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# Crop Farmers' Perception of the Role of Earthworm in Soil Improvement in Delta State, Nigeria

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**Abstract:** The study examined farmers' perception of the role of earthworm in soil improvement in Delta State, Nigeria. The specific objectives of the study are as follows: (i) assess the level of awareness of crops' farmers of the roles of earthworms in the soil.(ii) assess farmers' perception of earthworms' role(iii) identify farming practices that are inimical to the activities of earthworms.. A multi-stage sampling procedure was used to compose a sample size of 344 respondents. Data were collected using well structured and validated interview schedule and data were analysed using various descriptive statistical techniques such as tables, percentages, means and standard deviation, and inferential statistics (linear regression model). The result of the study indicated that majority of the respondents were not aware of the various roles of earthworms in the soil. However, the respondents that were aware agreed that earthworm enhances microbial degradation of organic matter (mean = 4.48), improves soil productivity and fertility (mean = 4.22), influences nutrient cycling process in many ecosystems (mean = 4.45), prepares the ground in an excellent manner for the growth of plants (mean = 4.78) and alters the physical and chemical properties of the soil to improve fertility (mean = 4.34). The respondents aware of the role of earthworms, nevertheless disagreed that earthworms casts have a greater population of beneficial microorganisms (mean = 1.48), earthworms are very important in inoculating soils with microorganisms (mean =1.38) and that earthworms are extensively used for vermi-composting in the study area (mean = 1.32); they also disagreed that earthworm stabilizes soil organic matter through its mineralization (mean = 2.16).
**Keywords**: Perception, Earthworm, vermi-composting, soil improvement, Delta, Nigeria

## INTRODUCTION

The soil is the most important asset to the farmer because all agricultural activities invariably take place on the soil. Therefore the protection of the soil against depletion is a good step towards sustainable management of its biological properties that determine long-term stability and productivity. It is generally believed that soil organisms benefit soil productivity but not much is known by most small-scale farmers about the organisms that live in the soil and the functioning of the soil ecosystem. Of the soil organisms, earthworms are among the most important to the farmers because of the crucial roles they play in the soil. Earthworms are invertebrates which belong to the Order Oligochaeta, Class Chaetopoda, and Phylum Annelida.

The crucial role of earthworms in soil improvement has been known for a very long time. Earthworms are widely distributed in many habitats, portraying effective activity, leading to the physical and chemical alterations in the soil resulting in improvement in soil fertility [1]. Consequently, may studies have been carried out to highlight the soil organisms (especially earthworm) contribution to the sustainable function of ecosystems[2]. Soil organisms like earthworms modify the soil and litter environment invariably by the accumulation of their biogenic structures. The cycling of nutrients is a critical ecosystem function that is essential to life on earth. Current studies have shown increasing interest in the development of productive farming systems with proper utilization of internal resource and therefore lower input requirement and cost[3-4]. At present, there is increasing evidence that soil organisms play a crucial role in Soil Organic Matter transformations and nutrient dynamics at different time and temporal scales through alteration and the production of biogenic structures for the maintenance of soil fertility and productivity[5-6]. Earthworms are a important soil organisms in natural ecosystems of the humid tropics and constitute a large proportion of soil living fauna biomass[7].

The roles of earthworms on soil biological processes and fertility improvements vary from one ecological system to another [8]. Earthworms build permanent burrows into the deep mineral zones of the soil; they pull organic matter from the top soil into their burrows for food. They produce physical structures through which they can change the availability or accessibility of a resource for other organisms[9].

Earthworms affect the supply of nutrients through death and decay of their tissues, and also mainly

through their burrowing activities; they produce aggregates and pores in or on the soil, thereby affecting its physical properties, nutrient cycling, and plant growth [10-11]. The biogenic structures constitute assemblages of organo-mineral aggregates. Their stability and the concentration of organic matter impact soil physical properties and organic matter dynamics. Besides they affect some important soil ecological phenomena within their "functional domain'' [12]; Lavelle [13] where they gather nutrients and resources that are later exploited by soil microorganism [14-15]. The effect of earthworms on the incorporation of organic matter varies depending on the time and space scales under consideration[16]. Thus, earthworms have been extensively used in vermicomposting[17], a low cost technology system for the processing or treatment of organic wastes [18]. Vermicomposting is a simple biotechnological process of making compost, in which certain species of earthworms are employed to accelerate the process of converting waste to produce a better end product [19]. Vermicomposting differs from composting in many respects[20]. It is a mesophilic process whereby microorganisms and earthworms are utilized at temperatures of between 10 to 32°C (not ambient temperature but temperature within the pile of moist organic material). The process is faster than normal compost making, because the material passes through the earthworm digestive tract, leading to the production of earthworm castings (worm manure) rich in microbial activity and plant growth regulators, and reinforced with pest repellence attributes.

Earthworms consume many kind organic wastes and reduce the volume by as much as 40 to 60%. The worm castings produced contain higher percentage of both macro and microelements than the garden compost.

Earthworms have been reported to promote mineralization by first breaking down organic matter and then mixing it together with soil mineral particles and microorganisms, and thereby providing new surfaces of contact between organic matter and microorganisms [21]. Earthworms fresh cast deposits are rich in macronutrients that are easily absorbed by crop plants [22]. Most of these nutrients are obtained from earthworm urine and secretions [24]. In poor soils that are highly leached especially in the humid tropics, earthworm activities are beneficial because of rapid fixation of the detritus into the soils [23]. Moreover, mucus production accompanied with water excretion in the earthworm gut is believed to promote the activities of other soil microorganisms [24]. This is accompanied by the accumulation of organic matter. Earthworm's cast and earthworm mucilages bind soil particles together and help in the formation of highly stable aggregates [25-26]. Several studies have shown that earthworms may stabilize soil organic matter through its mineralization and protection in their casts [27-30]. Moreover earthworms seem to increase the mineralization as well as the turnover of organic matter in soils [31].

From what has been said so far, it is therefore obvious that earthworms play very crucial role in improving the soil. It therefore no wonder that Ismail [32] referred to them as biological indicators of soil quality because the concentration of earthworms in the soil indicates the presence of a great population of bacteria, fungi, insects, spiders and other organisms and therefore a healthy soil [33].

Documents and studies on the role of earthworms in soil conditioning and soil improvement are in literature [34-37]. However, studies on the perception of farmers of these small creatures in Nigeria in general and Delta State in particular are lacking. In spite of the importance of earthworms as enumerated above, there is paucity of information on farmers' perception of the role of soil fauna, especially earthworm, in Delta State, Nigeria. There is therefore the need to assess farmers' opinions on the role these important soil fauna play in the soil. The following research questions therefore crop up: are crops' farmers aware of the importance of earthworms in Delta State? What is the level of awareness of farmers on the role of earthworms in the soil? What is the perception of those aware of activities of earthworms of their roles in the soil? What are some farming practices engaged by farmers that could be detrimental to the activities of earthworms? The objectives of the study are as follows: (i) assess the level of awareness of crops' farmers of the roles of earthworms in the soil.(ii) determine the perception of farmers of the role of earthworms; (iii) identify farming practices that are inimical to the activities of earthworms. The following hypothesis, stated in the null form was tested: there is no significant relationship between farmers' socio-economic characteristics and their perception of the role of earthworm in the soil.

## RESEARCH METHODS

The research work was conducted in Delta State, Nigeria. Delta state was carved out from the defunct Bendel state on August 27, 1991 by General Ibrahim Babangida regime. The State occupies an area of about 18,050 $Km^2$ of which nearly 2/3 is land. Delta State is situated approximately between Longitude 5°00' and 6°.45' East and Latitude 5°00 and 6°.30' north. It is bounded in the North and West by Edo State, in the East by Anambra, Imo, and Rivers States, in theSouth-East by Bayelsa State, and on the Southern flank is the Bight of Benin which covers about 160 kilometres of the State's coastline. Both oil production and agricultural activities are carried out in Delta. The population of the State is 4,098,291 (males: 2,674,306; females: 2,024,085) (National Population Commission, 2006).

Delta State is predominantly low-lying without prominent hills except in some parts of the northern fringes of the State. The State has a wide coastal belt permeated with rivulets and streams, which form part of the Niger-Delta.

The Major ethnic groups are: Isoko, Urhobos, Ukwuani, Itsekiri, Izon, Igbos, and Ika. Major crops raised in the State include cassava, yam, pineapple, citrus, potato, plantain/banana, oil palm, rubber and coconut. Animal production and fishing/aquaculture are also prevalent in the state. The average rainfall in the State is about 2000mm per annum and the average monthly temperature is between 30.4-36.4$^{o}$C; the relative humidly varies from 56-86 percent per annum. Delta state comprises three agricultural zones namely, Delta South, Delta central and Delta North.

Multi-stage sampling procedure was employed in selecting the respondents for the study. Six out of the twenty-five LGAs (Local Government Areas) in Delta State were randomly selected. The second stage of the selection involved the random selection of two rural communities from each of the selected six LGAs making a total of twelve communities. The next stage involved the random selection of thirty farmers from each of the twelve selected communities making a total of Three hundred and sixty (360) farmers selected and interviewed for the study.

However, 16 of the questionnaire were not returned, thus only 344 copies of the questionnaire were used for further analysis in the study.

Both primary and secondary data were used for the study. Information on the socioeconomic characteristics of farmers, awareness of farmers on role of earthworms and their farming practices were collected. Descriptive statistical tools like frequency counts, tables, percentages, means and standard deviation were used for data presentation and interpretation. The instrument for data analyses also included the Likert-scale with values: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree and 5 = strongly agree. The cut-off point was 3.0.

Different functional forms were fitted to determine the variables determining farmers' perception of the role of earthworms (semi-log, double log, linear and exponential models).
Mathematically, the linear regression model is implicitly specified as:

$$Y= F(X_1.X_2, X_3, X_4,X_5,X_6, X_7, X_8),$$

While the explicit form is given as:

$$Y=b_o+ b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e$$

Where,
Y= Physical quantity of bushmeat consumed in kilograms.
$X_1$= Gender (dummy)
$X_2$= Age (years)
$X_3$= Level of education (categorical)
$X_4$= Marital status (dummy)
$X_5$= farming experience
$X_5$= farm size
$X_5$= household size
e = Stochastic error term

The double log function is explicitly expressed as:

$$Log\ Y = Logb_o + b_1LogX_1 + b_2LogX_2 + b_3LogX_3 + b_4LogX_4 + b_5LogX_5 + b_6LogX_6 + e$$

The semi log form is expressed as:

$$Y = Logb_o + b_1LogX_1 + b_2LogX_2 + b_3LogX_3 + b_4LogX_4 + b_5LogX_5 + b_6LogX_6 + e$$

The exponential functional form is expressed as:

$$Log\ Y = b_o + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e$$

Where,

Log = natural logarithm
All other variables are as defined before

However, the linear functional form was used as it had the highest $R^2$, the highest number of significant variables and small standard error. The F-value of the linear functional form is also a good fit for the data.

## RESULTS AND DISCUSSION

### Socio economic characteristic of respondents

Most of the respondents are middle-aged. They are mostly females, married, and a high proportion (about 91%) had one type of formal education or the other, had a lot of experience in farming; majority are in low income group.

### Awareness level of the role of earthworms

The awareness level of farmers of the role of earthworms in their farms is as presented in Table 1. The result in Table 1 indicates that majority of the respondents were not aware of the various roles earthworms play in the soil. For instance, only about 7% of the respondents were aware of the fact that earthworms' casts have a greater population of useful microorganisms, while no farmer was even aware that earthworm casts have high enzymic activities than the surrounding soil.

**Table 1: Farmers awareness of the role of earthworms**

| Earthworm's role | Awareness level | |
|---|---|---|
| | Frequency(344) | Percentage (100) |
| Earthworm casts have a greater population of beneficial microorganisms | 24 | 7.14 |
| Earthworm casts have higher enzyme activities than surrounding soil | 0 | 0.00 |
| Very important in inoculating soils with microorganisms | 4 | 1.19 |
| Enhances microbial degradation of organic matter | 44 | 13.10 |
| Extensively used in vermi-composting | 8 | 2.38 |
| Improves soil productivity and fertility | 72 | 21.43 |
| Influences nutrient cycling process in many ecosystems | 68 | 20.24 |
| Releases substances beneficial to plant growth like auxins and cytokinins | 0 | 0.00 |
| Prepares the ground in an excellent manner for the growth of plants | 156 | 46.43 |
| Physical and chemical alterations of soil resulting in improvement in soil fertility | 42 | 12.50 |
| Stabilizes soil organic matter through its mineralization | 16 | 4.76 |

Source: Survey Data, 2015

### Farmers' perception of the role of earthworms

Table 2 shows the respondents perception of the various roles of earthworms in the soil. The perception of the respondents aware of the role of earthworm was presented in Table 2. The result in Table 3 clearly shows that the respondents agreed that earthworm enhances microbial degradation of organic matter (mean = 4.48), improves soil productivity and fertility (mean = 4.22), influences nutrient cycling process in many ecosystems (mean = 4.45), prepares the ground in an excellent manner for the growth of plants (mean = 4.78) and alters the physical and chemical properties of the soil to improve fertility (mean = 4.34). the respondents aware of the role of earthworms, however disagreed that earthworms casts have a greater population of beneficial microorganisms (mean = 1.48), earthworms are very important in inoculating soils with microorganisms (mean = 1.38) and that earthworms are extensively used for vermi-composting in the study area (mean = 1.32); they also disagreed that earthworm stabilizes soil organic matter through its mineralization (mean = 2.16).

**Table 2: Farmers' perception of the role of earthworms**

| Role of earthworm | Mean | Remark |
|---|---|---|
| Earthworm casts have a greater population of beneficial microorganisms | 1.48 | Disagreed |
| Very important in inoculating soils with microorganisms | 1.38 | Disagreed |
| Enhances microbial degradation of organic matter | 4.48 | Agreed |
| Extensively used in vermin composting | 1.32 | Disagreed |
| Improves soil productivity and fertility | 4.22 | Agreed |
| Influences nutrient cycling process in many ecosystems | 4.45 | Agreed |
| Prepares the ground in an excellent manner for the growth of plants | 4.78 | Agreed |
| Physical and chemical alterations of soil resulting in improvement in soil fertility | 4.34 | Agreed |
| Stabilizes soil organic matter through its mineralization | 2.16 | Disagreed |

Lkert-scale coded: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree and 5 = strongly agree

**Farming practices detrimental to activities of earthworms**

The result in Table 3 shows respondents perception the major farming practices adopted by farmers that are harmful to the activities of earthworms. From the findings, it was observed that bush burning was the most reprehensible in hampering the activities of earthworms.

**Table 3: farming practices harmful to earthworms**

| Farming practice | Mean | Standard deviation | remark |
|---|---|---|---|
| Bush burning | 4.78 | 0.78 | harmful |
| Tillage | 4.09 | 0.69 | harmful |
| Deforestation | 3.59 | 1.11 | harmful |
| Use of chemicals | 3.96 | 0.62 | harmful |
| Irrigation | 2.46 | 1.98 | not harmful |
| Use of organic manure | 0.64 | 0.59 | not harmful |

**Socioeconomic Variables Influencing Farmers' Perception of the Role of Earthworms**

The result of the regression analysis which was run to determine the socioeconomic factors that affect the perception respondents of the role of earthworm is presented in Table 4. Of the three functional forms fitted, the linear model chosen for reasons given earlier.

The significant variables were Farming experience, Farm size and educational level. The coefficients of these variables are positive and significant in influencing farmers' perception of earthworms' activities. Those who have spent many years in farming are more likely to be more aware of the activities of earthworms than those with lesser experience. Respondents with larger farms are more likely to explore and try options on how to manage their farms and thus more aware of the activities of earthworms. Moreover, literacy improves the respondents' knowledge level and may positively influence their perception of the roles of earthworms.

**Table 4: Relationship between socioeconomic variable and farmers' perception of role of earthworm**

| Variables | Coefficient | t-statistics | P value |
|---|---|---|---|
| Constant | 8.246 | 5.944 | 0.021* |
| Gender | 0.055 | 1.246 | 0.367 |
| Age | 1.331 | 1.008 | 0.512 |
| Level of education | 0.314 | 4.627 | 0.001* |
| Marital status | 2.115 | 0.998 | 1.411 |
| Farming experience | 0.047 | 2.984 | 0.004* |
| Farm size | 1.488 | 3.224 | 0.035* |
| Household size | 1.402 | 0.877 | 0.944 |
| $R^2$ | 0.845 | | |
| Adjusted $R^2$ | 0.792 | | |
| F-calculated | 284.991 | | |
| Standard error | 0.086 | | |

* Significant at $P \leq 0.05$

**Conclusion and Recommendation**

From the findings of the study it was quite obvious that most of the respondents were not aware of the activities of earthworms in the soil. Even those that were aware generally did not perceive most activities of earthworms to be important. There is therefore the need to sensitize farmers on the crucial role played by earthworms in the soil.

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