*International Journal of Studies in Education – Vol. 21, Issue 1, 2025, 308-316*
*ISSN: 2636-6320 (ONLINE) - 2636-6339 (PRINT) - https://ijose.unn.edu.ng/*

# INTEGRATION OF BIOGAS TECHNOLOGY INTO AGRICULTURAL EDUCATION CURRICULUM FOR WASTE MANAGEMENT IN UNIVERSITY FARMS IN SOUTH EAST NIGERIA

**Nnadi, Victor Maduka & Oketoobo, Emmanuel Akintunde**
Department of Agricultural and Vocational Education,
College of Education, Michael Okpara University of Agriculture, Umudike

**Abstract**
*This study examined the integration of biogas technology in Agricultural education curriculum for waste management in farms in Universities in south east, Nigeria. The study adopted a descriptive survey research design. A sample of 192 respondents comprising 27 lecturers of Agricultural education, 82 farm officers as well as 83 laboratory technologist drawn from a population of 369 respondents using multi staged sampling techniques. The instrument for data collection was a 36-item researcher developed questionnaire titled: Integration of Biogas Technology in Agricultural Education Curriculum for Waste Management Questionnaire (IBTAECWMQ).The instrument was validated by three experts.The stability aspect of the reliability of the instrument was determined using Pearson product moment coefficient which yielded an overall index of 0.85. The data was collected by the researcher with the help of three research assistants. Out of the 192 copies of the questionnaire administered, 185 representing 96% of the entire instrument distributed were returned and used for data analysis. Data collected were analyzed with mean and standard deviations to answer the three research questions raised for the study while Analysis of Variance (ANOVA) was used to test the three hypotheses that guided the study at 0.05 level of significant. Based on the findings made, it was recommended among others that Government should through the National Universities Commission (NUC) ensure that the course (biogas technology) is integrated into the Agricultural education curriculum for effective waste management in the university farms in the south east and Nigeria at large.*

**Keywords**: Integration, Biogas Technology, Agricultural education, Curriculum

## Introduction

Agricultural waste is one of the major problems facing farm managers due to the quantity of wastes produced at various intervals of farm operations. Lawal (2021) defined waste as any substance, solid, liquid or gaseous that remains as residue or an incidental by-product of the processing of substance or for which no use can be found by the organism or system that produces it. Okwesili, Ndukwe & Nwuzor (2016) defined wastes as substances or objects discarded as worthless or unwanted, defective or of no further value from manufacturing or production process. Achi and Maiyaki (2020) observed that wastes are classified conveniently with respect to their sources, Such include municipal waste, agricultural waste, and industrial waste among others. The amount of solid wastes in urban cities of developing countries such as Nigeria, has witnessed an increased level due to population explosion, increased agricultural activities and the growth of industries (Odejimi & Udotong, 2017). Agricultural wastes refers the remains gotten from the cultivation and refining of unprocessed agricultural goods which are mostly poultry and poultry by-products, crops remains, fruits, vegetables, dairy products, among others. These wastes are products of cultivation and processing of agricultural products which are mostly in the form of liquids, slurries or solids. According to Dangogo and Fernado (2016) agricultural wastes is defined as the residues obtained from grown and processed raw farm products among which are crops remains, meat, fruits, roots, husks, residual stalks, and vegetables. In this context, agricultural waste include any substance of plant or animal origin considered to be contaminated, spoiled, useless and unwanted in school farms which could be solid, liquid or gaseous in nature. State Environmental Protection Agency in Ezugwu and Aniago (2021) cautioned that previously

common practices of waste management are not now allowed; for example, burning of waste in the open spaces, using unlicensed farm tips or burying waste; putting farm waste in the household dustbin and so on. The agency maintained that agricultural waste can be avoided or minimized through product design, recycling schemes for waste, silage plastics and pesticides packaging; 'take-back' service for veterinary and machinery wastes and improved management practices such as biogas technology.

Biogas refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas, in the statement of National Non-Food Crop Centre (2017) is a gas produced by biodegradable materials such as biomass sewage, manure, municipal waste, faeces (dropping and dung), and kitchen waste among others. Deublein and Steinhauser (2019) viewed Biogas technology as the application of science on micro-organisms for harnessing their breaking down of organic matter in an oxygen-free environment (anaerobic digestion) to produce methane and other products useful to man. Biogas or the Anaerobic Digestion (AD) technology is one of the oldest forms of renewable energy (RE) (Abbasi, Tauseef & Abbasi, 2019). The first evidence of the use of this technology was found in ancient literature from various parts of the globe (Martineau, & Worley 2019). Biogas technology is also known to be one of the most appropriate alternatives to treat organic waste due to its ability to recover both material both the solid part as soil conditioner or organic fertilizer, the liquid part as fertigation water or liquid fertilizer) and energy ( the gas can be upgraded to natural gas quality and used as vehicle fuel, or converted into electricity) from waste. The multifaceted nature of this approach renders it a highly ranked method within the waste management hierarchy and an excellent tool for the realization of circular economy (Fagerström, Seadi, Rasi & Briseid, 2019). On the other hand, organic waste from municipalities has great potential to be used as a substrate for biogas plants and may impose environmental burdens when not properly handled. The economic prospect of biogas technology in Africa is great because of the availability of raw materials such as animal, human, agricultural and industrial wastes, it can also be part of curriculum in agricultural education.

Agricultural Education as defined by Osinem in Eze (2018) is the process of imparting knowledge, attitudes and skills to learners at any level of education in agriculture. At the informal. Agricultural Education is taught by the lecturers at both the state and federal universities in Nigeria. Agricultural Education at colleges of education and universities is drawn from the objectives of the larger society so as to achieve agricultural and economic policies of the country. This implies that the programme endows the recipients with a balanced approach between principles and practice of agriculture for effective management of agricultural waste in school farms. A farm is an agricultural land and /or building where crops are grown or animals are reared for economic purposes. School farm is regarded as educational facilities where students receive experience and instruction in agriculture in the school. Madu (2019) explian further still, it is a miniature pilot farm where scientific findings and innovations can be tried thoroughly and adjustment made before feedback is sent to researchers for improvement. The school farm is a laboratory, specifically designed and operated, for the purpose of carrying out practical's in agricultural education in order to impart knowledge and managerial skills to students through practice. It is an area specifically earmarked for agricultural activities, usually sited in the school or at a walking distance to the school compound. Boone, and Hugbes (2018) in a study noted that students acquire agricultural knowledge in classrooms in such areas like crop production, forestry, fish farming, agricultural business, farm management, livestock production and so on. School farm is an agricultural laboratory that interprets the acquired theoretical knowledge into practice through practical activities to gain experience. In this context, school farms are laboratory for teaching Agricultural Education lessons that exposes students to possess skills required for effective management of agricultural waste. In the school farm, students are provided with adequate equipment, farm space, farm structures, supply of fertilizers and animal feeds in order to carry out actual practical skills in agriculture. Even though the school farm has been perceived as

very important for imparting manipulative skills to students, it requires effective management of agricultural waste and relevant skills of the lecturers.

**Purpose of the study**

The purpose of this study is the integration of biogas technology in Agricultural Education curriculum for waste management in farms in universities in south east, Nigeria. Specifically, the study attempt to:

1. determine the objectives of biogas technology for inclusion in the curriculum of Agricultural Education for waste management in farms in universities
2. identify the content of biogas technology for inclusion in the curriculum of Agricultural Education for waste management in farms in universities
3. identify the materials required for instruction in an integrated biogas technology in the curriculum of Agricultural Education for waste management in farms in universities,

**Research Questions**

The following research questions guided the study

1. What are the objectives of biogas technology for intergration in the curriculum of Agricultural Education for waste management in school farms in universities?
2. What are the content of biogas technology for inclusion in the curriculum of Agricultural Education for waste management in school farms in universities?
3. What are the materials required for biogas technology in the curriculum of Agricultural Education for waste management in school farms in universities?

**Hypotheses**

The following null hypotheses were formulated and tested at the probability of 0.05 level of significance.

**$HO_1$:** There is no significant difference in the mean ratings of lecturers of Agricultural Education, Farm officers and Technologist on the objectives of biogas technology for inclusion in the curriculum of Agricultural Education for waste management in school farms in universities.

**$HO_2$:** There is no significant difference in the mean ratings of lecturers of Agricultural Education, Farm officers and Technologist on the content of biogas technology for inclusion in the curriculum of Agricultural Education for waste management in school

**$HO_3$:** There is no significant difference in the mean ratings of lecturers of Agricultural Education, Farm officers and Technologist on the materials required for biogas technology in the curriculum of Agricultural Education for waste management in school farms in universities.

**Methods**

The study adopted a descriptive research design, the study was carried out in university offering agricultural education in the south eastern Nigeria, the population of the study comprised of 369 respondents consisting of 51 lecturers of agricultural education,158 farm officers and 160 laboratory technologist from the universities. A sample size of 192 respondents consisting of 27 lecturers of agricultural education, 82 farm officers and 83 laboratory technologists were selected from the population. This was determined by using Taro Yamane method (1967). For the method, stratify proportionate sampling was used to class the sample size into 3 groups lecturers of Agricultural Education, Farm officers and Laboratory Technologist. Simple fraction of 0.5203 was used to estimate or determine the proportion of each stratum based on their number on the entire population. The instrument for data collection was a structured questionnaire titled " integration of biogas technology in agricultural education curriculum for waste management Questionnaire (IBTAECWMQ)"with correspond responses and coded respectively as follows. Strongly Agree (SA) – 4, Agree (A)- 3, Disagree

(D) – 2, Strongly Disagree (SD) - 1. The instrument was subjected to face validation by three experts or validates selected from different Departments and fields in the College of Education, Michael Okpara University of Agriculture Umudike. One validate was from the Measurement and Evaluation unit of the Department of Science Education and two from the Department of Agricultural and Vocational Education all in College of Education. A trial test was conducted on 30 respondents and Cronbach alpha was used to establish the reliability which yielded coefficient of 0.88 which considered the instrument reliable for the study. The mean score and standard deviation was used to research questions while analysis of variance was used to the hypothesis at 0.05 level of significance

**Research Question One:** What are the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities?

**Table 1: Mean Analysis of lecturers of Agricultural education, Farm officers and Technologists on the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities N=185**

| | **Objectives of biogas technology include:** | $\bar{X}_G$ | $SD_G$ | **Rmks** |
|---|---|---|---|---|
| 1 | Students explaining the meaning of biogas technology | 3.60 | 0.74 | Agreed |
| 2 | Students explaining the importance of biogas technology | 3.13 | 0.66 | Agreed |
| 3 | Instructors providing technical skills on construction of biogas chamber | 3.63 | 0.78 | Agreed |
| 4 | Students identifying how to generate sustainable and renewable energy | 3.76 | 0.7 | Agreed |
| 5 | Explaining how to reduce methane and greenhouse gas emission | 3.67 | 0.91 | Agreed |
| 6 | Identifying how to produce nutrient rich bye-product which can be used for natural fertilizer | 2.88 | 0.88 | Agreed |
| 7 | Identifying how to create job opportunities in the installation and maintenance of biogas technology | 3.62 | 0.93 | Agreed |
| 8 | reducing waste disposal cost and energy expenses | 3.27 | 0.78 | Agreed |
| 9 | Minimizing the environmental and health impact associated with open burning | 3.25 | 0.86 | Agreed |
| 10 | Identifying the education and research opportunities related to renewable energy | 3.22 | 0.78 | Agreed |
| 11 | Students' ability to mix input into biogas chamber | 3.69 | 0.63 | Agreed |
| 12 | Identifying the quantity of input materials | 3.54 | 0.66 | Agreed |
| 13 | Students' ability to ascertain how to drain the | 3.12 | 0.84 | Agreed |

| | | | |
|---|---|---|---|
| slurry | | | |
| **Cluster mean** | **3.42** | **0.80** | **Agreed** |

$\bar{X}$ = Group mean,, **SD** = Groups mean

The result in Table1 show that the mean ratings of the respondents in all the items (1-13) which are on the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school. These indicated their agreement to those item statements. The cluster mean responses of 3.42 for the groups mean which are all above the mean bench mark of 2.50 affirmed their agreement on those item statements as the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities. The cluster standard deviation of 0.80 for respondents showed that their mean responses were not far from the mean and from each other.

**Hypothesis 1**

There is no significant difference in the mean ratings of lecturers of Agricultural education, Farm officers and Technologists on the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities.

**Table 2: Analysis of Variance (ANOVA) of the Mean Responses of lecturers of Agricultural education, Farm officers and Technologists on the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities**

| | Sum of Squares | Df | Mean Square | F | Sig. | Remark |
|---|---|---|---|---|---|---|
| Between Groups | 283.188 | 2 | 141.594 | 3.145 | .241 | NS |
| Within Groups | 8239.813 | 183 | 45.022 | | | |
| Total | 8522.001 | 185 | | | | |

NS = No Significant

Data in Table 2 reveal a P-value of 0.241 which is greater than the alpha value of 0.05. Since the p-value is greater than the alpha value, the hypothesis of no significant difference was not rejected. Therefore, there is no significant difference in the mean ratings of lecturers of Agricultural education, Farm officers and Technologists on the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities.

**Research Question Two:** What are the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities?

**Table 3: Mean Analysis of lecturers of Agricultural education, Farm officers and Technologists on the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities N=185**

| S/N | Contents of biogas technology for inclusion in Agricultural Science curriculum include: | $\bar{X}_G$ | $SD_G$ | Rmks |
|---|---|---|---|---|
| 14 | Selection of site for biogas | 3.45 | 0.79 | Agreed |
| 15 | Construction of biogas chamber | 3.16 | 0.73 | Agreed |
| 16 | Preparation of biogas chamber | 3.64 | 0.75 | Agreed |
| 17 | Assessment of the quality of biogas chamber | 3.73 | 0.79 | Agreed |
| 18 | Monitoring of biogas chamber environment (temperature, PH) | 3.62 | 0.96 | Agreed |

| | | | | |
|---|---|---|---|---|
| 19 | Harvesting the biogas | 3.13 | 0.85 | Agreed |
| 20 | Purification of biogas | 3.05 | 0.83 | Agreed |
| 21 | Drainage of effluent and slurry | 2.97 | 0.75 | Agreed |
| 22 | Management of biogas chamber and accessories | 2.59 | 0.85 | Agreed |
| 23 | Precautionary measure for producing biogas | 2.89 | 0.88 | Agreed |
| 24 | Construction of dome for storage of biogas | 2.70 | 0.82 | Agreed |
| | **Cluster mean** | **3.18** | **0.82** | **Agreed** |

$\bar{X}$ = Group mean, SD = standard deviation

The results in Table 3 reveal the mean ratings of the respondents in all the items (14-24) which are on the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities, ranged between 2.55- 3.74 and are all above the mean bench mark of 2.50. Furthermore, the mean responses of the respondents in all the items, ranged between 2.59 -3.73 and are equally above the mean bench mark of 2.50. These indicated their agreement to those item statements. The cluster mean responses of 3.18 for the groups mean which are all above the mean bench mark of 2.50 affirmed their agreement on the above items as the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities. The cluster standard deviation 0.82 for the respondents showed that their mean responses were not far from the mean and from each other.

**Hypothesis 2**

There is no significant difference between the mean ratings of lecturers of Agricultural education, Farm officers and Technologists on the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities.

**Table 4: Analysis of Variance (ANOVA) of the Mean Responses of lecturers of Agricultural education, Farm officers and Technologists on the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities**

| | Sum of Squares | Df | Mean Square | F | Sig. | Remark |
|---|---|---|---|---|---|---|
| Between Groups | 279.411 | 2 | 139.706 | 2.949 | .311 | NS |
| Within Groups | 8644.305 | 183 | 47.237 | | | |
| Total | 8923.716 | 185 | | | | |

**NS** = No Significant

Results in Table 4 reveal a P-value of 0.311 which is greater than the alpha value of 0.05. Since the p-value is greater than the alpha value, the hypothesis of no significant difference was not rejected. Therefore, there is no significant difference in the mean ratings of lecturers of Agricultural education, Farm officers and Technologists on the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities.

**Research Question Three:** What are the materials required for instruction in an integrated biogas technology curriculum of Agricultural Education for waste management in school farms in Universities?

**Table 5: Mean Analysis of lecturers of Agricultural education, Farm officers and Technologists on the materials for biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities N=185**

| | Materials for biogas technology inclusion in Agricultural Science curriculum include: | $\bar{X}$ | StD | Rmks |
|---|---|---|---|---|
| 25 | Sewage sludge | 2.84 | 0.87 | Agreed |
| 26 | Food waste | 2.76 | 0.83 | Agreed |
| 27 | Waste from food industry | 2.84 | 0.81 | Agreed |
| 28 | Manure from livestock | 3.02 | 0.77 | Agreed |
| 29 | Distillery bye product | 2.82 | 0.81 | Agreed |
| 30 | Cement | 2.83 | 0.83 | Agreed |
| 31 | Sand | 2.99 | 0.87 | Agreed |
| 32 | Gravel | 2.93 | 0.91 | Agreed |
| 33 | Water | 2.84 | 0.78 | Agreed |
| 34 | Bricks | 2.96 | 0.81 | Agreed |
| 35 | Gas storage/ Gasometer | 3.07 | 0.89 | Agreed |
| 36 | Methane | 2.96 | 0.78 | Agreed |
| | **Cluster mean** | **2.91** | **0.83** | **Agreed** |

$\bar{X}$ = Group mean, **SD** = standard deviation

The results in Table 5 reveal the mean ratings of the respondents in all the items (24-36) which are on the materials required for instruction in an integrated biogas technology curriculum of Agricultural Education for waste management in school farms in Universities, ranged between 2.56- 3.41 and are all above the mean bench mark of 2.50. Furthermore, the mean responses of the respondents in all the items, ranged between 2.76 -3.07 and are equally above the mean bench mark of 2.50. These indicated their agreement to those items as the materials required for instruction in an integrated biogas technology curriculum of Agricultural Education for waste management in school farms in Universities. The cluster mean responses of 2.91 for the respondents which are all above the mean bench mark of 2.50 showed their agreement on the above items as the materials biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities. The cluster standard deviation of 0.83 for the respondents showed that their mean responses were not far from the mean and from each other.

**Hypothesis 3**

There is no significant difference between the mean ratings of lecturers of Agricultural education, Farm officers and Technologists on the materials required for instruction in an integrated biogas technology curriculum of Agricultural Education for waste management in school farms in Universities.

**Table 6: Analysis of Variance (ANOVA) of the Mean Responses of lecturers of Agricultural education, Farm officers and Technologists on the materials for biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities**

| | Sum of Squares | Df | Mean Square | F | Sig. | Remark |
|---|---|---|---|---|---|---|
| Between Groups | 277.690 | 2 | 138.845 | 3.140 | .303 | NS |
| Within Groups | 8091.433 | 183 | 44.215 | | | |

| | | |
|---|---|---|
| Total | 8369.123 | 185 |

**NS = No Significant**

Data in Table 6 indicated a P-value of 0.303 which is greater than the alpha value of 0.05. Since the p-value is greater than the alpha value, the hypothesis of no significant difference was not rejected. Therefore, there is no significant difference in the mean ratings of lecturers of Agricultural education, Farm officers and Technologists on the materials required for instruction in an integrated biogas technology curriculum of Agricultural Education for waste management in school farms in Universities

**Discussions**

The findings were discussed based on the major findings of the study. It was found from the study that the objectives of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities include the students' ability to explain the meanings and the importance of biogas technology as well as providing technical skills on construction of biogas chamber among others. The results further showed that there was no significant difference in the mean responses of the respondents on the topic. This implies that those stakeholders are in agreement that those objectives are those of biogas that need to be integrated in the curriculum of biogas Agricultural Education for waste management in school farms in Universities. The results agreed with Hatter (2019) who identified the objectives of biogas technology to include educating people on biogas production and promoting a better understanding of biogas technology, assisting the learner to become skillful in biogas technology as well as employment and income generation through modern method of biogas technology.

It was found from the study that the contents of biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities includes: the selection of sites for biogas technology, Construction of biogas chamber, preparation of biogas chamber, assessment of the quality of biogas chamber, harvesting of biogas, among others. The results further showed that there was no significant difference between the mean ratings of the respondents. This implies that the respondents did not differ in their responses on those contents of biogas technology that should be integrated into the curriculum of Agricultural Education for waste management in school farms in Universities. The results corroborated Ofuefule, Uzodinma and Onukwuli (2019) who recommended that the content of biogas technology for classroom teaching should involve three levels of research, theory and application. There is no doubt that the contents of biogas technology that should be integrated into the Agricultural education curriculum should be rich enough to enable the recipient as well as the students gain adequate knowledge of the technology and use such knowledge to create job and solve societal challenges.

The results also revealed that the materials for biogas technology for integration in curriculum of Agricultural Education for waste management in school farms in Universities include: sewage sludge, food waste, wastes from food industries, manure from livestock, Distillery bye product, cement, sand, gravels, water, bricks, methane, gas storage /gasometer among others. This implies that the respondents agreed in all the enlisted as the necessary materials for the construction of a biogas technology in an integrated curriculum of Agricultural Education for waste management in school farms in Universities. The results equally indicated that there is no significant difference between the mean ratings of the respondents on the materials required for the construction of biogas technology curriculum of Agricultural Education for waste management in school farms in Universities. This also implied that there is no disagreement among the respondents on the materials for construction of a biogas technology integrated curriculum of Agricultural Education for waste management in school farms in Universities. The results corroborated Orhorhoro, Ebunilo and Sadjere (2017) who enlisted the materials to be used for the construction of biogas technology to include cement, sand, gravel, water, bricks and cobblestones.

**Conclusion**

Based on the findings of the study, it was concluded that biogas technology be integrated into Agricultural education curriculum for effective waste management in the university farms in South East Nigeria through instructional methods by Agricultural Education lecturers.

**Recommendations**

Based on the findings and conclusions of the study, the following recommendations were made:

1. Government should through the National Universities Commission (NUC) ensure that the course (biogas technology) is integrated into the Agricultural education curriculum for effective waste management in the university farms in the south east and Nigeria at large.
2. The National Universities Commission should ensure that the content of biogas technology when integrated should cover more contents on waste management in the school farms.
3. The university administration should ensure that the materials for biogas technology are adequately provided for effective implementation of the objectives of the course when it is integrated into Agricultural education curriculum.

**References**

Abbasi, F., Tauseef, G. and Abbasi, T. (2019). Enhanced anaerobic digestion of biomass waste for optimized production of renewable energy and solids for compost. *International Congress Series*, 12(3), 221–229.

Achi, A. B. & Maiyaki, D. (2020). Biofuels development and adoption in Nigeria: Synthesis of drivers, incentives and enablers. *Energy Policy, 4*(3), 387-395.

Boone, H.N.; Boone, D.A. and Hugbes, J.E. (2018). Modernizing the agricultural education curriculum: An analysis of agricultural education teachers' attitudes, knowledge and understanding of Biotechnology. *Journal of Agricultural Education*, 47(1), 78-89.

Dangogo, S. M., & Fernando, C. E. C. (2016). A simple biogas plant with additional gas storage system. *Nigerian Journal of Solar Energy*. 5(8), 138-141.

Deublein, P. & Steinhauser, K. (2019). Development of an investment decision tool for biogas production from agricultural waste. *Renewable and Sustainable Energy Reviews*, 14(4), 1273-1282.

Ezegwu, F. & Aniago, P. (2019). Extension theory and practice: A review. *Animal Production Science*, 40(4), 493–502.

Fagerström, B., Seadi, V., Rasi, O. and Briseid, R. (2019). Biogs Technology Research in selected sub-Saharan African countries-A review. *African Journal of Biotechnology*, 8(7), 116-25.

Lawal, M. (2021). Centrality in social networks conceptual clarification. *Social Networks, 1*(3), 215–239.

Madu, A.Y. (2019). Management skill needs of women retirees in agriculture for processing paddy rice in Niger State. *Journal of Nigeria Association of Teachers of Technology*, 3(2), 5-40.

Odejimi, K. and Udotong, O. (2017). Poultry faeces management with a simple low cost plastic digester. Afr. J. Biotechnol, 8(8), 1560-1566

Okwesili, I., Ndukwe, R. and Nwuzor, H. (2016). A comparative study of biogas production from horse, goat and sheep dung. Nigerian Journal of Renewable Energy. 6(1-2), 43-47.

Osinem, U. (2017). A simple biogas plant with additional gas storage system. *Nigerian J. Solar Energ.* 7(8), 138-141.