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Composted Poultry Waste Use Intensity among Arable Farmers in Ogun State, Nigeria: Implication for Climate Change

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Authors' contributions

This work was carried out in collaboration between all authors. Author DAB designed the study, designed the questionnaire and wrote the first draft of the manuscript. Authors SUI and JOK made contribution to literature searches. Author SUI made added input in result discussion. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Increasing food production through improving land productivity, while conserving the environment and preventing climate change is pertinent to policy makers. This study assessed the predictors of composted poultry waste use intensity (CUI) among arable farmers and its implication for climate change.
Study Design: Survey design was used. Primary data was collected from surveyed participants.
Place and Duration of Study: Study was conducted in Ogun state, south-west Nigeria between August 2014 and April 2015.

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Methodology: multistage sampling technique was used to select 180 farmers. They were interviewed using well structured questionnaire. Descriptive statistics and the ordinary least square regression model were used in analyzing the data collected.
Results: Most of the farmers had below secondary education (57%), did not participate in cooperative (51%), had poor access to extension education (62%) and sourced compost too far from farm. Mean age and years of experience were 45±9.99 and 10.5±6.10 years respectively. Average farm size and income were 2.68±1.44 and ₦ 107,315 (approx. $537) respectively. About 78% of the respondents use both composted and untreated poultry manure while 38 % use only composted poultry manure which protects both the soil and the environment. Most of the farmers perceived vulnerability of their farms to degradation (53%) hence the need for conservation. The regression result showed that factors which increased CUI among farmers were farmers' education ($P< 0.05$), access to credit ($P< 0.01$), farm income ($P<0.01$), cooperative participation ($P<0.05$), perceive efficacy of compost ($P<0.05$), number of quality contacts with extension agents ($P<0.01$), enterprise combination by keeping poultry birds ($P<0.01$) and male farmers ($P<0.01$) while factors which decreased CUI included household size ($P< 0.01$), farm size ($P<0.01$), access to fertilizer subsidy, especially for inorganic fertilizers ($P<0.05$) and distance to the source of compost ($P<0.01$).
Conclusion: Policies to improve organic fertilizer subsidy, extension services and cooperatives for educating farmers on the advantages of intensifying the use of composted poultry manure, especially as regards climate change and public health should be put in place.

Keywords: Compost; arable crop; poultry; climate change.

1. INTRODUCTION

Meeting and bridging the demand and supply gap in a sustainable manner has been the challenge for food crop production in sub-Saharan Africa (including Nigeria) especially with increasing population and food insecurity [1]. The population of sub-Saharan African is expected to increase to about a billion by 2020 [2]. Increasing food production through improving land productivity, while conserving the environment and preventing climate change has become a pressing concern for policy makers because agricultural activities, especially waste management, have been identified as a major cause of greenhouse gas emission which leads to climate change [3]. In Nigeria, many lands are gradually losing their capability to support efficient production due to overwork, indiscriminate disposal of solid waste and degradation. One of the panaceas to land productivity problem is the use of fertilizers especially organic fertilizers. Most Nigerian farmers apply less than recommended quantity of fertilizers per hectare on their crop [1,4]. What farmers do to compensate and boost yield is to open up more lands for cultivation but this has become difficult with population explosion and pressure on land for alternative uses.

There is a nexus between stability of food supply and environmental conditions [5]. Stability of food supply requires best management practices (BMP) in both crop and livestock management (especially waste management as highlighted in this study). Improper management practices will adversely affect the environment (climate change), which in return will lead to degradation and ill health for livestock and man and consequently dwindled food supply and food insecurity. There has been some progress in the area of soil fertility management in sub-Saharan Africa during the past few decades [1] but there is yet need to focus on the interactions between farming practices and environmental conditions as highlighted in this study.

Liquidity constraint has often been cited as the major factor influencing the intensity of farmers' utilization of inorganic fertilizers for arable cropping [6]. Although efforts are being made by government to ameliorate this problem by way of fertilizer subsidy, much of these efforts have been sabotaged by political influence and bureaucratic bottlenecks [1]. Furthermore, continuous application of the inorganic fertilizers even when available, may lead to reduction in productivity of clay soils which dominates Africa [4,7]. Adeyinka et al. [8] postulated that continuous application of inorganic fertilizers can lead to water pollution or toxicity and the death of aquatics can lead to the emission of greenhouse gasses. There is therefore the growing need to intensify the use of the cheaper and more available organic fertilizers. The most available form of organic manure in Ogun state is the

compost from poultry litters due to the fact that poultry business is widely practiced across the state [9]. Waste production can be as much as 25,000 kilograms from each poultry house of approximately 2000 birds [5]. When properly treated and produced, composted poultry wastes have many advantages to public health and stemming climate change. For instance the production process eliminates waste materials that would have constituted a nuisance to the environment, increasing microbial contamination and emission of greenhouse gasses such as nitrogen oxide (N_2O), ammonia (NH_3), carbon dioxide (CO_2) and methane (CH_4) [10]. These emissions results in climate change with secondary impact on human health, land degradation, increased frequency of fires, poverty and malnutrition [11]. This has a lot of policy implication especially in achieving the millennium development goals (MDGs). It is against this backdrop that this study assessed the predictors of composted poultry waste use intensity among arable farmers in Ogun state and its implication for climate change. The *a priori* expectation is that with increasing use of poultry waste for compost, there will be a decline in indiscriminate disposal of poultry waste which in turn will cause a decline accumulation of greenhouse gases in the environment.

2. RESEARCH METHODOLOGY

The study was carried out in Ogun state, south west Nigeria. Ogun state's contribution to the poultry business is one of the largest in Nigeria [12]. The climate in the area favours the cultivation of arable crops like maize, cassava, fruits and vegetables. The multistage sampling technique was used to select the respondents for this study. Two hundred arable crop farmers were originally selected and questionnaire administered to them but 180 responses were found useful for analysis. The distribution of the questionnaire is as presented in Table 1.

Table 1. Distribution of questionnaire to respondents

Sampled local govt areas	Distributed	Retrieved
Ado- Odo/ Otta	70	65
Ifo	70	60
Ikenne	60	55
Total	200	180

Source: Field Survey, 2014

Data collected were analyzed using descriptive statistic and the ordinary least square regression model. Following Maiangwa et al. [13]; Olayide et al. [14]; Martey et al. [15] and Akpan et al. [16], Compost (composted poultry waste) use intensity (CUI) was defined as

$$CUI = \frac{\text{Quantity of compost used by ith farmer measured in Kg}}{\text{Area of land cultivated by ith farmer measured in hectare}} \quad (1)$$

The implicit compost use intensity function for the regression analysis is given as:

$$CUI = f\ (AGE, EDU, GEN, CRE, FAM, SCL, HHS, INC, SUB, EFF, EXT, POU, COP, DIS, e) \quad (2)$$

Where:

AGE = Age of farmers (in years)
EDU = Years of formal education of farmers
GEN = Gender of farmer head (male = 1; female = 0)
CRE = Access to needed credit (access = 1; otherwise = 0)
FAM = Farm size (hectare)
SCL = Scale of production (commercial = 1; otherwise = 0)
HHS = Household size
INC = Total monthly farm income (in N where N1~0.01USD)
SUB = Access to fertilizer subsidy (access = 1; otherwise = 0)
EFF = perceived efficacy of compost (high = 1; low = 0)
EXT = Contact with extension agent (frequency)
POU = Keeping of poultry farm (yes = 1; no =0)
COP = Cooperative participation (yes = 1; no =0)
DIS = Distance of farm to point of collection of compost (Km)
e = error term

Following Olayemi [17], the relationship between the endogenous variable and each of the exogenous variables were examined using linear, exponential, semi-logarithm and double-logarithm functional forms. The lead equation was chosen based on the value of the coefficient of determination (R^2), statistical significance and economic theory. The equations of the functional forms are specified as follow:

$$CUI = b_0 + b_1AGE + b_2EDU + b_3GEN + b_4CRE + b_5FAM + b_6SCL + b_7HHS + b_8INC + b_9SUB + b_{10}EFF + b_{11}EXT + b_{12}POU + b_{13}COP + b_{14}DIS + e \quad (3)$$

Exponential function:

$$Ln\ CUI = b_0 + b_1AGE + b_2EDU + b_3GEN + b_4CR + + b_{14}DIS + e \quad (4)$$

Semi log function:

$$CUI = lnb_0 + b_1lnAGE + b_2lnEDU + b_3lnGEN + b_4lnCRE + b_5lnFAM + b_6lnSCL + b_7lnHHS + b_8lnINC + b_9lnSUB + + b_{14}lnDIS + e \quad (5)$$

Double log function:

$$Ln\ CUI = lnb_0 + b_1lnAGE + b_2lnEDU + b_3lnGEN + b_4lnCRE + b_5lnFAM + b_6lnSCL + b_7lnHHS + b_8lnINC + b_9lnSUB + + b_{14}lnDIS + e \quad (7)$$

3. RESULTS AND DISCUSSION

3.1 Descriptive Result of Farmers' Personal Information

Results in Table 2 shows that 57% of the farmers had below secondary education. They were mostly male most of the farmers (73%) are male and mean age and years of experience were 45±9.99 and 10.5±6.10 years respectively. Average farm size was 2.68±1.44 which is below standard commercial scale of 3 hectares and above [18]. Size of land and level of education has great implication on the adoption of conservation measures by farmers. Fawole and Fasina [19] reported that farmers with bigger farm sizes are more likely to use commercially produced organic fertilizer which have been found to be environmentally friendly. Majority of the farmers (51%) do not participate in any cooperatives. Cooperatives often function to facilitate input sourcing for member farmers and information dissemination [15]. More than half of the farmers (52%) perceived land degradation as a problem threatening productivity in the area of study. This result is consistent with the work of Babalola [18] who identified vulnerability of substantial lands in Ogun state to degradation. Continuous tillage, indiscriminate use of fertilizers and incidence of climate change have been suspected as part of the cause of degradation [3].

Majority of the farmers (62%) reported that they have poor access (in terms of frequency of visits) to extension service. This, coupled with poor participation in cooperatives may largely be the reason why up to 78% of the farmers still used the untreated form of poultry waste. They did not have adequate information of the implication of this practice on the soil and the environment. This result is consistent with past findings [1, 12]. Most of them (51%) source their supply of compost from poultry farms far away from their farms. Average farm income per season was ₦ 107,315 (approx. $537). If farming households (average 7 members), with majority having farming as only source of income (59%), were to live solely on the farm income for a minimum cropping season of 4 months, individual member of the household will be living below poverty line of $1 per day. Although 51% had access to credit facility, up to 49 percent still lacked access.

3.2 Factors Influencing Composted Poultry Manure Use Intensity

The data on the determinants of composted poultry manure use intensity (CUI) was analyzed using double-logarithmic regression equation as lead equation which was chosen based on theoretical and statistical criteria as discussed earlier in the methodology. The adjusted R^2, which measured the ability of the explanatory variables to explain all the variation in the dependent variable for the equation, is 0.805 which shows that the combined effects of the independent variables accounted for 80.5% of the variations in CUI. The F – ratio provided an overall test of significance of the whole function of the regression line. This test shows that F – ratio is statistically significant at 5 percent level of significance.

The result of the regression analysis as presented in Table 2 shows that increase in farmers' education ($P< 0.05$), access to credit ($P< 0.01$), farm income ($P<0.01$), cooperative participation ($P<0.05$), perceived efficacy of compost ($P<0.05$), number of quality contacts with extension agents ($P<0.01$), enterprise combination by keeping poultry birds ($P<0.01$) and male farmers ($P<0.01$) will increase CUI in the study area and invariable reduce climate change of unused and indiscriminately disposed poultry waste. The descriptive result however showed low levels of education and income, poor cooperative participation and low enterprise combination with poultry business (Table 2).

Table 2. Farmers' personal characteristics

Characteristics	Mean (±SD)	Freq n=180	(%)
Gender: Male		131	72.8
Household size	6.68 (±2.51)		
Age (years)	45 (±9.99)		
Educ. level:			
Below secondary		102	56.7
Secondary & above		78	43.3
Farming experience 10.5 (±6.10)			
farm size	2.68 (±1.44)		
Belong to Cooperative		88	48.9
Perceived threat from degradation		94	52.2
Extension access rating:			
Adequate		110	61.1
Poor		70	38.9
Form of poultry waste used:			
Untreated only (n =180)		73	40.6
Composted only (n =180)		68	37.8
Both (n =180)		140	77.8
Main source of compost:			
Own poultry farm		46	25.6
Nearby poultry farm		43	23.9
Far away poultry farm		91	50.6
Access to credit		92	51.1
Major income:			
*GFI/ season 97,815 (±45,700)			
Farming as major occupation		106	58.9

** GFI (Gross Farm Income) in naira, ₦1~ $ 0.005;Source: Computed from Field survey (2014)*

Table 3. Regression result for determinants of compost use intensity

Variables	Beta coeff.	t-value
Constant	4.394**	7.458
Gender	0.626*	2.165
Age	-0.059	-0.128
Household size	-0.878**	-4.456
Education	0.158*	2.380
Credit access	3.077**	3.579
Farm size	-0.797**	-3.517
Scale of production	5.062	0.822
Farm income	0.504*	2.024
Access to fertilizer subsidy	-0.273*	-2.697
Cooperative participation	0.44**	2.778
Perceived efficacy of compost	4.230*	2.912
Contact with extension agent	0.065**	0.027
Keeping of poultry farm	5.530**	2.846
Distance to compost source	-1.738**	0.726

***sig at 1 %, * sig at 5 %. Mean dependent variable = 118.4kg/ha; R^{-2}= 0.805, F- ratio= 14.528**
Source: Computed from field survey (2014)

Furthermore, result showed that increasing household size (P< 0.01), farm size (P<0.01), access to fertilizer subsidy, especially for inorganic fertilizers (P<0.05) and distance to the source of compost (P<0.01) will decrease CUI. This result is consistent with Vide [20]; Abdoulaye and Sanders [6]. The descriptive result showed that farmers have large family size and lack of proximity to compost source (Table 2). The *a priori* expectation is that farmers with large farm holding, who are likely to be commercial farmers will use more of compost but it appears that larger scale farmers would likely prefer to use inorganic fertilizers. This result corroborates the need to improve farmers' perception of use of organic fertilizers and its implication for soil management and climate change.

4. CONCLUSION AND RECOMMENDATIONS

This study has been able to describe farmers' pattern of use of composted poultry manure while identifying its importance in waste management, public health promotion, organic agriculture promotion, sustainable management

of degradation and climate change. The result from this research forms a useful addition to the body of knowledge on climate change economics. The factors influencing composted poultry manure use intensity were identified and discussed. Based on the finding of this study, the following recommendations have been made for policy actions:

1. More efforts should be put into educating the farmers on the benefits of organic fertilizers, especially well treated ones particularly for climate protection.
2. While encouraging farmers to participate more in the cooperative organizations, periodic workshop and training should be organized in collaboration with the cooperative societies to teach farmers, who may not be able to afford commercially sold organic fertilizer, the procedure for composting poultry waste, especially faecal waste on their farms.
3. Fertilizer subsidy policy should include organically produced fertilizer. Finally,
4. Environmental education should be promoted both through extension services and the media.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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