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Review

Problems associated with pesticide usage and application in Nigerian cocoa production: A review

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The use of pesticides for effective pests control has generated a lot of concerns relating to public health and environmental pollution. With the new European Union (EU) Legislation on Maximum Residue Levels (MRLs) allowed on cocoa beans and its products, efforts are now intensified to seek measures towards its reduction. The Cocoa Research Institute of Nigeria (CRIN) has the mandate to screen and recommend potential cocoa pesticides and spraying equipment in Nigeria. The Institute has screened and recommended many of these pesticides and equipment in the past. However, with the new EU Legislation on MRLs allowed on cocoa beans and products, some of the pesticides still undergoing screening and the previously recommended pesticides were banned. This new regulation, which came into effect September 1, 2008, has left very few pesticides for use on cocoa both on farm and post farm activities in Nigeria.

Key words: Pests, residue, legislation, equipment, environment, hazard, pollution.

INTRODUCTION

It has been estimated that about 125,000 - 130,000 metric tons of pesticides are applied every year in Nige-ria. In 1991, cocoa pesticides accounted for about 31% of the total agro-chemical market of which fungicides accounted for 65% and insecticides 35% (Ikemefuna, 1998). Pesticide application equipment has been introdu-ced into the Nigerian cocoa farming system, together with the pesticides to be applied, ever since they were used in the industrialized world. Practically, all the different tech-niques available have, at a given time, been introduced more or less successfully.

Pesticide use in Nigeria has been on the increase ever since its introduction in early fifties for cocoa production. Nigerian cocoa production is still dependent on pesticides to attain acceptable levels of crop production. The anti-mirid campaign, which followed the recommendation of Lindane in 1957, resulted in remarkable increase in cocoa production from an average of 103,000 tons per annum in 1961 - 67 periods to 212,000 tons per annum in 1961 - 65 periods (Gerard, 1967). Poor insecticide coverage resulting from the use of inefficient application equipment, wrong timing, irregularity and wrong techni-que of spraying are capable of accelerating the rate at which insects develop resistance to pesticides. Hence, along with the screening of new insecticides, fungicides and herbicides, new spraying pumps are usually eva-luated by the Cocoa Research Institute of Nigeria (CRIN), for their efficiency before they are recommended for use in the application of cocoa pesticides. CRIN has the man-date to screen and recommend potential cocoa pesti-cides and spraying equipment in Nigeria.

However, with the new European Union (EU) Legi-slation on Maximum Residue Levels (MRLs) allowed on cocoa beans and products, some of the pesticides still undergoing screening and the previously recommended pesticides were banned. This new regulation, which came into effect September 1, 2008, has left very few pesticides for use on cocoa both on farm and post farm activities in Nigeria (Table 1). This review paper therefore attempts to elucidate the problems associated with pesti-cide application and equipment that is used in the pro-duction of cocoa in Nigeria and a way forward to imple-menting the right solutions.

HISTORICAL BACKGROUND OF COCOA PESTICIDE USE IN NIGERIA

“Pesticides” are chemical substances that derive their name from the French word “Peste”, which means pest or plague and the Latin word “caedere”, to kill (Akunyili and

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Table 1. List of pesticides currently approved for use on cocoa farms in Nigeria.

S/n	Trade name	Active ingredient	Commercial presentation form	Test pests
	Insecticide			
1.	Dursban48EC	Chlorpyrifos	Emulsifiable Concentrate	Mirid
2.	Actara25 WG.	Thiamethoxam	Wettable Granule	Mirid
3.	Proteus 170 O-TEQ	Deltamethrin 20g/L + Thiacloprid 150g/l	Oil Dispersion	Mirid
	Fungicide			
1.	Funguran^{-OH}	Copper hydroxide	Wettable powder	Black pod
2.	Champ DP	Copper hydroxide	Dustable powder	Black pod
3.	Ridomil gold 66WP	Cuprous oxide + metalaxyl-M	Wettable powder	Black pod
4.	Nordox 75WP	Cuprous oxide	Wettable powder	Black pod
5.	Kocide 101	Cuprous Oxide	Wettable powder	Black pod.
	Herbicides			
1.	Touch down	Glyphosate	Soluble concentrate	Weed
2.	Round up	Glyphosate	Soluble concentrate	Weed

Ivbijaro, 2006). Pesticide therefore can be defined as any chemical substance or mixture of substances intended for preventing, destroying, repelling, or mitigating the effect of any pest of plants and animals. They include herbicides, insecticides, rodenticides, fungicides, molluscides, nematicides, avicides, repellents and attractants used in agriculture, public health, horticulture, food storage or a chemical substance used for a similar purpose (NAFDAC, 1996). Application of pesticides is the most widely adopted method of cocoa insect pest and disease control because of their quick and effective action.

The period between 1938 to 1944 marked the evaluation of miricidal efficacies of botanicals (pyrethrum and derrimac dusts), inorganic salts (nicotine sulphate and lime-sulphur), tar petroleum oil distillates and organochloride insecticides (DDT 25EC) at 2.2% active ingredient concentration on cocoa under laboratory and field condi-tions (Eguagie, 1971). From 1944 to early fifties, chlorinated hydrocarbon insecticides (BHC, Caldron, Dieldrin, Heptachlor and Chlordane) and insecticide applicators were evaluated simultaneously (Eguagie, 1971). In 1957, Gamma BHC (Gamalin 20EC) at 0.25% concentration using knapsack spra-yers was eventually recommended for use in Nigeria (Youdeowei, 1974). The outbreak of termites in young cocoa was effectively controlled by application of Aldrex 40EC at 1% concentration to the soils around the base of the plant.

Dieldrin at 0.25% concentration was effective for the control of ant species, which are known to spread the propagules of the black pod disease pathogen (Maddison and Idowu, 1976). In the seventies, the following fungicides: Caocobre-Sandoz - copper oxide; Brestan - Tin Triphenyl acetate; Bordeaux mixture - copper sulphate + lime; Perenox - copper oxide; Procida BBS - copper sulphate + 5H2o; Orthodifolatan - 4-Cyclohexane Dicarboxymide, were all tested and approved for use in Nigeria. In addition, new fungicides continue to be tested for determination of their suitability for use in the control of the black pod disease (Adegbola, 1975; 1977; 1978).

The intensive use of organochlorides and Lindane-based insecticides for mirid control in Nigeria resulted to the development of resistance by the mirids, thereby rendering the insecticides ineffective (Entwistle, 1964; Gerard, 1967; Booker, 1969; Youdoweei, 1971; Omole et al., 1977). The development of resistance to these insecticides by the pests according to Idowu (1989) may be attributed to the following reasons:

i) Inadequate coverage of cocoa trees during blanket spraying, which could be as a result of using poor spray equipment or irrational selection of trees within the plantation.
ii) Application of sub-lethal dosages of the pesticide. This could be as a result of use of un-recommended pesticide or adulterated/expired pesticides or complete disregard by farmers for CRIN recommendations for pesticide application.

In a continuous effort to combat the resistance problems, new pesticides and spraying equipment were screened regularly at CRIN and those found suitable were recommended to cocoa growers (Omole et al., 1977; Nwana et al., 1983; Idowu, 1987, 1989; Asogwa et al., 2009). Different brands of pesticides, the trombone spra-yers, pneumatic/hydraulic knapsack pumps (high-volume spraying), the motorized knapsack sprayer (low-volume spray-ing) and the swing fog machine (insecticide/oil smoke), have been evaluated and recommended as pesticide applicators (Table 2, 3, 4, 5 and 6).

Inappropriate use of these pesticides and application equipment often results in the contamination of ground and surface water, causes soil/air pollution and disturb

Table 2. List of insecticides previously approved for use on cocoa farms in Nigeria.

S/N	Trade name	Active ingredient	Chem. class	Commercial presentation form	% Active ingredient	Mixture ratio	Test insects
1.	Agrothion	Fenitrothion	Organo-phosphate	Emulsifiable-concentrate (EC)	20	12.5 ml/L	Termites
2.	Basudin	Diazinon	Organo-phosphate	Emulsifiable-Concentrate (EC)	60	4.2 ml/L	Mirid
3.	Dursban	Chlorpyrifos	Organo-phosphate	Emulsifiable-Concentrate (EC)	48	5.2 ml/L	Mirid
4.	Elocron	Dioxacarb	Carbamate	Wettable Powder (WP)	50	3.9 g/L	Mirid
5.	Mipcin	Isoprocarb	Carbamate	Wettable Powder (WP)	75	15.1 g/L	Mirid
6.	Unden	Propoxurr	Carbamate	Emulsifiable Concentrate (EC)	20	12.5 ml/L	Mirid
7.	Thiodan	Endosulfan	Cyclic Sulphuric group	Emulsifiable Concentrate	35	7.2 ml/L	Mirid
8.	Decis-Dan/ Cracker 282 E.C.	Endosulfan and Delttame tlirin	Pyrethoid	Emulsifiable Concentrate	280 (2.0 g)	-	Mirid

Table 3. List of fungicides previously approved for use on cocoa farms in Nigeria

S/N	Trade name	Active ingredient	Dosage	Rate/ha
1.	Caocobre-Sandoz	Copper oxide	13.5 g/10 L H_20	3.36 kg/ha
2.	Ridomil Plus 72 WP	Metalaxyl + Copper	33 g/10 L H_20	3.24 kg/ha
3.	Brestan	Tin Triphenyl acetate	13.5 g/10 L H_20	2.33 kg/ha
4.	Kocide 101	Copper hydroxide	40 g/10 L H_20	2.5 kg/ha
5.	Bordeaux mixture	Copper sulphate + Lime	40 g/10 L H_20	3.8 kg/ha
6.	Perenox	Copper oxide	40 g/10 L H_20	3.4 kg/ha
7.	Procida BBS	Copper sulphate + $5H_20$	40 g/10 L H_20	3.8 kg/ha
8.	Orthodifolatan	4-Cyclohexane Dicarboxymide	45 g/10 L H_20	1.9 kg/ha

Table 4. List of herbicides previously approved for use on cocoa farms in Nigeria.

S/N	Trade name	Active ingredient	Type of herbicide	Rate of active ingredient	Mixture ratio
1.	Asulam + Loxynl 2 - 40	Methyl- sulfanily carbamate	Carbamate (selection) post emergence systemic herbicide	3.4 + 0.5 kg/ha	3.0 L/ha
2.	Glyphosate	N- (Phosphono methyl) glycine	Broad spectrum post-emergence herbicide	1.92 kg/ha	-
3.	Paraquat	1.1 Dimethyl 1- 4.4 bipiridinium (cation) dichloride	Non- selective contact action herbicide	0.56 kg/ha	3.0 L/ha

the equilibrium between insects, their parasites and predators and may result in the development of insect biotypes that are resistant. Progress is being made towards reduction in pesticide usage by the use of cultural practices and resistant varieties.

COCOA PESTICIDE APPLICATION AND EQUIPMENT

CRIN regularly evaluates new spraying pumps, for their efficiencies before they are recommended or disapproved for use by cocoa farmers.

Knapsack sprayer

This type of sprayer comes in a wide range of 5, 12, 15, 16 and 20 litre capacity models. They are suitable for work ranging from vegetable patches to extensive industrial/tree crops, covering the needs of every one from amateurs to most demanding professionals. Shaking the tank vigorously after

Table 5. List of sprayers tested and recommended for use on cocoa farms in Nigeria between 1957 and 2000.

S/N	Name	Manufacturer/Local company representative
Pneumatic knapsack sprayers		
1	Maruyama MHC8	-
2	CP 100 falcon	-
3	CP 148	-
4	Flora Birchmeier	-
5	Gloria 172 RT	-
6	Four Oaks	-
7	Solo Jet Pak – 425	-
Pneumatic knapsack sprayers		
8	AS-Motor	-
9	Maruyama DMD 140	-
10	MS – Iyanmer	-
11	Solo 423	-
Swing fog machines		
12	SN 11	-
Hand pumps		
13	Lancet	-

Table 6. List of Sprayers tested and recommended for use on cocoa farms in Nigeria between 2003 and 2008.

S/N	Name	Manufacturer/Local company Representative
Hydraulic knapsack sprayers		
1.	Pulmic PM 120:	Sanz hnos of Spain/The Candel Company, Nigeria.
2.	Jacto PJ – 16:	Maquinas Agricolas Jacto S.A./Dizengoff Company Ltd Nigeria.
3.	Rosy 16:	Di Martino, Italy/Saro Agro Science, Nigeria.
4.	Solo:	Solo Sprayers Ltd., England/Harvest Field Industries Ltd., Nigeria.
5.	Neptune 15:	Kwazar Corporation S.C., Jaktorow, Poland/Lajibam Auto & Agric concerns Ltd., Nigeria.
6.	Osatu:	Goizper S. Coop, Spain/Adewale Oladayo Trading Stores Ltd., Nigeria
7.	CP 15:	Hardi International A/S of Denmark/Nunees Nig. Ltd.
8.	Kizan KJ – 16:	Indo German Agril Sprayer/African Agro Co Ltd., Nigeria.
9.	Volpi 78:	Davide Luigi Volpi S.P.A. Italy/Jubaili Agrotec Ltd., Nigeria.
10.	Titan heavy duty:	Marolex SP Zo. O Poland/Komes Ventures Ltd., Nigeria.
11.	Mob:	MOB Company UK/Harvest Field Industries Ltd., Nigeria.
12.	Garden 15:	Di Martino S.P.A Italy & Fem-Fun Nigeria Ltd/Timmy Fak General Works Ltd
Motorized knapsack sprayer		
13.	ANVL/Tornado WFB 18:	Agro Nigerian Ventures Ltd/ Lajibam Auto Agric Concerns Limited
Trombone sprayers		
14.	Solo 28 MKI:	Solo Sprayers Limited/ Adewale Oladayo Trading Store Ltd., Nigeria.
15.	Matabi Trombone:	Matabi Spain/Insis Crop Care Nigeria.
16.	Hudson trombone 61224HD	Hudson Asia Limited/ Harvest Field Industries Ltd., Nigeria
17.	Hudson trombone 612219HD	Hudson Asia Limited/ Harvest Field Industries Ltd., Nigeria.

mixing the pesticide provides agitation, which builds pressure by pumping the lever up and down to compress the air in the pressure chamber. The nozzle is interchangeable to limit the desired pattern of spray. The nozzle orifice determines the droplet of spray materials. Nozzle with very large droplets will have greater impact on the leaf, which will result to runoff causing contamination of the soil. Some knapsack sprayers possess extensible lance (detachable telescopic components). The length of the lance can easily be adjusted by moving the two components. This makes it easier for the sprayer to

get effective tree canopy coverage in tree crop plantations. They are readily available in the local market with spare parts and unit cost ranges between 83.3 - $108.3.

Motorized knapsack sprayer

This is a powerful and efficient knapsack sprayer with vertical and horizontal spray pattern, high power volume, high air speed and designed to minimize back strain. It covers professional spraying needs in nurseries, plantations, forest and areas with steep slopes and where it would be difficult to operate with larger sprayers. Their initial cost outlay is high and ranges between 1,000 - $1,250 per unit. Its operation and use also requires a sound technical know-how and they are not readily available in the local mar-kets.

Trombone or Hidronette system sprayers:

These are double action sprayers with adjustable nozzle and jet range of 6 – 8 meter. They are ideal for treating fruit trees and other tree crops. They possess a special feature of a telescopic extension. The counter weight enables this unit to be used with other types of recipient as all models fit tanks and knapsacks of 5, 12 and 16 litres. This sprayer is highly favoured among cocoa farmers for application of insecticides and fungicides because of the relative lower costs of between 50 - $58.3. But unfortunately, it can not be used to apply herbicides effectively.

Swing fog machines

The fogging machine is a specially constructed combustion engine, which injects an oil- containing insecticide into its exhaust gas, which in turn vaporizes it. The oil on leaving the exhaust pipe condenses to form a dense fog consisting of aerosol droplets less than 15 m in dia-meter. The combination of a volatile fumigant fraction and minute combination aerosol makes fogging very effective for the control of insects. The fog should be released close to the ground level of the plantations and allowed to drift to the target sites. However, it is the most expensive spray equipment because of its initial cost out-lay. It is not readily available in the local markets and unit cost ranges from 1,250 - $1,417.

The results of the relative efficiencies and cost-benefit attributes of Pneumatic knapsack (CP 148), motorised knapsack mist blower (Solo 423) and swing fog machine (SN 11), show that swing fogging was the quickest method of applying miricide in large cocoa farms (Omole and Ojo, 1981; Idowu, 1982, 1985). The swing fog machine was capable of covering in one hour about 50 times or 30 times of the area, which mistblower and the pneumatic knapsack pumps, respectively, would cover within the same period (Idowu and Olunloyo, 1984; Idowu, 1985, 1989). There were no significant differences among the miricidal effects of the pesticide formulations, whether it was applied either as coarse droplets with pneumatic pump, or as fine droplets with motorized mistblower, or as smoke, with swing fog machine. None of the trial plots sprayed with the different application equipment showed any phytotoxicity on the cocoa trees. There was also no unusual outbreak of minor pest of cocoa in any of the trial plots indicating no disruption of natural balance of the fauna in cocoa agro-ecosystem (Idowu, 1985, 1989).

INHERENT PROBLEMS IN COCOA PESTICIDE APPLICATION

Toxicity and phytotoxicity

Many of the Class I (highly or extremely toxic) pesticides are still being used in developing countries (Friedrich, 1996). A major cause of poisoning when using knapsack or trombone sprayer is the spilling of pesticides over the back of the operator because of a faulty locking cap of the container. Cracks and leaks in containers and in over aged rubber hoses, and not renewing or loosing washers are a great cause for leakages that often poison the user, wastes pesticides, causes environmental pollution and may become phytotoxic where pesticides fall on crops at high doses (Meijden, 1998).

Mismanagement and maintenance of equipment

There have been reports of high incidence of mismanagement of equipment by cocoa farmers such as incurrect handling, leaving mixed pesticides in the sprayer overnight etc. The farmers also occasionally damage nozzles by enlarging the hole to increase the discharge rate. The lack of maintenance of pesticide application equipment is as a result of lack of spare parts (due to unavailability and unaffordability) and specialized mechanics to repair and maintain the equipment. Most of the cocoa farmers are not literate, hence they indulge in serious malpractices in pesticide application such as; wrong use of nozzles, mixing together of different classes of pesticides, unable to distinguish one pest from the other, use of wrong formulations and doses, wrong timing of application and lack of knowledge on the time needed for degradation of pesticides (Asogwa, 2006, 2008).

Poor availability of pesticides/equipment

A major constraint to good pest management in cocoa agro ecologies of Nigeria is that of inconsistent pesticide availability. Due to limited infrastructure and inefficient supply chain, pesticides are not present when needed, thus defeating one of its most significant advantages, that of rapid effectiveness during sudden pest population increases. There are also serious cases of fake, adulte-

rated and banned pesticides still been sold in the local markets (Victor, 2008; Auwal-Ahmad and Awoyale, 2008). Majority of the Nigerian cocoa farmers still make use of substandard and inappropriate spraying pumps such as the 'Lancet'.

However, even in cases where they use recommended pumps, little attention was paid to the use of appropriate (cone/fan) jets and extension lances. Most of the trees are not covered adequately by the pesticides, the target pests are missed or partially attacked, resulting in the gradual emergence of resistant strains (Idowu, 1989). The relatively higher deposition of spray fluids on cacao trees by the use mainly, of high volume spraying with the pneumatic knapsack sprayer in Nigeria, as compared with the use of low-volume spraying with motorized mist blower in Ghana, and with fogging sprayers (insecticide/oil smoke) in the Cameroon, accelerated the development of resistance in Nigeria (Collingwood, 1976).

Lack of safety measures

Lack of safety precautions causes contaminations and poisoning in the field. Unfortunately, investments in protective clothings, masks or gloves only pay back in terms of health and well being, not in financial terms. Most of the cocoa farmers are ignorant of the hazardous effects of pesticides and are very unlikely to buy protective clothings, especially in cases where they are scarce. In Nigeria generally, farmers do not wear any protective materials at all, no matter what pesticide is being applied (Meijden, 1998). Other precautionary measures are scarcely observed by these farmers as they are found eating, smoking or drinking in-between spraying activities. The left over pesticides and empty containers are not properly disposed as the containers are sometimes washed and used for domestic purposes.

Wrong dosage of pesticide

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 cocoa 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 cocoa production (Meijden, 1998).

Pesticide misuse

There is evidence of poor pesticide education and misuse in Nigeria, for instance a situation where over dosage for the purpose of effecting rapid kill of crop pests is common among government trained, or agency trained and assisted small-scale farmers (Ivbijaro, 1998) . It has also been noticed that these farmers sometimes use these pesticides for purposes other than that for which they are manufactured. Some stunning revelations of pesticide misuse have been reported by some scientists (Ivbijaro, 1977; Youdeowei, 1989; Ivbijaro, 1990, 1998) as follows:

i) Lindane formerly used for the control of cocoa mirids is poured into rivers, lakes and streams to kill fish, which is then sold for human consumption.
ii) Mixing of fungicides and insecticides together during fungicide application period to reduce workload of spraying each differently.
iii) Spraying Gamalin 20 on drying cocoa beans to prevent moulds and maggot development.
iv) Careless disposal of expired pesticides and use of pesticide containers for domestic purposes.

Poor extension services

It is the primary duty of the front line staff of the extension system to enlighten the cocoa farmers on safety precautions as well as general knowledge on pesticide application. In Nigerian cocoa agro ecologies however, these systems are limited in terms of poor staffing and mobility. Extensionists generally lack support, are poorly trained in pesticide management, lack motivation, and there are hardly any follow-up (Meijden, 1998) . The extensionists are generally trained more on which pesticides should be used for which pest rather than on the equipment and application techniques. Also, for the fact that extension workers are not always available for advice, the farmers rely on pesticide vendors and product labels for information on how to apply the pesticides and the safety precautions. The major producers and distributors of cocoa pesticides in Nigeria have in most cases not taken responsibility to provide training for their retailers to enable them assist the end users with precautionary measures.

Low government intervention

In Nigeria, the pesticide regulatory role of the 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, very low budgetary allocation of operating funds, lack of formulation control and pesticide residue analysis facilities and capabilities (Youdeowei, 1989).

DISCUSSION

Over reliance on synthetic chemicals to control cocoa pests has given rise to a number of problems, which may affect the food chain and impacting negatively on biological diversity. The wrong use of synthetic pesticides can lead to secondary outbreaks of pests that are normally under natural control resulting in their rapid proliferation. There have also been cases of pests becoming tolerant or resistant to pesticides, resulting in the use of double and triple application rates (Stoll, 2000). Besides, other problems such as health hazards, undesirable side effects and environmental pollution caused by the continuous use of synthetic chemical pesticides (Nas, 2004), have renewed interest in the application of botanical pesticides for crop protection. Scientists are now experimenting and working to prevent or reduce pest infestation using indigenous plant materials. However, the use of such plant extracts to control pests is not a new innovation, as it has been widely used by small-scale subsistence farmers (Roy et al., 2005).

Pesticides use on cocoa farms has over the years become more specific and less toxic but environmental pollution still exists. However, since practically no data exists on this issue in Nigeria, the extent of the pollution of the agrarian communities can only be guessed. Presently, there is neither any detailed research on environmental impact of pesticides in Nigeria nor any monitoring process in place. The only form of regulation involves the registration of brands of agro-chemicals by the National Agency for Food and Drug Administration and Control (NAFDAC) and screening and recommendation of pesticide formulations and spraying equipment for cocoa by CRIN. The procedures are to ensure that substandard products are not marketed in Nigeria and to confirm the efficacy of formulations offered for cocoa pests control. There is need for the regulatory agencies to contain the sale of substandard pesticides for cocoa as well as other crops in Nigeria. Recently, NAFDAC announced the ban on the use of 30 chemicals in Nigeria in line with the new EU legislation on pesticide use (Auwal-Ahmad and Awoyale, 2008; Victor, 2008). This should be backed up with regular monitoring to ensure that these products are not marketed.

It has become clear that malpractice in pesticide application contributes greatly to the environmental hazards caused by pesticide use. Given the nature of pesticides, these hazards can never be eradicated, but improving the situation, ranging from using better and properly functioning application equipment to training farmers, would minimize the damage (Meijden, 1998). Though the chemical industry is aware of the environmental effect of the misuse of pesticides, they are not giving due regards to promotion of ecologically sound practices that will enhance sustainability in agricultural production. This could be attributed to the fact that the agrochemical business in Nigeria is not adequately coordinated. It is fragmented and unorganised, with a lot of malpractices going on in the process of its marketing and distribution. The resultant effect of such lapses include; counterfeiting and faking, recycling of old stocks, manufacturing of empty plastic containers to market adulterated agrochemicals, which are sold at reduced prices and lack of disposal facilities (Edache, 1998; Oduwole, 2001).

It has been established that farmers in Nigeria have poorly adopted much of the technical knowledge on cocoa pest management acquired from scientific research. The major factors responsible for inefficient application of pesticides are financial constraints, poor techniques, inappropriate equipment, ill timing, inadequate understanding and lack of concern for the consequences of careless use of pesticides (Oduwole, 2001).

The majority of cocoa farmers are often unaware that pesticides should be used in specific dosage in order to be as cost- effective as possible. Another addition to this problem is the unavailability of measuring instruments, illiteracy of farmers and non-calibrated spraying equipment. A means of assuring that at least the concentration of the pesticide in the spraying liquid is correct is the supply of pesticide in sachets containing sufficient dose for each knapsack load, as has been done for some pesticides in Nigeria and other parts of West and Central Africa.

The system proved to be remarkably successful and durable for farmers who could obtain water (Matthews, 1987). There is therefore the need for manufacturers of pesticides to attach to each pesticide bottle a measuring cap that will contain the exact dose for each knapsack load.

The current “EU Regulation 149/2008/EC” has posed a great challenge to all the cocoa stakeholders (Federal Government, State Governments of producing states, National Cocoa Development Committee (NCDC), CRIN, Agrochemical companies, Processors, Farmer Associations and Cooperatives, Banks and Core Investors) in Nigeria.

This has led to organization of national work-shops involving key stakeholders, with a view of fashioning out a formidable strategy to tackle this challenge. Of utmost importance is the evolution of a new national cocoa extension programme, which will embark on aggressive campaign to educate the farmers on this new development and to use only the recommended pesticides.

Finally, considering the prevalent scarcity of farm labour and the inability of cocoa farmers to adhere to recommendations on miricide application, fogging, which is considered the most feasible of the other application techniques, could have been recommended. However, the major constraints to the adoption of this fogging technique are the initial high cost out- lay (e.g. high cost of the machine), inadequate technical expertise to train, organize and supervise cocoa fogging and especially due to the fact that most (90%) cocoa farms in Nigeria are owned by peasant farmers with small holdings (1 - 2 ha) having nearby farm settlements and animals (Omole and Ojo, 1981).

Conclusion

The fogging was considered as the most feasible of all the spraying techniques. However, its adoption depends on the farmers preparedness to invest on the initial cost out-lay of the machine and to cooperate with neighbouring farmers for organised fogging and maintenance of the machine (Idowu, 1989). But in view of the fact that pesticide application trials with the various equipment showed no significant miricidal effects nor phytotoxicity on the cocoa tree, it is recommended that the various sprayers could be used by cocoa farmers for application of pesticides for routine protection of cocoa farms in Nigeria depending on the availability and the farmers' capability to afford them.

The 'Lancet spraying pumps despite its popularity among cocoa farmers (because of its relative low cost and ease of operation and maintenance) was not appro-ved because it does not give adequate spray coverage. Its use has also been found to result in considerable wastage of insecticides during spraying (Idowu, 1989).

A joint pesticide monitoring and regulatory task force should be set up to enforce the removal and disposal of all banned chemicals from circulation. The Government and agrochemical companies should ensure the constant availability in the markets of those active ingredients that are within the new class of allowed pesticides at reasonnable costs. It is only when that is done that the non proliferation of banned agrochemicals outside the "EU Regulation 149/2008/EC" can be guaranteed amongst the cocoa farmers in Nigeria.

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