Assessment of Agrochemical Usage, Health Risk Awareness, and Occupational Exposure Outcomes among Smallholder Farmers in Osara, Kogi State, Nigeria

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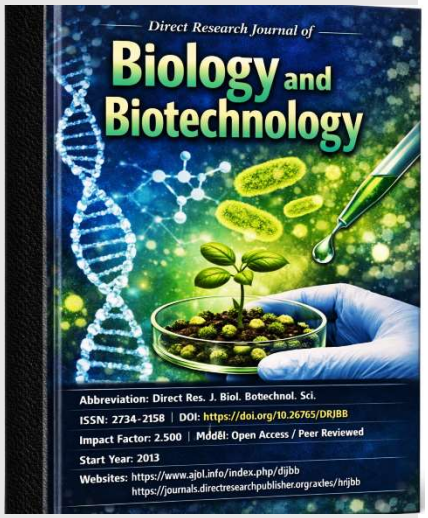
ABSTRACT

Agrochemical use has become an essential component of modern smallholder farming systems in Nigeria; however, inadequate knowledge and unsafe handling practices continue to pose serious occupational health and environmental risks. This study assessed farmers' socio-demographic characteristics, agrochemical usage patterns, awareness of associated health and environmental risks, sources of safety information, and reported health outcomes. A cross-sectional survey design was adopted, and data were collected from 60 farmers using a structured questionnaire covering socio-demographic variables, frequency and type of agrochemical use, risk awareness, information sources, and self-reported health effects. Descriptive statistics were used for data analysis. Results showed that the majority of respondents were male (80.0%) and within the age range of 25–44 years (60.0%), while most had primary or secondary education (63.3%) and operated farms between 1–3 hectares (53.3%) Agrochemical use was widespread, with chemical fertilizers being the most frequently applied input (66.7% weekly), followed by insecticides (40.0% weekly) and herbicides (36.7% weekly). Awareness levels varied, with higher knowledge of acute toxicity (66.7%) compared to chronic health effects (40.0%). The predominant sources of agrochemical information were fellow farmers (60.0%) and agrochemical vendors (46.7%), while extension services and formal training were less utilized (26.7% and 16.7%, respectively). Reported health outcomes included skin irritation/rashes (53.3%), gastrointestinal problems (33.3%), respiratory symptoms (30.0%), and chronic conditions (10.0%). The study concludes that despite widespread agrochemical use, farmers exhibit significant gaps in risk awareness and rely heavily on informal information sources, contributing to reported health complaints. Strengthening agricultural extension services, promoting structured safety training, and improving access to protective equipment are recommended to reduce occupational exposure and enhance sustainable agricultural productivity.

Keywords: *Agrochemicals, farmers, occupational health, pesticide exposure, Nigeria, safety awareness*



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INTRODUCTION

The increasing demand for food production, coupled with declining soil fertility and shrinking arable land, has intensified the use of agrochemicals such as fertilizers, herbicides, and pesticides as essential inputs for sustaining agricultural productivity, particularly in developing countries (Bhatia & Sindhu, 2024; Sande et al., 2024; Parven et al., 2025). In Nigeria, the adoption of agrochemical inputs has intensified as farmers seek to enhance crop yields, control weeds and pests, and improve overall farm efficiency. Although the use of these inputs contributes significantly to food security and agricultural commercialization, growing evidence indicates that their widespread and often indiscriminate application poses substantial environmental, occupational, and public health risks (Udoekpo et al., 2024; Venugopal et al., 2025). Recent studies have reported the persistence of pesticide residues in agricultural soils and food systems, raising concerns regarding ecosystem contamination and long-term human exposure (Udoekpo et al., 2024). Furthermore, research has shown that many smallholder farmers continue to apply agrochemicals without adequate knowledge of recommended safety procedures, resulting in unsafe handling, poor disposal practices, and limited use of personal protective equipment (Oshingbade et al., 2025; Yami et al., 2025). These challenges are exacerbated by weak regulatory enforcement, inadequate extension services, and limited access to training on safe agrochemical use (Adeola et al., 2025). Consequently, farmers and rural communities remain vulnerable to acute and chronic health effects associated with agrochemical exposure, while environmental sustainability is increasingly threatened by soil degradation, water contamination, and biodiversity loss (Venugopal et al., 2025). Understanding the drivers of agrochemical use and the factors influencing farmers' safety practices is therefore essential for developing sustainable agricultural policies that balance productivity goals with environmental protection and human health considerations (Yami et al., 2025; Adeola et al., 2025).

The widespread use of agrochemicals without adequate awareness of their potential health and environmental hazards continues to represent a significant challenge in agricultural production systems, particularly among smallholder farmers in developing countries. Evidence suggests that insufficient knowledge of safe handling practices, limited use of personal protective equipment, and poor adherence to recommended application guidelines increase farmers' vulnerability to agrochemical-related health problems and environmental contamination (Oshingbade et al., 2025; Yami et al., 2025). This situation underscores a critical gap in agricultural health research and highlights the need for comprehensive assessments of farmers' knowledge, agrochemical use patterns, and health-related experiences. Understanding these dynamics is essential for developing evidence-based interventions, strengthening extension services, and promoting safer agrochemical management practices that safeguard both human health and sustainable agricultural productivity (Apeh, 2018; Olowogbona et al., 2021; Yusha'u et al., 2023; Zhang et al., 2018; Adeola et al., 2025; Venugopal et al., 2025). Therefore, this study investigates the socio-demographic characteristics of farmers, their agrochemical application practices, their awareness of associated health risks, and the sources of information that influence their safety behaviors.

MATERIALS AND METHODS

Study Design and Population Sampling

This study employed a **cross-sectional survey design**, consistent with similar agricultural health research conducted among farmers in Nigeria (Apeh, 2018). To capture a comprehensive profile of agrochemical use and awareness, a multi-stage sampling strategy was applied. First, farming communities known for active crop production were purposively selected. Next, individual farmers within each community were selected using simple random sampling from farmers' lists provided by local extension offices. This approach mirrors methods used in studies examining farmers' agrochemical practices and health awareness in the Toro and Bauchi regions (Ibrahim, 2019). The sample size was determined to ensure adequate statistical representation while reflecting the scale typically used in related Nigerian farming studies.

Data Collection Instruments and Procedures

Data were collected using a **structured questionnaire** administered through face-to-face interviews. The questionnaire covered five key domains: socio-demographic characteristics, the type and frequency of agrochemical usage, awareness of health risks associated with agrochemical exposure, sources of safety information, and self-reported health outcomes. This instrument design is aligned with prior studies which developed similar questionnaires to assess agrochemical knowledge and practices among rural farmers in Southeast Nigeria (Okeke & Nwankwo, 2017). Questions were pre-tested on a small subset of farmers in nearby communities to confirm clarity, ensure cultural sensitivity, and refine response options.

Training and Ethical Considerations

Enumerators received training on ethical consent protocols, question administration, and strategies for minimizing response bias. Ethical approval was obtained from a recognized institutional review board, and

informed consent was secured from all participants before data collection began. Farmers were assured of confidentiality and anonymity, following ethical procedures used in comparable agrochemical perception studies (Adeoye et al., 2019).

Data Management and Analysis

Completed questionnaires were reviewed daily for completeness and consistency. Data were coded and entered into statistical software (e.g., SPSS) for analysis. Descriptive statistics including frequencies and percentages were calculated to summarize socio-demographic information and patterns of agrochemical use, consistent with analytical procedures in related research (Apeh, 2018). Where relevant, cross-tabulation and chi-square tests were used to examine relationships between demographic factors and levels of health risk awareness.

RESULTS

The results of the socio-demographic characteristics of the farmers are presented in Table 1. This table provides a detailed overview of the age distribution, gender composition, education levels, farming experience, and farm sizes among the sampled farmers. It shows that the majority of farmers fall within the 25–44 years age bracket, suggesting that farming is predominantly carried out by individuals in their prime working years. The male population significantly outnumbers females, reflecting gender dynamics in agricultural engagement. Education levels indicate that most farmers possess primary or secondary education, which may influence their access to agricultural information and adoption of modern practices. Farming experience varies, with a notable proportion having 11–20 years, highlighting the presence of experienced individuals. Farm sizes are mostly within 1–3 hectares, indicating small-scale farming operations. The table captures these patterns comprehensively, allowing readers to understand the demographic context of the sample and the potential implications for agricultural practices, resource allocation, and training interventions.

The results of the types and frequency of agrochemical usage among farmers are detailed in Table 2. This table illustrates the different agrochemical types used, including insecticides, herbicides, fungicides, chemical fertilizers, and pesticide mixtures. It highlights both the frequency of use and the number of farmers employing each chemical. For each agrochemical, weekly and occasional usage patterns are provided, reflecting the intensity and regularity of applications. The purposes of application are also captured, showing that insecticides and pesticide mixtures are primarily used for pest control, herbicides for weed management, fungicides for disease prevention, and fertilizers for crop growth. The table provides a comprehensive summary of the farmers' chemical management practices, indicating the level of reliance on various agrochemicals and highlighting trends in both conventional and mixed use. These results offer valuable insight into farmers' practices and potential exposure levels to different chemical agents, serving as a basis for planning safety measures and training programs.

The results of farmers' awareness of health implications associated with agrochemical exposure are captured in Table 3. This table categorizes awareness into 'Very Aware,' 'Aware,' and 'Not Aware' for multiple health indicators, including acute toxicity, chronic effects, chemical residues in products, and environmental impacts. It provides a clear quantification of farmers' knowledge regarding immediate and long-term health risks. Acute toxicity awareness is higher, suggesting familiarity with observable, short-term health effects, while understanding of chronic conditions and chemical residues is lower, indicating potential gaps in knowledge about prolonged exposure and food safety. Environmental impacts awareness is moderate, highlighting partial comprehension of ecological consequences. The table summarizes the degree of knowledge among farmers, allowing for an assessment of where educational interventions or awareness campaigns may be necessary. It provides an objective snapshot of knowledge levels

The results of the sources of information on agrochemical safety utilized by farmers are presented in Table 4. This table details the various channels through which farmers acquire knowledge on chemical safety, including extension services, fellow farmers or community knowledge, media outlets such as radio, TV, or social media, agrochemical vendors, and workshops or training programs. It quantifies the number of farmers relying on each source and the corresponding percentages, providing insight into the relative importance of each information channel. The table shows that community knowledge and peer interactions are the dominant sources, while formal training and extension services are less utilized. Media sources and agrochemical vendors serve as supplementary sources of information. The table captures these patterns clearly, offering a descriptive account of information flow among the sampled population. This provides a basis for targeting interventions, designing educational campaigns, and identifying underutilized channels for promoting safe practices.

The results of the reported health outcomes related to agrochemical exposure among farmers are detailed in Table 5. This table enumerates health effects such as skin irritation or rashes, respiratory issues, eye irritation or blurred vision, gastrointestinal problems, and chronic conditions, along with the number of affected farmers, percentages, and severity levels. Mild to moderate conditions like skin irritation and gastrointestinal problems are most commonly reported, whereas severe chronic

Table 1: Distribution of Respondents by Socio-Demographic Characteristics (n = 60).

Variable	Category	Frequency (n)	Percentage (%)
Age	<25	6	10.0
	25-34	16	26.7
	35-44	20	33.3
	45-54	12	20.0
	>=55	6	10.0
Gender	Male	48	80.0
	Female	12	20.0
Education Level	No formal	16	26.7
	Primary	20	33.3
	Secondary	18	30.0
	Tertiary	6	10.0
Farming Experience	<5 years	8	13.3
	5-10 years	18	30.0
	11-20 years	22	36.7
	>20 years	12	20.0
Farm Size	<1 ha	10	16.7
	1-3 ha	32	53.3
	4-6 ha	12	20.0
	>6 ha	6	10.0

Keys*: n = frequency of respondents; % = percentage of total respondents within each variable group; ha = hectares.*

Table 2: Types, Frequency, and Purpose of Agrochemical Use among Respondents (n = 60).

Agrochemical Type	Frequency of Use	Number of Farmers (n)	Percentage (%)	Purpose of Application
Insecticides	Weekly	24	40.0	Pest control
	Occasionally	36	60.0	Pest control
Herbicides	Weekly	22	36.7	Weed control
	Occasionally	38	63.3	Weed control
Fungicides	Monthly	32	53.3	Disease prevention
	Occasionally	28	46.7	Disease prevention
Fertilizers (chemical)	Weekly	40	66.7	Crop growth
	Occasionally	20	33.3	Crop growth
Pesticide mixtures	Occasionally	24	40.0	Multi-purpose pest control

Keys*: n = number of farmers reporting each usage pattern; % = percentage of total respondents; application frequency refers to the reported usual pattern of use.*

Table 3: Respondents' Awareness of Health and Environmental Implications of Agrochemical Exposure (n = 60).

Awareness Indicator	Very Aware (n)	Aware (n)	Not Aware (n)	Total Aware (%)
Acute toxicity	12	28	20	66.7
Chronic effects	6	18	36	40.0
Chemical residues in products	8	24	28	53.3
Environmental impacts	10	20	30	50.0

Legend: *n = number of respondents; Total Aware (%) = combined percentage of respondents who were either Very Aware or Aware for each indicator.*

Table 4: Sources of Information on Agrochemical Safety among Respondents (n = 60).

Source of Information	Number of Farmers (n)	Percentage (%)
Extension services/agricultural officers	16	26.7
Fellow farmers/community knowledge	36	60.0
Media (radio, TV, social media)	20	33.3
Agrochemical vendors	28	46.7
Workshops/training programs	10	16.7

conditions are less frequent, indicating that acute effects are more immediately observable by farmers. The table provides a structured account of both frequency and severity of health outcomes, offering a descriptive overview without inferring causality. It summarizes the prevalence of health complaints among farmers who use agrochemicals and serves as a basis for understanding potential health risks and prioritizing interventions, monitoring programs, and further research into occupational health safety.

Table 5: Reported Health Outcomes Associated with Agrochemical Exposure among Respondents (n = 60).

Health Outcome	Number of Farmers (n)	Percentage (%)	Severity
Skin irritation/rashes	32	53.3	Mild to moderate
Respiratory issues	18	30.0	Mild
Eye irritation/blurred vision	14	23.3	Mild
Gastrointestinal problems	20	33.3	Mild to moderate
Chronic conditions	6	10.0	Severe

Legend: *n = number of respondents reporting each health outcome; % = percentage of total respondents. Multiple health outcomes may apply.*

DISCUSSION

The findings of this study provide important insights into farmers' agrochemical use patterns, awareness of associated risks, sources of safety information, and health outcomes. The socio-demographic profile of respondents revealed that most farmers were between 35 and 44 years of age (33.3%), with males constituting 80.0% of the study population (**Table 1**). This age distribution suggests that agrochemical application is largely undertaken by economically active individuals who are actively engaged in crop production. The predominance of male farmers is consistent with findings reported by Adeola et al. (2025), who observed that pesticide-intensive farming activities in Nigeria remain largely male-dominated because men typically control larger farm holdings and undertake more physically demanding agricultural tasks. The relatively low proportion of respondents with tertiary education (10.0%) (Table 1) may partly explain the inadequate understanding of agrochemical hazards observed in this study. Previous studies have shown that educational attainment positively influences farmers' ability to understand product labels, comply with safety instructions, and adopt recommended protective measures (Oshingbade et al., 2025).

The widespread use of agrochemicals among respondents demonstrates the increasing dependence of smallholder farmers on chemical inputs to enhance agricultural productivity. Chemical fertilizers were the most frequently used agrochemicals, with 66.7% of respondents reporting weekly application, followed by insecticides (40.0%) and herbicides (36.7%) (Table 2). This finding reflects the growing pressure on farmers to improve crop yields under conditions of declining soil fertility, pest infestations, and increasing food demand. Similar patterns have been documented across sub-Saharan Africa, where chemical inputs have become essential components of agricultural intensification strategies (Sande et al., 2024). However, the frequent use of pesticides and fertilizer products raises concerns regarding cumulative environmental contamination and occupational exposure. Of particular concern is the finding that 40.0% of respondents reported using pesticide mixtures (Table 2). Similar practices have been reported by Yami et al. (2025), who noted that farmers often combine multiple pesticides to reduce labour costs and increase pest control effectiveness. Nevertheless, pesticide mixing can increase toxicological risks, alter chemical interactions, and elevate the likelihood of adverse health outcomes among users.

The results further revealed substantial gaps in farmers' awareness of agrochemical hazards. While 66.7% of respondents were aware of acute toxicity effects, awareness of chronic health implications was considerably lower (40.0%) (Table 3). This suggests that farmers are more familiar with immediate symptoms of poisoning than with long-term consequences arising from repeated exposure. Comparable findings were reported by Venugopal et al. (2025), who observed that farmers readily recognized symptoms such as skin irritation, headaches, dizziness, and respiratory discomfort but possessed limited knowledge of chronic conditions linked to prolonged agrochemical exposure. The low awareness of chronic health risks identified in this study may be attributed to inadequate training opportunities, poor dissemination of occupational health information, and limited interaction with agricultural extension services. Furthermore, only half of the respondents demonstrated awareness of environmental impacts (50.0%) and chemical residues in agricultural products (53.3%) (**Table 3**). This finding is consistent with evidence from recent studies indicating that environmental risk perception among smallholder farmers remains relatively low despite increasing concerns regarding pesticide contamination of soil, water resources, and food systems (Adeola et al., 2025).

An important finding of this study is the dominance of informal communication channels as sources of agrochemical safety information. The majority of respondents relied on fellow farmers (60.0%) and agrochemical vendors (46.7%), whereas only 26.7% obtained information from extension officers and 16.7% participated in formal training programmes (Table 4). This pattern reflects persistent weaknesses in agricultural extension delivery systems in many rural communities. Similar observations were reported by Yami et al. (2025; Ssekkadde et al., 2026), who found that peer networks and pesticide retailers frequently serve as the primary sources of agrochemical information among Nigerian farmers. Although such channels facilitate information exchange, they may also contribute to the spread of inaccurate or incomplete safety recommendations. Conversely, studies evaluating pesticide safety

interventions have demonstrated that structured training programmes significantly improve farmers' understanding of label instructions, hazard communication, safe storage practices, and personal protective equipment use (Oshingbade et al., 2025). Therefore, strengthening extension services and increasing access to farmer training programmes remain critical components of effective risk reduction strategies.

The health outcomes reported by respondents further highlight the potential consequences of inadequate agrochemical safety practices. Skin irritation and rashes were the most commonly reported symptoms (53.3%), followed by gastrointestinal problems (33.3%), respiratory issues (30.0%), and eye irritation (23.3%) (Table 5). These findings are consistent with a recent meta-analysis by Desye et al. (2024), which identified dermatological disorders, respiratory symptoms, headaches, and gastrointestinal disturbances as the most prevalent manifestations of occupational pesticide exposure among agricultural workers. The high prevalence of skin-related symptoms may be associated with direct dermal contact during mixing, spraying, and equipment cleaning operations, particularly where personal protective equipment is not consistently used. Similarly, respiratory symptoms may result from inhalation of pesticide aerosols during application. Although only 10.0% of respondents reported chronic conditions (**Table 5**), the true burden of long-term health effects may be underestimated because chronic illnesses often develop gradually and remain undiagnosed in resource-constrained rural settings. Recent reviews have emphasized that repeated low-dose agrochemical exposure may contribute to neurological disorders, endocrine dysfunction, reproductive abnormalities, and certain cancers, particularly in regions where regulatory oversight is weak and protective equipment use remains inconsistent (Venugopal et al., 2025, Parasram & Choudhury, 2026).

Conclusion

The study highlights that smallholder farmers in the surveyed area extensively use agrochemicals but exhibit limited awareness of associated health and environmental risks. Socio-demographic factors, reliance on informal information sources, and inadequate training contribute to unsafe practices and the prevalence of mild to severe health outcomes. It is recommended that targeted interventions, including structured educational programs, regular extension services, and accessible personal protective equipment, be implemented to improve farmers' knowledge and safety behaviours. Strengthening regulatory oversight and promoting community-based awareness campaigns will further mitigate health risks while sustaining agricultural productivity.

Conflict of Interest: None

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