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Adoption of Recommended Agrochemical Practices among Crop Farmers in Kaduna and Ondo States, Nigeria

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Abstract

This study assessed the level of adoption of recommended agrochemical practices among crop farmers in Kaduna and Ondo States of Nigeria. It measured the perception of farmers on pesticides and their knowledge on the harmful effects of pesticides. A total of 260 crop farmers who have sustained the use of agrochemicals for at least five years were selected for the study using a multi-stage sampling technique. Data were collected using pretested, structured interview schedule. Descriptive statistics (mean and percentages) were used for data analysis. The results obtained revealed that 33.1% of the farmers considered pesticides as always favorable (harmless) whereas 30% of the respondents perceived pesticides as sometimes unfavorable (harmful). All (100%) the respondents indicated that pesticides cause damage to human health. Furthermore, the level of adoption of recommended agrochemical practices (RAPs) was generally low (weighted mean =1.49) despite high level of awareness (weighted mean =2.24). This study recommends that campaign for attitudinal changes on the use of agrochemical should be mounted by extension agencies in collaboration with relevant stakeholders.

Key words: *Recommended agrochemical practices; Adoption; crop protection chemicals.*

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Introduction

Promoting agricultural development requires the introduction of innovations that emanates from science and technology embodied in crop protection chemicals (CPCs) for improved crop production. The introduction of these innovations into the agricultural practices of any nation holds the key to the development of the sector. The ability of the small-scale farmers to adopt these innovations becomes very crucial if the sector must continue to contribute to national earnings. However, adoption of the agrochemical is one; adopting the recommended practices is another issue altogether.

The CPCs that are particularly useful to farmers consist of different types of insecticides, fungicides, herbicides, rodenticides and nematicides available in the market. The other group

consists of seed treatment chemicals and growth regulators. In Nigeria, the strategy had always been to encourage the establishment of private agrochemical plants in the country or their importation by interested investors. The existing plants only re-formulate and package CPCs for sales.

There is widespread recognition that farmers misuse agrochemicals while protecting crops from incidences of pests, diseases and weeds. High incidence of pesticide misuse and unprecedented level of pesticides related accidents and their attendant consequences on the people's health is quite alarming (Food and Agriculture Organization, 1998; Abdullahi, 2008). Furthermore, available literature as well as field experiences from various practitioners indicate a demand-supply system that just emerged by chance, hence not perfect but characterized by adulteration, use of expired chemicals as well as inefficient use, improper storage habits, high retailing prices, and lack of safety measures (Akinyosoye, 2005). However, useful amount of work has been done by research institutes and extension agencies in providing information on research-based Recommended Agrochemical Practices (RAPs) (Laary, 2012; Zyoud *et al*, 2010; Asogwa and Dango, 2009; and Kishi, 2005).

In recent time also, there has been a steady increase in the amount of pesticides marketed for agricultural use. In the European Union alone, more than 200,000 tonnes of pesticides (active ingredients) are used annually (Eurostat statistical books, 2007). Between 2005 and 2010, the total volume of global sales rose from US$ 31 billion to US$ 38 billion (CropLife International, 2006 and 2010). The amount of pesticides used internationally has risen fifty-fold since 1950 (Ecobichon, 2001). China uses and produces the largest amounts of pesticides (Pesticide Action Network, 2010).

In developing countries, the effects of acute poisoning due to exposure to dangerous levels of pesticides in food are apparently more severe than in industrialized countries. Two examples from Africa: in 2008 Nigeria reported that 112 people had been poisoned by pesticide-contaminated food. Two children died as a result. Another report from Nigeria recorded 120 cases of poisoning of students who had eaten beans contaminated with lindane (Organic Consumer Association, 2008; Integrated Regional Information Network, 2008). Some pesticides that are restricted and banned in industrialized countries are used in many third-world countries (Wessling *et al*., 1997).

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Despite these efforts, recommended agrochemical practices (such as use of genuine product, proper calibration of equipment, appropriate application techniques, ensuring personal health and safety, and ensuring environmental safety) have been poorly adopted thus resulting in agrochemical failure, environmental hazards as well as health hazards (Olowogbon *et al.* 2013). The wrong use of agrochemicals on farms exposes farmers to some risks due to the hazardous effects of these chemicals. The residual effect of the chemicals on crops also constitutes concern if the chemicals are not properly handled. This is due to the fact that pesticides are toxic and can have serious health hazards on human beings (Mokwunye, 2012; Atu, 1990). To guard against these dangerous effects, Idowu (1996) recommended precautionary measures in chemical application.These include; wearing of nose shield to avoid inhalation; putting on protective clothing, rubber gloves and boots; refraining from smoking, eating and drinking during spraying; and covering of food and water to avoid contamination. However, Abdullahi (2008) noted the persistent incidences of agrochemical-related accidents.

Among the pesticides that are frequently associated with documented cases of poisoning are carbamates and organophosphates, which are in WHO class I, endosulfan, which the Stockholm Convention has earmarked to be phased out worldwide, and paraquat (Kishi, 2005, and Secretariat of the Rotterdam Convention, 2010). According to Vaagt (2005) and Akinyosoye (2005), these pesticides are often freely available on the markets in developing countries or smuggled in for use or sale.

Illegal trade in pesticides is a significant global problem. In developing countries,as much as 30% of the pesticides do not meet internationally recognized safety standards (Vaagt (2005). In India, for example, the Ministry of Agriculture has determined thatone-third of the pesticide samples examined do not comply with official standards (World Health Organization, 2002).

The most striking significance of this study is that, an x-ray of literature on the use of crop protection chemicals in Nigeria indicated that very few has evaluated how recommended agrochemical practices were adopted by farmers. Essentially, the data generated through this study would serve as a basis for understanding how recommended agrochemical practices are being adopted in the country. This can then be used for making appropriate policy.

Extensionists, economists and sociologists have made extensive contributions to the literature on the adoption and diffusion of innovation in agriculture. Such research typically focuses on the long-term extent of adoption, rate of adoption and the factors that influence the adoption decision. Some studies have been conducted on the adoption of plant protection measures against pests and diseases of different fruits, yet some others have been carried out on the use of pesticide spray. Most other studies are limited to just the adoption of agrochemicals. However, the adoption of agrochemical should go beyond just measuring the adoption of a particular agrochemical for whatever purpose.

With this background therefore, the need for a systematic investigation of the farmer's level of awareness and adoption of recommended agrochemical practices becomes imperative. Hence, this study assessed the level of awareness and adoption of recommended agrochemical practices among crop farmers in Kaduna and Ondo States of Nigeria. It also measured the perception of farmers on pesticides and their knowledge of the harmful effects of pesticides.

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Methodology

Kaduna and Ondo States from the Northern and Southern Nigeria, respectively were used for this study. Both States have the highest record of use of agrochemicals in the different agroecology where they belong. Kaduna State lies between longitude 06′00 and 09′10′East of the Greenwich Meridian between and latitudes $09^{0}00$ and $11^{0}30$ north of the Equator. Occupying an area of approximately 48,473.2 square kilometers (FOS, 2006), Kaduna State shares common borders with Kano and Katsina States to the north; Bauchi and Plateau States to the north-east; the Federal Capital Territory and Nasarawa State to the south; and Niger and Zamfara States to the south-west. Ondo State lies between latitudes 5°45' and 7°52'N and longitudes 4°20' and 6° 05'E. Its land area is about 15,500 square kilometres. Ondo State is bounded on the east by Edo and Delta States, on the west by Ogun and Osun States, on the north by Ekiti and Kogi States and to the south by the Bight of Benin and the Atlantic Ocean. Ondo State top the list in cocoa production (Moore 1980; Ogunlade and Aikpokpodion, 2010) which involves heavy use of fungicides for the control of fungal diseases. A wide range of fungicides are available in the State (Olabode *et al.*, 2011).
The two States have markedly different agroecological condition. This difference could make crop protection practices (as well as the type of agrochemicals used) to vary substantially in the two States. However, both States are noted for heavy use of agrochemicals. Traditionally, Nigerian farmers have been relying heavily on pesticides for the control of various weeds, insect pests and diseases, leading to the high importation of these products and their prices have become so high that it is becoming impossible for local farmers to afford (Schwab *et al.,* 1995).

This study focused on crop farmers who have been using agrochemicals for at least five years in Kaduna and Ondo States of Nigeria. The selection of these States and locations where the primary data were collected was based on high volume of crop production and prominent use of agrochemical as reported by NAERLS and NPAFS (2011). A multi-stage sampling technique was employed in selecting 260 respondents (who are adopters of agrochemicals). Data for this study were collected from primary source. Primary data was collected with the use of pretested, validated, structured interview schedule. Personal observationwas also used. Secondary sources such as annual reports of ADPs, published materials like textbooks, journals, bulletins and extension guides as well as reports from relevant institutions among otherswere utilized. Internet materials were also used.

Adoption is the decision of farmers to make full use (apply) of specific recommended practices of agrochemicals on continuous basis as the best course of action available. Recommended practices describe the efficient and effective use of a specific agrochemical in a worthwhile manner as suggested by relevant authority (producer or regulatory agent). Responses were rated on a 3-point Likert type scale thus: very often (2), seldom (1), and never (0). Adoption score was computed by summing the responses of respondents' score for each item in the RAPs variable to obtain a weighted sum. The weighted sum was further divided by the number of respondents to obtain a weighted mean for each of the items. The weighted mean (representing the adoption level) was classified thus: 2.5 – 3 (High), 2 – 2.49 (Moderate), and <2 (Low).

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Results and Discussion

Farmers' knowledge and perception on pesticide effects

The perception of 33.1% of the farmers was considering pesticides as always good whereas 30% of the farmers perceived pesticides as sometimes harmful and 26.9%) of the farmers perceived pesticide as sometimes good (Table 1). As for the harmful effects of pesticides, all respondents indicated that pesticides cause damage to human, animal and wildlife health and water bodies and 17% indicated that pesticides cause other damages than those indicated. In line with the damages pesticides could cause, the farmers were asked if it would be possible to protect the damage and only (48.1%) indicated that it is possible. Workers' knowledge of hazards, which must be correct, is important for the prevention of acute and chronic poisoning: erroneous beliefs can seriously impair farmers' capacity to protect themselves against the risks of pesticides (Tijani, 2006). In a study by Raksanam *et al*, (2012) in Thailand, it was reported that great majority of the farmer participants in the study had a clear knowledge that pesticides could harm their health. The findings of this study confirms that of Amera and Abate (2008) that generally, farmers have varying knowledge on the harmful effects of pesticide to human health, animal health, wild life, as well as water bodies.

Table 1: Perception of farmers on pesticides and their knowledge on the harmful effects of pesticides

Variables	Percent
Farmers perception about pesticides	
Always favorable	33.1
Sometimes favorable	26.9
Always unfavorable	10.0
Sometimes infavorable	30.0
Don't know	-
Farmers' knowledge on harmful effects of pesticides*	
Pesticides can cause damage to human health	100
Pesticides can cause damage to animal health	79.6
Pesticides can cause damage to wild life	34.2
Pesticides can cause damage to water bodies	49.6
Pesticides can cause damage to all indicated	83.8
Pesticides can also cause other damages than indicated	17
Perception of farmers on possibility of protecting pesticide hazards	
Yes, pesticide hazards can be protected	48.1
No, we cannot protect pesticide hazards	27.3
Don't Know if it is possible to protect pesticide hazards	24.6

*Multiple responses indicated

Farmers' level of awareness of recommended agrochemical practices

Awareness had been identified as an important variable in the adoption decision of a farmer. This is because a farmer cannot adopt if he/she is not aware or exposed to the recommended practices. Result in Table 2 indicates that most farmers had good awareness and understanding of the recommended agrochemical practices. The expectation is that adoption of these practices would be high. For proper understanding, recommended practices were categorized into five (5). These are application techniques, health and safety, environmental safety, genuine products, and

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equipment calibration. Variable which recorded low awareness by farmers include proper calibration of sprayer (M=1.48), keeping pesticides away from other herbicides (M=1.91), avoid entering sprayed farm until 12 hours after spraying (M=1.87) and proper disposal of empty container (1.99). Experiences on the field have shown that farmers mix two or more pesticides as well as use more than the recommended concentration of pesticides. This practice could put the farmers at risk, due to the synergistic or potentiating effect of chemicals. Yasin *et al* (2002) confirms this experience. Yet, other farmers use less than the recommended concentration of pesticides which could lead to pesticide failure. Calibration of sprayers is very essential even when they are in perfect working conditions. The spraying of farms with overdose of pesticides will result in farmers incurring huge financial losses due to wastage and phytotoxicity, which will decrease the yield. However, the major risk of overdose or underdose is the increased likelihood for the pests to develop resistance against pesticides, which can have devastating large-scale effects on crop production (Meijden, 1998).

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Table 2: Level of Respondents' Awareness of recommended agrochemical practices

Variables	FA	LA	U	Weighted sum	Weighted mean
Genuine Product					2.34
Purchasing from reputable source	149	67	44	625	2.40**
Avoid using expired/banned chemicals	129	80	51	598	2.30**
Using the appropriate agrochemicals	112	90	58	574	2.21**
Checking that seals and original labels have not been broken	148	90	22	646	2.48**
Avoid buying chemical too early in the growing season	122	99	39	603	2.32**
Equipment Calibration					2.08
Proper calibration of sprayer	28	70	162	386	1.48*
Using the right dosage	96	105	59	557	2.14**
Regular repair and maintenance of spraying equipment	141	64	55	606	2.33**
Using the right equipment	133	91	36	617	2.37**
Application Techniques					2.37
Following labeling instructions	142	82	36	626	2.41**
Avoid spraying against wind direction	128	90	42	606	2.33**
Health and Safety					2.20
Wearing protective clothing	151	81	28	643	2.47**
Keep herbicides separate from other types of pesticides	59	118	83	496	1.91*
Observation of the waiting period	112	97	51	581	2.23**
Avoid entering sprayed farm until 12 hours after spraying	69	88	103	486	1.87*
Avoid mixing herbicide with fungicide	139	85	36	623	2.39**
Check stored pesticides regularly for sign of damage or leakages	98	91	71	547	2.10**
Applying the agrochemical at the right time	122	101	37	605	2.32**
Never store pesticides in living rooms, kitchen, animal house or toilets	103	86	71	556	2.14**
Avoid leaving pesticides in equipment overnight	126	81	53	593	2.28**
Avoid eating, drinking and smoking during spraying	128	83	49	599	2.30**
Environmental Safety					2.21
Proper handling and storage of agrochemical	109	82	69	560	2.15**
Proper disposal of empty container	93	73	94	519	1.99*
Avoid using chemical for different purpose e.g. treating animal wound	132	78	50	602	2.31**
Keep pesticides away from source of drinking water, wells, & streams	146	70	44	622	2.39**
Weighted mean sum					55.62
Weighted mean average					2.24**

** Good; * Fair. FA=Full awareness and understanding (2.5 – 3), LA=Little awareness and understanding (2 – 2.49) U=Unaware at all (< 2)

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Level of Adoption of Recommended Agrochemical Practices

The distribution of farmers on different levels of adoption of RAPs is shown in Table 3. All the recommended practices are yet to gain grounds in the rationality of farmers as they all recorded poor adoption. Many farmers are aware of the recommended practices but are unwilling to adopt them.

Items measured under equipment calibration recorded the lowest level of adoption. The overall weighted mean was 1.38. This could be a result of the high technicalities involved in equipment calibration. Improper calibration could result in high or low dosage thereby resulting in undesired result i.e. leading to poison or agrochemical failure respectively. Some farmers still mix herbicide in open bucket and apply the chemicals using leaves. Irregular repair and maintenance of equipment recorded a weighted mean of 1.42 indicating that farmers do not have good maintenance culture for their pesticide equipment. Use of wrong equipment among respondents was also indicated. Sprayer calibration is usually proposed and taught in research and training institutions, but is hardly ever done in practice, which usually results in the use of wrong dosage of pesticides. Calibration of sprayers is very essential even when they are in perfect working conditions.

The spraying of crop with overdose of pesticides will result in farmers incurring huge financial losses due to wastage and phytotoxicity, which will decrease the yield. However, Meijden (1998) asserted that the major risk of overdose or under-dose is the increased likelihood for the pests to develop resistance against pesticides, which can have devastating large-scale effects on crop production.

Health and safety measures in the use of agrochemicals were not adopted by respondents despite their level of awareness. Non-wearing of protective clothing, non-observance of waiting period, entering sprayed farm less than 12 hours after spraying, and mixing herbicides with fungicides were common practices among farmers. It is well recognized that if pesticide is applied too close to harvesting date, toxic substances are probably retained in consumer food. This result is similar to the findings of Ekanayaka and Wijeratne (2004) who reported that farmers in Sri Lanka did not adhere to the pre-harvest interval (PHI) (waiting period). Farmers harvested their crops just 4–7 days after pesticide application instead of the recommended 14 days of using Bencarb. In the same manner, two families lost key members when they slept in the same room where cowpea treated with fumigants was stored, due to inhalation, while three contract sprayers lost their lives when they sprayed insecticides to control cowpea insect pests without wearing suitable protective clothing (Dugje *et al;* 2008). Farmers often find that protective clothing uncomfortable to wear and choose not to use it, which adds unnecessary risk.

Studies have shown negative attitudes towards special protective clothing (Rucker *et al.*, 1988; Gomes *et al*, 1999; and Mekonnen and Agonafir, 2002). In the study by DeJonge *et al.* (1983), farm workers felt positive towards a traditional work shirt-and-jeans-type outfit. As an alternative to standard, often uncomfortable personal protective devices, the use of traditional work clothing fabrics with selected chemical finishing has been suggested (Csiszar *et al.*, 1998). Ajayi and Akinnifesi (2005) reported that farmers understand labels that advise users to protect themselves. These were labels which advised users to protect their eyes, put on boots, hand gloves or to protect their nose and mouth. This indicated that farmers were well aware of the possible health effects of

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pesticides on humans. However, some farmers bought pesticides without labels as reported by Amera and Abate (2008).

In the same vein, environmental safety measures were poorly adopted. Proper handling and storage of pesticides as well as proper disposal of empty container recorded the lowest weighted mean of 1.33 and 1.48 respectively. Generally, item categorised under 'genuine products' also recorded low adoption. This indicates that farmers use inappropriate chemicals, use banned/expired chemicals; and still purchase from non-reputable sources. Youdeowei (1989) noted that the pesticide regulatory role of the Nigerian government is generally not carried out satisfactorily. The effective control of pesticides in the West-African sub-region remains poor and seriously hampered by several factors including lack of proper legislative authority; shortage of personnel in pesticide regulatory procedures, lack of infrastructure, transportation, equipment and materials.

Similar to the findings of Raksanam *et al.* (2012), Isin and Yildirim (2007) have reported that although, farmers (in Turkey) read the recommendations and instructions on pesticide's label, less than 60% of them exactly followed the directions. Some of them prefer to use unsuitable pesticides in order to ensure the yield and quality of fruits. Several factors might account for this apparent reckless attitude regarding self-protection by the farmers. This underscores the need for educational intervention efforts to stress the health impacts and environmental issues from pesticide use in Nigeria. Greater enforcement of regulations regarding field and housing sanitation are needed as well as to enhance the level of substantive dialogue with government policy makers. Ntow *et al.* (2006) tested the perceptions of farmers about chemicals' potential for harm among vegetable farmers in Ghana. They found that various inappropriate practices in the handling and use of pesticides caused possible poisoning symptoms among those farmers who generally did not wear protective clothing.
It must be noted that only two items were moderately adopted by the respondents (avoid spraying against the wind (2.28), and avoid eating/drinking/smoking during spraying (2.17). This could be due to the fact that both usually have instant and direct consequences on human health.

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Table 3: Level of respondents' adoption of recommended agrochemicals practices

Variables	Very Often	Seldom	Never	Weighted sum	Weighted mean
Genuine Product					**1.64***
Purchasing from reputable source	37	46	177	380	1.46*
Avoid using expired/banned chemicals	40	51	169	391	1.50*
Using the appropriate agrochemicals	16	149	95	441	1.69*
Checking that seals and original labels have not been broken	56	72	132	444	1.71*
Avoid buying chemical too early in the growing season	70	80	110	480	1.85*
Equipment Calibration					**1.38***
Proper calibration of sprayer	15	47	198	337	1.29*
Using the right dosage	34	28	198	356	1.37*
Regular repair and maintenance of spraying equipment	32	46	182	370	1.42*
Using the right equipment	38	47	175	383	1.47*
Application Techniques					**1.79***
Following labeling instructions	21	40	199	342	1.31*
Avoid spraying against wind direction	126	81	53	593	2.28 **
Health and Safety					**1.40***
Wearing protective clothing	10	18	232	298	1.14*
Keep herbicides separate from other types of pesticides	11	19	232	303	1.17*
Observation of the waiting period	12	30	218	314	1.21*
Avoid entering sprayed farm until 12 hours after spraying	13	29	218	315	1.21*
Avoid mixing herbicide with fungicide	14	36	210	324	1.25*
Check stored pesticides regularly for sign of damage or leakages	28	50	182	366	1.41*
Applying the agrochemical at the right time	27	62	171	376	1.45*
Never store pesticides in living rooms, kitchen, animal house or toilets	37	55	168	389	1.49*
Avoid leaving pesticides in equipment overnight	34	63	163	391	1.50*
Avoid eating, drinking and smoking during spraying	102	100	58	564	2.17 **
Environmental Safety					**1.51***
Proper handling and storage of agrochemical	20	47	193	347	1.33 *
Proper disposal of empty container	31	63	166	385	1.48*
Avoid using chemical for different purpose e.g. treating animal wound	47	53	160	407	1.57*
Keep pesticides away from source of drinking water, wells, & streams	55	66	139	436	1.67*
Weighted mean sum					37.40*
Weighted mean average					**1.49***

** Moderate, * Low. Categorization: High = 2.5 – 3, Moderate = 2 – 2.49, Low = < 2

Conclusion and Recommendations

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This study concludes that farmers' adoption of RAPs is low (M=1.49) despite the high level of awareness (M=2.24). Based on the findings of this study, it is recommended that Stakeholders (government extension services, EPA, NAFDAC, input dealers, FBOs and NGOs) should collaborate to mount a powerful campaign for attitudinal changes among farmers on the need to adopt RAPs in order to ensure personal health safety and the safety of the environment. Also, regular training of farmers should practically emphasize application techniques, as well as personal health and safety measures.

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