and livestock production in developing countries enhances environmental problems that are gradually becoming a barrier for development. Biogas technology is considered as one of the solutions to environmental problems caused by manure management. Of benefits can be mentioned that biogas is renewable and clean and can be used for heating and cooking, which saves trees, thus reducing deforestation, it improves the working environment for women and reduces odor, pathogens and flies. However, a major part of biogas production consumed in building, mainly in the residual sector for cooking and heating, with the remainder upgraded to biomethane and blended into the gas networks or used as a transport fuel.

The biogas technology can help reduce poverty and support a sustainable development. However, in a country like Egypt with at least 2% growth rate annually, we have to find out some of non conventional ways to mitigate and alleviate the urgent requirements for peoples particularly who are living in the rural regions of Egypt. Extension service must be taken into consideration for farmers and rural peoples through national programme to be supported from the government and non governmental organizations.

Conclusion and final remarks:

Biomass as an important kind of renewable energy represents the major energy resource for the people in rural areas in Egypt (Abd Allah *et al.*, 2016), which including animal and poultry wastes, crop residues, agro-industrial wastes and other types of biomass materials. The concept of utilizing the biomass as a potential renewable energy resource to produce heat, electricity, and

power become more ambitious (Atyia *et al.*, 2017). Biogas is produced when bacteria digest organic matter (biomass) in the absence of oxygen. This process is called anaerobic digestion. It occurs naturally anywhere from the within the digestive system to the depth of effluent ponds and can be reproduced artificially in engineered containers calkled digesters.

Biogas energy is a clean and sustainable form of energy that could be used as an alternative to fossil fuels (Surroop and Mohee, 2012). The main raw material used to produce biogas in Egypt is the dung of buffalo and cattle animals. Actually, Egypt has 19.9 million head of livestock and animals (CAPMAS, 2016), of which there are 8.115 million head of buffaloes and cattle (FAO, 2018). This means huge quantities of cattle and buffaloes manure. Simultaneously, storage of manure in open air generates CH4 and CO2 by anaerobic self-remediation of manure which can strongly contribute to the global warming (Neshat *et al.*, 2017). Additionally, the stored cattle dung is considered an attractive environment of pathogens as well as bad pungent odor. Methane emissions can be avoided by treating manure in biogas facilities where methane can be recovered and converted to green fuel (Rico *et al.*, 2014). Hence the exploiting of cattle and buffaloes manure to produce the biogas as a gaseous bio-fuel using the bioprocess of anaerobic digestion (AD) becomes one of the most prospective routes towards a world free of pollution. For consecutive studies, this research note will be followed with some of applicable research works to ensure and enhance the State's Vision for a real sustainable development in our country.

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التخلص الأمن من المخلفات الحيوانية بانتاج البيوجاز والسماد العضوى باستخدام الوسائل البيولوجية: دراسة مبدئية

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الملخص العربي

طبقا لرؤية الدولة المصرية ٢٠٣٠ والتى تهدف الى تحقيق تنمية مستدامة لاسيما فى القطاع الريفى وأيضا خطة الرئيس الطموحة فى المشروع التنموى الهام "حياة كريمة" فان الباحثين فى الجامعات والمراكز البحثية يبذلون قصارى جهدهم فى توظيف المخرجات البحثية لتكون أهدافا تطبيقية تخدم المجتمعات المحيطة بهم وتعالج القضايا الهامة. وفى هذا السياق فان مشكلة التلوث أحد المعضلات الهامة والتى يجب أن نضعها فى دائرة الضوء لإستخدام التقنيات الحديثة والمناسبة للحد منها ويأتى فى هذا الصدد كميات المخلفات الحيوانية والناتجة عن مزارع الإنتاج الحيوانى بالمحافظة والتى تسبب تلوثا بيئيا ملحوظا يضر بصحة المواطنين.

ان هذه الدراسة صممت كى تعطى مثالا تطبيقيا لكيفية تنفيذ مشروع البيوجاز وانتاج الأسمدة العضوية وكيف أمكن توظيفه للتخلص الأمن من المخلفات الحيوانية وقد هدف المشروع البحثى أن يتم تنفيذ خطواته البحثية بالشراكة مع سكان محافظة المنوفية وشباب الخريجين تشجيعا لهم بتكرار هذا النموذج التطبيقى الهام لديهم فى مزارعهم وفى سبيل تبسيط ذلك القيت عدة محاضرات نظرية وعملية للتنفيذ الفعلى للمشروع. اننا نهدف من هذه الورقة البحثية ان نقدم نموذجا مبسطا كمقدمة لخطوات قادمة سوف يتم توظيفها فى مشروع تنموى كبير ينفذ على نطاق واسع ليس فقط للحد من التلوث ولكن أيضا لبسط حياة كريمة وايجاد فرص عمل لسكان محافظة المنوفية.