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Strategies for the control of pests and diseases for sustainable cocoa production in Nigeria

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ABSTRACT: Pests and diseases have largely contributed to the declining productivity of cocoa in Nigeria. About 25 – 30% loss in yield of cocoa has been attribute to the cocoa mired, *Sahlbergella singularis*. 17% is lost through the feeding of the cocoa pod borer *Characoma strictigrapta* while losses attributable to the major disease of cocoa (the black pod disease caused by *Phytophtora megakarya*) range from 30 – 90% in Nigeria. The estimated farm holdings of peasant farmers account for 90% of the 700,000 hectares of land under cocoa cultivation. Many of these farms are poorly maintained, neglected or completely abandoned and with scattered stands. This has drastically reduced the effective hectarage of cocoa in Nigeria to 300,000 – 500,000 hectares thereby bringing down the potential yield realizable from the use of available improved technologies from 1,500kg – 3,000kg dried beans per hectare to the current average yield is 500kg/ha, which is far below the genetic potentials of the crop. This paper articulates the various concerted research efforts which could be harnessed to integrated management of the important pests and diseases of cocoa in Nigeria. The vigorous extension of these technologies to the farmers lays the key to the problem of sustainable cocoa production in Nigeria.

Key Words: Cocoa production; Pest control; Nigeria.

Introduction

Prior to independence in 1960, cocoa export accounted mainly for the agricultural export, which made over 80% of the Gross National Product (GNP) of the Nigerian economy (Ajakaye, 1977). Although its relative importance as a major exchange earner has declined as a result of the growth in the petroleum industry, it remains the largest single foreign exchange earner of all agricultural export crops and the backbone of the economy of the Southern States of Nigeria. It is still the most important agricultural export crop and accounted for about 37.9% of agricultural export in 1997 (Oduwole, 2001).

Currently, a total land area of 700,000 hectares is planted with cocoa (Fasina, 1999). The crop effectively occupies only about 500,000 hectares of these. Decline in cocoa production started in 1971 with a production of 255,000 metric tones and 241,000 tonnes in 1972 and was lowest in 1978/79 with 137,000 metric tones (Are and Gwynne-Jones, 1974). Yields declined further from a peak of about 350,000 metric tones in the mid 80s to about 58,700 metric tones in 1986. This was largely due to old age of trees, disease and pest attack, abandonment of productive holdings as a result of low price incentives

between 1976 and 1985 (Fasina *et al*., 2001). Lack of organized effort at increasing or even maintaining production and the degradation of much of suitable cocoa lands restricted to the southern parts of Nigeria also contributed to the downward trend (Adesimi and Ladipo, 1975). However, the current production rate as at 2000-2003 was between 165,000 – 180,000 metric tones (Taylor, 2000, ICCO, 2002/2003).

Pests and diseases have largely contributed to the declining productivity of cocoa in Nigeria. For example, about 25-30% loss in yield of cocoa has been attribute to the cocoa mired, *Sahlbergella singularis* while about 17% is lost through the feeding of the cocoa pod borer *Characoma strictigrapta*. Losses attributable to the major disease of cocoa – the black pod disease caused by *Phytophtora megakarya* range from 30-90% (Fasina *et al*., 2001; Ndubuaku *et al*., 2003). Concerted research efforts have been made to develop various control techniques (cultural, biological and chemical) which could be harnessed for integrated management of the important pests and diseases of cocoa in Nigeria. However, an effective process for the transfer ot technologies to cocoa farmers that will enable them to understand and adopt these more ecological approaches has been lacking. The extension of these technologies to the farmer would need to be pursued vigorously to increase the effective hectarage of established cocoa in Nigeria.

The objective of this paper therefore is to proffer strategies for the effective control of pests and diseases for sustainable cocoa production in Nigeria.

Economic pests and diseases of cocoa

The cacao agro-ecosystem in Nigeria is inhabited by many insect species. The most economically important and widespread species is the brown cacao mired, *Sahlbergella singularis*, Hagi (Hemiptera, Miridae) which accounts for 25-30% yield loss annually. Other insect species of economic importance are the cacao pod borer, *Characoma stictigrapta* Hmps (Lepidoptera:Noctuidae), the shoot feeders, *Anomis Leona* Shaus, *Earias biplaga* Wlk (Lepidoptera:Noctuidae) and *Sylepta retractalis* Hmps (Lepidoptera:Pyralidae). In areas where the cacao swollen shoot virus (CSSV) disease is prevalent, the meanlybug vectors of the disease, *Planococcoides njalensis* Laing, *Planococcus citri* Risso and *Ferrisiana virgata* Ckll (Homoptera:Pseudococcidae) could also be important (Gerard, 1967; Youdewei, 1974, Ojo, 1980; Ndubuaku *et al*., 2003).

Among the minor pests of cacao, the shield bug. *Bathycoelia thalassina* (H&S) (heteroptera, Pentatomidae), the pod miner, *Mamara* species (Lepidoptera Lithocoletidae) and the root-feeding termites, *Macrotermes bellicosus* (Smeath) (*nigenensis* Sjost) are significant. These and other minor pests such as the sap-sucking psyllid. *Mesohomotoma (Tyora) tessmanni* Aulman (Homoptera:Psyllidae) and the cacao thrips, *Selenothrips rubrocinctus* Giard (Thysanoptera:Thripidae) occasionally attain the status of major pests when agro-ecological conditions in young cacao or ageing cacao plantations, which are undergoing rehabilitation become more favourable to them (Eguagie, 1974a; 1974b; Igboekwe, 1984).

The *Phytophtora* pod rot disease caused by the fungus *Phytophtora megakarya* and the cacao swollen shoot disease caused by Cacao Swollen Shoot Virus are the most important economic cacao diseases in Nigeria. Losses attributable to black pod disease of cacao range from 30-90%. The secondary invasion of pathogenic fungi such as *Calonectria rigidiuscula* following attack by mind and shoot feeders causes dieback resulting in stagheadedness.

Control of Pests and Diseases of Cocoa

In controlling the major and minor pests and diseases of cocoa in Nigeria, the integrated Management approach involving chemical, cultural and biological control methods is recommended. However, the greatest reliance is on the use of pesticides because it provides immediate and quicker remedy in the periods of serious pest outbreaks. Details of some of the recommended approaches are as follows:

1. Insecticides/fungicides recommended for the control of cocoa pests and diseases: The insecticides recommended and approved for mired control in Nigeria are the organophosphates (Diazinon, Fenitrothion, Quinalphos); Organic Hydrocarbon (Endosulfan, mixture of Endosulfan and Deltamethrin) and Carbamates (Isoprocarb, Propoxur and Dioxacarb). Spraying with copper-based fungicides is the recommended chemical method for disease control. The brands of fungicides are Caobre Sandoz, Ridomil Plus, Ridomil Gold, Perenox Kocide 101, Champ DP, Funguran and Copper Nordox. Fungicide spraying is recommended to start at the beginning of rains (April) and repeated every three weeks until the end of the rainy season by October. Pesticides used are subjected to efficacy tests and then selected based on various

criteria which include minimal effective dose, secondary effect of treatment on secondary fauna, residual activity and minimal residue and tainting effect in the cocoa produce.

2. Calendar spraying versus pest monitoring and use of economic threshold: Until recently, the recommendation has been to spray cacao farms for mired control at 21 days intervals commencing from August to November and then once a month in December and January. Contrary to this recommendation, most farmers begin spraying at the onset of the early rains in April/May. Such actions, which often extend till the end of the blackpod season in August are inadvertently directed to shoot feeders which for most of the time are minor pests of cacao. It was observed that during the major mired season, most farmers are pre-occupied with harvesting and processing such that anti-capsid activities are delayed until November to February. By then the effects of mired attack (lesions on chupons, pods and canker, leaf shedding, die-back, stagheadedness etc.) have become most obvious with the peak of dry season (Idowu, 1989).

Presently a threshold intervention system, which involves a farmer-oriented mired monitoring and damage assessment method (pest/damage symptom identification pest counting and deciding whether to spray) is recommended. The symptoms include:

- Fresh lesions on chupons and fan branches
- Fresh lesions on pods and cherelles
- Pockets of dried/wilted fan branches/chupons
- Fresh cankers on trunks/branches
- Formation of stagheads
- Canopy blast in very bad situation
- Pole/dying tress in very bad situations
- Nymphal and adult mirids especially at pod/stem interface and underneath pod peduncle.

In Nigeria, observations have shown that a threshold intervention system is preferred to a calendar-based program because mired attack on cocoa is variable, causing occasional high losses (Enwistle, 1972; Eguagie, 1974b, Idowu, 1982). Thus insecticide usage can be reduced and savings on pesticides can be obtained in years with low pest attack.

3. Determination of damage threshold intervention levels: The recommended procedure for the determination of damage threshold and decision on insecticide spraying is as follows:

a. Farmer walks through length and breadth of farm (TRANSECT) and scores the presence or absence of mireds, mired numbers and fresh damage symptoms per tree on 100 pod-bearing trees selected per ha per farm.
b. The number of infested trees gives a sensitive measure of damage (% damage).
c. The decision is then made as follows:
   <5% damage – do not spray
   >5-25% damage – spot spray
   *25% damage – blanket spray.
d. If a high proportion (70-75%) of the infested pods are already mature and ripened, farmers are advised not to spray. Similarly, spraying is also avoided if harvest is due 9-13 days ahead or if 85-90% of main crop for the year is already harvested (Idowu *et al*., 2001).

4. Pesticide application equipment recommended for the control of pests and diseases of cocoa: Poor insecticide coverage resulting from the use of inefficient application equipment, wrong timing, regularity and technique of spraying is capable of accelerating the rate at which insects develop resistance to pesticides. Hence, along with the screening of new insecticides and fungicides, new spraying pumps are usually evaluated by the Cocoa Research Institute of Nigeria, for their efficiencies before they are recommended for use in the application of cocoa pesticides. Different brands of the pneumatic and hydraulic knapsack pumps (high-volume spraying), the motorized knapsack mistblower (low-volume spraying) and the swing fog machine (insecticide/oil smoke), have been evaluated and recommended and pesticide applicators. The swing fogging method was established as the quickest method of applying

miricide in large cacao farms and was capable of covering in one hour about 30 times or 50 times of the area which the mistblower and the pneumatic knapsack pumps, respectively, would cover within the same period (Idowu, 1985; 1988; 1989; Ndubuaku *et al*., 2003; 2004; Asogwa *et al*., 2004; 2006; Anikwe *et al*., 2006).

Considering the prevalent scarcity of farm labour and the inability of cocoa farmers to adhere to recommendations on miricide application, fogging is considered the most feasible of the other application techniques. It is also noteworthy that relatively higher deposition of spray fluids on cacao tress by the use mainly, on 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 (insecticide/oil smoke) in the Cameroon was said to have accelerated the development of resistance in Nigeria (Colllingwood, 1976). However, the major constraints to the adoption of this technique are the initial high cost out-lay, 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 having nearby farm settlements and animals.

Environmental factors and pesticide use in Nigeria

It has been estimated that about 125,000-130,000 metric tones of pesticides are applied every year in Nigeria. 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).

It has been observed that 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. The agrochemical business in Nigeria is not adequately coordinated. It is fragmented and unorganized. The resultant effect of these lapses is wrong use of pesticide, counterfeiting and faking, recycling of old stocks and lack of disposal facilities (Oduwole, 2001).

Presently, there are 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 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 pest control. However, there is yet no serious effort on the part of regulatory agencies to contain the sale of substandard pesticides for cocoa as well as other crops in Nigeria.

Cultural methods recommended for the control of cocoa pests

The following cultural practices are recommended for use either singly or in combination as an when necessary to minimize invasion and build-up of mirids, black pod disease and herbaceous/parasitic weeds in smallholder cocoa farms.

a. Use of plantain as shade crop for newly established cocoa farms; shade has been found suitable in protecting young cocoa from full sunlight, which can cause moisture stress.
b. Intercropping of young cocoa with broad-leaved cocoyam, maize and cassava is recommended as a means of indirectly controlling weed. Intercropping has been found to be effective in suppressing weeds in young cocoa plantations. The number of weeding per annum in various crop mixtures ranges from 2-3 against 4-5 per annum in sole cocoa (Adenikinju and Folarin, 1971; Adeyemi, 1989). The leaves of arable crops intercropped protected the young cocoa by serving as baffles to most of the cocoa pests and by conserving soil moisture for the optimal development of the young cocoa (Idowu, 1999).
c. Intercropping cocoa with oil palm is al recommended as yield of oil palm and cocoa in the intercropped plots are superior to their corresponding sole crop yields (Adenikinju, 1986; Adeyemi, 1989).
d. Filling gaps created by dead stands, by replacing dead trees with vigorous seedlings under old cocoa or suitable shade crops such as plantain is recommended to reduce the formation of capsid pockets.
e. Maintenance of high standard farm sanitation, which reduces incidence of pests and diseases in cocoa plantations. Weeding is carried out through slashing or application of herbicides.

The herbicides recommended for the control of weeds are Paraquat, Glyphosate and a formulated mixture of Glyphosate and Terbuthylazine (Folar 525 SC).

f. Regular removal of basal chupons and aerial chupons with fresh mired lesions deprive cocoa capsids, shield bugs, meanlybugs, psyllids and most other shoot feeders of suitable feeding and breeding sites, thereby suppressing rapid build-up of their populations.

g. Routine destruction of infected cherelles and moribund pods is effective in curtaining *Phytophthora* pod rot. This will reduce the source of infection from canopy and other unknown sources, which may be responsible for 60% of infection in certain instances (Gregory, 1981). It also prevents rapid build-up of mirids and pod borers such as *Characoma stictigrapta*.

h. Hand crushing of nymphal and adult mirids found on pod-stalks and pods/stem.

i. Preservation of known predators of mirids such as *Oecophylla* spp and spiders by avoiding spraying their nets/tents even during spraying operations.

j. Digging up of eggs of *Zonocerus variegates* around August to expose them to drying and death.

k. Timely harvesting of healthy and infested mature/ripened pods to prevent over-ripening and reduce losses due to pests, diseases and rodents.

l. Removal of shade trees which shed fruits that invite squirrels and other rodents into cocoa farms.

m. Clearing of a wide strip round the plot to prevent squirrels from entering the farm from nearby bush.

n. Careful harvesting of cocoa trees and avoidance of knife cut on pods and stems so as not to provide entry points for pests and diseases.

o. Watching out for the first appearance of black pod at the beginning of the early rains in order to commence early preventive fungicide application.

p. Cutting and burning of swollen shoot diseased trees.

q. Planting of clones which have been found to exhibit considerable tolerance/resistance to CSSV.

r. Construction of drainage to get rid of excess water and to reduce high humidity in water-logged areas of the farm.

s. Pruning overgrown shade and fan branches to improve air circulation and reduce high humidity inside the cocoa farm thereby reducing spread of diseases.

t. Routine cutting of mistletoes, twinning plants and epiphytes before the onset of the early rains and during the August break.

Biological control of cocoa pests

Not much work has been done in the integration of biological control with chemical control of cocoa pests in Nigeria. Notable biocontrol agents (parasites, predators and diseases), which suppress field populations of *S. singularis* have been reported. The bracond parasite (*Euphorus salhbergella*) accounts for 6-42% parasitism of the nymphs. *Mermis* spp. accounts for 4% parasitism. The predators are *Oecophylla longinoda* and species of Reduvidae, Araneidae and Mantoidae (Idowu, 1989).

Areas of future research interest

Proposed future project activities include:

1. Screening of compounds and botanicals for mired and black pod management that are environmentally friendlier and less toxic to humans than the synthetic insecticides. These include: Aqueous Crude Neem Seed Extracts (ANSE), Nitroguanidine insecticide and Actellic/Talstar (Pyrethroid) cocktail, all of which have been reported to have proved effective against mired species in trials in Ghana (Padi *et al*., 2001).
2. Intensification of the search for known natural enemies of cocoa mirids and exploitation of cocoa husbandry practices, which favour the natural enemies. Of particular interest is collaboration with CRIG and CABI in the use of mycopesticides (*Beauvana bassiana*) for mired control.

3. Intensification of the search for pest/disease/drought tolerant cocoa materials.
4. Evaluation of fumivap; the new technique of fumigation for the control of mired, which has been found effective and extremely simple to use in Cote d'Ivoire.
5. Intensification of efforts for the release of high yielding and *P. megakarya* pod rot tolerant cultivars.
6. Studies on rodent biology, ecology and damage as a basis for developing strategies for their control in cocoa plantations in Nigeria.
7. Adopting the pheromone technology developed by CRIG to control the brown cocoa mirids in Nigeria.
8. Investigation into the laboratory breeding of mirids, *S. singularis*.

Current status of cocoa pest management technology transfer and adoption

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 technique, inappropriate equipment, ill timing, inadequate understanding and lack of concern for the consequences of careless use of pesticides (Oduwole, 2001).

It has been reported that in 1998, regardless of the class of cocoa pesticides, the rate of adoption of the recommended usage rates by cocoa farmers in Nigeria was about 14%. Between 1976-1981, when the Federal Government provided 50% subsidy for the purchase of these pesticides to increase its adoption, the farmer's use rates were about 24% of the recommended usage rates. It was reaffirmed that adoption of pesticides is higher when farmers' previous incomes are better and a policy towards income stabilization through input subsidies will not only result in increased adoption of the recommended use rate of pesticides but will also result in better management and increase farmers' cocoa yield (Adegeye and Ditto, 1985; Oduwole, 2001).

Currently, the Federal and state governments of the cocoa producing states have reintroduced subsidy of pesticides and other farm inputs in cocoa production through the National Cocoa Rehabilitation Programme. There is also a liberal import policy, which has resulted in a great influx of different types and brands of pesticides, and farmers face a critical choice of which particular brand to us.

Constraints to technology transfer

The constraints to technology transfer relate to:

- Institutional restrictions and insufficient funds
- Insufficient manpower to reach all small holders
- Lack of expertise in cocoa technology transfer among extension agents
- Ineffective communication of technologies
- Lack of farmer participatory approaches to technology transfer.

Future approaches to technology transfer

The recommended future approaches to technology transfer in Nigeria include:

1. The Farmer Field School (FFS) training methodology should be fully incorporated to complement the existing extension delivery system. A farmer participatory approach is more likely to produce a technology, which will be better adapted.
2. Extension workers should be adequately trained on the principles and application of pest management technologies to cocoa. Training should incorporate social science and communication skills.
3. Educational materials (written and other media) should be simplified to enable farmers carry out the prescribed activities with ease.
4. Participant farmers supported with some inputs (e.g. seedlings, pesticides, transportation, direct access to researchers etc.) should be used as informal extension agents.

Conclusion

Research has made a lot of contributions to the growth of cocoa industry in Nigeria. However, many technologies, which have been developed, are yet to be extended and adopted by cocoa farmers. It has been estimated that farm holdings of peasant farmers account for 90% of the 700,000 hectares of land under cocoa cultivation in Nigeria. Presently, many of these farms are poorly maintained, neglected or completely abandoned and with scattered stands. Consequently, the effective hectarage of cocoa in Nigeria is 300,000 – 500,000 hectares. While the potential yield realizable from the use of available improved technologies is 1,500kg – 3,000kg dried beans per hectare, the current average yield is 500kg, which is far below the genetic potentials of the trees.

To improve the effective hectarage of established cocoa in Nigeria, the extension of the available pest management technologies, which have been articulated in this paper, will need to be pursued vigorously. For the farmer to adopt them, new strategies for effective transfer of knowledge that enables them to understand and adopt these better ecological approaches will have to be developed.

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