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Determinants of Compliance with Standard Practices of Pesticide Use Among Cocoa Farmers in Southwestern Nigeria

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Abstract

Cocoa production in Nigeria is limited due to pests and diseases. In an attempt to control these, farmers apply pesticides which leave chemical residue in cocoa beans. There are established standard practices to address the abuse in use of pesticides. However, there is dearth of information on factors that predispose cocoa farmers to comply with approved standard practices. Therefore, determinants of compliance with standard practices of pesticide use by cocoa farmers in Southwestern Nigeria were investigated. A three-stage sampling procedure was used to select respondents. Two cocoa producing States (Oyo and Ondo) were purposively selected. Two Local Government Areas (LGAs) known for cocoa production were selected from each state. Systematic random sampling was used to select 10% of registered farmers to give 354 respondents. Interview schedule was used to collect data on respondents' variables. Data were analysed using descriptive statistics and multiple regression at α 0.05. Most farmers were male (70.3%) and had secondary education (31.9%). Respondents' age and farming experience were 58.0 and 27.0 years, respectively. Farmers' yield and annual income were 0.449 tonnes obtained from an average of 6.25 ha cocoa farm size and ₦1,331,519.60 equivalent to $3,698.67, respectively. Determinants of compliance with standard practices of pesticides use for both dosage and procedure were determined by age (β = -0.20), income (β = 0.15), exposure to information (β = 0.36), constraints (β = -0.27) and accessibility to approved pesticides (β = -0.11). Exposure of farmers to information and realising more money motivates them to purchase approved pesticides that will aid compliance with standard practices. As age of farmer increases, the ability to comply will be limited. A farmer who is constraint with poor access to recommended pesticides will go for unapproved types which are against compliance. Concerted efforts should be put in place by relevant bodies to ensure sustainable income, information access for respondents in order to adhere to recommended protocols and enhanced cocoa yield.

Keywords: Practice compliance, dosage compliance, cocoa farmers, pesticide use

INTRODUCTION

Cocoa (*Theobroma cacao* L.) is a leading commodity crop in West Africa with over 70% of world cocoa production cultivated in the region. West Africa supplies 90% of cocoa required by European cocoa industry (Crozier, 2013). Nigeria is a notable producer of cocoa beans in the world with Cote d'Ivoire being the highest. Other important producers are Ghana, Ecuador, Cameroon and Indonesia contributing to the enterprise (ICCO, 2020). In Nigeria, cocoa is widely grown by small-scale farmers in 14 States with a greater proportion from the South West (Adeniyi *et al.*, 2014).

Globally, around 50 million people depend on cocoa for their livelihoods, while governments in producing countries rely on earnings from cocoa to finance economic and social development programmes (Fairtrade, 2016). Cocoa is the main agricultural export in Nigeria producing annually 300,000-350,000 tonnes. Nigeria exports about 96% of its cocoa beans per year (Pedabo, 2013). The country's production is dependent on pesticides to attain acceptable levels of crop production. Cocoa plays a significant socio-economic role in Nigeria. It accounts for almost 2% of Nigeria's export earnings. It is a major source of foreign exchange for the country. Cocoa export contributed over ₦103 billion ($338.17) to Nigerian economy in 2018 (Okunade, 2019). The crop serves as the single largest non-oil foreign exchange income earner contributing significantly to the nation's Gross Domestic Product (GDP). It provides employment for over 200,000 households in areas of the Nigeria that grow the crop (Popoola *et al.*, 2015). Cocoa is used in the production of cocoa powder, chocolate, beverages, wine, bread, butter and other products.

For the sustainable production of these cocoa products, it is important to ensure compliance of farmers with approved pesticides application practices to control insect pests and diseases. Compliance is beneficial not only for consumers concerned with the food safety of the end product but is also beneficial to the health and wellbeing of producers and other stakeholders in the supply chain. Compliance helps to safe guard a sustainable supply of cocoa beans, income and improved quality for cocoa producing communities and the country as a whole. Annually, approximately 2 million tonnes of pesticides across the globe are utilized, out of which 47.5% are herbicides, 29.5% are insecticides, 17.5% are fungicides and 5.5% are other pesticides (De *et al.*, 2014). It has been estimated that by the year 2020, the global pesticide usage will increase up to 3.5 million tonnes (Zhang, 2018). Compliance with standard pesticides protocol helps to reduce the possibility of exceeding the Maximum Residue Limits (MRLs) of 0.01mg/kg permitted for cocoa production (Bateman, 2015). The MRLs are the maximum concentration of pesticide residue (expressed as mg/kg of residue to food/animal feed) likely to occur in or on food and feed after the use of pesticides according to Good Agricultural Practices (GAP).

The European Union (EU) observed traces of chemical residues in the cocoa beans exported to consuming countries (Okoffo *et al.*, 2016). It has become a major concern in the international market due to its serious risk to the health of consumers of cocoa beans products. The importance of responsible pesticides use and compliance by farmers with approved pesticides is in line with Nigerian government effort in boosting cocoa production to meet increasing demand. However, its production is limited by so many factors some of which include effect of insect pest and diseases, poor quality beans, knowledge and attitude. Others include high cost of farm inputs such as fertilizers, pesticides, seeds, shortage of labour and so on (Idris *et al.*, 2013; Cadoni, 2013). The issue of pesticide residue resulting from pesticides application is a major concern to consuming countries. It compromises cocoa bean quality leading to health problems and rejection of bean in the international market.

Okoffo *et al.* (2016) reported that indiscriminate use of chemicals to spray diseased cocoa trees on farm can have unintended environmental consequences and quality issues. This suggests non-compliance to acceptable standards. Ibitayo (2011) reported that some farmers do not follow instructions on the pesticides label and use their own discretion in mixing and applying self-determined dosage to achieve quick results. Bateman (2015) reports that an assessment of the quality of cocoa beans imported into the EU included measurement of traces of substances that have been used on cocoa farms and this has been a serious issue to consumers. Studies regarding pesticides have become important in order to ensure the production of good quality cocoa beans, decrease pesticide risk and help to improve public health policies. Pesticides can provide useful control solutions if applied properly. They must be approved for use on the basis of GAP to increase productivity and quality in a manner that respects both the environment and health standards.

In order to stem this situation, the Cocoa Research Institute of Nigeria (CRIN) in line with international standard screened and recommended some pesticides which were approved by government for farmers' use in controlling insect pests and diseases associated with cocoa. These include fungicides: Copper (1) Oxide + Metalaxyl-M, Metalaxyl + Copper (1) Oxide, Copper Hydroxide, Mandipropamid + Mefenoxam and Pyraclostrobin + Dimethomorph; insecticides: Thiamethoxam, Acetamiprid + Cypermethrin, Thiacloprid + Deltamethrin and Imidacloprid; herbicides: Glyphosate (CRIN, 2019).

Non-compliance with approved chemicals to control insect pest and disease problems necessitated the European Cocoa Association (ECA) and EU to place a regulation on the irrational use of pesticides on cocoa trees. There is dearth of information on whether farmers comply or not with recommended practices. Therefore, the study was carried out to describe the personal characteristics of cocoa farmers and ascertain the factors determining compliance with standard practices (dosage, procedure) of pesticides use by cocoa farmers in Southwestern Nigeria in the study area.

MATERIALS AND METHODS

Study Area

The study was carried out in Oyo and Ondo States in the Southwestern Nigeria. Oyo State covers an area of 2.79 million hectares of land out of which 332,667 hectares can support cocoa production. The State has 41,447 ha currently under cultivation. Ondo state is the highest and leading cocoa producing state while Oyo States is a medium producer. There are 33 Local Government Areas (LGAs) in Oyo State, out of which 17 produce cocoa. Ondo State covers a land area of 14,793 km^2. It has 326,000 ha suitable for cocoa production. The current area under cultivation is 149,687 ha (CRIN, 2008). Ondo State has 18 LGAs, out of which 14 produce cocoa. The target population of the study comprised small scale cocoa farmers from Oyo and Ondo States who were duly registered with Tree Crop Units in the State Ministries of Agriculture.

Sampling Procedure

A multi-stage sampling procedure was used in selecting the respondents for the study. The first stage involves purposive selection of two States (Oyo and Ondo) and two Local Governments Areas (LGAs) predominantly producing cocoa. The next stage was the random selection of respondents among the registered cocoa farmers in the selected local governments. In Oyo and Ondo States, the LGAs that were involved in large scale cocoa production were selected for the study. Two LGAs each were selected from the two States due to their high level of production. A systematic random sampling was used to select ten percent of the registered farmers from the States Ministry of Agriculture in each of the selected local government areas. This was done by simple random sampling technique based on the list of cocoa farmers. In Oyo State, out of the total number of registered farmers in Afijio and Oluyole LGAs, 26 and 20 were selected respectively. In Ondo State, out of the total number of registered farmers in Idanre and Akure South LGAs, 228 and 88 were selected respectively making a total of 362 which were proposed for the study but 354 were later used because some of the interview schedule instruments were not useful for analysis.

Data Collection Methods

Data were collected with the use of interview schedule from field survey of cocoa farmers. The instrument contains independent variables (personal characteristics): age, farming experience, number of years spent schooling, farm size and yield. Other variables investigated include estimated annual income, exposure to information, constraints, accessibility, knowledge, attitude and cocoa beans price of respondents. The dependent variable was compliance in terms of dosage and procedure with standard practices of pesticides use. Secondary data were also obtained from published and unpublished sources found in journals, books, proceedings and others materials. Table 1 describes the independent variables of the study.

The dependent variable of the study is compliance with standard practices of pesticides use on cocoa production. First, an approved guide on standard pesticides practices was used to know respondents that complied or not. The respondents were asked to tick the recommended pesticides they use out of the list provided. Those that indicated that they use a particular pesticide were further asked to indicate the dosage and procedure of use to spray cocoa trees. The information so obtained for each pesticide from each respondent on dosage and procedure were compared with the approved practice. Any deviation from the approved for dosage and procedure was considered by the researcher as non-compliance. A score of 0 was therefore assigned to non-compliance while a score of 1 was assigned to compliance. A compliance score for each of the respondent was computed based on the number of pesticides used. Compliance was computed in the form of percentage compliance, which is the proportion of the number of pesticide used to which respondents complied multiplied by 100 for both dosage and procedure.

Table 1. Measurement of independent variables of the study

Variables	Description	Variable type/criteria
Sex	Sex of farmers	Dummy: male = 1, female = 2
Marital status	Marital situation	Categorical variable: married = 1, single = 2, divorced = 3, widowed = 4
Age	Age of farmers	Continuous variable
Cocoa farm size	Total cocoa farm size in ha	Continuous variable
Price of cocoa beans	Price of cocoa beans in Naira	Continuous variable
Estimated annual income	Estimated annual income from cocoa beans in Naira	Continuous variable
Years of experience	Total number of farming experience in years	Continuous variable
Cocoa yield last season	Total number of bags/kg cocoa beans	Continuous variable
Number of years spent schooling	Total number of years spent schooling	Continuous variable
Exposure to information	Sources of information with score value	Never = 0, occasionally = 1, often = 2
Constraints	Farmers' constraints with score value	Categorical variable: major = 3, minor = 2, not a constraint = 1
Accessibility	Access to approved pesticides	Dummy: have access = 1, no access = 2
Knowledge attitude	Knowledge of farmers on pesticides use with scored value attitude of farmers to pesticides use (Use of attitudinal questions with scored value)	Dummy: Correct = 1, incorrect = 2, strongly agree = 5, agree = 4, undecided = 3, disagree = 2, strongly disagree = 1

Table 2. Approved guide on standard practices for recommended pesticides dosage and procedure

Pesticides	Dosage	Procedure	Target pests/disease/weed
Fungicides			
1. Ridomil Gold Plus WP 66	Dissolve 50 g/15 L of water in a knapsack sprayer	First add half of the water inside knapsack sprayer and put chemical. Cover and shake. Then, add the remaining, mix well, cover and shake again before spraying. The fungi cides should be sprayed every 21 days interval	Black pod
2. Funguran $^{-OH}$	Dissolve 60 g/15 L of water in knapsack sprayer	Same procedure is applied	Black pod
3. Ultimax plus	Dissolve 50 g/15 L of water in a knapsack sprayer	Same procedure is applied	Black pod
4. Champ DP	Dissolve 50 g/15 L of water in a knapsack sprayer	Same procedure is applied	Black pod
5. Kocide 2000	Dissolve 50 g/15 L of water in a knapsack sprayer	Same procedure is applied	Black pod
Insecticides			
6. Actara 25 WG	Dissolve 6 g/10 L of water in a knapsack sprayer	Same procedure is applied	Mirids
7. Esiom 150 SL	Dissolve 8.33 mL/10 L of water in knapsack sprayer	The insecticides should be sprayed every 30-35 days interval	Mirids
8. Proteus 170 O-TEC	Dissolve 27 mL/10 L of water in knapsack sprayer	Same procedure is applied	Mirids
Herbicides			
9. Clear weed	Dissolve 200 mL/15 L of water in knapsack sprayer	Same procedure is applied	Weeds
10. Touch Down	Same dosage for 9	Same procedure is applied. The herbicides should be sprayed every 3 months interval	Weeds
11. Round Up	Same dosage for 9	Same procedure is applied	Weeds

The approved guide for recommended pesticides dosage and procedure from CRIN used for the study is shown in Table 2.

Data Analysis and Analytical Tools

Descriptive statistics (mean, frequency, percentage distribution) were used to analyse the independent variables. Multiple regression was used to determine the significant determinants contributions of the independent variables to the dependent variable. These were done by putting the independent variables into the regression equation in order to know those variables that affect compliance with pesticide use. The independent variables were used to test against the compliance score of the dependent variable. The level of significance was tested at $p < 0.05$.

The model is expressed as:

$$Y = a+b_1x_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots +b_nX_n +e$$

Where:

- Y = Compliance with standard pesticides use on cocoa (1 = compliance, 0 = Non- compliance).
- a = Constant term.
- $b_1, b_2 \ldots bn$ = Regression coefficients.
- e = error term.
- $X_1, X_2 \ldots X_n$ = Selected independent variables which include:
- X_1 = Age of respondents (total age in years).
- X_2 = Cocoa farm size in hectares
- X_3 = Price of cocoa beans (actual price of cocoa beans in Naira).
- X_4 = Estimated annual income from cocoa beans (actual earnings).
- X_5 = Years of experience in cocoa farming (total number).
- X_6 = Cocoa yield (in kg/ha).
- X_7 = Number of years spent schooling.
- X_8 = Exposure to information (score value).
- X_9 = Constraints (score value).
- X_{10} = Accessibility to approved pesticides (score value).
- X_{11} = Knowledge level of cocoa farmers on pesticides use (score value).
- X_{12} = Attitudinal disposition to cocoa pesticide use (score value).

RESULTS AND DISCUSSION

Personal Characteristics of Respondents

The results in Table 3 show that 70.3% of the respondents were males while 29.7% were females. It indicates that men were more involved in cocoa production. This is similar to the study of Akintelu *et al*. (2019) which reported that men actively participated in cocoa production compared to the female cocoa farmers in Oyo State. Married people (77.1%) were more involved in cocoa production than single (5.7%), divorce (4.2%) and widowed (13.0%). It means that cocoa farming operation using pesticides were carried out by married men and women. This suggests availability of family labour for application of pesticides on cocoa trees.

The mean age of respondents was 58 years. It suggests that most of them were gradually aging and could be limited in carrying out production practices. For instance, an aging cocoa farmer carrying 15 L knapsack sprayer to spray cocoa tress in an acre of cocoa will find it difficult to effectively handle when compared to a youth. It implies that the farmers were getting old and this may affect their use and compliance with pesticides standard for cocoa production in the study areas. Conversely, youths who are more energetic people are less involved in cocoa production. This indicates that cocoa production is left in the hands of aged farmers that are not physically strong to carryout farming operations. It was reported by Iremiren (2011) that old people were more involved in cocoa production in Nigeria. Most cocoa farmers in villages are growing old and this could limit their farming activities. This is seen as a factor that will militate against government efforts to promote a tripling of cocoa production.

The educational status of respondents shows that more (37.3%) had primary and 31.9% went to secondary school while 20.9% of respondents had no formal education. The least was tertiary having about 10%. It means that majority had one form of education or the other which will likely help them to read pesticides labels before use which will assist in compliance to pesticides application. The respondents had varying farming experience. The bulk (37%) of these respondents had 21-30 years of farming experience in cocoa farming. This was closely followed by 33.6% with farming experience of 11-20 years. Their mean farming experience was 27 years. These findings imply that the farmers had enough years of farming experience which could be an added advantage for adherence to standard practices of pesticides use. Years of experience have often contributed to the productivity of farmers since farmers with many years of experience are likely to be more skilled than those with lesser years of experience. A study conducted by Eze & Olorunfemi (2010) revealed that most cocoa farmers had relevant length of farming experience in cocoa production activities. In terms of farm size, the result shows that 59.6 % of respondents had 6-10 hectares (ha), 36% had less or equal to 5 ha and those who owned above 15 ha were only 0.6%. The mean farm size was 6.25 ha. The implication of this is that cocoa farm size which was normally between 1-5 ha are gradually increasing. The expansion will suggest more use of pesticides on cocoa trees. Idris *et al*. (2013) supported this finding that the average farm size of 7.18 ha indicates that cocoa farmers were relatively medium scale producers.

The mean yield was 3,125 kg obtained from 6.25 ha cocoa farm size which translated to 0.499 tonnes/ha. This suggest that most respondents obtained a reasonable yield from their farms. Although reports may be conflicting, annual cocoa yields for Nigeria are generally estimated at an average of between 300,000 to 350,000 tonnes (Fairtrade, 2016). The average yield/ha of traditional cocoa variety is less than 450 kg/ha while hybrids developed by CRIN produces 1.9 to 2.3 tonnes/ha (Agbongiarhuoyi *et al.*, 2019). The result of the study however gave an increase above estimated yield due to good agricultural practices and increased farm sizes of farmers in the study area. The application of the right pesticide to control insect pest and diseases of cocoa will reduce infestation and enhance yield. The implication of this is that the use of pesticides will likely increase the yield of cocoa. This situation was also reported in Nepal by Bhandari (2014) that optimum use, correct method and right time of application of pesticides ensures increased crop production. This was reflected in the estimated income which earned respondents an average of $3,698 during cocoa season. In Nigeria, cocoa farmers believe that if they do not apply insecticide and fungicide to control insect pest and disease attack, they will record poor yield. The reason for this is that blackpod disease is predominantly affecting cocoa trees and if not controlled, the damage in terms of annual crop loss is as high as 90% (Adeniyi, 2019).

The respondents realised over three thousand dollars estimated income from the sales of cocoa beans in the study area. Those who obtained less or equal to $1,388 were 16.9%. It means that majority of the respondents got some reasonable income from cocoa production before this study was conducted in 2017. The price of cocoa beans was quite good during this period and the pesticides used could have boosted production of respondents which could enhance compliance. This is an indication that high income will motivate farmers to purchase approved pesticides that will be used to control disease problems on cocoa. The findings of Ogunjimi & Farinde (2012) supported the above results that cocoa farmers realised more income from their cocoa farms sprayed with chemicals which might be due to increase in price of cocoa in international market.

There is no significant contribution of the selected factors on compliance with standard practices of pesticide use by farmers. The contribution of the factors on compliance with standard practices of pesticide use in Table 4 is discussed for both procedure and dosage of approved pesticides used by farmers. The results show that compliance with standard practices of pesticide used by farmers was regressed with the independent variables in order to ascertain the determinants of compliance in the study area. These independent variables include age, cocoa farm size, price of cocoa beans, estimated annual income, years of experience, cocoa yield for previous season, number of years in school, exposure to information, constraints, accessibility, knowledge and attitude of respondents towards standard practices of cocoa pesticide use.

Determinants of Respondents' Compliance

The result in Table 4 gave an R square value of 0.285 meaning that variables in the regression model put together explain 28.5% variation of the contribution to the dependent variable. The result shows that compliance with both dosage and procedure of pesticide use by respondents was determined by exposure of farmers to information (β = 0.36), constraints (β = -0.27), age (β = -0.20), estimated annual income (β = 0.15) and accessibility (β = -0.11). Exposure of farmers to information (β = 0.36) and estimated annual income (β = 0.15) contributed positively to compliance with standard practices. The implication is that for every unit increase in exposure to information and estimated income from cocoa, compliance with approved practices increase by 0.36 and 0.15 units.

Table 3. Selected personal characteristics of respondents N = 354

Variables	Frequency	Percentage	Mean
Sex			
Male	249	70.3	
Female	105	29.7	
Marital status			
Married	273	77.1	
Single	20	5.7	
Divorced	15	4.2	
Widowed	46	13.0	
Age in years			58.2
Less or equal to 30	7	2.0	
31-40	36	10.2	
41-50	77	21.8	
51-60	83	23.4	
61-70	97	27.4	
Above 70	54	15.2	
Educational status			
No formal education	74	20.9	
Primary	132	37.3	
Secondary	113	31.9	
Tertiary	35	9.9	
Farming experience in years			26.5
Less or equal to 10	17	4.8	
11-20	119	33.6	
21-30	131	37.0	
31-40	50	14.1	
41-50	29	8.20	
Above 50	8	2.30	
Cocoa farm size (ha)			6.25
Less or equal to 5	126	35.6	
6-10	211	59.6	
11-15	15	4.2	
Above 15	2	13.0	
Yield of cocoa/ha			0.499 tonnes
Less or equal 1tonne	46	13.0	
1-2tonnes	90	25.4	
2-3tonnes	69	19.5	
3-4 tonnes	59	16.7	
4-5tonnes	39	11.0	
Above 5tonnes	51	14.4	
Estimated annual income (₦)			(₦1,331,520)
Less or equal 500,000	60	16.9	($3,699)
501,000-1,000,000	95	26.9	
1,000,001-1,500,000	68	19.2	
1,501,000-2,000,000	63	17.8	
Above 2,000,000	68	19.2	

Exposure of farmers to information and getting more money will motivate them to purchase approved pesticides that will aid compliance with standard practices. Also, as age of farmers increases, the ability to comply will be limited. A farmer that is constraint with poor access to recommended pesticides will go for un-approved types which are against compliance. The result is in line with Ogunjimi & Farinde (2012) who reported that most cocoa farmers were exposed to information on chemical usage from extension agents, fellow farmers and sales agent. They added that cocoa farmers having more income were due to increase in price of cocoa in international market.

Table 4. Contributions of variables in the regression equation to both dosage and procedure compliance with standard practices of pesticide use on cocoa trees

Determining factors	Both dosage and procedure		
	Beta	t	Sig.
(Constant)		9.525	0.000
Age	-0.203	-3.044	0.003 *
Cocoa farm size	0.071	1.080	0.281
Price of cocoa beans	-0.032	-0.689	0.492
Estimated annual income	0.147	2.220	0.027 *
Years of experience	0.080	1.203	0.230
Cocoa yield last season	0.048	0.944	0.346
Number of years spent schooling	0.033	0.659	0.510
Exposure to information	0.358	5.439	0.000 *
Constraints	-0.271	-4.485	0.000 *
Accessibility	-0.111	-1.996	0.047 *
Knowledge	0.005	0.087	0.931
Attitude	0.011	0.207	0.836

Notes: *Significant 5% (0.05); R = 0.534; R square = 0.285; Adjusted R square = 0.260; Standard error of the estimate = 7.512; Dosage compliance 18.7%; Procedure compliance 13.9%.

Variables such as constraints (β = -0.27), age (β = -0.20) and accessibility (β = -0.11) contributed negatively to compliance with standard practices of pesticides use by farmers. It implies that for every unit increase in constraints, farmers' age and accessibility, compliance with standard practices decreases by -0.27, -0.20 and -0.11 units respectively. Idris *et al*. (2013) corroborated this result and reported that farmers who use pesticides for cocoa production encounter constraints of high cost of pesticides and non-availability in some cases. Other variables in Table 4 did not significantly influence compliance with standard practices of pesticide use.

CONCLUSIONS

Based on the findings of the study, the basic education of respondents assisted them in acquiring some knowledge about the use of pesticides in controlling cocoa insect pest and diseases. A reasonable number of respondents were growing old in age. This was found to reduce compliance with standard practices. Compliance with dosage and procedure was found to be low in the study area. The main factors determining respondents' compliance with standard practices of pesticides use in cocoa production for both dosage and procedure were determined by age, income, exposure to information, constraints and accessibility to approved pesticides.

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