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Comparative Analysis of Arable Farmers' Uses of Inorganic and Organic Manures in Delta State, Nigeria

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ABSTRACT

The study compares the use of organic manure and fertilizer by arable crop farmers in Delta State, Nigeria. A total of 166 respondents have selected through a multistage random sampling procedure. Results showed that a minute 5.4% of the respondents make use of both types of manure, and that cost, availability of manure, and hazardous effect or pollution were major problems associated with the use of in organic fertilizers. Offensive odour, bulkiness, presence of weed materials and pests and diseases were major problems of using organic manure. Lack of technical know-how and land tenure were major problems confronting both respondents using chemical fertilizer and organic manure. The perceived benefits of using organic manure among others were improvement of soil structure, increased farm yield, increasing water-holding capacity and porosity of soils. Regression result indicated that age, educational level, farm size, farming experience and extension contact were significant in determining farmers' use of manure type. From the findings, it was recommended that problems of using manures should be tackled by designing appropriate agricultural policies and intensifying extension efforts in the area; extension programmes designed for farmers should include an orientation on the proper use of manures.

Keywords: Arable, Manure, Fertilizer, Benefits

INTRODUCTION

The practice of growing arable crops such as grains (cultivated grasses grown for their edible starchy grains which include wheat, maize or corn, rice, sorghum, barley, millet), pulses (edible seeds from the legume family, high in protein which includes cowpea, groundnut and peas), oilseed crops(grown for the oil extraction from the seeds rapeseed, soybean and sunflower), forage crops(crops used for animal feed, fresh or preserved such as clovers and timothy), tuber crops (crops whose edible portion is a short thickened underground stem or root-like potato, yam, cassava) and fiber crops(crops are grown for fiber yields like cotton and flax) by the people of Delta State has been known since from time immemorial. Such arable crops are mainly ephemerals or annuals which are usually grown on plowed lands. The yields of arable crops could be very high especially when planted on virgin soils.

With Delta State population given as about 4.1million in the 2006 population census and an estimated growth rate of 3.18%, it implies that the population of the state is now over 6 million. The increase in population, leading to pressure on the land, implies that the yield of arable crops may continue to decline rapidly due to a decline in soil fertility. This is more so, especially in areas where the fallow period of farmlands had been drastically reduced. Poor supply of nutrients due to declining soil fertility as a result of a reduced fallow period is a major

constraint to crop production (Ramaru et al., 2000).

Therefore, to improve the productivity of such impoverished soils, it becomes imperative that farmers apply manures to farmlands. Manures or fertilizers are substances usually added to the soil with the primary aim of improving soil fertility. Fertilizer or manure, according to the international fertilizer industry association, is regarded as material containing 5% of more of the three essential plant nutrients (Adrian et al., 2014). Fertilizers or manures are soil amendments that guarantee the minimum percentages of Nitrogen, Phosphate and Potash (Adrian et. al. 2014). The aim of applying fertilizer or manure to the soil is to make crops grow faster by supplying the elements that are needed in readily available forms. These mineral elements, when utilized by crop plants will lead to an increase in soil fertility and ultimately higher crop yields. Broadly speaking, there are two major types of fertilizer or manure: organic manure (which include farmyard manure, green manure and compost which are derived from animal matter, human excreta, or vegetable matter) and synthetic or industrial inorganic manure otherwise known as chemical fertilizer which is made from synthetic materials and it come in various forms (Heinrich et al. 2009).Thus, the fertilizer could be organic or inorganic material of natural or synthetic origin that is applied by farmers to soils to supply nutrients essential to the growth and development of crops; they are used to enrich the soil with mineral elements that soils do not inherently have.

The use of inorganic fertilizer or organic manure has been known to be useful in improving the productivity of the soil (Adeniran et al., 2017). Given that the most important natural resource is the soil, it is important to preserve the humus topsoil and maintain or increase its organic matter content to increase the nutrient providing ability and to carry on environment-friendly nutrient management (Rigby and Ca"ceres, 2001 and Defoer, 2002). This will ensure adequate nutrients for crops' growth, thus increasing yields. To achieve this, the use of organic fertilizer is important as the continuous use of inorganic fertilizers results in soil structure destruction, environmental pollution by contaminating the air, soil and water in the environment (Savci, 2012).

The advantages of fertilizer include: increasing crop yield and improving the quality of the land, improving soil texture and faster growth of crops (EPA, 2013). Their disadvantages include: boosting fast growth of weeds, Excessive use has negative environmental effects such as contamination of water (nearby rivers and water supply system) and reducing the oxygen content in water making the water unfit for consumption and causing the death of Aquatic animals (Wilfred, 2002), soil acidification and changes in soil biology (Carroll et al., 2004).However, the use of inorganic fertilizers on farms can cause serious soil degradation by destroying the structure, increase soil acidity and nutrient imbalance and finally bring about low yield but the use of organic fertilizer or manure can help in protecting the soil from the above adverse effects (Savci, 2012).

Recognizing the several deficiencies inherent in the use of chemical fertilizer in crop production, many agricultural organizations and experts have advocated the use of organic manures as alternatives to inorganic or chemical fertilizer (Adeoye, 1985). The use and benefits of accruable from organic manure have been extensively discussed by many scholars (Adediran et al., 2003; Adetunji, 2010). Unlike inorganic fertilizer, nutrients in organic manure are released more slowly and are preserved for an extended period of time in the soil, ensuring prolonged residual effects, improved root growth and development, and improved crop yields (Abou El-Magd, 2006). Organic manure also helps to improve the soil through lowering bulk density, minimizing soil erosion and increasing soil fertility (Wheeler, 2008). The problem of underground water

pollution, soil pollution and air pollution created by the use of inorganic fertilizers and the need to have a better environment could justify the use of organic manure (Savci, 2012).

Many people thus support the use of organic manure now a day especially in the production of organic food products which plays a great role in the health of man. Although the use of organic fertilizer is being advocated for because of its soil conservation property and its eco-friendliness over the inorganic fertilizer, its rate of use among farmers in Delta State has not been ascertained. Therefore, there is a need to assess the level of use of organic fertilizer or manure as compared to the use of fertilizer. It is very necessary to determine the socio-economic characteristics of the farmers using manure on their farms, the percentage of farmers using organic manure or fertilizers, problems associated with the use of any of these manures, perceived benefits of the various manures used. The objectives of the study were therefore to: describe the socio-economic characteristics of the farmers, ascertain the percentage of farmers using organic manure or fertilizers or both, and determine the problem for the use of any of these manures, determine perceived benefits of using the various types of manure. The following hypotheses, which were stated in null forms, were tested: Ho_1: there is no significant relationship between socioeconomic variables (age, gender, marital status, education attainment, farm size, farming experience, household size and extension contact) and the use of inorganic manure; Ho_2: there is no significant relationship between socioeconomic variables and the use of organic manure; Ho_3: there is no significant relationship between socioeconomic variables and the use of manure. The study would help to determine the extent of farmers' usage of the two types of manure with a view to extension implications.

RESEARCH METHODS

The study area: This study was conducted in Delta state, Nigeria. The area has a landmass of 1, 286 square kilometers with a population of about 4 million (NPC, 2006). The area was chosen because farmers in the state are known for using both manure and fertilizer.

Sampling technique and sample size: The sampling frame (i.e. the target population) of the study consists of all arable farmers in the State who had or are currently using manure. Data used for this study were collected by a multi-stage sampling procedure. In the first stage, 3 LGA areas were randomly selected from each of the agricultural zones of the State due; the local government areas selected were: Patani, Isoko North and Bomadi in Delta South; Ughelli North, Ethiope Eastand Okpein Delta central; and IkaSouth, Oshimili South and Ndokwa west in Delta North. In the second stage, three (3) communities were randomly selected from each of the selected local government areas; the local government areas selected were: Patani (Uduophori, Aven, Bolou-Angiama), Isoko North (Egbahe-Emevor, Idheze-Irri, Edhemoko) and Bomadi (Ajogbabri, Odorubu, Agoloma)in Delta South; Ughelli North (Edjeba, Agbarha-Otor, Oteri), Ethiope East (Isiokolo, Igun, Okpara Waterside) and Okpe (Inabome, Igbimidaka, Amuokpokpo) in Delta central; and Ika South (Emutu, Aliagwa, Alisor), Oshimili south (Umuagwu, Ezukwu, Ogbeobi)and Ndokwa west (Emu-ebendo, Emu-Uno, Ogbagu) in Delta North.. In the third stage, twenty (20) arable crop farmers were randomly selected from each of the communities to give a total sample size of 180 respondents. A questionnaire was used to obtain information from the 180 and observations of the researcher on the field. However, only 166 copies of the questionnaire were used for the study as the remaining 12 were either improperly filled or never returned. The procedure for the sample size selection is presented below.

Table 1: Procedure for sample size selection

Agro-ecological Zone	Local Government	Community	Expected Sample	Actual sample
Delta South	Patani	Uduophori	20	20
		Aven	20	18
		Bolou-Angiama	20	19
	Isoko North	Egbahe-Emevor	20	20
		Idheze-Irri	20	19
		Edhemoko	20	20
	Bomadi	Ajogbabri	20	19
		Odorubu	20	19
		Agoloma	20	19
Delta Central	Ughelli North	Edjeba, Oteri	20	20
		Agbarha-Otor	20	20
		Oteri	20	19
	Ethiope East	Isiokolo	20	19
		Igun	20	20
		Okpara Waterside	20	20
	Okpe	Inabome	20	19
		Igbimidaka	20	18
		Amuokpokpo	20	20
Delta North	Ika South	Emutu	20	20
		Aliagwa	20	20
		Alisor	20	20
	Oshimili South	Umuagwu	20	20
		Ezukwu	20	19
		Ogbeobi	20	20
	Ndokwa West	Emu-ebendo	20	20
		Emu-Uno	20	19
		Ogbagu	20	19
Total			**180**	**166**

Data analysis

Data for the study were analyzed by descriptive statistics like simple frequency counts, percentages, mean, standard deviation and logistic regression analysis. Instrument for data analysis also included the 4-point Likert-type scale with values 1 = strongly disagree, 2 = disagree, 3 = agree and 4 = strongly agree. The binary logistic regression can be expressed as:

$$\hat{p} = \frac{\exp(b_0 + b_1X_1 + b_2X_2 + ... + b_pX_p)}{1 + \exp(b_0 + b_1X_1 + b_2X_2 + ... + b_pX_p)} \quad .....1$$

$\hat{P}$ is the expected probability that the outcome is present; X_1 through X_p are distinct independent variables; and b_0 through b_p are the regression coefficients. The multiple logistic regression model is sometimes written differently. In the following form, the outcome is the expected log of the odds that the outcome is present,

$$Ln\,[Pi / (1\text{-}Pi)] = a_0 + \beta_1X_1 + \beta_2X_2 + \ldots + \beta_nX_n \quad .....2$$

where the subscript i means the ith observation in the sample. P is the probability that a respondent uses chemical fertilizer, organic manure or both as the case may be and (1-P) is the probability that a respondent does not use chemical fertilizer, organic manure or both. a_0 is the intercept term and $\beta_1,\beta_2,\ldots\ldots\ldots, \beta_n$ are the regression coefficients of the independent variables X_1, $X_2,\ldots\ldots\ldots, X_n$.

It is observed that the right-hand side of the equation above looks like the multiple linear regression equation. However, the method used for calculating the regression coefficients in a logistic regression model is quite different from the one used to calculate the regression coefficients in multiple linear regression. In logistic regression the coefficients derived from the model (e.g., b_1) indicate the change in the expected log-odds relative to a one-unit change in X_1, holding all other predictors constant. Therefore, the antilog of an estimated regression coefficient, $\exp(b_i)$, produces an odds ratio.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the farmers indicated that 77.00% of the respondents were in the economically active age group of 20-60 years. Only about 11.40% and 11.60% of the respondents were above 60 years and below 20 years

respectively. Many researchers think that age plays a major role in the dissemination, adoption and diffusion of innovations (Aldosari et al., 2017). Younger farmers are known to embrace change than the old farmers and they readily accept and adopt innovations and new ideas, and information diffuses among them faster (Habib et al., 2007). About 56.22% of the respondents were females while 43.78% were males, indicating that females dominate in arable farming in the State. The majority of the respondents (78.91%) were married indicating that marriage is highly cherished in the area. It was observed that only about 7.4% of respondents were illiterate, while the remaining 92.6% had one form of formal schooling or the other. 26% had primary education; 37.2% were with secondary school education; 29.4% of the respondents had tertiary education. This implies that the literacy level of the respondents was quite encouraging. People who are educated are expected to have positive attitudes towards the acquisition of agricultural skills, knowledge and information as compared to illiterate people (Habib et al., 2007). The results of farm size indicated that 73%, 25.1% and 1.9% of respondents have landholdings of sizes 2 hectares and below, between 2.1-4 hectares and above 4hectares respectively. The finding implies that most arable farmers in the study area are smallholders. According to Aldosari et al. (2017) farm size plays a crucial role in the diffusion and adoption of innovations among the farmers. The research findings also revealed that the majority of the respondents (69.7%) had over 15 years of farming experience, 23% of respondents had 11-15 years, 5.5% of respondents had 6-10 years of farming experience; only 1.8% had less than 6 years farming experience. The household size was moderate, the average being 5 persons. The results of income distribution among the respondents showed that the majority (89.6%) were low-income earners, earning less than N100000 ($230); 9.2 % earn between N100000 to N200000; a minute 1.2% earn above N200000. Household size was moderate as the average was 6 persons per home. Finally, the extension contact was very poor as only 10.2 % of the respondents had contact with an extension agent for a year.

Farmers Use of Fertilizers and Organic manure

The result in Table 2 shows the number of farmers using organic manure or fertilizer or both. From the table, about 82.5% of the respondents make use of organic manure while only about 12.1% of the respondents use inorganic fertilizer. A minute 5.4% of the respondents make use of both types of manure. This finding implies that organic manure is the predominant manure used by respondents in the study area. Rigby and Ca‟ceres(2001) and Defoer (2002) opined that many farmers the world over have now resorted to the use of organic manure due to its eco-friendly nature and its effect on protecting the soil. Alimi et al. (2006) found that organic manure is commonly used by farmers to supply nutrients to their crops perhaps because they are a cheap source of nutrients to their crops thus reducing the cost of production.

Table 2: Distribution of respondents according to types of manure used

Type of Manure	Frequency (166)	Percentage (100)
Organic manure	137	82.5
Fertilizer	20	12.1
Both	9	5.4

Source: Field data

Problems of Using Manure Type

The various reasons given by respondents are presented in Table 3. The various problems associated with the use of chemical fertilizers and inorganic manures are presented in Table 3. The results showed that while cost, availability of the product, and hazardous effect or pollution of the environment were all major problems associated with the use of fertilizers, these were minor or less serious problems associated with the use of organic manure. On the other hand, offensive odour, the bulkiness of the material, presence of weed materials and incidence of pests and

diseases were major problems of using organic manure but minor problems associated with the use of chemical fertilizers. Savci (2012) asserted that pollution of the environment is a major problem associated with the use of fertilizer. Ajewole (2010) and Aderinoye-Abdulwahab and Salami (2017) reported that offensive odour, the bulkiness of organic fertilizer, and cost (especially in transportation) were among the problems associated with the use of organic manures.

Lack of technical know-how and the problem of land tenure were major problems confronting both respondents using chemical fertilizer and organic manure, whereas awareness and cultural factors were not regarded by the respondents as constraints to the use of manures. The findings on the lack of technical know-how are supported by Odhiambo and Magandini (2008) who observed that most farmers do not know how to use fertilizers. Most farmers complain that they don't actually know how to apply chemical fertilizer or organic manure. Also, most farmers are tenants on the land they are currently cultivating, so they do not want to carry out any improvement on the land. This prevailing land tenure system thus discourages farmers from using fertilizers.

Table 3: Distribution of respondents according to Problems of using manure types

S/N	Problem	Inorganic fertilizer			Organic manure		
		Mean	St. Dev	Remark	Mean	St. Dev	Remark
1.	Cost of manure	3.61	0.47	Major	1.97	0.29	Minor
2.	Availability	3.59	0.51	Major	2.24	0.66	Minor
3.	Hazardous effect (Pollution)	3.59	0.48	Major	2.18	0.59	Minor
4.	Technical know-how	3.52	0.56	Major	3.14	0.58	Major
5.	Land tenure system	3.22	0.62	Major	3.31	0.53	Major
5	Offensive odour	2.44	0.65	Minor	3.22	0.46	Major
5.	Bulkiness	2.39	0.23	Minor	3.55	0.58	Major
6.	Awareness	1.88	0.18	Minor	2.47	0.49	Minor
7.	Cultural factors	1.79	0.11	Minor	1.99	0.39	Minor
8.	Presence of weed seeds	1.01	0.02	Minor	3.44	0.44	Major
9.	Incidence of pests	1.00	0.03	Minor	3.38	0.52	Major

Source: Field data

Respondents' perceived benefits of Using Inorganic Fertilizers and organic manures

The benefits of using both types of manures are presented in Table 4. The result showed that for fertilizer, the perceived benefits of the respondents were increased yields and improvement in soil porosity. Therefore, apart from the direct effect in boosting yields of farmers, chemical fertilizers stand to have no other major benefit on the soil. As for inorganic manure, the benefits are numerous as can be seen in Table 4. The perceived benefits of using organic manure were; improvement of soil structure, increased farm yield, environmentally friendly, production of beneficial microorganisms like Rhizobium bacteria and blue-green algae that are involved in nutrient cycling, availability in most times, enhancement of nitrogen fixation, improving the water-holding capacity of soils and improvement of soil porosity.

Table 4: Respondents' perceived benefits of using different types of manure

S/N	Perceived benefit	Inorganic Fertilizer		Organic manure	
		Mean	Remark	Mean	Remark
1	Improves soil structure	1.86	Not Ben	3.77	Benefit
2	Increases yield	3.67	Benefit	3.55	Benefit
3	Environmentally friendly	2.05	Not Ben	3.32	Benefit
4	Easy to get/ Availability	1.58	Not Ben	3.30	Benefit
5	Produce beneficial micro-organisms	1.99	Not Ben	2.98	Benefit
6	No trace of hazardous material in plants	1.98	Not Ben	3.44	Benefit
7	Encourages nitrogen fixation	2.01	Not Ben	3.19	Benefit
8	Improves soil water holding capacity	1.55	Not Ben	3.22	Benefit
9	Improves soil porosity	3.35	Benefit	3.69	Benefit

Source: Field data

Test of hypotheses

To ascertain the factors influencing the use of fertilizer among the arable farmers in Delta State, multicollinearity tests were first conducted among the independent /explanatory variables. Test results showed the absence of multicollinearity. As a result, all the independent variables were entered and the equation fitting the log it regression model was estimated. The model chi-square for the three regression run was satisfactory indicating that the models used were good fits. The result in Tables 5 and 6 indicated that the following variables relating to the use of inorganic fertilizer and organic manure were significant at $P < 0.05$: age (X_1), level of education (X_4), farm size (X_5), farming experience (X_6) and extension contact (X_8), which implies that these variables were the important factors affecting farmers' use of fertilizer in arable crop production in Delta State. Age and farming experience were significant for only organic fertilizers. The coefficient of age was negative implying that the older farmers were cautious of the use of fertilizers, probably due to the hazardous effect of inorganic fertilizer they might have experienced. The coefficient of the level of education was negative and significant for inorganic fertilizer but positive and significant for organic manure, which implies that farmers with higher education use inorganic fertilizer less than farmers with low education, but use more of organic manure. This could be because education extricates farmers from ignorance, and enables the farmer to know the dangers of the use of inorganic fertilizer in crop production and their deleterious effects on soils. This result is similar to those of Cooke (1982) and Asomonye (1991). The coefficient of farm size was positive and significant, indicating that farmers with larger farm sizes use more inorganic fertilizer and organic manure than farmers with small farm sizes (Tables 5 and 6). The coefficient of farming experience was negative and significant for inorganic fertilizer but positive and significant for organic manure, indicating that the more experienced farmers use lesser fertilizers in crop production than less experienced farmers. The coefficient of extension contact was positive and significant for both inorganic fertilizer and organic manure, implying that farmers who are in contact with extension agents use more fertilizer than farmers that do not have extension contacts.

The findings on farm size and extension contacts are supported by the findings of Likita (2005) and Dittoh (1991), while that on farming experience is corroborated by Ohajianya et al, (2007).

Sex (X_2) and household size (X_5) were not significant at $P<0.05$, implying that these variables were not relevantin influencing farmers' use of fertilizer. This finding is corroborated by those of Ohajianya et al, (2007) in their study on comparative analysis of organic and inorganic fertilizer use in cassava production in Imo State.

Table 5: Maximum likelihood estimates of the Fertilizer Usage model

Variable	β coefficient	S/error	Odd ratio	P-value
Age (X_1)	-0.765	0.388	2.442	0.038**
Sex (X_2)	0.884	0.564	1.003	0.477
Marital status (X_3)	0.227	0.115	0.299	0.902
Education attainment (X_4)	-0.334	0.330	3.667	0.044**
Farm size (X_5)	2.999	1.442	9.039	0.034**
Farming experience (X_6)	-0.058	0.846	2.403	0.002**
Household size (X_7)	0.044	0.211	0.399	0.884
Extension contact (X_8)	-0.135	0.008	2.227	0.049**
Constant	-8.771	1.588	0.004	0.001**
Chisquare	71.993			
Sample size	166			
Nagelkerke R^2	0.624			

Source: Field data **Significant at P<0.05

The regression result for both types of manure is presented in Table 7. The results clearly showed that the same variables significant for the use of inorganic fertilizer were also significant for manure use (whether inorganic fertilizer or organic manure). This is expected because manure includes either fertilizer or organic manure. The same explanation equally applies.

Table 6: Maximum likelihood estimates of Organic Manure Usage model

Variable	β coefficient	S/error	Odd ratio	P-value
Age	-0.877	0.421	0.997	0.751
Sex	0.004	0.220	0.803	0.606
Marital status	0.501	0.662	0.900	0.772
Education attainment	-0.811	0.669	2.997	0.003**
Farm size	-0.722	0.712	1.044	0.048**
Farming experience	0.709	1.002	1.333	0.072
Household size	0.528	0.633	0.945	0.433
Extension contact	1.044	0.977	4.766	0.022**
Constant	-9.440	0.997	0.041	0.028
Chisquare	74.677			
Sample size	166			
Nagelkerte R^2	0.577			

Source: Field data **Significant at P<0.05

Table 7: Maximum likelihood estimates of both types of Manure Usage model

Variable	β coefficient	S/error	Odd ratio	P-value
Age	-0.684	1.208	4.333	0.031**
Sex	1.211	0.742	1.000	0.644
Marital status	1.200	1.411	0.774	0.447
Education attainment	1.003	0.911	3.445	0.042**
Farm size	-2.334	0.991	3.022	0.033**
Farming experience	1.880	0.801	6.441	0.045**
Household size	0.802	0.822	0.813	0.611
Extension contact	2.001	0.688	5.002	0.004**
Constant	-4.744	0.558	0.001	0.006
Chisquare	78.944			
Sample size	166			
Nagelkerte R^2	0.633			

Source: Field data **Significant at P<0.05

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, it was evident that most of the respondents in Delta State use organic manure in preference to fertilizer. It could be concluded from the study that the respondents benefit more from using organic manure than using fertilizer. However, the use of both manures is hampered by several constraints. Such problems should be tackled by appropriate agricultural policies and intensifying extension efforts in the area. Extension service is very crucial to the use of manure innovation in the area, so extension efforts should be intensified. Moreover, extension programmes designed for farmers should include an orientation on the proper use of manures. The respondents, especially older farmers should be trained on the use and application of inorganic fertilizer and organic manure. It is obvious that when these recommendations are implemented, this will definitely boost the productivity of arable crop farmers in the area.

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