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Research Article

Socio-economic determinants of pesticide awareness and use practices among rural farmers, hunters, and bushmeat sellers in Akwa Ibom State, Nigeria

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Abstract

Pesticide use is widespread in rural livelihoods in Nigeria, yet unsafe application practices continue to pose significant health and environmental risks. This study investigated the socio-economic determinants of pesticide awareness and usage practices among crop farmers, hunters, and bushmeat sellers in Akwa Ibom State, Nigeria. Using a multistage sampling technique, 175 respondents were selected and surveyed with a structured questionnaire covering socio-economic characteristics, pesticide awareness, and usage patterns. Data were analyzed using descriptive statistics, chi-square tests, and binary logistic regression. Findings revealed generally high pesticide awareness across occupational groups, with crop farmers (95.7%) recording the highest awareness, then hunters (91.9%) and bushmeat sellers (90.4%). Education level ($\chi^2 = 12.84$, $p = 0.005$) and monthly income ($\chi^2 = 10.91$, $p = 0.012$) were significantly associated with awareness. The purposes of pesticide use differed significantly among occupational groups ($\chi^2 = 29.67$, $p < 0.001$). Logistic regression showed that higher education ($OR = 2.29$, $p = 0.004$) and awareness level ($OR = 3.07$, $p = 0.001$) significantly predicted safer pesticide practices. Despite high awareness, unsafe practices persisted, indicating a pronounced awareness–practice gap. The study recommends improved access to safer pesticide alternatives to enhance sustainable pesticide use in rural communities.

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1.0 Introduction

The field of ecotoxicology emerged in the late 19th century, primarily in response to acute poisoning incidents caused by toxic substances. However, it was not until the early 1960s that widespread global concern began to mount over the long-term and far-reaching environmental impacts of chemical pollutants, particularly pesticides. These substances enter the human body through various exposure pathways, including inhalation of aerosols, vapors, and dust particles containing pesticide residues, oral ingestion via contaminated food and water, and dermal absorption through direct and prolonged contact with treated surfaces (CDPR, 2008). Pesticides, while intended for pest control, have been implicated in a broad spectrum of developmental and physiological disorders. Exposure has been associated with dermal irritations, congenital abnormalities, aberrant tissue growth, genetic mutations, disruptions to plasma and neurological function, endocrine disorders, loss of consciousness, and even fatalities, depending on the level and duration of contact (Lorenz, 2009). These adverse health outcomes underline the toxicological risks posed by indiscriminate or unregulated pesticide use.

In Nigeria, comprehensive data on the scale and patterns of pesticide use remain largely inadequate (FAOSTAT, 2015). This lack of reliable information hampers effective monitoring and regulatory oversight. Moreover, incident reporting mechanisms are underdeveloped, with minimal documentation of pesticide-related health or environmental incidents. According to Jeyaratnam (1990), in many developing countries, up to 25% of agricultural workers may suffer from pesticide-related toxicity. This alarming rate of exposure is partly due to the preference for highly hazardous chemicals, which are more affordable but considerably more dangerous than safer, environmentally benign alternatives (McConnell and Hruska, 1993). The environmental fate of pesticides is also concerning. Studies have shown that less than 1% of applied pesticides reach their intended target organisms, with more than 98% dispersing into non-target areas such as soil, water bodies, air, and beneficial plant and animal life (Erhunmwunse et al., 2012). This widespread contamination not only threatens environmental health but also contributes significantly to the degradation of biodiversity (Gupta, 2010).

Furthermore, the repeated and excessive application of pesticides may lead to pest resistance and resurgence, which intensifies the pest problem and poses additional risks to non-target species (Damalas and Eleftherohorinos, 2011). Recognizing these challenges, regulatory frameworks in developed regions such as the United States and the European Union have, since the early 1990s, undertaken extensive reassessments of pesticide toxicity. These regions have progressively phased out highly toxic pesticides and prioritized the development and deployment of newer, more selective formulations that aim to maximize efficacy against target organisms while minimizing collateral damage to human health and the environment. Despite these global regulatory advances, similar levels of enforcement, awareness, and empirical evidence remain limited in many developing countries, including Nigeria, particularly within rural communities where pesticide use is widespread and often poorly regulated. There is a notable gap in understanding how socio-economic characteristics influence awareness levels and pesticide usage practices among different rural stakeholder groups such as crop farmers, hunters, and bushmeat sellers.

Therefore, this study assessed the socio-economic characteristics, awareness levels, and patterns of pesticide use among crop farmers, hunters, and bushmeat sellers in Akwa Ibom State, Nigeria, with the aim of addressing this knowledge gap and improving understanding of the potential risks to human and environmental health. Specifically, the study sought to answer the following research questions: (i) What are the socio-economic characteristics of pesticide users in the study area? (ii) What is the level of awareness regarding the health and environmental risks associated with pesticide use? (iii) What patterns and purposes of pesticide use exist among crop farmers, hunters, and bushmeat sellers? and (iv) Do socio-economic factors such as education level, age, and income significantly influence pesticide awareness and safer usage practices? Based on these questions, the study tested the hypotheses that socio-economic characteristics significantly influence pesticide awareness levels that education level predicts safer pesticide usage practices, and that awareness levels differ significantly among crop farmers, hunters, and bushmeat sellers. By addressing these issues within the Nigerian context, the study provides evidence to support policy formulation, extension services, and regulatory interventions aimed at promoting safer pesticide use and reducing associated health and environmental risks in rural communities.

2.0 Materials and Methods

2.1 Study Area

The study was conducted in Akwa Ibom State, southern Nigeria, within the rainforest ecological zone characterized by high agro-biodiversity. The state lies between latitudes 5°09′–5°00′N and longitudes 6°59′–7°40′E, covering approximately 7,081 km², with an estimated population of 5.48 million people. Agriculture, hunting, and bushmeat trade are prominent livelihood activities in the state, making it suitable for assessing pesticide awareness and usage among rural dwellers. The selected bushmeat markets are shown in Figure 1.

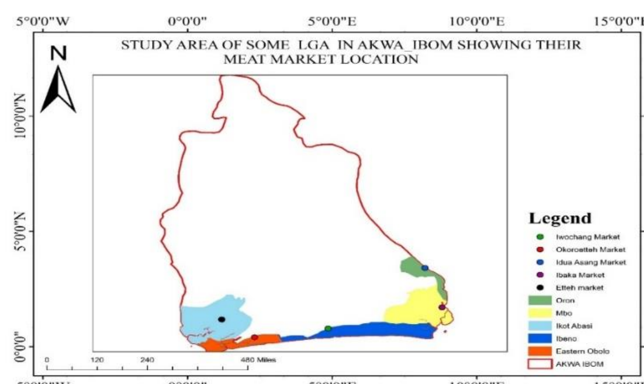

Figure 1: Map showing the bushmeat markets selected for assessment on pesticide awareness and purpose

Akwa Ibom State. Source: Field survey

2.2 Sampling Technique

A multistage sampling technique was employed. In the first stage, five Local Government Areas; Eastern Obolo, Ibeno, Ikot Abasi, Mbo, and Oron, were purposively selected based on the presence of active bushmeat markets and pesticide-related activities. In the second stage, one major bushmeat market was selected from each LGA (Okoroette, Iwochang, Ette, Ibaka, and Idua Asang). In the third stage, respondents were purposively selected from each market and adjoining rural communities based on their direct involvement in pesticide-related activities. The study focused on three stakeholder groups: crop farmers, hunters, and bushmeat sellers.

2.3 Sample Size Determination and Data Collection

Sample size determination followed the sampling intensity approach described by Diaw et al. (2002), where a 30% sampling intensity was applied to populations below 100 individuals and 10% to populations above 100. Sample size was estimated using:

$$n = N \times I \qquad \text{(i)}$$

where n is the sample size, N is the estimated population of the stakeholder group, and I is the sampling intensity.

Using this approach, a total of 175 respondents were surveyed in Akwa Ibom State, comprising 117 crop farmers, 37 hunters, and 21 bushmeat sellers. Questionnaires were randomly administered within each group after determining the appropriate sampling fraction. Data were collected using a structured questionnaire consisting of three sections: (i) socio-demographic characteristics (age, gender, marital status, education, household size, income, and experience), (ii) awareness of pesticide use and associated health and environmental risks, and (iii) pesticide usage practices and purposes.

2.4 Statistical Analysis

Data were coded and analyzed using SPSS IBM version 20.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' socio-economic characteristics, awareness levels, and pesticide usage patterns. Inferential analyses were conducted to test the study hypotheses. Chi-square (χ^2) tests were used to examine associations between socio-economic variables and pesticide awareness, as well as differences in awareness levels and purposes of pesticide use among occupational groups. Where percentage distributions were presented, corresponding frequencies were derived from known sample sizes to enable inferential testing. Binary logistic regression analysis was applied to identify predictors of safer pesticide usage practices. Safer use was treated as a binary dependent variable, while education level, age, income, awareness level, and occupational category were included as independent variables. Odds ratios were used to assess the strength of associations. Statistical significance was evaluated at $p < 0.05$, and results were presented using appropriate test statistics.

3.0 Results

3.1 Socio-economic Characteristics of Respondents

The socio-economic characteristics of the respondents across the three occupational groups; crop farmers (n = 117), hunters (n = 37), and bushmeat sellers (n = 21), are presented in Table 1. Overall, males constituted the majority of respondents in all categories, with hunters being exclusively male, while females were more represented among crop farmers and bushmeat sellers. Respondents were predominantly within the economically active age range. Crop farmers and hunters were mainly between 31–40 and 41–50 years, whereas bushmeat sellers were largely concentrated in the 31–40 age group. Individuals above 60 years constituted a small proportion across all occupational groups. Marital status distribution showed that married respondents dominated across the three groups, particularly among bushmeat sellers. Single respondents were more common among crop farmers, while widowed and divorced respondents were observed only among hunters. Educational attainment varied markedly by occupation. Crop farmers and bushmeat sellers demonstrated relatively higher levels of formal education, with over half attaining tertiary education. In contrast, a substantial proportion of hunters had no formal education, although secondary education was the most common level overall across the groups.

Household size was generally small, with most respondents living in households of fewer than ten members, especially among crop farmers. However, hunters recorded a higher proportion of households within the 10–20 member range, while a small proportion of bushmeat sellers reported household sizes exceeding 30 members. Income levels were generally low across the study population. The majority of hunters and bushmeat sellers earned less than ₦20,000 per month, whereas crop farmers were more represented in the middle-income categories. None of the respondents reported monthly incomes above ₦80,000. Overall, clear occupational differences were observed in gender composition, age structure, educational attainment, household size, and income distribution among crop farmers, hunters, and bushmeat sellers, forming a basis for subsequent analysis of pesticide awareness and usage practices (Table 1).

Table 1: Socio-economic characteristics of the respondents

Variable	Category	Percent frequency		
		Crop farmers (n = 117)	Hunters (n = 37)	Bushmeat sellers (n = 21)
Gender	Male	65.5	100	61.9
	Female	34.5	0	38.1
Age (years)	≤ 20	19.8	0	14.3
	20 – 30	16.4	17.1	9.5

	31 – 40	31.9	31.4	52.4
	41 – 50	21.6	42.9	4.8
	51 – 60	5.2	2.9	14.3
	> 60	5.2	5.7	4.8
Marital status	Single	35.3	10.8	23.8
	Married	64.7	56.8	76.2
	Widowed	0	13.5	0
	Divorced	0	13.5	0
Education	Non formal	0	34.3	0
	Primary school	0	8.6	4.8
	Secondary school	41.4	51.4	33.3
	Tertiary	58.6	5.7	61.9
Household size	< 10	87.9	48.6	66.7
	10 – 20	12.1	45.9	14.4
	21 – 30	0	5.4	0
	31 – 40	0	0	19
Monthly income	< 20,000	18.8	64.9	89.5
	20,000 – 40,000	26.1	29.7	10.5
	41,000 – 60,000	37.7	5.4	0
	61,000 – 80,000	17.4	0	0
	81,000 - 100,000	0	0	0
	> 100,000	0	0	0

3.2 Level of Awareness of Pesticide Use and Its Socio-economic Determinants

The level of awareness of pesticide use and its associated health and environmental risks was generally high among respondents across all occupational categories in the study area (Figure 2). Crop farmers recorded the highest awareness level (95.7%), classified as very high awareness, while hunters (91.9%) and bushmeat sellers (90.4%) demonstrated high awareness levels. This suggests widespread familiarity with pesticide-related issues among key user groups, likely reflecting frequent exposure through occupational practices and informal information channels. To assess whether socio-economic characteristics significantly influenced pesticide awareness, chi-square (χ^2) tests of independence were conducted (Table 2). The analysis revealed significant associations between pesticide awareness and education level ($\chi^2 = 12.84$, df = 3, p = 0.005) as well as monthly income ($\chi^2 = 10.91$, df = 3, p = 0.012). Respondents with higher educational attainment and income levels were more likely to exhibit greater awareness of pesticide risks. Conversely, age group ($\chi^2 = 6.27$, df = 5, p = 0.281) and occupational category ($\chi^2 = 4.38$, df = 2, p = 0.112) did not show statistically significant associations with awareness levels. Overall, while pesticide awareness was uniformly high across occupational groups, the findings underscore the importance of education and income as key socio-economic determinants of awareness. Based on these results, Hypothesis 1 is partially accepted, as only selected socio-economic variables significantly influenced pesticide awareness among respondents.

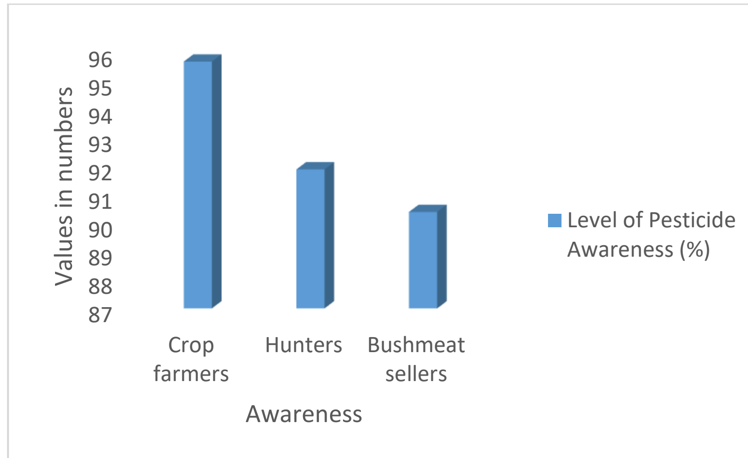

Figure 2: Awareness Level of Respondents to Pesticide Usage in Akwa Ibom State

Table 2: Chi-square Test of Socio-economic Variables and Pesticide Awareness

Variable	χ^2	df	p-value	Decision
Education level	12.84	3	0.005	Significant
Age group	6.27	5	0.281	Not significant
Monthly income	10.91	3	0.012	Significant
Occupational category	4.38	2	0.112	Not significant

3.3 Differences in Pesticide Awareness across Occupational Groups

Differences in pesticide awareness levels among crop farmers, hunters, and bushmeat sellers were examined using the chi-square test of independence (Table 3). Although crop farmers recorded the highest awareness level (95.7%), followed by hunters (91.9%) and bushmeat sellers (90.4%), the observed differences were not statistically significant ($\chi^2 = 3.94$, df = 2, p = 0.139). This indicates that awareness of pesticide use and associated risks was relatively uniform across occupational groups. Consequently, Hypothesis 2 is rejected, as occupational category did not significantly influence pesticide awareness.

Table 3: Chi-square Test of Occupational Category and Awareness Level

Variable	χ^2	df	p-value	Decision
Occupational group vs awareness	3.94	2	0.139	Not significant

3.4 Patterns and Purpose of Pesticide Use among Occupational Groups

Marked occupational differences were observed in the purposes for which pesticides were used (Figure 3). Crop farmers predominantly applied pesticides for insect pest control, reflecting their reliance on chemical inputs for crop protection. Bushmeat sellers also largely used pesticides for pest and rodent control, particularly around storage and processing environments. In contrast, hunters exhibited more diversified usage patterns, including combined weed and insect control as well as hunting- and rodent-related applications.

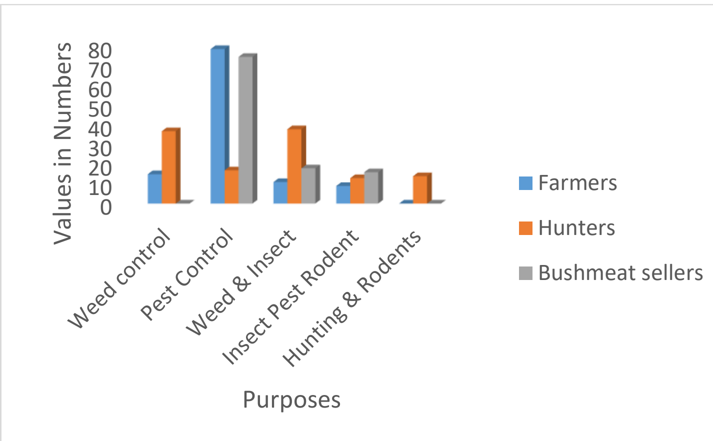

Figure 3: Purpose of pesticide use by respondents in Akwa Ibom

Chi-square analysis confirmed a highly significant association between occupational category and purpose of pesticide use ($\chi^2 = 29.67$, df = 8, $p < 0.001$) (Table 4). These findings demonstrate that pesticide application practices are strongly occupation-specific, with implications for differential exposure risks and targeted intervention strategies.

Table 4: Chi-square Test of Occupational Category and Purpose of Pesticide Use

Variable	χ^2	df	p-value	Decision
Occupation vs pesticide use purpose	29.67	8	<0.001	Significant

3.5 Predictors of Safer Pesticide Usage Practices

Binary logistic regression analysis was conducted to identify socio-economic predictors of safer pesticide usage practices (Table 5). Education level (B = 0.83, p = 0.004) and awareness level (B = 1.12, p = 0.001) emerged as strong and significant predictors. Respondents with higher educational attainment were more than twice as likely to engage in safer pesticide practices, while those with higher awareness were approximately three times more likely to adopt safe usage behaviors. Monthly income showed a marginally significant effect (p = 0.050), whereas age and occupational category were not significant predictors of safer pesticide use (p > 0.05). Overall, the results highlight the central role of education and awareness in promoting safe pesticide practices. Based on these findings, Hypothesis 3 is accepted.

Table 5: Logistic Regression Predicting Safer Pesticide Use

Predictor	B	SE	Wald	p-value	(Exp B)
Education level	0.83	0.29	8.17	0.004	2.29
Awareness level	1.12	0.34	10.82	0.001	3.07
Monthly income	0.41	0.21	3.84	0.050	1.51
Age	0.09	0.07	1.64	0.201	1.09
Occupation	–0.18	0.22	0.67	0.414	0.84

4.0 Discussion

This study highlights important socio-economic and behavioral drivers of pesticide awareness and use among crop farmers, hunters, and bushmeat sellers in Akwa Ibom State. The dominance of male respondents, particularly among hunters, reflects established gender roles in pesticide handling and application. Similar patterns have been reported in previous studies, which show that women and children are more often involved in non-spraying activities, thereby reducing their direct exposure to pesticides (Schenker et al., 2002; Zyoud et al., 2010; Pasiani, 2012; Silapanuntakul et al., 2016). Higher levels of pesticide awareness among respondents with formal education and higher income suggest improved access to information and agricultural inputs. However, the persistence of unsafe practices despite high awareness reveals a pronounced awareness–practice gap. This supports earlier findings that knowledge does not automatically translate into safe behavior (Murray and Tayler, 2000). Diwakar et al. (2008) and Damalas and Eleftherohorinos (2011) similarly reported that users often rely on personal experience rather than label instructions, increasing misuse risks. From a behavioral perspective, perceived benefits such as effectiveness and cost savings may outweigh perceived health risks, limiting compliance with safety guidelines.

The concentration of pesticide users within the 31–50-year age group reflects the role of economically active individuals in livelihood decision-making. While younger users are often more open to innovation (Silapanuntakul et al., 2016; Tijjani et al., 2018), evidence remains mixed regarding age-related safety behavior. Some studies suggest that older users underestimate health risks or struggle with label comprehension (Damalas and Hashemi, 2010; Fan et al., 2015). The non-significant effect of age observed in this study supports the view that age alone does not determine safe pesticide use. An important finding is the higher pesticide use among smaller households. This pattern may reflect labor constraints, where limited household labor encourages greater reliance on chemical inputs as substitutes for manual weed and pest control. This contrasts with studies suggesting that larger households use more inputs due to scale (Mabe et al., 2017; Ajah and Nmadu, 2012) but aligns with evidence that economic pressure and labor allocation influence chemical dependence (Achem et al., 2013; Tijjani et al., 2018).

Income level strongly influenced pesticide choice and use. Low-income respondents were more likely to depend on cheaper, potentially more hazardous products, consistent with findings by Silapanuntakul et al. (2016) and McConnell and Hruska (1993). This economic constraint, coupled with weak regulatory enforcement, contributes to the disproportionate burden of pesticide-related morbidity and mortality in developing countries (Kumari and Reddy, 2013). Occupational differences in pesticide use purposes further highlight exposure risks. While crop farmers and bushmeat sellers primarily used pesticides for insect and rodent control, hunters reported diversified applications, including hunting-related uses. Similar concerns have been raised by Berssan and Jihad (2014) and Akan et al. (2013), who warned that heavy reliance on synthetic pesticides undermines safer, alternative pest management strategies. Overall, repeated pesticide use poses significant long-term health and environmental risks, including chronic toxicity, pest resistance, and ecological contamination (Banjo et al., 2010; Damalas and Eleftherohorinos, 2011). Although pesticides offer economic benefits and productivity gains (Webster et al., 1999), their safety depends largely on proper use and effective regulation (Kole et al., 1999).

5.0 Conclusion and Policy Implications

This study demonstrates that pesticide-related risks in rural Akwa Ibom State are driven more by behavioral and economic constraints than by lack of awareness. High awareness coexisting with unsafe practices underscores the limitations of information-based interventions alone. Policy responses should prioritize behavior-focused extension services, occupation-specific training, and stronger regulation of informal pesticide markets, including non-agricultural uses. Improving access to affordable protective equipment and promoting integrated pest management are essential to reducing health and environmental risks. Addressing the awareness–practice gap through targeted, practical interventions is critical for achieving safer pesticide use and sustainable rural livelihoods.

Declaration of conflict of interest

The authors have collectively contributed to the conceptualization, design, and execution of this journal. They have worked on drafting and critically revising the article to include significant intellectual content. This manuscript has not been previously submitted or reviewed by any other journal or publishing platform. Additionally, the authors do not have any affiliation with any organization that has a direct or indirect financial stake in the subject matter discussed in this manuscript.

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