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On-farm practices adopted by cocoa farmers during pesticides application in Oyo and Ondo States of South Western Nigeria.

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Abstract:
Background*: The study was a survey aimed at studying pesticide application practices and choice of sprayer types among cocoa farmers in South-western Nigeria towards ensuring minimum pesticide usage and appropriate choice of sprayer for different farm operations for sustainable cocoa production in the study area. It specifically aimed at examining application practices, choice of sprayer, pesticide concentration, time of spraying, methods of loading sprayer and identifying training needs.*
Materials and Methods*: A set of pre-tested questionnaire was used to collate information from farmers while multistage sampling procedure was used to select 50 respondents each from two villages in Idanre Local Government of Ondo State and 45 respondents each from two villages also in Ogo-Oluwa Local Government Area of Oyo State.*
Results*: Results showed that 100% of the respondents make use of manually operated sprayer and 55.9% use knapsack type of sprayer. 74.7% of the respondent increased the frequency of application above the recommended rate, while 68.4% increased dosage above the recommended rate, 95.7% spray pesticide in the morning, 86.3% select a small hole nozzle (low volume) for application and only 43% of the respondents ensure constant mixing of pesticide during operation.*
Conclusion:*Most farmers apparently used spraying equipment and application practices based on what are at their disposal without basic knowledge and recourse to guiding principles for effective and efficient use of pesticide for controlling pests and diseases. It is recommended that for sustainable cocoa production, training and re-training of farmers on Good Agricultural Practices and Pesticides Usage is needed for efficient use of pesticide and choice of sprayer.*
Key Word*:Application practices; Pesticides; Sprayer;Concentration; farmers.*

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I. Introduction

Pesticides have now been used on cocoa for more than 60 years, with notable early research carried out independently in the former West African Cocoa Research Institute (now the Research Institutes of Ghana and Nigeria), Brazil, Cameroon, Costa Rica, Côte d'Ivoire, Indonesia, Malaysia and Togo. By the early 1970s, a number of effective control techniques had become established and there was little incentive for change until environmental awareness increased in the 1990s. Notable amongst these were concerns over the widespread use of lindane for the control of cocoa insect pests; this chemical was eventually phased out: but not until the early 21st century in some countries. Many farmers believe that pesticides work, at least against some cocoa pest problems, and continue to use them depending on the pest and country.[1,2] Pesticide use in Nigeria has been on the increase since its introduction in the early 1950ˇˇs for cocoa production [3]: the nuisance of pests like brown cocoa mirids, termites, cocoa stem borers and defoliator insects etc. and diseases like cocoa black pod disease and cocoa swollen shoot virus are strong factors responsible for the dwindling cocoa production in Nigeria.[2] Cocoa has a relatively green image and cultural methods (removal of diseased plant parts, etc.) are the most proven and cost effective first line of defense against its diseases and insects. However, pesticides are used on cocoa in certain circumstances. Implementation of all control methods by farmers is often poor. Proper technique of application of pesticides is very vital just as the selection of the equipment used[4]. They noted further that the main purpose of pesticide application is to cover target with maximum efficiency and minimum effort to keep the pest under control as well as minimize contamination on non-target organisms or environment. The right selection of sprayers and timely application of pesticides play vital roles for effective pest control[5].

The choice of sprayer equipment depends on its specific use and the need for a pest-weed control measure while noting that 70% of the success of crop protection products depends on the effectiveness of application. [6]showed that the standard recommendation for physical attribute of sprayer to include tank height, width, length of pump handle, weight, length of lance with extension, length of hose, length and width of Strap, diameter of tank opening, vertical and horizontal thrust, efficiency of nozzle and width discharge. There are essentially two types of equipment commonly used for spraying cocoa trees: motorized knapsack mist-blowers (or air-blast sprayers) and manual (hydraulic) sprayers. Design of various sprayers, including their accessories, affects suitability and effectiveness for a specific purpose. Their selection alongside the accessories is very vital for any application. Incorrect application practices are also as dangerous as bad spraying equipment or their inappropriate selection. Almost all small-holder farmers use manual (hydraulic) sprayers, which are globally the main method of pesticide (especially fungicide) application to cocoa. Motorized mist-blowers now have many uses, but they were originally developed for obtaining good droplet coverage in the tall cocoa trees of West Africa. FAO provides guidelines on the minimum requirements for agricultural pesticide application equipment, but unfortunately in any visit to sprayer stores or farmers in many cocoa growing areas, it can be difficult to find equipment that complies with these requirements. For portable equipment (as used by most farmers and especially small-holders), specifications are given for sprayer tanks, pumps, etc., with specific requirements on nozzles. The FAO envisages that member countries should put sprayer quality standards into law as with pesticides, but sadly, few countries have implemented this. Hydraulic nozzles remain the most widely used method of spraying chemical pesticides. They are fitted to a wide range of spraying systems ranging from the very basic hand-held trombone sprayers, side-lever knapsack sprayers, compression sprayers (originally designed for vector control, but used by some cocoa farmers). The two common forms of manual side-lever knapsack sprayer are illustrated: (i) where the tank mixture is pumped using a diaphragm or (ii) a piston mechanism; both require two valves. Distribution of spray deposited with a lance depends very much on the skill of the operator in keeping a steady pumping and walking speed and directing the nozzle to the target areas (pods, foliage, branches, etc, depending on the pest). The FAO has produced guidelines on minimum equipment standards[7] for manual sprayers that include various aspects relating to weight, durability, leakage, ease of cleaning and maintenance, instruction manuals, etc[1]. Many manual sprayers used by smallholder cocoa farmers world-wide are fitted only with variable cone nozzles, and few farmers know which setting to use. When screwed down to its minimum setting (a very fine spray), they produce a hollow cone spray, comparable in quality to standard fixed geometry cone nozzles. However, even unscrewing the outer cover slightly to produce a spray jet (as commonly done when attempting to treat high branches of tree crops) results in a dramatic increase in droplet size[8]. With regards to spray quality, a relatively small number of large droplets may represent a large proportion of the spray volume (that could have been turned into a large number of more efficient small droplets). These larger droplets are highly likely to run off leaves, fall back onto the ground (run-off or exo-drift) and be wasted. This is a contributory factor to poor or variable efficacy. Manual knapsack sprayers are typically maintained by farmers themselves; although, there have been government or cooperative support initiatives. It can be difficult to convince smallholders that it usually pays in the long-term to choose a good quality, robust sprayer and always ask the question "will I be able to find spare parts for it?"[1] The wrong use of pesticide application equipment in cocoa production has attracted global concern about the impact of these pesticide on public health with respect to pesticide residue on cocoa and its products: problems of over-or-under (excessive or inadequate) application rate include crop injury, poor pest control and injury to subsequent crop when using residual pesticide application practices[5,9]. This study was carried out to ascertainthe on-farm pesticide application practices among cocoa farmers in order to offer probable solutions to identified problems for effective and efficient pesticide application.

II. Material And Methods

A multi-stage sampling procedure was used to select the sample for the study. Ondo and Oyo States were purposively selected due to their cocoa production records.

Study Design:A well-structured questionnaire was individually administered to ninety-five farmers (45 in Oyo and 50 in Ondo State).

Study Location:The study was carried out in Oyo and Ondo states.

Study Duration: October to December 2015.

Sample size: 95 farmers.

Sample size calculation: One Local Government Area (LGA) well noted for cocoa production was selected from each of the two states. Two villages were also chosen from each LGA and fifty farmers (50) were selected from Idanre (Onikokojiya and Owena) and forty-five (45) cocoa farmers were selected from Ogo-Oluwa (Otamokun and Ibere) LGA resulting in ninety-five farmers.

Subjects & selection method: The study population was drawn from cocoa farmers with pest and disease problems.

Procedure methodology
After the initial farm visit, a well-designed questionnaire was used to collect the data of the farmers. The questionnaire included socio-demographic characteristics such as age, gender, educational status, pesticides application practices.

Statistical analysis
Data was analyzed using SPSS version 20 (SPSS Inc., Chicago, IL). Student's *t*-test was used to ascertain the significance of differences between mean values. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

Socio-economic characteristics of farmers in the study area are described in figure 1to 5. The ages of farmers ranges between 20 and 90 years. Those within the ages of 20 and 50 years were relatively young, being 57.9% of the total population studied, while 42.1% were 51 to 90 years old. The implication of this is that substantial percentage of farmers in South-western Nigeria is relatively old. This does not sustainably encourage cocoa production as they are likely to resist new information and refuse to source information (figure 1).

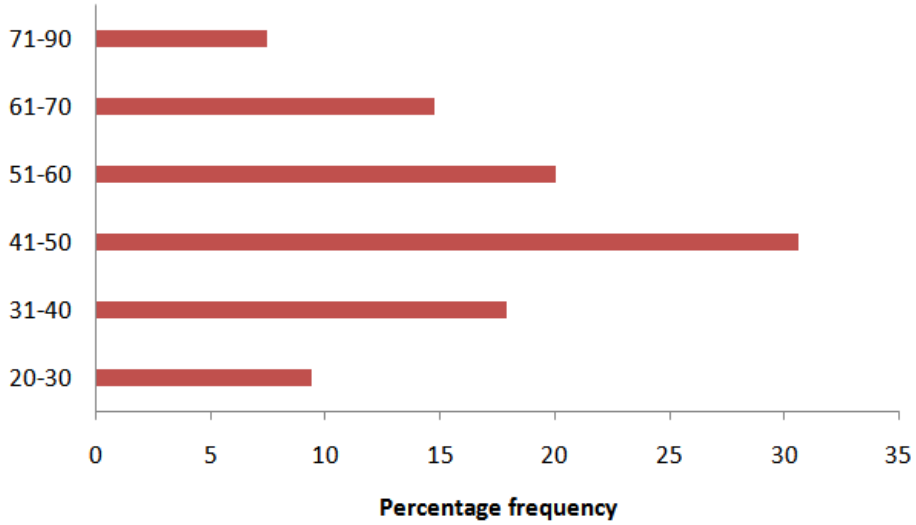

Figure 1: The percentage frequency of farmers' age in the selected areas.

Figure 2 also indicates that about 75% of the farmers sampled had more than 10 years farming experience which will promote knowledge transfer and can boost productivity.

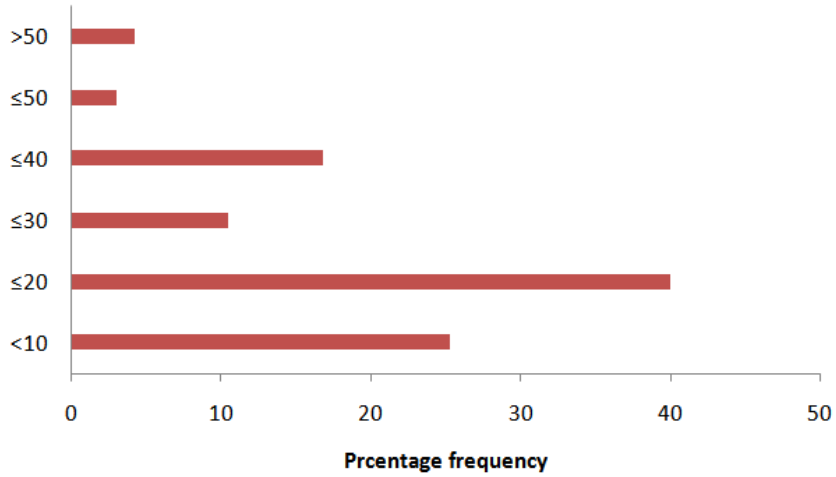

Figure 2: The percentage frequency of farmers' experience in the selected areas.

76.8% of the farmers had small area of farm, between 0.1 and 4 hectares (figure 3). This is an indication that majority of cocoa farmers are incapacitated in one way or the other and should be encouraged to increase their farm size probably through provision of incentives.

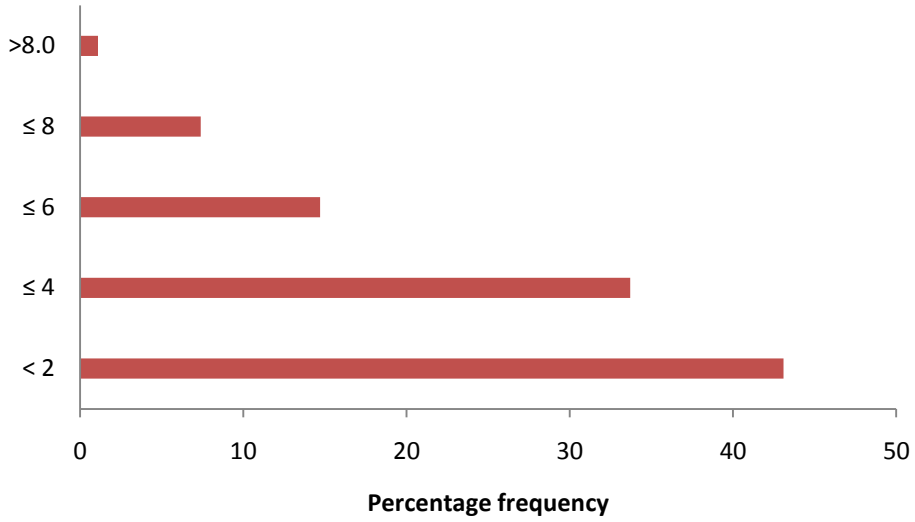

Figure 3: The percentage frequency of farmers' hectarage in the selected areas.

It was noted that more male (77.9%) were involved in cocoa production than female (22.1%) figure 4.

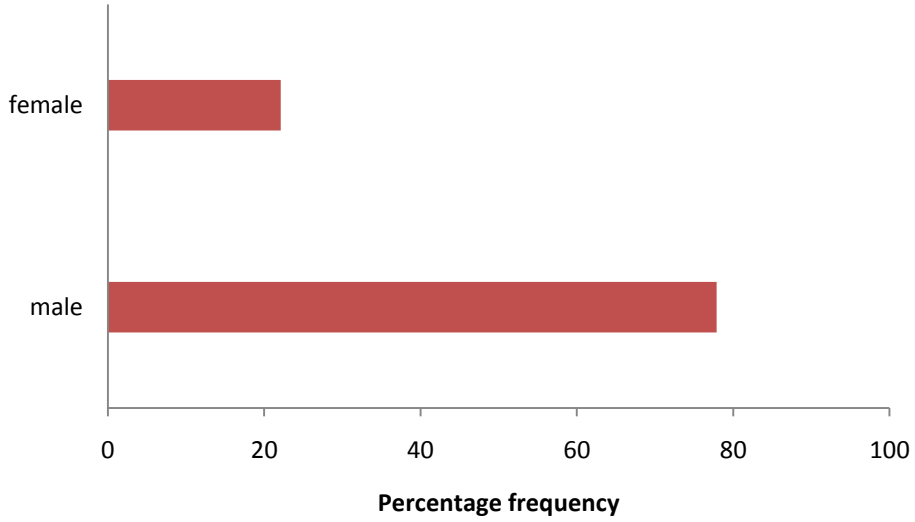

Figure 4: The percentage frequency of farmers' sex in the selected areas.

The educational status of farmers is very important for interpreting and accepting new innovations and technologies in agriculture. However, very low percentage of farmers (5.3%) possessed higher certificates while 31.6% were SSCE holders and a substantial number (21.0%) had no formal education at all (figure 5).

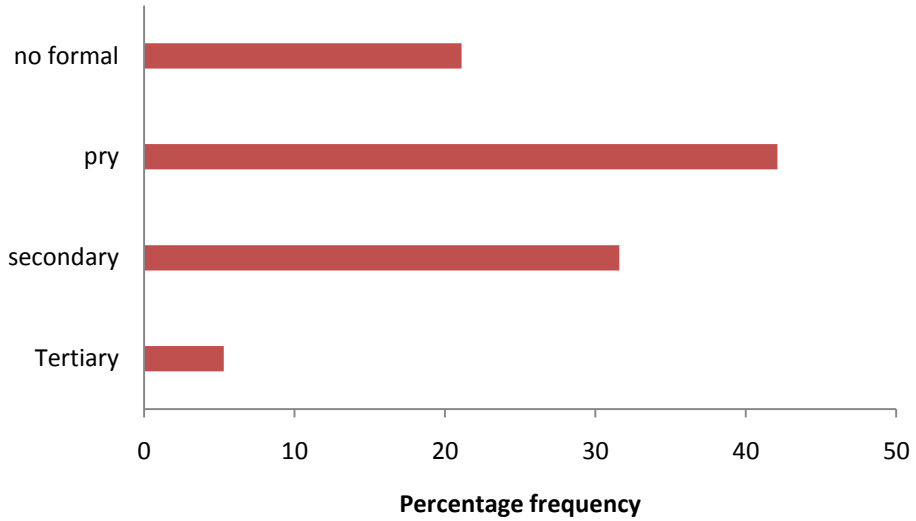

Figure 5: The percentage frequency of farmers' educational status in the selected areas.

50% of the respondent uses knapsack sprayer, 40% trombone sprayer and 5% uses the motorized sprayer (figure 6).

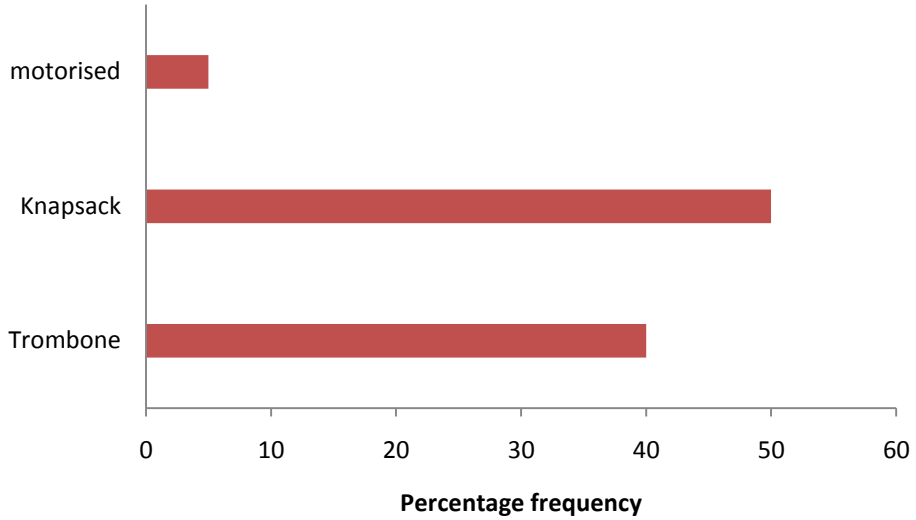

Figure 6: The percentage frequency of sprayer type used by farmers in the selected areas.

86.3% of the farmers selected a low volume nozzle for spraying pesticides as against 5.3% that were indifferent about nozzle selection(figure 7).

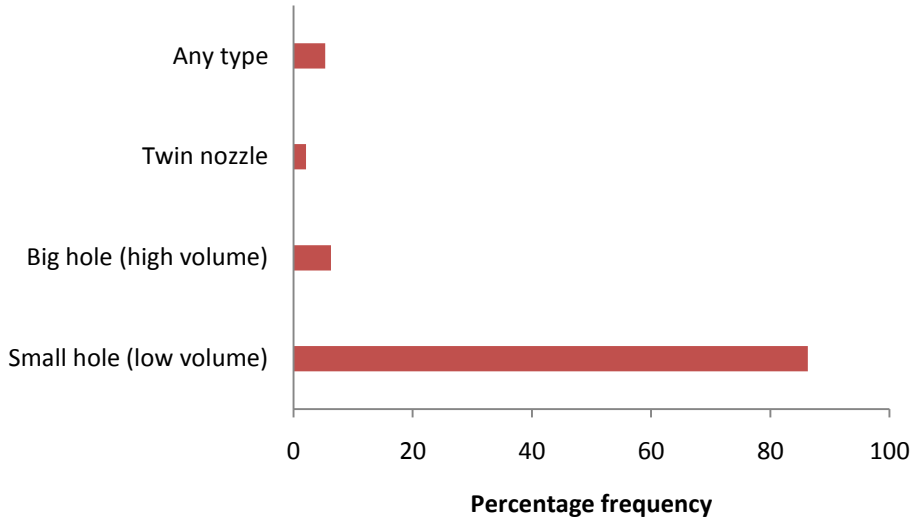

Figure 7: The percentage frequency of nozzle types used by farmers' in the selected areas.

Majority (71.6%) of the respondent followed the recommended label dose, while 10.5% used fraction of recommended rate and 17.7% adopted indiscriminate pesticide usage (figure 8).

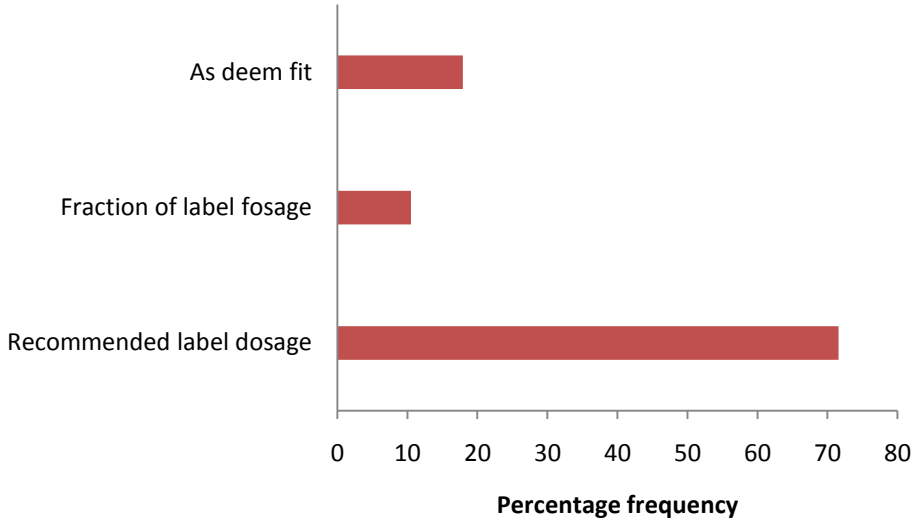

Figure 8: The percentage frequency of pesticide usage by farmers in the selected areas.

Reasonably, number of farmers (95.7%) applies pesticides in the morning which is popularly acceptable, while 4.3% were indiscriminate about choice of time (figure 9).

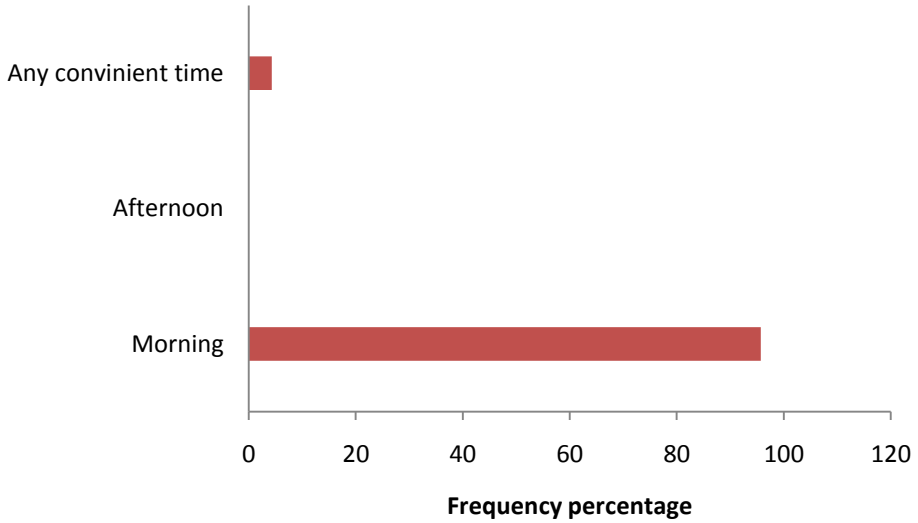

Figure 9: The percentage frequency of time of pesticides application farmers in the selected areas.

Significant number of respondent (56.8%) spray cocoa trees at 4 to 6 weeks" interval, 41% 1 to 3 weeks" interval while 1.1% sprayed before fruiting and on-setting of rain (figure 10).

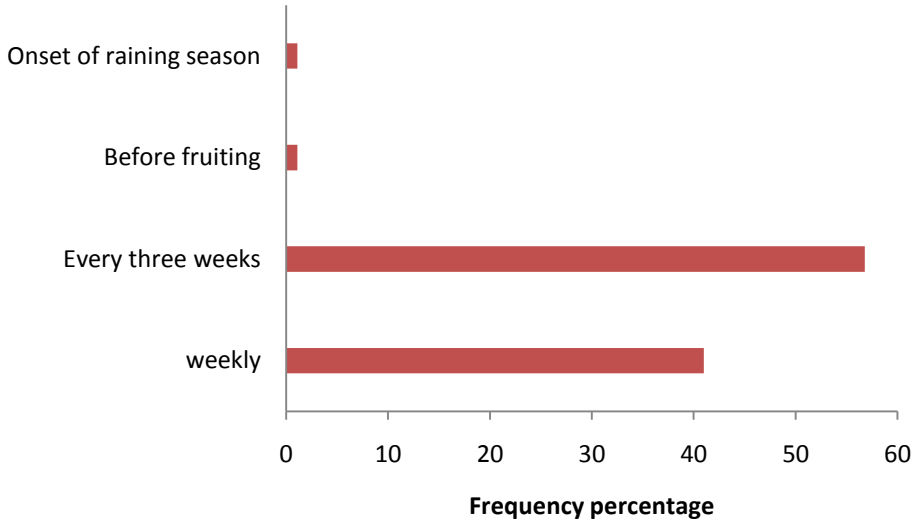

Figure 10: The percentage frequency of spraying interval by farmers in the selected areas.

44.2% half-fill the tank with water before adding pesticide which is the acceptable method/practice, 20% of the farmers fill up the tank before adding pesticides, a total of 31.55% either pour the pesticides and add water or mix separately in a container, while 4.3% mix as convenient (figure 11).

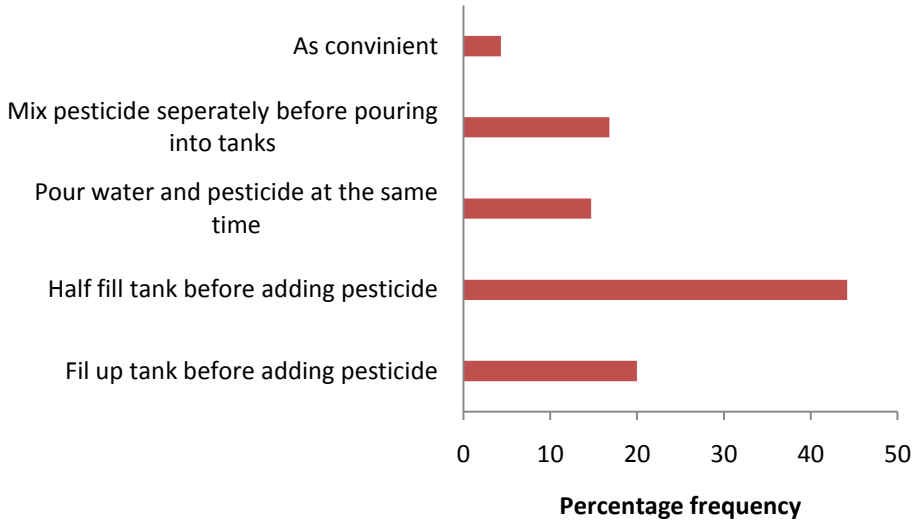

Figure 11: The percentage frequency of farmers' pesticide mixing methods in the selected areas.

Of the respondents, only 43.5% (figure 12) take cognizance of important requirements like shaking the pesticide in the tank periodically after mounting the sprayer which ensures optimum results.

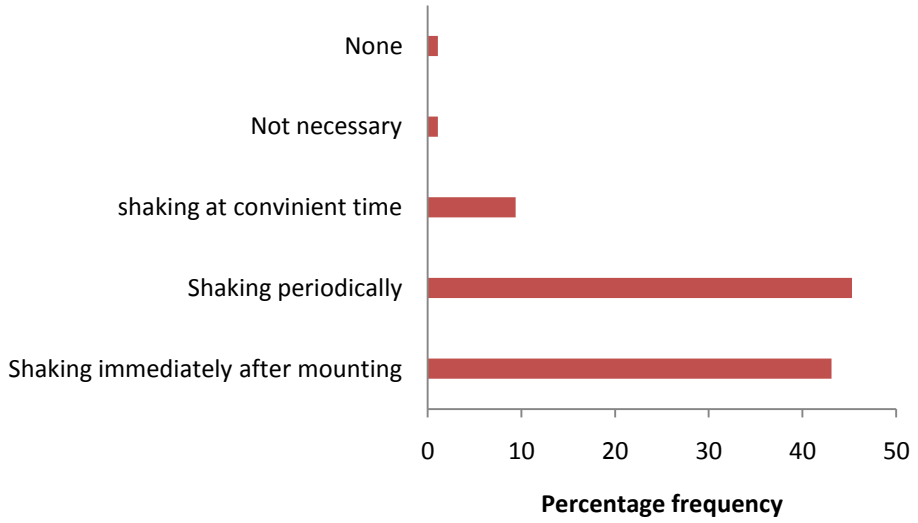

Figure 12: The percentage frequency of interval of sprayer shaking by farmers during spraying in the selected areas.

Table 1 showed that a relatively high number of respondents (74.7%) increased the frequency of pesticide application, while 68.4% increased the dosage as a result of high level of infestation of diseases and pests. Substantial number of respondent (22.1 and 42.1%) did not understand the importance of precaution and maintenance of sprayer such as spraying in the direction of the wind and washing of sprayer before and after use.

Table1: Pesticides application practices among farmers in the selected areas.

	Yes		Never		Occasionally		Always	
	Freq	%	Freq	%	Freq	%	Freq	%
Application of pesticides for pest and disease control	95	100	0	0	5	5.3	90	94.7
Increasing frequency of application for high levels of infestation.	71	74.7	24	25.3	51	53.7	20	21.0
Increasing the dosage for high levels of infestation.	65	68.4	30	31.6	59	62.1	6	6.3
Rectifying leakages in the flow line of the sprayer only if it is serious.	64	67.4	31	32.6	39	41.1	25	26.3

Spraying against the window give good result.	21	22.1	74	77.9	21	22.1	0	0
Washing of sprayer before and after use is not important for Good spraying result.	40	42.1	55	57.7	34	35.8	6	6.3
Do you adjust the length of your lance when spraying cocoa trees that are tall?	60	63.2	35	36.8	25	26.3	35	36.8
Mixing of two different types of pesticides in the same tank during a sing application.	30	31.6	65	68.4	25	26.3	5	63.2
The wearing of protective clothing during spraying is essential.	90	94.7	5	5.3	30	31.6	60	63.2
Do you have and wear protective clothing during application?	5	5.3	90	94.7	2	2.1	3	3.2

Source: Field Survey, 2015.

IV. Discussion

The ages of farmers ranges between 20 and 90 years. Those within the ages of 20 and 50 years were relatively young, being 57.9% of the total population studied, while 42.1% were 51 to 90 years old. The implication of this is that substantial percentage of farmers in South-western Nigeria is relatively old. This does not sustainably encourage cocoa production as they are likely to resist new information and refuse to source information. 75% of the farmers sampled had more than 10 years farming experience which will promote knowledge transfer and can boost productivity. 76.8% of the farmers had small area of farm, between 0.1 and 4 hectares. This is an indication that majority of cocoa farmers are incapacitated in one way or the other and should be encouraged to increase their farm size probably through provision of incentives. It was noted that more male (77.9%) were involved in cocoa production than female (22.1%). This is corroborated by a report on coffee production (which shares the same agro ecology with cocoa)[10,11]. This is a good trend as men are regarded to be more energetic to handle herculean tasks such as land clearing better than women. Very high percentage (94.7%) of the farmers is married which encourages division of labour between men and women. According to Adebiyi et al. (2009), females mostly undertook on-farm processing and preservation or storage crops like cocoa and kola; the contributions of women were more than that of men in primary processing of coffee beans (Agbongiarhuoyi et al., 2013). The educational status of farmers is very important for interpreting and accepting new innovations and technologies in agriculture. However, very low percentage of farmers (5.3%) possessed higher certificates while 31.6% were SSCE holders and a substantial number (21.0%) had no formal education at all. Reportshowed that most cocoa farmers are not literate; hence, they indulge in serious malpractices in pesticide application such as wrong use of nozzles, wrong formulations and doses, inability to distinguish one pest from the other and wrong timing of application[12]. [3]also noted that education is positively associated with pesticide use, indicating that the highly educated use more pesticides. It may be difficult for those without formal education to interpret, understand, adopt and utilize information on new techniques of farming.

Significant number of respondent (56.8%) spray cocoa trees at 4 to 6 weeks‟ interval, 41% 1 to 3 weeks‟ interval while 1.1% sprayed before fruiting and on-setting of rain. Majority (71.6%) of the respondent followed the recommended label dose, while 10.5% used fraction of recommended rate and 17.7% adopted indiscriminate pesticide usage. The implication of this is that most farmers are adopting approved pesticide application standards which will ensure quality cocoa beans for local and international market. It will also ensure minimum pesticide residue levels and promote good health for consumers of cocoa products. 86.3% of the farmers selected a low volume nozzle for spraying pesticides as against 5.3% that were indifferent about nozzle selection. Selecting correct spray nozzle type and size is essential for pesticide application[5,13]. High volume spraying, mostly obtained through hydraulic nozzles, is the most common and popular method of pesticide application; but low volume (LV) and ultra-low volume (ULV) are preferred for economic pest control[14]. However, relative higher deposition of spray fluids on cocoa trees by the use of high volume spraying when compared with the use of low volume spraying by motorized mist blower in Ghana and fogging sprayers in the Cameroon accelerated the development of resistance[15]. It may, therefore, imply that majority of cocoa farmers in the study area were using the appropriate nozzles for applying pesticides. Notwithstanding, majority of the Nigerian Cocoa farmers still use substandard and inappropriate spraying pumps while attention was not paid to the use of appropriate jets and extension lances where recommended pumps were used[5]. This trend is not encouraging for good pesticides spraying as high volume nozzles are recommended[14].

Reasonably, number of farmers (95.7%) applies pesticides in the morning which is popularly acceptable, while 4.3% were indiscriminate about choice of time. 44.2% half-fill the tank with water before adding pesticide which is the acceptable method/practice, 20% of the farmers fill up the tank before adding pesticides, a total of 31.55% either pour the pesticides and add water or mix separately in a container, while 4.3% mix as convenient. This implies that a reasonable number of farmers are yet to understand the best procedure for mixing pesticides when loading the sprayer tank.

Of the respondents, only 43.5% take cognizance of important requirements like mixing the pesticide in the tank periodically after mounting the sprayer which ensures optimum results. A relatively high number of respondents (74.7%) increased the frequency of pesticide application, while 68.4% increased the dosage as a result of high level of infestation of diseases and pests. This is an attitude that does not sustain cocoa production in Nigeria and it corroborates the fact that indiscriminate use of pesticides by farmers without following manufacturer's instructions ultimately affects the quality of cocoa beans[2]. It is noteworthy thatEuropean Union (EU) has set maximum residue limit (MRL) for cocoa beans for consumption among her citizens which is considered important for exportation and safe local consumption of Nigerian cocoa beans. TheMRL for cocoa bean according to Bateman (2015) is 0.01mb/ha. Higher percentage (64.7%) of the farmers wait until there is a serious leakage from sprayer before rectification. Only 26.3% of the farmers always rectify sprayer leakages whenever it is observed in the flow line. This may be detrimental to spraying efficiency as well been injurious to farmers‟ health if keen attention is not paid to leakages and promptly rectification during spraying operation.

Substantial number of respondent (22.1 and 42.1%) did not understand the importance of precaution and maintenance of sprayer such as spraying in the direction of the wind and washing of sprayer before and after use. Maintenance and mismanagement was identified as one of the problems of pesticide application among Nigerian cocoa farmers[12,15]. Steps such as cleaning the sprayer and nozzle thoroughly after each use, and using clean water and inlet net will ensure effective performance and prevent damage to subsequent crops sprayed and undesirable reaction between residual and new CPPs[14].

IV. Conclusion

This study has revealed that there are challenges in pesticide application in terms of practices and spraying facilities/equipment used among cocoa farmers in the study area, which may impact negatively on the environment and the health of eventual consumers of the produce. It is noteworthy that most farmers adopted the recommended dose as stipulated by the manufacturers. However, some of the farmers still lack good knowledge of the best practices for effective pesticide spraying; this could probably be due to their low level of education on inadequate information on the righttechniques of pesticide application and this implies that training and retraining of farmers is required on pesticides usage and the attendant health risks.

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