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Economics of Poultry Waste Management Policy in South East Nigeria: Exploring the Determinants using Choice Experiment Model

C.C. Onyia, B.C. Okpukpara, A. Onyekuru 10.18805/ag.DF-444

ABSTRACT

Background: The study was motivated by the lack of poultry waste management policy in Nigeria to develop better initiatives for the development of green and alternative energy sources to mitigate climate change. Multiplicities of researches have neglected the research in this area despite the environmental health concerns and benefits associated with it.

Methods: The study was conducted in 2019. Three states with a high concentration of poultry farmers in South East Nigeria were selected. A multi-stage sampling technique was used to select poultry farmers and policy actors for the study. Data sourced from primary sources were analyzed with descriptive statistics inferential statistics and a choice experiment model.

Result: The result from the study showed that all the farmers depended on fossil fuel for processing and preservation while only 5.79 per cent depended on biogas energy sources. In addition, the study showed that the farmers' preference for pollution control was significantly determined by pollution fee ($p<0.01$), biogas subsidy ($p<0.01$), technical standard ($p<0.01$) and manure handling rate ($p<0.01$) and the manure market ($p<0.01$). The result of the interaction of the coefficient of variable showed that socio-economic characteristics were significantly determined by education ($p<0.05$) and environmental condition assessment ($p<0.01$). The study suggests the incorporation of biogas subsidy in the national subsidy framework to attract the deserved attention from farmers, private and public on the economic and health benefits of environmental protection.

Key words: Choice experiment, Economics, Poultry, Waste control policy.

INTRODUCTION

Livestock plays a significant role in reducing poverty, improving resilience *and* combating food insecurity and malnutrition. Livestock, especially poultry, present unique prospects for the rural poor, particularly women and youth (FAO, 2017). The Nigerian poultry industry has the second-largest chicken population in Africa (SAHEL, 2015). However, the increase in the poultry population results in the generation of waste of different categories along the poultry value chain. Most of these wastes are excellent sources of organic and inorganic nutrients that are of value if managed and recycled properly regardless of flock size. However, they also pose potential environmental and human health concerns (Akanni and Benson, 2014).

The Intended Nationally Determined Contributions (INDCs) formed the basis of the 2015 Paris Agreement on Climate Change. Nigeria was a signatory, which dovetails to Nigerian environmental policy or law on poultry waste control policy. Unfortunately, these laws have left much to be desired over the years due to poor implementation arising from improper coordination and evidence for action. Thus, a need was felt for a concerted effort to generate the required evidence for policy and planning in this regard. Onu *et al.* (2015) reported that 20 per cent of the poultry farmers disposed of their wastes by emptying into pits and streams, while 10 per cent burnt their wastes. The masses did not understand the environment when the policies were being formulated, nor was there mass environmental education and awareness about the sustainable environment. So there was a need to evaluate farmers' preferences for poultry pollution control in this regard.

However, studies investigating poultry waste control policies were limited in the literature. A comparative analysis of emission of methane from livestock farms in Enugu, Eastern Nigeria by Ac-Chukwuocha *et al.* (2011) did not emphasize poultry wastes management. Onu *et al.* (2015) studied and identified the different waste management methods and factors affecting them; and concentrations of aerial pollutant gases in selected poultry pens. The study by Okoli *et al* (2004) was based on the management of poultry waste in Imo State. None of these studies made efforts to look at determinants of poultry waste control policies. Thus, investigation into the determinants of poultry waste control policies becomes a compelling necessity.

Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.

Corresponding Author: B.C. Okpukpara, Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.
Email: benjamin.okpukpara@unn.edu.ng

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MATERIALS AND METHODS

The study was conducted in the South East, Nigeria in 2019. The region had a significant concentration of poultry (World Bank, 2017). A multistage sampling technique was used to select 225 poultry farmers for the study. The sampling frame was made available from the Poultry Association of Nigeria (PAN). However, after data cleaning due to protest response, failure to complete the questionnaire, among others, a total of 190 questionnaire from farmers were used for the data analysis. Data for the study were collected from primary sources using a set of questionnaire, focus group discussions and interview schedules. Data were analyzed with descriptive statistics, conditional logit models and a choice experiment model. The study adopted Dan, Guzhen, Ning and Zhang (2016) choice experiment model and theory.

Description of variables

The choice experiment attributes, description, levels were coded and presented in Table 1.

Choice task design

The choice experiment (CE) was designed with the assumption that the observable utility function would follow a strictly additive form. The model was specified so that the probability of choosing a particular livestock pollution control policy was a function of the attributes and the alternative specific constant (ASC). Based on the attribute and level settings, 864 which is 3×4×2×4×3×3 virtual policy profiles was constructed from the levels of the different attributes of different levels of poultry control policies (Table 1). The virtual profile represented the full factorial experiment. However, it was unrealistic for farmers to compare and select from 745,632 (864×863) tasks. Respondents will generally be fatigued after comparing more than 15-20 profiles (Wu *et al.,* 2014). Experimental design methods and R software version 3.6.0 were used to structure the presentation of the levels of the six attributes in the choice sets (Louviere, Hensher and Swait, 2000). An orthogonalization procedure was employed, which recovered only the main effects and gave 24 pair-wise combinations. Therefore, each randomly selected farmer was presented with six choice cards. Farmers were required to indicate their most preferred choice n on each card, which contained options A, B and C (baseline) options (Table 2). Options A and B represented the expected situation with different livestock pollution control policies that will increase the manure handling rate; the baseline option represented the baseline alternative situation. The baseline option was included in the choice sets in order to obtain welfare measures that are consistent with demand theory (Bennett and Blamey, 2001). Farmers were required to indicate their most preferred choice on each card, which contained options A, B and C (baseline) options. The alternative specific

Table 1: Construction of choice experiment attributes and levels.

Attributes	Description	Levels	Codes
Technical support	Government consultations provide knowledge about manure treatment technologies to farmers	No technical support (baseline) Medium technical support High technical support Total = 3	Dummy
Pollution fees	Pollutant discharge fees are levied if poultry farmers do not reduce pollution according to the pollution standard	0 Naira/head/month(baseline) 400,000 Naira (USD 964)/head/month 500,000 Naira (USD 1205)/head/month 600,000 Naira (USD 1446)/head/month Total = 4	Continuous
Technical standards	Requirements for farmers to use particular standards to manage poultry pollution	Yes No (baseline) Total = 2	Dummy
Biogas subsidies	Subsidies provided to farmers who use a biogas infrastructure	0 Naira/farmer 180,000 Naira (USD 434)/farmer 220,00 Naira (USD 530)/farmer 270,000 Naira (USD 651)/farmer Total = 4	Continuous
Manure market	Price of manure in the market	0 Naira/ton (baseline) 50,000 Naira (USD 120)/ton 60,000 Naira (USD 145)/ton Total = 3	Continuous
Manure handling rate	Changes in manure environmentally -friendly handling rate	0 per cent increase 5 per cent decrease 15 per cent increase Total = 3	Continuous

Total levels = 864 which is 3×4×2×4×3×3.

Table 2: The choice set of poultry pollution policy.

Attributes	Option A	Option B	Option C (Baseline)
Technical support	High technical support	Medium technical support	No technical support
Pollution fees	400,000 Naira/head/month	0 Naira/head/month	0 Naira/head/month
Technical standards	Yes	Yes	No
Biogas subsidies	0 Naira/household	270,000 Naira/household	0 Naira/household
Manure market	50,000 Naira/ton	0 Naira/ton	0 Naira/ton
Manure handling rate	5% decrease	15% increase	0% increase

Table 3: Level of farmers awareness of modern methods of poultry waste disposal.

Modern method of waste disposal	Level of awareness
Biogas from poultry waste	3.1842*
Green disposal (composting)	2.4789*
Gasification	1.5526
Proper timing on land	2.5368*
Vermiculture	1.9450

* = Aware.

Constants (ASC) equaled 1 when neither option A or B was chosen and 0 when respondents chose C. The effects of socio-economic variables on choice were captured by the interaction of socio-economic variables with the ASC variable.

Conditional logit model (CLM)

Suppose that farmer 'i' chooses policy profile 'm' among the 'n' subset in task C. We can define an underlying latent variable U^*_{im} which denotes the value function associated with farmer i choosing option m. Under a fixed budget constraint, farmer 'i' will choose alternative 'm' so long as $U^*_{im} > U^*_{in}$, for any n'"m. The researcher does not directly observe U^*_{im}, but instead directly observes U_{im}, where:

$$U_{im} = 1 \text{ if } U^*_{im} = \max (U^*_{i1}; U^*_{i2};\ldots;U^*_{in})$$

0 otherwise

According to the random utility theory, the utility associated with a choice is comprised of a deterministic component V_{im}, which comprises of factors observable by the researcher and an error component ε_{im}, which is independent of the deterministic part and follows a predetermined distribution. This error component implies that predictions cannot be made with certainty. Thus, the utility U^*_{im} associated with farmer 'i' whose choice is alternative 'm' is given by:

$$U^*_{im} = V^*_{im} + \varepsilon_{im}$$

The choice of livestock pollution control policy profile m by farmer i is made based on $U^*_{im} > U^*_{in}$, for any $n \neq m$. Thus, the probability for farmer i in choosing livestock pollution control policy Profile m can be expressed as:

$$P_{im} = \text{Prob}\,(V_{im} + \varepsilon_{im} > V_{in} + \varepsilon_{in};\ \forall\ n \in C,\ m \neq n)$$
$$= \text{Prob}\,(V_{in} + \varepsilon_{im} > V_{im} - V_{in}; \forall\, n \in C,\ m \neq n)$$

According to Maddala (1986), if random component of utility ε_{im} is assumed following a Gumbel (extreme value type I) distribution with cumulative distribution function,

$$F(\varepsilon_{im}) = \exp[-\exp(-\varepsilon_{im})]$$

then, under the assumption that $\varepsilon_{i1}, \varepsilon_{i2}, \ldots, \varepsilon_{im}$ are identically and independently distributed and follow the Gumbel distribution with scale parameter, the probability of any particular poultry pollution control policy profile m being chosen can be expressed in terms of a logistic distribution. The equation can be estimated with a Conditional Logit Model (CLM) (Greene, 2011; Mcfadden, 1974), which takes the general form:

$$P_{im} = \frac{\exp(\lambda V^*im)}{\sum_{n\in c}^{n} \exp(\lambda V^*in)}$$

The conditional indirect utility function generally estimated is:

$$V_{im} = ASC + \beta_{mhr} + MHR_{im} + \sum_{k=1}^{k} \beta_k X_{mk} + \sum_{h=1}^{h} \alpha_h S_{ih} * ASC$$

X_{mk} = Technical support; Pollution fee; Technical standard; Biogas subsidy; Manure market.

S_{ih} = Gender; Age; Education; Environmental condition assessment; Household size.

Where

ASC = An alternative specific constant, which captures the effects on utility of any attributes not included in choice specific poultry pollution control policy attributes.

β_{mhr} = The co-efficient of outcome variable MHR_{im} (Manure handling rate).

X_{Mk} = The k^{th} characteristic value of the choice m.

β_k = The parameter allied to the kth characteristic.

S_{ih} = Socio-economic characteristics vector of poultry farmer i and αh is the vector of the coefficients related to the poultry farmer socio-economic characteristics.

Results and Discussion

The result on the level of awareness of the farmers on the use of biogas energy sources from poultry waste and other modern methods of waste disposal is presented in Table 3. The result showed that all the farmers depended on fossil fuel for processing and preservation while only 5.79 per cent depended on biogas energy sources. It showed that the respondents were aware of biogas from poultry waste (3.1842), proper timing on land (2.5368) *and* green disposal (2.4789). This finding is dissimilar to the report of Chigasa, *et al* (2010), where the majority (61.19 per cent) were not aware and the remaining 38.91 per cent were aware. It was similar to the report of Abdulkarimm *et al.* (2013), that only 48 per cent of the respondents were aware of biogas while 52 per cent of them were unaware of it.

The waste management strategies by the respondents is presented in Table 4. The result showed that the majority (82.63 per cent) of the respondents sold their poultry wastes out to crop farmers and marketers, both bagged in dry forms and in wet forms. Poultry manure marketing and demand by the crop was a serious business in farms sited around crop-producing areas. Although the business was season-driven. Its demand increased at the onset of raining season for crop farming and declined during crop harvesting and the start of the dry season. Some farmers (14.21 per cent) buried their poultry wastes, while 5.79 per cent burnt the feces as a disposal method. The least (2.1 per cent) practiced a combination of flushing and burying. This was similar to Onu *et al.* (2015) findings and dissimilar to Akanni and Benson (2014).

The result on waste utilization strategies of farmers showed that all the farmers utilized some of their poultry waste as organic manure. In contrast, the least (4.7 per cent) utilized poultry waste to produce biogas. 6.84 per cent utilized some of their poultry waste to control erosion, while 10 per cent used it as a supplement in fish feed such as maggots and used as livestock feed. The findings is supported by Onu *et al.* (2015) and Mijinyawa and Dlamini (2006) that the majority of poultry farms recycled wastes as farmyard manure for crop production. In terms of waste collection, the result showed that the majority (67.89 per cent) of the respondents used manual scrapping with a shovel as a method of waste collection and the least (4.74 per cent) flushed their poultry waste with water into a collector. The farmers adopted manual scrapings with shovels as it was cheaper to employ labourers than mechanized scrapping. However, the mechanized scrapping method ensured a better environmental condition as the collection frequency could be increased. The collection frequencies also showed that 36 per cent of the respondents collected their wastes fortnightly, while the least (6.36 per cent) collected their poultry wastes weekly from the poultry farm. The farmers on the battery cage system collected their wastes daily because their feces did not mix with wood shavings that dry the litter, thereby producing wet litter. This result also agreed with Kalu, Ajaruonye and Okwara (2016) and Adeoye *et al* (2014). According to Anosike (2007), daily waste removal was essential to a hygienic and healthy environment in poultry production. Therefore, necessary actions must be taken to ensure that poultry farmers in South East Nigeria comply strictly with the given regulations on managing poultry wastes.

Determinants of farmers preferred choice of poultry pollution control policy

A multicollinearity test was carried out on the attributes before estimating the CLM. The result of conditional logit estimates with alternative specific constant (ASC) is presented in Table 5. The result showed that the model's overall fit was satisfactory by conventional standards used to describe probabilistic discrete choice models. Analysis of independent variables showed that the pollution fee was positively significant showing that including a pollution fee in a poultry pollution policy will likely attract the farmers' adherence. The pollution fee was positively significant with a coefficient of 3.05e-06. This implies a 0.0003 per cent likelihood of the farmers choosing a pollution fee as a component of pollution control policy.

The technical standard was positively significant, showing that including a technical standard attribute in a poultry pollution policy will likely attract the farmers and drive their active participation. The technical standard was positively significant with a coefficient of 1.06. This implies a 106 per cent likelihood of the farmers choosing technical standards as a component of pollution control policy.

Biogas subsidy was positively significant, showing that a biogas subsidy attribute in a poultry pollution policy will likely attract the farmers and drive their active participation.

Table 4: Percentage distribution of waste management strategies by farmers.

Variable	Frequency	Percentage
Methods of waste disposal		
Selling	157	82.63
Burying	27	14.21
Burning	11	5.79
Methods of waste utilization		
Biogas and power generation	9	4.74
Erosion control	13	6.84
Organic manure	190	100
Supplement in fish feed such as maggots and feed for livestock	19	10
Methods of waste collection		
Manual scrapping with a shovel	129	67.89
mechanized scrapping using	52	27.37
conveyors flushing	9	4.74
Frequency of waste collection		
Daily	55	28.95
Weekly	12	6.36
Fortnightly	68	35.79
Monthly	55	28.95

Table 5: Parameter estimates of the poultry control policies using conditional logit model with alternative specific constant (ASC).

Independent variables	Betas	Coefficient	Standard error
Pollution fees	β_1	3.05e-06 ***	2.90e-07
Technical standard	β_2	1.06104 ***	.1231671
Medium technical support	β_3	-.0957297	.1459356
High technical support	β_4	-.01771	.137558
Biogas subsidy	β_5	.0000183 ***	1.06e-06
Manure market	β_6	-.0000125***	2.12e-06
Manure handling rate	β_7	8.741077 ***	.7266157
ASC	β_8	-4.065708 ***	.3124849

*** Significant at 1 per cent level.
Number of obs = 3,420
LR chi^2 (8) = 804.35
Prob>chi^2 = 0.0000
Log likelihood = -850.12302
Pseudo R^2 = 0.3212.

The biogas subsidy was positively significant with a coefficient of 0.0000183. This implies a 0.00183 per cent likelihood of the farmers choosing biogas subsidy as a component of pollution control policy with a biogas subsidy.

The manure market was negatively significant, showing that including a manure market attribute in a poultry pollution policy will likely repel the interest of the farmers in keeping to pollution control measures. The manure market was negatively significant with a coefficient of -0.000012. This implies a 0.0012 per cent likelihood of the farmers not choosing a pollution control policy with the manure market. The significantly negative coefficient for the manure market indicates that a negative utility impact will occur if manure can be sold at a higher price. This is because farmers might need to input extra effort or resources (time, money, *etc.*) for the increase as most pollution occurs during drying and transportation.

The manure handling rate was positively significant, showing that including manure handling rate attributes in a poultry pollution policy will attract the farmers and drive their active participation. The manure handling rate was positively significant with a coefficient of 8.74. This implies an 87 per cent likelihood of the farmers choosing a pollution control policy with a manure handling rate.

Alternative specific constant was negatively significant, showing that inclusion of ASC is very important as some farmers will choose a baseline option in a poultry pollution policy other than choose the alternative options of poultry pollution policy. The coefficient of ASC was negatively significant, which suggests that farmers, in general, would prefer to change their current livestock pollution management. This was in line with the findings from the statistical description that showed that 64.2 per cent of poultry farmers were willing to manage poultry pollution. The coefficients of pollution fees, biogas subsidies and manure handling rate attributes were all positively significant, suggesting that these attributes influence poultry farmers' choice behavior in a significantly positive way participating in poultry control policies. Similar results have been found elsewhere (Adamowicz *et al.*, 1998).

Results of the conditional logit model with ASC interacting with farmers' socio-economic characteristics is presented in Table 6. The interactions between ASC and socio-economic variables captured the influence of those variables on the probability that a respondent will opt for the baseline alternative situation. The results showed that the interaction of coefficient of variable ASC and years spent in formal school was negatively significant, indicating a higher likelihood that educated farmers will opt for improved options. The number of years spent in school transcends to the values, knowledge, attitudes, skills and capacity for further enlightening environmental issues (Hogan, 2002). Environmentally engaging educational activities provide a platform for farmers to exercise the knowledge needed to improve their environment.

Further, the interaction between the coefficient of variable ASC and environmental condition assessment was positively significant, indicating a higher likelihood that farmers with good environmental condition assessment will opt for the alternative baseline option. This could be because the farmers already established sanitary measures that ensured a good environmental condition which was cost-intensive and so viewed the alternative options as meant for farmers with very bad hygienic measures.

The results on the constraints to the production of biogas energy from poultry wastes and other modern methods of waste disposal areas is shown in Table 7. The significant variables in the analysis were inadequate and intermittent government support (3.75), lack of skilled labour for installation and operation (3.39), limited awareness about opportunities for biogas applications (3.28), need for consistent

Table 6: Parameter estimates of the interaction between the poultry control policies and socioeconomic characteristics of farmers using conditional logit model with alternative specific constan (ASC).

Independent variables	Betas	Coefficient	Standard error
Pollution fees	β_1	3.03e-06***	2.86e-07
Technical standard	β_2	.9519374***	.1199886
Medium technical support	β_3	-.066701	.1431566
High technical support	β_4	.025954	.1365982
Biogas subsidy	β_5	.0000166***	9.78e-07
Manure market	β_6	-9.89e-06***	2.04e-06
Manure handling rate	β_7	8.789472***	.7232577
ASC	β_8	-3.385786***	.7287198
ASC × Gender	β_9	-.1030615	.2265786
ASC × Age	β_{10}	-.0051818	.0075573
ASC × Years spent in school	β_{11}	-.05614**	.0283609
ASC × Household size	β_{12}	.0395042	.0514895
ASC × Envtassmt	β_{13}	.2037048*	.1067428

*Significant at 10 per cent level, **Significant at 5 per cent level, ***Significant at 1 per cent level.

Number of obs = 3,420.

LR chi^2 (8) = 774.50.

Prob > chi^2 = 0.0000.

Log likelihood = -865.05114.

Pseudo R^2 = 0.3092.

Table 7: Constraints to the use of modern waste management methods and biogas production from poultry waste.

Modern method of waste disposal	Constraints
Limited information about opportunities for biogas applications	3.2842*
Initial cost of installations	3.1895*
Lack of skilled labour for installation and operation	3.3947*
Inadequate and intermittent government support	3.7474*
Feedstock availability	2.1632
Need for consistent maintenance	3.2526*
Competition from fossil based alternatives	1.4632
Behavioural and social acceptance	1.8895

* = Serious constraints.

maintenance (3.25) and initial cost of installations (3.19). This finding corroborates with the report of Mittala, Ahlgrena and Shuklab (2018) that financial and economic barriers, Market barriers, Regulatory and institutional barriers, Technical and infrastructural barriers constrained the dissemination of biogas use.

Conclusion

Various socio-economic, environmental and pollution policy attributes influence farmers' choice of poultry pollution control policy. The findings imply that including pollution fees, biogas subsidy, technical standards, manure handling rate attributes and targeting more educated farmers will drive the adoption and implementation of poultry pollution policies while investing in the provision of manure markets may not yield the desired outcome. In addition, a negative utility impact will occur if manure can be sold at a higher price because farmers might need to input extra effort or resources. The result also implies that it may not be necessary to emphasize farmers with good environmental conditions since they already working with appropriate sanitary measures. The focus should be directed to farmers with poor environmental conditions by providing suitable environmental conditions on their farms. The result also suggests strict environmental policy at the local government and community levels to ensure environmental control policy compliance.

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References

Abdulkarimm, I.B., Lambu, B.Y. Ahmed and Sheriff, F.M. (2013). Attitude on biogas as an alternative domestic energy in urban kano. Academic Research International. 4(6): 25-31.

Ac-Chukwuocha, N.B., Ogbuagu, D.H., Okoro, V.O. (2011). A comparative analysis of methane emission from livestock farms in Enugu, Eastern Nigeria. Journal of Agricultural Science and Technology. 1(6A): 908-919.

Adamowicz, W., Boxall, P., Williams, M., Louviere, J. (1998). Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. Am. J. Agric. Econ. 80: 64-75.

Adeoye, P.A., Hasfalina, C.M., Amin, M.S.M. Thamer, A.M. and Akinbile, C.O. (2014). Environmental implication of poultry waste generation and management techniques in Minna, Semi-arid Region of Nigeria. Annual Research and Review in Biology. 4(10): 1669-1681.

Akanni, K.A. and Benson, O.B. (2014). Poultry waste management strategies and environmental implications on human health in Ogun State, Nigeria. Soil and Water Resources. 7(1): 18-26.

Anosike, V. (2007). Health implications of poultry waste utilization for urban agriculture: An eco-health approach. Epidemiology. 18(5): 4-7.

Anukam, L.C. (1997). Case Study IV-Nigeria. In: Water Pollution Control: A Guide to the Use of Water Quality Management Principles, [Helmer, R. and I. Hespanhol, (Eds.)]. Taylor and Francis, Washington. DC: WHO/UNEP, ISBN-13: 9780419229100.

Bennett, J., Blamey, R. (2001). The Choice Modelling Approach to Environmental Valuation. Edward Elgar Publishing, Cheltenham.

Chigasa, C.U., Ibeto, C.N., Okpara, C.G., Nwoke, O.O., Obi, I.O., Nnaji, C.E., Oparaku, O.U. and Unachukwu, G.O. (2010). Level of awareness and utilization of biogas technology in south-eastern zone of Nigeria. International Journal of Applied Agricultural Research. 5(5): 569-574.

Dan P., Zhau, G., Zhang, N. and Zhang, L. (2016). Farmers preferences for livestock pollution control policy in China. A choice experiment method. Journal of Cleaner Production. 131: 572-582.

Food and Agricultural Organization, FAO. (2017). FAO's Work on Climate Change. United Nations Climate Change Conference 2017. http://www.fao.org/3/a-i8037e.pdf.

Greene, W.H. (2011). Econometric Analysis. Prentice Hall.

Hogan, K. (2002). A sociocultural analysis of schools and community settings as sites for developing environmental practitioners. Journal of Environmental Education Research. 8(4): 413-437.

Kalu, E., Ajaruonye, A.N. and Okwara, N. (2016). Waste Management Practices in Selected Poultry Farms in Umuahia, Abia State. Journal of Veterinary Advances. 6(9): 1310-1316.

Louviere, J.J., Hensher, D.A., Swait, J.D. (2000). Stated Choice Methods: Analysis and Applications. Cambridge University Press, Cambridge.

McFadden, D. (1974). Published in: Frontiers in Econometrics. New York [U.A.]: Academic Press, ISBN 0-12-776150-0.

Mittal, S., Ahlgrena, E.O. and Shuklab, P.R. (2018). Barriers to biogas dissemination in India: A review. Energy Policy. 112: 361-371.

Mijinyawa, Y. and Dlamini, B.J. (2006). Livestock and poultry wastes management in Swaziland. Livestock Research for Rural Development. Volume 18. Article #88.

National Environmental Standards and Regulations Enforcement Agency (Establishment) Act (NESREA) (2007). Retrieved 20th January 2018.

Okoli, I.C., Alaehie, D.A., Akanno E.C., Okoli, C.G., Opara, M.N., Uchegbu, M.C., Ogundu, U.E. and Iheukwumere, F.C. (2004). Concentrations of aerial pollutant gases in selected poultry pens in Imo State, Nigeria. International Journal of Poultry Science. 3(6): 427-431.

Onu, D.O., Offor, E.I., Okpara, B.O. (2015). Poultry wastes management strategies and environmental implications in Abia State. International Research Journal of Agricultural Science and Soil Science. 5(6): 159-164.

SAHEL. (2015). An Assessment of the Nigerian Poultry Sector. http://sahelcp.com/an-assessment-of-the-nigerian-poultry-sector/.Sahel11, 1-3. retrieved Dec. 2021.

World Bank. (2017). Livestock Productivity and Resilience Support Project. Washington, D.C.

Wu, L., Yin, S., Xu, Y. and Zhu, D. (2014). Effectiveness of China's organic food certification policy: Consumer preferences for infant milk formula with different organic certification labels. Can. J. Agric. Econ. 62: 545-568.