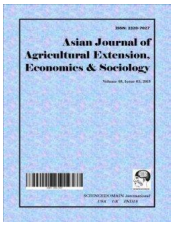

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# Yam (*Dioscorea* spp.) Farmers' Coping Strategies against Yam Beetle (*Heteroligus* spp.) in Delta State, Nigeria: Implication for Food Security

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author SOE designed the study, wrote the protocol and supervised the work. Authors ECE and SOE carried out all laboratories work and performed the statistical analysis. Authors SOE and ECE managed the analyses of the study. Author EOE wrote the first draft of the manuscript. Author EOE managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.*

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## ABSTRACT

The study examined the various strategies adopted by yam farmers of Delta State in coping with the menace of yam beetle (*Heteroligus meles*). The specific objectives were to: describe the socio-economic characteristics of yam producers in Delta State; ascertain the economic losses caused by yam beetle in Delta State; determine the various strategies adopted by farmers in Delta State in coping with the menace of yam beetle; examine the effectiveness of the various coping strategies. A multi-stage sampling procedure was used to compose a sample size of 225 respondents.

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Primary data were obtained from respondents with the use of structured and validated questionnaire. Various descriptive and inferential statistical methods were used in data analysis. The result showed that majority of the farmers (98.2%) adopted the use of multiple cropping in combating the menace of yam beetle; about 93% adopted late planting and 55.1% agrochemicals. Most of the farmers thus witnessed minimal losses in their farmers since they adopted one form of coping strategy or the other. The study further revealed that the use of agrochemical was the most effective coping strategy. The regression result showed that with the exception of gender, marital status and household size, all other factors were statistically significant at $\rho \leq 0.05$, indicating that they influenced respondents' adoption of coping strategies. The implication of these findings for food security was that yam production in Delta state is likely to improve, thereby leading to increase in food supply in the area since farmers are combating the menace of beetles. However, it was recommended, among others, that farmers should be enlightened on the need of using effective coping strategies.

*Keywords: Coping strategy; beetle; economic losses; agrochemical; delta; Nigeria.*

## 1. INTRODUCTION

Nigeria is the world's largest producer of yam, accounting for over 76% of the world production [1] According to the Food and Agricultural Organization (FAO) statistics, in 1985, Nigeria produced 18.3 million tonnes of yam from 1.5 million hectares, representing 73.8% of total yam production in Africa [2]. Yam production in Nigeria has nearly doubled since 1985, with Nigeria producing 35.017 million metric tonnes with value equivalent of US$5.654 billion [3]. The world's second and third largest producers of yams, Cote d'Ivoire and Ghana, merely produced 6.9 and 4.8 tonnes of yams in 2008 respectively [4]. According to the International Institute of Tropical Agriculture , Nigeria accounted for about 70% of the world production amounting to 17 million tonnes from land area 2,837,000 hectares under yam cultivation [5]. Yam, a tropical crop in the genus Dioscorea, has many species out of which six are economically important staples [6]. Out of these, *Dioscorea rotundata* (white yam) and *Dioscorea alata* (water yam) are the most commonly grown species in Nigeria [7]. Yams are cultivated in the coastal region in rain forests, woody savannah and southern savannah habitats. Yam is in the class of roots and tubers that is a staple of the Nigerian and West African diet, which provides some 200 calories of energy per capita daily [8]. In many yam-producing areas of Nigeria, it is said that "yam is food and food is yam." Yam also has an important social status in gatherings and religious functions, which is assessed by the size of yam holdings one possesses. Although it is grown widely in Nigeria, the area where it is grown most is the Benue State (land area of 802,295 km²), one of the states in Benue valley of Nigeria where the labour intensive practices are still the norm and the land holdings are small. Because of high level of yam production in the State, it is known as the Nigerian Bread Basket.

However, the production of yam in Nigeria is very low and cannot meet the growing demand at its present level of use. This is because there are several factors militating against optimum yam production which include expensive planting materials (seed yams/setts) labour, staking, weed menace, diseases and insect pests. In spite of the central role yam plays in the lives of Nigerians, its production could be adversely affected, especially by pests and diseases. Unreliable rains and pest and disease outbreaks cause wide variations in resource availability and in crop yields. The major factor in this regard is the destruction to yams caused by the yam tuber beetles, *Heteroligus* species [9-11]. These beetles are very serious insect pests of yam in riverine areas particularly in the rainforest zones [12]. Serious losses and drastic reduction in tuber yield and market value as a result of the beetle damage has been reported by [13] and [11]. Damage due to yam beetles ranged from 27.69% to 39.72% with a mean beetle attack rate of 32.69% that caused a loss of tubers worth N1.09 million in market value [11]. The menace of these insects had caused untold hardships to farmers in terms of economic losses. It therefore becomes imperative that the various ways farmers have coped in managing yam beetles in their farms be examined.

In spite of the importance of yam in Delta State, its production has faced many challenges. One of the limiting factors to yam production is the incidence of pests. Pests of yam could cause serious crop losses to farmers in Nigeria and Delta State in particular. Yam beetle

(*Heteroligus meles*) is the most serious pest affecting yam production in the area. Damage due to yam beetles is much [11].

Serious losses and drastic reduction in tuber yield and market value as a result of the beetle damage has been reported by [14] and [13]. High cost of pesticides and cost of equipment and labour were reported as major obstacles to the effective control of yam tuber beetles [11]. Since the yam beetle could lead to considerable losses to farmers in the area, it therefore becomes imperative that farmers manage this pest properly in order to boost their productivity. The following research questions then arise: what are the socio-economic characteristics of yam producers in Delta State? What is the extent of losses caused by yam beetles? How have farmers in Delta State been able to cope with the menace of yam beetles over the years? How effective are these coping strategies in ameliorating the menace of yam beetle? The objectives of the study are therefore to: describe the socio-economic characteristics of yam producers in Delta State; ascertain the economic losses caused by yam beetle in Delta State; determine the various strategies adopted by farmers in Delta State in coping with the menace of yam beetle; and examine the effectiveness of the various coping strategies. The study tested the following hypothesis, stated in the null form: there is no significant relationship between the socio-economic characteristics of farmers and their coping strategies against yam beetle.

## 2. RESEARCH METHODOLOGY

The study was conducted in Delta State, Nigeria (longitudes 5°00' and 6°45' East and latitudes 5°00' and 6°30' North). Delta State shares common boundaries with Edo and Ondo States to the North-West, Imo and Anambra States to the North-East, Rivers and Bayelsa to the South-East. In the South and South-West it has approximately 122 km of coast line bounded by the Bight of Benin on the Atlantic Ocean. The major ethnic groups are Urhobo, Igbo, Ezon, Isoko and Itsekiri. It has an estimated population of 4,098,291 [15] and total land area of 18,050 $km^2$, and about one-third of this is swampy and waterlogged. It experiences average rainfall of about 2000 mm per annum with an average monthly temperature of 30.4-36.4°C and a relative humidly varying room 56-86% per annum. Delta State is divided into three agricultural zones namely, Delta South, Delta Central and Delta North. Other crops, besides yam, grown in the state include cassava, plantain/banana, oil palm, mango, orange, pineapple, and cocoyam.

The state is rich in biodiversity and the mangrove swamps are the largest in Africa. However, climate change impacts have led to loss of wetlands through deforestation, oil spills and saline intrusion from sea level rise and flooding having devastating effect on the state's biodiversity resource and livelihood options [16].

### 2.1 Sampling Procedure and Sample Size

A multi-stage sampling procedure was used to compose a sample size of 225 respondents. This was done as follows: out of the three agricultural zones in the state, one local government area was randomly selected from each zone. Seventy-five (75) respondents were selected from each of the randomly selected local government areas, giving a total of 225 respondents that were sampled and studied.

Primary data were obtained from respondents with the use of structured and validated questionnaire. The content of the questionnaire was validated by experts in the fields of agricultural extension and agronomy to ensure that the content reflect the objectives of the study. The instruments for primary data collection include a five point Likert Scale with values: 1= strongly disagree, 2= disagree, 3= undecided, 4=agree and 5=strongly agree. From point 3 will be regarded as effective while below 3 as non-effective as used by [17]. Furthermore, data were collected from secondary sources such as journals, past research work, government records, documented statistics collected from the study area, internet and library.

Descriptive and inferential statistical methods were used in data analysis. Information was presented using tables and simple percentages. Inferential statistics that was used in testing the stated hypothesis was a regression model. Coping strategy was the dependent variable while some selected socioeconomic variables were the independent variables. As all the farmers surveyed used one form of coping strategy or the other, we apply an ordinary least square, (OLS) estimation instead of Tobit, Probit or Logit model to explain the variation in use of coping strategies [18]. The linear model was the best fit as it has the highest $R^2$ and most variables were significant. The model is as specified below:

Mathematically, the regression model is implicitly specified as:

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

While the explicit form of the linear relationship is given as:

$$Y=b_o+ b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_6x_7+e)$$

Where,

Y= intensity of coping strategy.
$X_1$= Gender
$X_2$= Age
$X_3$= Marital status
$X_4$= educational level
$X_5$= farming experience
$X_6$= household size
$X_7$= farm size
e = Stochastic error term

## 3. RESULTS AND DISCUSSION

### 3.1 Socioeconomic Characteristics of Yam Farmers

The socioeconomic characteristics of the respondents in the study area are presented in Table 1. The result indicated that more women were actively involved in yam production than men. This result is contrary to expectations of many as yam is culturally regarded as a "man" crop in Delta State [11]. Most of the respondents (97.23%) were in their economically active age group. A relatively large household size was found in the study area with an average size of eight persons per household. These findings support the preponderance of large family sizes among the poor in rural areas reported by many scholars [2,19]. About 93.33% of the farmers had one form of formal education or the other. Most of the yam farmers had secondary education. Illiteracy and lack of education poses significant constraints to agricultural productivity in sub-Saharan Africa. According to [19] and [20], farmers who are educated formally are more likely to adopt modern agricultural innovations in order to increase overall productivity than their less educated counterparts. Moreover, apart from being early innovators that provide examples that may be copied by illiterate farmers, educated farmers are better able to copy those who adopt innovation, thereby enhancing wider diffusion of the new technology in the community [21].

Most of the respondents had a lot of experience in farming. Over 90% of the farmers had more than ten years farming experience. [22] indicated that length of time of farming business can be linked to the age of farmers, access to capital and experience in farming may explain the tendency to adopt innovations and new technology. All farmers sampled had contact with extension in one way or the other.

The economic losses to farmers in monetary terms, as a result of yam beetle attack on their farms are presented in Table 2. The result indicated that majority of the respondents incurred minimal losses in their farms. For instance, whereas as much as 40.9% of the respondents incurred losses of only N10000 and below, only about 0.9% of them incurred losses of more than N50000. The reason adduced for this was probably due to the fact that most of the respondents had adopted some strategies in one way or the other to combat yam beetle attack.

The various coping strategies adopted by yam farmers is presented in Table 3. The result shows that most of the farmers (98.2%) adopted the use of multiple cropping in combating the menace of yam beetle. This was followed by the adoption of late planting (92.9%) and agrochemicals (55.1%). Most of the yam farmers feel that multiple cropping (i.e. growing different crops on the same piece of land at the same time) serves as insurance for them against crop failure. Late planting of yam was adopted by most of the yam farmers as this helps the farmers' yams to escape attack of the pest. Some farmers also use agrochemicals like Aldrin dust or Gammalin 20 to dust their yams before planting. However, in view of the deleterious nature of most of these agrochemicals, their usage by yam farmers is dwindling.

### 3.2 Effectiveness of the Coping Strategies Adopted By Farmers

The effectiveness of the various coping strategies adopted by farmers is as shown in Table 4. From Table 4 it is obvious that, according to the respondents, the use of agrochemicals (mean = 4.79) was the most effective coping strategy adopted by farmers in the study area. This was followed by late planting (mean = 4.68) and multiple cropping (mean = 4.0). [23] reported that the use of insecticide was very effective in the control of yam beetle.

### 3.3 Relationship between Socioeconomic Variables and Coping Strategies of Farmers

A regression analysis was run to determine the influence of some selected socioeconomic characteristics on coping strategies of farmers; the variables included farmers' gender, age, marital status, educational level, farming experience, household size and farm size. Coping strategy was the dependent variable and was not categorized neither was it dichotomized since there was no farmer who did not use one way or the other to cope with the menace of yam beetle. Hence binary logit or multinomial logit were not employed in the regression analysis [24]. The model fitted the data (Chi-square of 89.1; $P<0.01$) and indicated that all parameters considered were different from zero (Table 5). Five factors had significant influences on the adoption of coping strategies by farmers. Table 5 shows that with the exception of gender, marital status and household size, all other factors were statistically significant at $P \leq 0.05$, indicating that they influenced respondents' adoption of coping strategy. Farming experience positively affected the adoption of coping strategies ($P<0.05$).

**Table 1. Socio-economic characteristics of respondents**

| Variable | Frequency (225) | Percentage (100%) |
|---|---|---|
| **Gender** | | |
| Male | 110 | 48.89 |
| Female | 115 | 51.11 |
| **Age** | | |
| 20 – 30 years | 13 | 5.78 |
| 31 – 40 years | 65 | 28.89 |
| 41 – 50 years | 105 | 46.67 |
| 51 – 60 years | 36 | 16.00 |
| 61 and above | 6 | 2.67 |
| **Marital status** | | |
| Single | 28 | 12.44 |
| Married | 172 | 76.44 |
| Widowed | 14 | 6.22 |
| Divorced | 11 | 4.89 |
| **Educational background** | | |
| No formal | 15 | 6.67 |
| Primary school | 56 | 24.89 |
| Secondary school | 134 | 59.56 |
| Tertiary education | 20 | 8.89 |
| **Farming experience** | | |
| 1 – 10 years | 22 | 9.78 |
| 11 – 20 years | 68 | 30.22 |
| 21 – 30 years | 98 | 43.56 |
| 31 years and above | 37 | 16.44 |
| **Household size (number)** | | |
| 1 -5 | 94 | 41.78 |
| 6 – 10 | 131 | 58.22 |
| **Farm size (ha)** | | |
| 2 and below | 178 | 79.11 |
| Above 2 | 47 | 20.89 |
| **Extension agent contact** | | |
| Monthly | 23 | 10.22 |
| Weekly | 14 | 6.22 |
| Others | 188 | 83.56 |

*Source: Field survey, 2014*

**Table 2. Economic losses to yam farmers due to yam beetle attack**

| Economic loss (Naira/ha) | Frequency | Percentage |
|---|---|---|
| Above 50000 | 2 | 0.9 |
| 40001- 50000 | 6 | 2.7 |
| 30001- 40000 | 6 | 2.7 |
| 20001- 30000 | 55 | 24.4 |
| 10001- 20000 | 64 | 28.4 |
| 10000 and below | 92 | 40.9 |

*Source: Field survey, 2014*

**Table 3. Coping strategies adopted by yam farmers**

| Strategy | Frequency* | Percentage |
|---|---|---|
| Use of agro chemical | 124 | 55.1 |
| Late planting | 209 | 92.9 |
| Fallowing | 12 | 5.3 |
| Alternative cropping | 56 | 24.9 |
| Multiple cropping | 221 | 98.2 |

*Source: Field survey, 2014*
** Frequency greater than 100 due to multiple responses*

**Table 4. Effectiveness of various coping strategies against yam beetle**

| Strategy | Mean | Standard deviation | Rank of mean |
|---|---|---|---|
| Use of agrochemical | 4.79 | 0.51 | 1st |
| Late planting | 4.68 | 0.73 | 2nd |
| Multiple cropping | 4.01 | 0.66 | 3rd |
| Alternative cropping | 2.94 | 0.59 | 4th |
| Fallowing | 2.42 | 0.81 | 5th |

*Source: Field survey, 2014*
*Likert scale: 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree*

**Table 5. Relationship between socioeconomic variables and coping strategies of farmers**

| Characteristic | B | Standard error | T | p-value |
|---|---|---|---|---|
| Constant | 1.754 | 1.988 | 0.842 | 0.192 |
| Gender | -0.467 | 0.911 | 0'766 | 0.546 |
| Age | -0.094 | 0.041 | 3.988 | 0.002* |
| Marital status | 0.045 | 0.033 | 0.997 | 0.422 |
| Educational level | 0.512 | 0.042 | 3.124 | 0.031* |
| Farming experience | 0.433 | 0.051 | 3.222 | 0.038* |
| Household size | 0.866 | 0.085 | 0.688 | 0.450 |
| Farm size | 0.474 | 0.422 | 2.946 | 0.044* |

*Source: Field survey, 2014;*
**Significant at P< 0.05*

This means that farmers with many years of experiences in agriculture were the major adopters of coping strategies against yam beetle. The level of education also positively affected farmers' decision to adopt coping strategy ($P$<0.05). Thus, farmers who are highly educated were more amenable to adopt various coping strategies. There was a positive and significant relationship between coping strategy and farm size of farmers. Extension services played a key role in the mechanism of diffusion and adoption. All farmers in the study area were exposed in one way or the other to extension services, and this could help the farmer to obtain relevant information on coping strategies against yam beetle. This result is corroborated by findings of [25] and [24], who asserted that extension had a positive impact on the adoption and the diffusion of agricultural practices.

## 4. CONCLUSION AND RECOMMENDATION

Empirical evidence from the study indicated that the yam farmers in the study area employed various strategies to cope with the menace of yam beetle in their farms. However, the farmers made lesser use of agrochemicals in spite of the fact that agrochemicals were rated by the respondents as the most effective means of combating yam beetles. It was also observed that some socioeconomic variables like age, educational level, farming experience and farm size influence coping strategies adopted by farmers. The implication of these findings for food security was that yam production in Delta State is likely to improve, thereby leading to increase in food supply in the area. However, from the findings of the study, the following recommendations are made:

1. The cost of agrochemicals for controlling yam beetle should be reduced to encourage yam farmers to use them.
2. Since education is crucial to the adoption of coping strategy, farmers should be trained on the need of using effective coping strategies.

When these measures are instituted, this will go a long way in boosting yam production in the area, thus improving food security in the state.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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