Photo of cocoa tree showing pods by Sufor K.N, 2006

Controlling black pod and attack of mirid on cocoa using chemical pesticides by farmers in the Southwest province of Cameroon

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Credit

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Declaration

I, **Sufor Kingsly Ngengong**, declare to the senate of the Norwegian University of Life Sciences, Norway, that this is the product of my own original research work. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature…………………. Date………………

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Controlling black pod and attack of mirid on cocoa using chemical pesticide by farmers in the Southwest province of Cameroon.

Abstract

Cocoa (*Theobroma cocoa*), is cultivated mostly by small-scale farmers and is grown in the humid forest zones of Southern, Central and Southwestern provinces in Cameroon. It stands as the main cash crop to more than 75 % of the population of Cameroon. It production is based on how farmers use chemical pesticides to control black pod and attack of mirid noted to be the major disease and pest respectively of the cocoa crop. In this study, data collection from variables like field monitoring, farmer's constraints, pesticide used and equipments working condition have been analyzed to see the effects it has on controlling black pod and attack of mirid on cocoa. Also, the health and environmental dangers resulting from using chemical pesticides have also been evaluated. Results from the empirical data from the field research conducted show that farmers spray chemical pesticide on their fields irrationally thereby letting insect pests to develop resistance to some chemical pesticides. This has been attributed to the fluctuating weather and climatic condition of the Southwest province. Deplorable road conditions during the rainy season were the spraying activity become intense has been recorded high. This has significantly affected the control of black pod and mirid attack negatively as farmers find it difficult to purchase chemical pesticides at cheaper cost in city markets. Dosage of chemical pesticide and the method of mixing during spraying were understood to be an individual affair and most of the farmers were caught applying under-dose due to high pesticide cost. Over 95% of the farmers complain of pesticide costs being too high making some pesticides unaffordable. This has been attributed to the open-market systems farmers find themselves today following liberalization of the cocoa sector in the country during the late 1980s. Much is still expected from the government, like establishing institutions were researchers, extension officers and licensed buying agents (LBAs) can collaboratively work with farmers so that farmers can get the necessary assistance required to improve cocoa production. Provision of loan for infrastructure development for farm to market roads, capital loan for purchase of pesticides and spraying equipments are some of the opportunities farmers will very much benefit from the government to keep the cocoa sector in the country alive.

List of acronyms and abbreviations

AFTA	Association for Temperate Agroforestry
CICC	Conseil Interprofessionnel du Cacao et du Café
CMB	Cotton Marketing Board
EPA	Environmental Protection Agency
FAO	Food ad Agricultural Organization
FCFA	Currency in French speaking West and Central Africa
ICM	integrated crop management
ICRAF	International Centre for Research in Agroforestry
ICCO	International Cocoa Organization
IITA	International Institute of Tropical Agriculture
IPM	integrated pest management
IRAD	Institut de Recherche Agricole pour le Développement
LBA	Licensed Buying Agents
MINADER	Ministry of Agriculture and Rural Development
NPMB	National Produce Marketing Board
NRI	Natural Resources Institute
ONCC	National Office of Cocoa and Coffee
PIC	Prior Informed Consent
PNVRA	National Agricultural Extension Program
SODECAO	Cocoa Development Company
STCP	Sustainable Tree Crop Program
USD	United States Dollars

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1.0 INTRODUCTION

1.1 Cocoa cultivation in Cameroon

Cocoa *(Theobroma cacao)*, cultivated mostly by small-scale farmers is grown in the humid forest zones of the Southern, Central and Southwestern provinces of Cameroon. It originates from the Andes in the Upper Amazon basin and was first cultivated along the Mount Cameroon area in the Southwest province of Cameroon in 1890 (Temple, 1995).

Cultivation starts by farmers manually clearing forestland. In exceptional cases where there are big trees, chain saws are used to cut down the trees. Clearing of forestland land is done in a selective manner, whereby plants or tree species of economic value are deliberately retained by the farmers. Examples include indigenous fruits, medicinal plants and timber tree species (e.g. groundnut tree (*Ricinodendron heuelotii)*, cola (*Cola nitida*), (*Voacanga africana*); (Duguma et al., 2001)

Cocoa production in the Southwest involves planting of trees on a forestland, though it is not a dominant practice, farmers do plant trees to various types of food crops for one season or two after the land is selectively cleared (Leplaideur, 1985; ICRAF, 1987; Duguma and Franzel, 1996; Duguma et al., 1990).

Farmers initially start by planting on the cleared land egussi melon (*Cucumeropsis mannii*) and maize (*Zea mays*). *C mannii* is a very important food crop in West Africa, it is a climber that grows around the unburned logs thus conserving moisture, increasing humidity and accelerating the process of its decomposition (ICRAF, 1987). When the food crops are harvested, cocoa is then inter-planted with maize, plantain (*Mussa spp AAA*), cassava (*Manihot utilissima*) and other food crops during subsequent seasons.

Inter-cropping is done to exploit the ‘virgin’ soil that is believed to be very fertile. When the food crops are seasonally and annually harvested as they mature, the cocoa is left to develop and is continuously taken care-of till maturity.

The cocoa tree grows best in tropical regions, on a belt between approximately 20^o north and 20^o south of the equator. Most cocoa is grown at an altitude of less than 400 meters (1200 feet) above sea level.

Cocoa bean when harvested, it is dried, packaged and send to chocolate industries where it serves as the principal raw material for chocolate making.

1.2 Cocoa diseases and pests in Cameroon

The major disease and pest faced by cocoa farmers in the Southwest province is the black pod (a fungal disease caused by *Phytophthora spp. e.g P. megakarya and P. palmivora*) and mirids or capsids (caused by *Sahbergella spp. e.g. Distantiella theobroma* and *Helopeltis spp.*) respectively. *P. megakarya* was originally identified in Nigeria in 1979 (Brasier and Griffin, 1979), but become the predominant species in Cameroon, Fernando Po and Gabon in 1981 (Brasier et al., 1981; Nyasse, 1992).

Also, *H. begrothi* has positively been recorded only in Cameroon and *H. gerini* Carayon common in Southern Cameroon. Another capsids species *Bathycoelia thalasina* is found in Ghana.

In Cameroon, controlling the spread of *P. megakarya* is among the most important agronomic and economic priorities, because average losses are estimated at over 50 % of potential production when left untreated (Lass, 1997; Despréaux, 1988; Despréaux et al., 1989).

Mirid is a damaging pest of cocoa reported in Cameroon and West Africa as a whole. *Sahlbergella singularis* and *Distantiella theobroma* are the common species noted. *Distantiella spp*., are the most damaging pests of cocoa and occasional damage resulting from capsid attack has shown to be accounted for 30 - 40 % of pod losses (Neuenschwander and Vos, 2002)

1.2.1 Galleries of cocoa pods infected and destroyed by pests, diseases and rodents

A) *Phytophthora. megakarya:* Cameroon

B) *Phytophthora. palmivora*: Brazil

C) *Sahlbergella singularis* (left): geographically the more widespread species *Distantiella theobroma* (right)

D) *Helopeltis bergrothi*: probably does less damage than other capsids in Africa.

E) *Bathycoelia thalasina* on cocoa (right) to pod causing lesions

F) Damage cause by Rat (left) and Squirrel cocoa pods

Figure 1 (A-F) Galleries of cocoa pods infected and destroyed by pests, diseases and rodents (Entwistle, 1972)

The figures above show cocoa pods been infected by fungi diseases and capsids. A few rodents like rats and squirrels have also been noted as being very destructive.

Infection of the cocoa pods by *Phytophthora spp.* is characterized by appearance of black spots on the cocoa pod, hence the name black pod disease (Figure 1 A-B)

Another important scourge affecting cocoa production are mirids. They are nocturnal sucking insects that usually will not feed during the day unless conditions are dull and wet (Patterson, 1914). Cocoa attack by mirids is characterized by dark markings known as lesions on both pods and shoots resulting to collapse of the plant tissues (Figure 1 C-E). Economic losses and underproduction could be very pronounced during early infection of the young cocoa shoots by the black pod disease and mirid attack. This is because the infected and/or attacked young shoots can no longer generate any cocoa bean, the finished product of post harvesting.

Rodents like rats and squirrels (Figure 1 F) eat mature cocoa beans leading to a decrease in cocoa production. Thus, they have also been noted as enemies to farmers.

1.3 Weather and climate

The fluctuating weather and climatic condition of the Southwest province has a great influence on the frequency of pesticide application to combat pests and diseases of cocoa. The ideal temperature at which cocoa is grown is between 18 ^{o}C and 32 ^{o}C (65 ^{o}F and 90 ^{o}F), and rainfall should be at least 1000 mm but not more than 3000 mm (400 to 1100 inches) per year (Cocoa, 2001).

Climate of the Southwest province is characterized by two seasons;

- The dry season lasting from October to March and the
- The wet or rainy season lasting from April to September (MINADER, 2005)

Humidity tends to be very high during the wet season, coupled with the comparatively high altitude of the cocoa belt, the nights are on the cool side and this combination favors and contributes immensely to *Phytophthora* development. The degree of *Phytophthora* development varies and depends greatly on the weather and climatic conditions (i.e. rainfall, temperature, humidity and relative sunlight) the cocoa fields are exposed to.

1.4 Field monitoring and pesticide application

Generally in Cameroon and the Southwest province in particular, in addition to shade control, pesticide application still stands as the only solution to control pests and diseases of cocoa.

Monitoring of cocoa fields and pesticide application is based on the weather and climatic conditions. The weather and climatic condition known to be fluctuating, determines the frequencies of pesticide application to control black pod disease and mirid attack by cocoa farmers in this region.

Monitoring of cocoa fields and applying pesticides could not always lead to a successful control of black pod. This is because the mycelium has been found in varying amounts in rotting cocoa pods, and viable *Phytophthora* spores have been found to survive on heaps of pod husk for up to three months. Also, insects, particularly ants have been found to be involved in the spread of *Phytophthora* in several places.

Another source for *Phytophthora* spread are disease pods on tall cocoa trees that could not be effectively sprayed or harvested, as they could continue to disperse inoculums from high in the canopy. It could be very challenging to control black pod and mirids during the wet season because of the unpredicted weather conditions. Barombi Kang, one of the study sites has been reported to have a gradual increase in the number of rainy days during the wet season being 90, 152 and 170 days in 2003, 2004 and 2005 respectively (MINADER, 2005).

Mirid attack is greatly enhanced by less shading of the cocoa fields and surrounding forest lands, In the wet season, pesticide application is highest and the dose could vary from one farmer to the other. While some farmers are using 2 or more sachets[1] of pesticide per knapsack sprayer, some are not only applying 1 or less than a sachet per knapsack but go beyond to hit the nozzle of the sprayer to reduce the droplet size of the pesticide.

In the Southwest province of Cameroon, there are no modern meteorological station built that could be of help to farmers regarding weather forecasting. Thus, this has enabled cocoa growers in the Southwest province of Cameroon apply pesticide irrationally. The irrational pesticide application has subsequently led to insect pests developing resistance to some chemical pesticides. On this same note, it has in some cases resulted to pesticide costs outweighing the benefits (Rola and Pingali, 1993).

Copper fungicides are principally used to control the black pod but could be difficult to effectively control the spread during the rainy or wet season as chemicals are often washed off by the heavy rain and thus require the farmers to repeat spraying.

Callisulfan (Endosulfan), an insecticide, is mostly used to control mirids. Mirids, whose saliva on piercing young cocoa shoots is toxic enough to collapse the plant tissue (Entwistle, 1965). Mirids can kill and cause severe damage to young green shoots of cocoa and the damage is restricted to periods of flush when this type of tissues is present. Young cocoa is particularly susceptible to mirid attack. Mirids make cocoa difficult to establish and can prolong the bearing time by several years.

Farmers used varying herbicides like Gramoxone (Paraquat), Glyphader (Glyphosate), Kalach (Glyphosate) and Roundup (Glyphosate) to control weeds in this region. Farmers are usually very dynamic when it comes to using pesticides to control pests and diseases of cocoa. It is usually a common practice to see that if a pesticide is not effective for a given pest, farmers replace the less effective pesticides with a "stronger

[1] Sachets are small packets containing quantifiable amount of pesticide with directory for use usually written on it. The packets can either contain fungicides, insecticides or herbicides.

product" of high toxicity, disregarding whether the new product is appropriate for a given crop or not (Waichman et al., 2007).

Reports from a baseline survey conducted in the Southwest province in 2001 by the Sustainable Tree Crop Program (STCP) of the International Institute of Tropical Agriculture (IITA)-Cameroon, shows that pesticide application has had remarkable increase overtime in the Southwest province. This is because until now, cocoa farmers consider pesticides as the "silver bullet" to control pests and diseases of cocoa.

1.5 Storage of pesticides and working conditions of spraying equipments

Pests and disease control is generally not only limited to the various types of pesticides applied, but also to the working conditions of the various types of equipments used by farmers during spraying. The effective control of cocoa pods in such a case will depend on the manner farmers handle and/or store pesticides and spraying equipments. This has been shown to have a great impact on controlling pests and diseases of cocoa (Mathew, 2003). Proper storage of pesticides will maintain its original form and thus do a better effective control than a faded and/or improper storage one.

Farmers have the freedom to choose whichever pesticide they think will effectively do a great job to them. Chemical mixing, dosage, frequencies of pesticide application of the cocoa fields also tend to vary from one farmer to the other. This has been attributed to factors like input financial viability and the ecological locations of the cocoa fields.

(a) Knapsack sprayers- Lever operated

(b) Farmer spraying cocoa pods

Figure 2 Knapsack sprayers (a) commonly used with farmer (b) demonstrating the spraying exercise

Knapsack sprayers could be of various types and designs. The lever-operated knapsack sprayers (Figure 2 a) are principally used to spray cocoa fields in the Southwest province. Knapsack sprayers are designed to be carried on the back during the spraying exercise (Figure 2 b). Generally, all sprayers are designed to be carried with ease by farmers during spraying. The knapsack sprayers in figure 2, (a) are new and in good working conditions. Generally, a good sprayer will operate efficiently and thus lead to effective control of pests and diseases than an average or bad one.

1.6 Health hazards

As farmers struggle to meet up with high cocoa productivity by suppressing pests and disease attack through pesticide application, misuse and misappropriation of pesticide handling often result, leading to pesticide poisoning of some cocoa growers.

Pesticide poisoning still continues to remain a major problem to some developing countries in the world. Its overuse has been curtailed somehow during the past decades due to recent technology like integrated pest management (IPM [1]), but the risk awareness and body exposure during handling is still a major point of concern. Farmers are not protected enough during spraying, and as such, pesticide poisoning continues to be recorded high.

In Cameroon, irrespective of a list of homologated pesticide recommended to be used by cocoa farmers, there has been more or less no control of pesticide use and farmers continue to use what they think will enable them control pests and diseases of their crops effectively. This has also been one of the contributing factors to the increasing health hazards in this region. For one can never tell what farmers use on their fields as pesticides, all in the name of controlling pests and disease of cocoa.

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[1] "IPM is a pest management system which in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible, and maintains the pest population levels below those causing economic injury"(Smith et al., 1966).

Health and food hazards resulting from pesticide manipulation has been of great concern by the World Health Organization (WHO) and the Food and Agricultural Organization (FAO). Provisions to refuse to consent hazardous chemical imports has been stressed by the FAO during the incorporation of the Prior Informed Consent (PIC) in 1989 into the International Code of Conduct on the distribution and use of pesticides by FAO in 1985. The ineffective control of pesticide in the West-African sub-region still remains a witness (Youdeiwei, 1989).

Report from the WHO says, annually, 20,000 persons out of 1 million victims of pesticide poisoning end up dying (WHO, 1986). Irrespective of pesticide hazards resulting from pesticides applications, worldwide spending on pesticide acquisition continue to increase. In 1988, US$20 billion was spent on herbicides, US$ 6.1 billion on insecticides and US$ 1.3 billion on other pesticides (NRI, 1991).

Nonetheless, pesticide poisoning is not only limited to misuse or misappropriation of pesticide handling but go beyond to the various protective materials (clothing, goggles, nose protector, boots to mention just a few), and the design of spraying equipments used during pesticide application. It is based on the design of spraying equipments that, the FAO carried out a rapid appraisal on the suitability of equipments used to apply pesticides in different regions of the world (Mathew, 2003).

1.7 Environmental hazards

Air, water, land—these are elements of "the environment" that the Environmental Protection Agency (EPA) seeks to protect.

The impact of pesticides on natural enemies of the target pests has undermined the pesticides' long-term effectiveness. With the removal of predators[1] and parasites[2] by pesticides, many pest species hitherto suppressed by their natural enemies returned at

[1] Predators are beneficial insects (e.g. spider, beetles, lacewings), that prevent or limit pest problems in the farms. They do not feed on or harm plants, instead feed on and destroy pest species.

[2] Parasites here are those be useful to farmers, e.g. Flesh flies (*Neobellier citellivora*) is one of the most devastating parasites of the Richardson's ground squirrels (squirrels feed and destroy farmers cocoa pods). The adult fly lays live larvae (maggots) primarily on the backs of ground squirrels. The larvae then burrow beneath the skin and begin feeding and can lead to death of the squirrel.

much greater numbers (pest resurgence), and indigenous species, which had previously been economically insignificant, emerged as secondary pests (Youdeowei and Service, 1983; Kenmore, 1991).

For instance, following an intensive rice monoculture in Indonesia in the 1970/71 season, the rice brown planthopper (*Nilaparvata lugens*), which was hitherto not considered as pest in many rice growing countries, suddenly assumed pest proportions with over-use of insecticides against rice stem borers. In areas where farmers used a lot of chemicals, the rice brown planthopper densities increased about ten times higher than in other fields where insecticides were not used (Kenmore, 1991).

It is estimated that 68 % of environmental contamination result from agriculture (Majid, 1997). This is principally due to the widespread use and disposal of pesticides by farmers. As farmers spray cocoa trees fields to control pests/diseases and weeds, pesticide ends up in the soil, and through surface run-off, water animals are destroyed as well as pollution to the air through evaporation.

The contamination of the environment by pesticides through leaching residues into ground and surface water and by soil accumulation has been recorded very high in some developing countries. For example, during a comparative large survey in Thailand, residues were found in over 90 % of soil, sediment and fish samples as well as in over 50 % of water samples (Jungbluth, 1996).

1.8 Problem statement

Farmers in Cameroon have been facing a lot of crises in the cocoa production sector, as far back as in the late 1980s. This has principally been as a result of liberalization of the cocoa sector. The National Produce Marketing Board (NPMB), a parastatal, was responsible for the acquisition and distribution of chemical pesticides to cocoa farmers. Farmers were solely relying on subsidized pesticides from the government and were therefore not concerned about alternatives to heavy pesticide use. This never lasted long when the cocoa sub-sector was badly hit by the overall economic crisis in 1989. Cocoa prices fall at the international level and the government had to undergo tough structural adjustment programs. The government withdraws from subsidizing farmers and above all, liberalized the cocoa product market (Sonwa et al., 2002).

The use of mistle blowers to control pests and diseases on farmers' cocoa fields carried out by well trained state agents at no cost to the farmers came to a hault. The responsibility was shifted to the private sector, the Licensed Buying Agents (LBAs) who until now has not been able to meet up with equal responsibility. A new law was promulgated dealing with pest control: Law No. 90/013 of 10 August 1990, with its implementation decree No. 92/223 of 25 May 1992. This law abrogated previous laws and set the regulating framework for pest control activities. However, these laws did not really enter into force until 1996 when the technical ministries finally settled the practical modalities. This was done in conformity with Article 6 of the International Code of Conduct for the Distribution and Use of Pesticides.

Post-liberalization of the cocoa sector and the economic crisis during the early 90s have been a remarkable onset for cocoa farmers' difficulty. They have not been able to receive subsidies from the government and institutions meant to support the cocoa sector are weak and ineffective. Examples of institutions include the National Agricultural Extension Program (PNVRA), Cocoa Development Company (SODECAO), Conseil Interprofessionnel du Cacao et du Café (CICC) and the National Office of Cocoa and Coffee (ONCC). These all lack the resources required to fulfill the support roles ascribed them.

Similarly situation was experienced in Zimbabwe were until 1997, the Cotton Marketing Board (CMB), a parastatal, offered package services to farmers in cotton areas, linking the supply of high quality cotton seed to chemical supplies and direct marketing opportunities (Keeley and Scoones, 2003).

During the post-1991 period of liberization and deregulations, the main parastatals, Seed Coop and CMB were sold off during the 1990s with the government retaining only a minority stake. The company operated with a separate management structure independent of the government benefiting from the exclusive rights to a range of important germplasm developed in the public sector over many years. Thus the credit package farmers used to get from parastatals to ensure that the system was controlled vertically through the CMB was lost and the cotton sector in Zimbabwe was becoming unsuccessful thereafter.

In Cameroon, some of the other problems resulting from liberization of the cocoa sector have been fluctuation of pesticide costs that have been noted to be gradually increasing overtime. This is probably because the LBAs who now deal directly with the farmers determine always to their favor, the costs and sales prices of pesticides and cocoa bean respectively. The high costs recorded during the onset of the post-liberalization era was compounded with the devaluation of the CFA franc (FCFA) that hit the economy in 1994 making almost all the cocoa input costs to be doubled, thus, unaffordable to some farmers. Consequently, the cocoa production sector suffered from neglect and in some cases was abandoned (Losch et al., 1990).

High pesticide costs have been reported to be increasing by more than 95 % of cocoa farmers in this region. The increasing pesticide costs have been considered a constraint, thus a contributing factor that could have possibly led to the persistent attack of black pod and mirid on the cocoa crop. Nonetheless, a report from the baseline study in 2006 by STCP/IITA on Tree Crop Production and Livelihoods Project for the Centre and Southwest provinces, says cocoa production in the Southwest province has been on an increase instead, increasing by about 5 - 35 % in the last few years. This has been favored by the relatively more fertile soils in the province with farm sizes averaging between 1 and 1.25 ha.

Comparatively, cocoa production in the Centre province has dropped from 50 % to 40 % contribution to the national output with farm sizes averaging between 0.5 and 0.8 ha. Also to consider, there are some financially viable farmers who even though could afford the expensive pesticides still complain that attack of black pod and mirid still remain a major problem to handle.

Generally in Cameroon and from previous studies documented, farmers in Cameroon from day to day keep developing—in addition to chemical control—local or traditional methods to control pests and diseases of cocoa, all in the name to curb high pesticide costs. Thus one could raise the question “Is persistent black pod disease and mirid attack resulting from pesticide constraints like those resulting from high pesticide cost OR from irrational (inappropriate and untimely) pesticide application frequencies by cocoa farmers”?

1.9 Study objectives

This study stresses to understand how cocoa farmers in the Southwest province of Cameroon today use pesticides with the following as specific objectives;

- Understand how farmers monitor their cocoa fields and decide to use chemicals
- Identify the constraints in managing pests and diseases of cocoa
- Identify what pesticides they use and how they handle and apply them
- Identify the different equipments/clothing acquired, handling and their storage
- Evaluate the safety/health awareness associated with pesticide handling and application
- Evaluate the environmental awareness associated to pesticide manipulation.

2.0 LITERATURE REVIEW

2.1 Cocoa on the national economy

Cocoa stands as the main cash crop to 75 % of the population of Cameroon (Nfinn, 2005). Cameroon being the 4th highest producer of cocoa in Africa producing over 180.000 ton annually is also the 6th world producer, producing 5 % of the world total production (ICCO, 2003).

Cameroon cocoa belts represent about 37 % of the total cultivated soil of the country. It production has risen gradually from 130.000 ton to 180.000 ton within the past ten years. Within this same period, cocoa prices at the world market fell resulting to a decline in the country's export earnings.

Globally, yield loss due to disease is estimated at about 30 % (Padwick, 1956). In West Africa, it ranges from 10 to 80 %, 10 to 30 % in Cote d'Ivoire, 30 to 50 % in Ghana and Togo, and 50 to 80 % in Cameroon (Bakala and Kone, 1998). On the same note, 450 000 ton of cocoa is lost in West Africa as a result of the black pod rots. Equally, over 200 000 ton of cocoa is lost in West Africa, resulting from capsids (*Sahlbergella spp; Distantiella theobroma)* attack. Various estimates of cocoa losses, typically between 1 – 20 % are attributed to vertebrates (woodpeckers, squirrels, rats and large mammals) attack (Entwistle, 1972).

2.2 Indigenous and traditional ways to manage pests and diseases of cocoa

Traditional method of indirect pest control measures practiced and relied on by farmers (like crop rotation or intercropping, mechanical means of pest control such as pulling out of weeds, removal of egg masses from plants, and destroying of crop residues) has over the past several decades caused an important shift following the introduction of toxic chemicals which was believed to kill large number of pests easily and in a short period of time (Kwame, 1996). Thus, the use of toxic chemicals to control pests and diseases continue to be at the forefront.

None the less, because of high pesticide costs, the desirability for pests control alternatives by the indigenous farmers is becoming evident. Today, cocoa farmers in the Centre and Southern provinces of Cameroon can produce locally made pesticides from plant extracts. Examples of extracts are "Banga"*(Canabis sativa)*, "Essingari" *(Guirbourtia tesmanii,)* "Elon" *(Erythrophleum ivorense)* which are used to combat pests and diseases of cocoa (Sonwa et al., 2002).

2.3 Pesticides commonly used in Cameroon

The pesticide names (trade names) listed below are those the farmers are familiar with. Pesticide effectiveness depends so much on the active ingredient that constitutes a particular pesticide. In Cameroon, a trade name (e.g. Ridomil; a fungicide) can be used for 3 different types (e.g Ridomil Gold plus 66 WP, Ridomil Gold 65 WP, Ridomil Plus 72 WP) all having different proportion of active ingredients. The same applies to some insecticides and herbicides (Table 2.1).

The WHO classification for each pesticide is also listed to understand the health hazards farmers encounter each time users are exposed to pesticides.

Table 2.1 Homologated chemical pesticides used in Cameroon for 10 years (for 20th March 2003), (MINADER, 2006)

Only pesticides commonly used by cocoa farmers have been listed.

Pesticide trade names	Active ingredient	WHO classification
Fungicides		
Ridomil plus 72 WP	Metalaxyl (12 %) + cuprous oxide (60 %)	III
Ridomil gold plus 66 WP	Metalaxyl (6 %) + cuprous oxide (60 %)	III
Ridomil gold 65 WP	Metalaxyl (5 %) + cuprous hydroxide (60 %)	III
Nordox 75 WG	Copper oxide (58 %)	III
Nordox 50 WP	Cuprous oxide (58 %)	III
Kocide 2000	Cuprous hydroxide (54 %)	III
Kocide 101	Cuprous hydroxide (56 %)	III
Caocobra	Cuprous oxide (56 %)	III
Callomil plus	Metalaxyl (12 %) + cuprous oxide (60 %)	III
Insecticides		
Callisulfan 35 EC	Endosulfan 350 g/l	II
Cypercal 12 EC	Cypermethrine 12 g/l	II
Basodine 600 EW	Diazoninon 600 g/l	II
Thiodane 50 EC	Endosulfan 500 g/l	II
Actara 25 WG	Thiamethoxam 250 g/l	III
Karate 5 EC	Lamda-cyhalothrine 50 g/l	III
Herbicides		
Gramazone super	Paraquat 200 g/l	II
Roundup 120 SL	Glyphosate 120 g/l	U
Roundup 360 SL	Glyphosate 360 g/l	U
Glyphader	Glyphosate 360 g/l	U
Kalach 120 SL	Glyphosate 120 g/l	U
Kalach 360 SL	Glyphosate 360 g/l	U

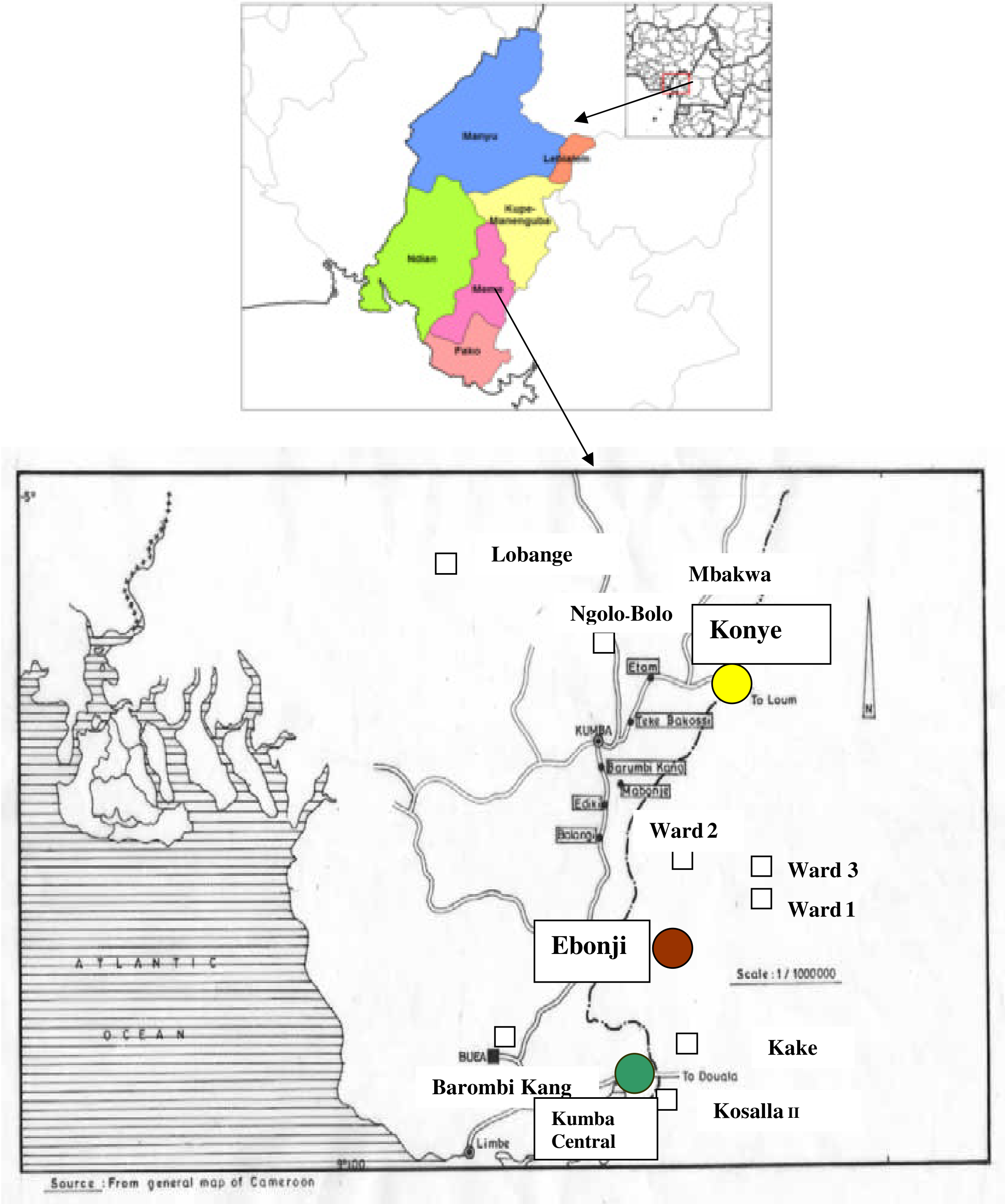
Ia = extremely hazardous, Ib = highly hazardous, II = moderately hazardous,
III = slightly hazardous, U = unlikely to present acute hazard in normal use.

According to Pest Management Notes No. 12 on Sustainable Cocoa Production Systems, it is recommended that farmers spray copper-based fungicides up to 7 times a year to control black pod, nonetheless excessive dosage and the use of spurious products has been recorded (Kranthi et al., 2002; Shetty, 2003). The elimination of natural enemies and pest resistance has reduced the efficiency of pesticides to control pest populations. Over 500 pests have now developed resistance to one or more types of pesticides (Wandji et al., 2005). Pesticides can be dangerous and pesticides are expensive.

Today, farmers applying pesticides to control pests and diseases of cocoa have been reported to be of ill health resulting from misuse and misappropriate of pesticide handling. This has been of great concerned by the Food and Agricultural Organization (FAO) of the United Nations. Health hazards resulting from misuse or misappropriate of pesticide handling is not only limited to the pesticide itself but go beyond to the various protective clothing and equipments designed to be used during pesticide application. Farmers have been reported to be exposed to pesticide spillages resulting from both inconsistent designing of the spraying equipment and inappropriate protective clothing.

In West Africa and in Cameroon in particular, pests and disease of cocoa are still dependent on pesticides to attain acceptable levels of production. Modern pesticides have reached the most remote areas of the world; nonetheless, the technology used for their application often reflects technical standards of 40 years ago, resulting in a waste of pesticides and unnecessary environmental contamination (Friedrich, 1996).

Farmers in the Southwest province have individual spraying habits, while some farmers practice irrational pesticide application by spraying frequently to control black pod and pests; some are on the opposite site spraying not often and practice under dose pesticide application. Farmers still use nozzles of knapsack sprayers that are worned and the result has been pesticide leakage during the spraying exercise leading to pesticide waste and ineffective pest and disease control. Cases have been reported where by only changing the nozzles of lever operated knapsack sprayer, 70 % of pesticides could be saved compared to farmer’s previous practice (Stallen and Lumkes, 1990).



Key: **Kumba Central** **Ebonji** **Konye**

Figure 3. A descriptive map of the Southwest province showing Meme division, the study area

3.0 STUDY AREA AND METHODOLOGY

3.1 Description of study area

The South west province is one amongst the 10 provinces of Cameroon. It has a population of over 1.242.749 million with a total area of 24.571 km^2. The population density approximates 51 inhabitants per km^2 (INS, 2004).

Meme division is one amongst the six divisions of the Southwest province. It is bounded on the south by Fako division, on the East by Mungo division, on the North by Kupe Muanenguba division and on the west by Ndian division.

Meme division has a relatively low relief and is well drained. It has a cosmopolitan population of about 200.000 inhabitants with over 75 % of the population involved in farming. The soil of Meme division is naturally rich and consists of volcanic soil in particular. This has greatly enhanced rapid tree growth leading to early cocoa production.

In addition to cocoa, coffee and rubber are also major cash crops grown in Meme division (MINADER, 2005) with respective average yearly production (Table 3.1).

Table 3.1 Major cash crops grown in Meme division (MINADER 2005)

Crops	Average yearly production (tonnes)
Cocoa	15.000
Coffee	6.000
Rubber	4.000

The communication network in Meme division is mainly by road transport. During the rainy season, the road networks especially the farm to market road in the rural areas is deplorable making it almost impossible to access certain zones in the division.

Kumba central, Konye and Ebonji are located within the rainforest zone of the Southwest province of Cameroon approximately 100 km, 140 km, and 118 km respectively from the Atlantic Ocean with latitudinal and longitudinal positions of ($4^o3´$ N, $9^o3´$W), ($4^o8´$ N, $9^o3´$W) and ($4^o5´$ N, $9^o4´$ W) respectively (Figure 3).

The regions are all in plain surrounded by volcanic mountains: the Rumpy Hills (1765 m) to the north-west, the Kupe Mountain (2050 m) to the north-east, and Mount Fako or Cameroon Mountain (4094 m) to the south-west.

3.2 Weather and climatic conditions of Meme division

The Meteorological station of choice in this study was that located at Barombi-Kang, one of the sample villages located in the Kumba Central. This is because, it is the only one located within the study area. Information on climatic and weather conditions in the South west province could also be recorded from other stations like those of Mukonje and Mbonge. The two later stations mentioned were those taken into consideration by the Sub-divisional delegation of agriculture and rural development in the South west province under the Ministry of Agriculture and Rural Development (MINADER) during the 2006 annual report

Table 3.2 (A-C) Rainfall, Temperature, Relative humidity and Sunshine in Meme division (MINADER, 2006)

A) Rainfall

The annual average rainfall recorded in 2005 by the Meteorological Station was 2126.2 mm with a total of 170 rainy days (Table 3.2 A). The figures recorded in the Kumba central areas were assumed not to vary much from the other study zones that hadn't meteorological stations. The greater the number of rainy days, the wetter the cocoa fields and the more pesticides farmers will have to use to control the black pod disease since *Phytophthora spp.* become dominant.

Rainfall (mm) for the past three semesters 2005/2006 recorded at the Barombi-Kang Meteorological station

Semesters / Stations	January-June 2005		July – December 2005		January – June 2006	
	Rainfall	Rainy days	Rainfall	Rainy days	Rainfall	Rainy days
Mukonje	959.5	35	845.7	37	426.8	20
Barombi-Kang	1132.8	71	993.4	99	23.95	35
Mbonge	-	-	-	-	-	-

B) Temperature

The annual average temperature recorded in 2005 within the study zones did not vary much and range between 21 °C and 42 °C (Table 3.2 B).

Average temperature (°C) for the past three semesters 2005/2006 recorded at the Barombi-Kang Meteorological station

Semesters / Stations	January – June 2005		July – December 2005		January – June 2006	
	Temperature (°C)					
Mukonje	minimum	maximum	minimum	maximum	minimum	Maximum
	23.5	30.5	23.5	34.4	23.6	30.5
Barombi-Kang	22.0	40.5	21.8	41.7	23.9	25.7
Mbonge	-	-	-	-	-	-

The maximum average temperature of 25.7 °C recorded within the first 6 months (January – June) of 2006 is considered very low, thus because places will be too cold, farmers are likely to use more pesticides to control pests and diseases of their cocoa fields. The lower the temperatures, the more farmers are likely to use more pesticides on their fields to control the black pod disease since *Phytophthora spp*. become dominant**.**

C) Relative humidity and sunshine

The annual relative humidity recorded in 2005 varies from 52 % to 74 %. High humidity favours *Phytophthora* development, thus the higher the relative humidity, the more pesticides farmers will have to use on their cocoa fields to control black pod disease. Unfortunately, relative humidity for the first 6 months of 2006 was lacking, thus pesticide application could not be presumed. This same year, the annual average sunshine of 208.15 hours/day was recorded, thus there were more sunshine days than rainy days in the year 2005 (Table 3.2 C).

Relative humidity (%) and sunshine (hours/day) for the past three semesters 2005/2006 recorded at the Barombi-Kang Meteorological station

Semesters / Unit	January-June 2005	July – December 2005	January – June 2006
Relative/humidity	52	74	-
Sunshine	174.5	208.15	157.2

3.3 Field work and data collection

The field work was conducted over a period of three months (November 2006 through January 2007) assisted morally by IITA- Cameroon formally arranged by my supervisor at Noragric, (Norwegian University of Life Sciences, UMB) and co-supervisor at Bioforsk (Aas, Norway). There were two enumerators during the field work who were suitably qualified with a minimum qualification of a diploma. These were; the researcher himself, assisted by another guy (a field assistant presently working with STCP-IITA, Cameroon) almost of the same age as the researcher and recommended by the researcher's field supervisor.

The research was carried out in a region were the researcher hailed and has an understanding of the cocoa cropping system since he was assisting his parents part time in their cocoa fields while studying. Thus it was not a major problem for him to develop his questionnaire for the field work. Also, the enumerator working with the researcher has been to cocoa fields and has equally administered questionnaires to farmers, thus communication with farmers was obviously not a major problem. The previous association of the researcher with cocoa farmers gave him added advantages and pre-testing of the household questionnaires didn't take us long to come out with a final one. Thus while in the field, data collection was not a major problem to us.

A) Survey methods

The three study zones (Kumba Central, Konye and Ebonji) were those initially selected by STCP/IITA during a baseline study on tree crop production and livelihoods project for the Centre and Southwest provinces of Cameroon (STCP/IITA, 2006). Within these study zones, a reconnaissance survey was conducted to selected villages which have households practicing cocoa farming be it in group or at individual level.

Amongst the three study zones of the study, Kumba Central is the largest and biggest commercial town in Meme Division. Unlike Konye, approximately 40 km from Kumba central, Ebongi is only 18 km. Thus, it was chosen to be the reference point to the other two study zones and pre-testing of the household questionnaire was administered in all the 3 selected villages (Barombi-Kang, Kake II and Kossalla II) in the Kumba central study zone. Pre-testing of the household questionnaire was convenient but carried out by randomly selecting a total of nine households, three coming from each of the villages. There were all together 10 villages selected from the three study zones in an irrational manner. The irrational selection was as a result of some zones having more villages practicing cocoa farming than others.

B) Data collection methods

Both qualitative and quantitative methods were complimentarily used to collect as much detail information as possible for the study. Qualitative method of data collection was principally by group discussion with the farmers, and this usually occurs in a situation were we happen to find the farmers sitting in group. Useful information from the group discussion were jotted down that helped in the 'result and discussion' to get a broader picture and clear understanding how pesticides are being used by the farmers to control black pod diseases and pests on their cocoa fields.

Quantitative method of data collection was conducted by administering structured questionnaire to households engaged in cocoa farming. Interviewing was by face-to-face contact and responses from the structured questionnaire administered were entered using a pencil. A total sample size of 100 was fixed for all the three study zones. Selection of respondents was done by probability using simple random sampling. Statistical analysis was principally based on quantitative variables answered during data collection.

The total numbers of respondents were not equal across all the three study zones. This was because there were some areas that sample collection were much easier to get than others within the limited time frame. We were able to get in contact with more interviewee in Ebonji, second by Konye and lastly Kumba central. Sample collection was achieved by moving into households and interviewing the farmers. Cocoa farmers were interviewed individually based on the following variables:

1. household characteristics,
2. acquisition , handling and storage of spraying equipments
3. acquisition, handling, storage of the various pesticides use
4. frequency of pesticide application and dosage
5. safety and protective strategies, environment awareness as well as pesticide risk perception
6. And also their constraints in acquisition of equipments and pesticides to pests and disease control.

Individual interviewing was necessary as we assume each farmer has got his/her own system of pests and disease control, as such a farmer response should not be influenced by another farmer. Each interview lasted for one and a half hour and was principally conducted in the evenings when the farmers have returned from the farms. Listed below are the various sampled villages for the study with their respective total number of interviewees (Table 3.3).

Table 3.3 Study zones showing the number of interviewees per sampled village

Zones	Central area	Sample villages	Number of interviewees
1	Kumba central	Kake II	8
		Kossala II	8
		Barombi Kang	16
2	Konye	Konye	4
		Ngolo-bolo	4
		Lobange	10
		Mbakwa-supe	10
3	Ebonji-	Ward I	15
		Ward II	15
		Ward III	10
Total	3	10	100

3.4 Ethical issues

This is mainly concerned with how to treat research subjects and what activities to engage in or not in relation with other subjects. Bryman (2004) asserted that some writers tend to differ widely on issues of ethical concern. However there are some basic ethical principles that researchers should always understand to guide them in the fields. Ethical issues like invasion of privacy, confidentiality, and harm to participants, informed consent and deception (Bryman, 2004:509) should be taken note of by researchers.

In this study some ethical issues were respected while on the field especially those problems likely to arise in the course of data collection.

Before we could go into the field we had with us authorization from STCP/IITA-Kumba branch to avoid unforeseen circumstances of identification that could cause a delay in our work. While in the field, we always met first the community leader known as the Chief, some of who after going through our authorization, will later on pass our message to the village community so that the farmers can collaborate during data collection.

Also, before we could start administering the household questionnaires, we made farmers to understand that, we are conducting the study purposely for research and that results from our findings could possibly help them subsequently more especially if agricultural extension services are to be established. The reason behind this was because, during pre-testing of the questionnaire, we realized some farmers were falsifying some of their responses to our questions as they felt they will be pinpointed if any benefit is to come later. For those parents who could not understand our questions well, a chance was given to either children and/or spouse for detail explanation.

3.5 Statistical analysis

Data from household questionnaire was analyzed using Microsoft Office Excel 2003, Minitab 15 Statistical package. Tests were run at 95 % confidence level.

A) Descriptive statistics

These statistics involves using means, standard deviation, minimum and maximum variables of the data set. It was used to tests for variables describing household, farmer's characteristics, land tenure situation acquisition of pesticides and spraying equipments with their handling and storage, frequency of pesticide application and their dosage, health and environmental awareness during pesticide application.

Testing variables from household characteristics such as sex and age distribution of household, level of education, we can be able to explain to some extend the impact of household characteristics to controlling black pod diseases and pests of cocoa by farmers in the Southwest province. Minitab statistical package was preferably used to run tests.

Microsoft Office Excel 2003 was the sole software used to plot graphs from the findings of this study.

B) Linear regression

This is used to establish a relationship between ***dependent variable (regressand)*** and ***independent variables (regressors)***. In this study the dependent variable (outcome of black pod disease and mirids control) was considered while independent variables (such as respondent level of education, farmers participatory learning, nature of mixing pesticides, frequency of pesticide application, pesticide storage and also the working condition of knapsack sprayers) were also considered. The linear regression with multiple regressors according to Stock and Watson (2007) was used;

The model was estimated by the general equation;

$$Yi = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_k X_{ki} + u_{i,\, i=1,\, \ldots,\, n,} \quad \text{..........} 6.6$$

$\boldsymbol{\beta_0}$ is a constant

$\mathbf{Y_i}$ is the i^{th} observation on the dependent variable (the outcome of black pod disease control and mirid attack).

$\mathbf{X_{1i}, X_{2i}, \ldots, X_{ki}}$ are the i^{th} observation on each of the k regressors (such as respondent level of education, farmers participatory learning, nature of mixing pesticides, frequency of pesticide application, pesticide storage and also the working condition of knapsack sprayers).

$\mathbf{u_i}$ is the error term.

The model was used to test to see those quantitative variables (regressors) that could really have an impact on controlling black pod diseases and mirids on farmers cocoa fields. The quantitative variables were considered to have an impact on the outcome of controlling black pod disease and mirids of cocoa by the farmers.

The linear regression with multiple regressors was successful since all the farmers in the Southwest province face the problem of black pod disease and mirids attack.

4.0 RESULTS AND DISCUSSION

4.1) Farmer's characteristics and land tenure situation

4.1.1 Farmer's characteristics

Table 4.1 Descriptive statistics of variables for farmer's characteristics defined during data collection

Variables	Description	Mean	Std dev	Minimum	Maximum
Sex	Sex is a dummy variable (0= female and 1= male)	0.9900	0.1000	0.0000	1.0000
Age	Age of the farmer (years)	45.54	13.18	22.00	75.00
Marital status	Marital status of the farmer 1=single, 2=married, 3=widow, 4=widower, 5=divorce	1.8926	0.3696	1.0000	5.000
Education	Farmer's level of education 0=none,1=primary,2=secondary, 3=upper secondary,4= university	1.2400	0.7264	0.0000	5.0000
Organization	If farmer is member of a farming group or organization .It is a dummy variable (0= No, 1= Yes)	0.5800	0.5160	0.0000	1.0000
Organization type	Organization type if farmer is member of a farming group or organization 1=farming,2=research, 3=cooperative, 4=CIG	1.895	1.277	1.000	4.000

A) Sex

Sex is a dummy variable that indexes the gender of the farmer (0=female, 1=male). Most of the farmers (99 %) interviewed were men (Table 4.1). In this study region, a man was considered the head of each household[1] and was the sole source of information during data collection, though in exceptional cases, a household member could come in to better explain in those cases where the household head cannot understand the enumerators well.

Also in this study, women were interviewed, but these were in exceptional cases like death of a husband where a woman automatically assumes the position as head of each household. In this situation, a woman therefore has land user rights and has rights to own lands.

Generally in the Southwest province at Cameroon at large, cocoa cropping is considered as men's business, thus they are generally those who get recent information on pests and disease control and also incur whatever risks it takes to manage the cocoa crops than the women. On this same note, controlling black pod disease and mirid attack involved carrying knapsack sprayer with pesticides in it (approximately 16 liter by volume) and spraying cocoa pods, this is usually very heavy and women cannot carry. Thus the researcher hypothesized that sex is positively related to controlling black pod disease and mirid attack.

B) Age

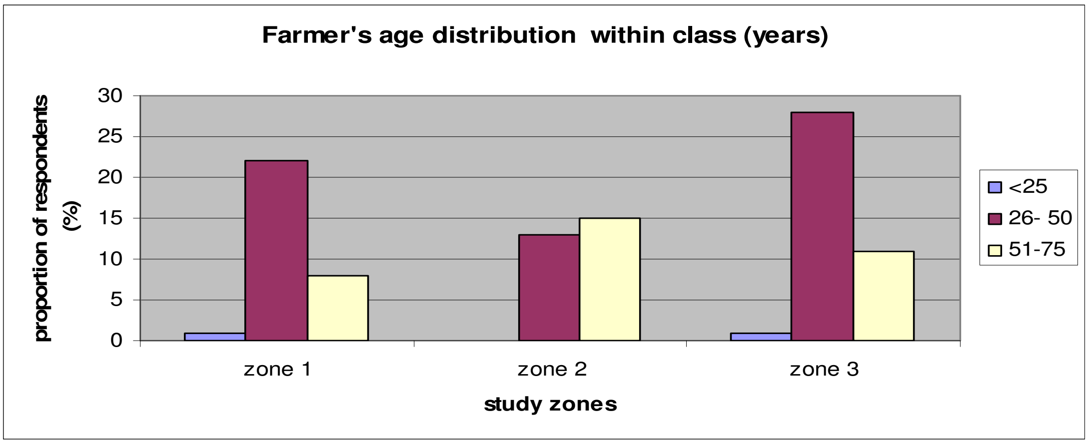


Figure 4 Farmer's age distribution to controlling black pod diseases and mirid attack on cocoa

[1] Household has been defined as 'a group individuals living together and eating from the same pot' (Lwesya, 2004:25).

The age of a farmer could be a very important tool to understanding how cocoa farmers control and manage pests and diseases on their fields.
The age distributions of household recorded that most of the farmers were young or middle-aged men within the ages of 26 years and 50 years. This is the age class that most of the farmers actively involved in cocoa farming belong. This proportion of respondents within this age class across the study zones were as follows; 22 % in Zone 1, 13 % in Zone 2 and 28 % in Zone 3 (Figure 4).

Age has been hypothesized to be negatively related to pesticide expenditure (Nkamleu et al., 2007). This hypothesis was from results documented from a study by Gockowski and Ndoumbe (2004) that young farmers are more likely to adopt new agricultural technologies. Relating this to this study and considering the fact that most of farmers actively involved in cocoa farming are young or middle age, the hypothesis holds true since this age class (26-50 years) are those actively involved in cocoa cropping and management, and therefore willing to learn new agricultural technologies to manage pests and diseases of their crops.

Over 35 % of the respondents were between the ages of 51 and 75 years who even though have lots of farming experience often say they hire laborers to work on their plots during the cocoa season. This is because farmers belonging to this age class are getting retired and thus not active enough like those within the age of 26 and 50 years. Thus, it has been hypothesized that, those cocoa plots actually controlled by the owner themselves are less exposed to black pod diseases and mirids attack than those controlled by laborers since laborers are just passer-byes and do not pay much attention.

The average number of persons per household in this study is seven and is considered to be directly proportion to cocoa production. That is the greater the household number, the greater is that household possibilities to increasing cocoa yields.

C) Education

The level of education attained by a farmer has been interpreted to have a positive impact on controlling black pod disease and mirids. Education enhances farmers willingness to learn new agricultural technologies, thus contributes immensely on how to manage pests and diseases of their crops in a better way. Educated farmers have been found to be more likely to adopt agrochemicals (Nkamleu and Adesina, 2000; Asfaw and Admassie, 2004).

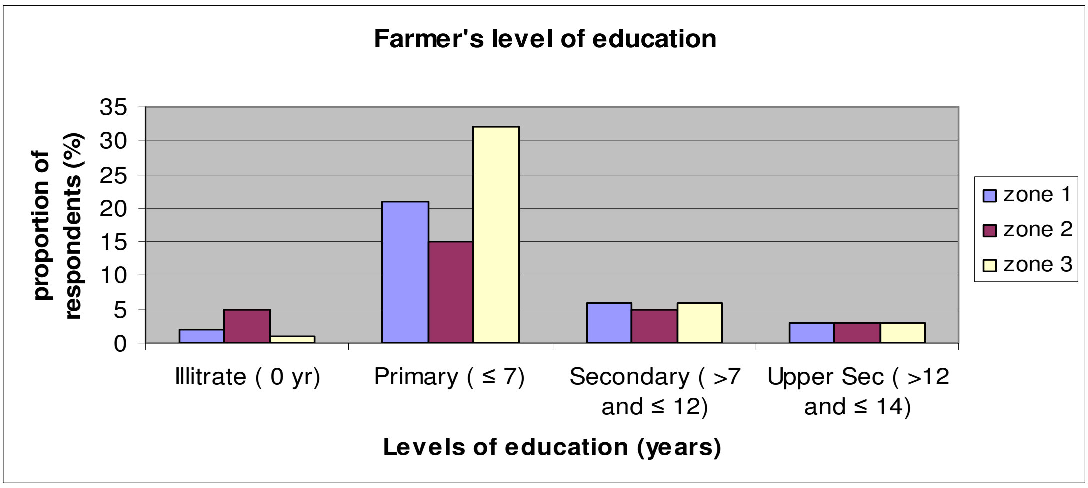


Figure 5 Farmer's level of education to controlling black pod disease and mirid attack on cocoa

Over 8 % of farmers are illiterate; majority (69 %) of which have attained the primary level of education, usually 7 years or less following the Cameroon educational system for these age groups. Most of the farmers in the group who had a complete primary education (7 years) with partially or complete secondary and upper secondary education could have a good reading and writing skills (Figure 5). According to Nkamleu and Adesina (2000), it is obvious that the more educated farmers are more likely to adopt agrochemicals thus given them greater opportunities of improving the control of black pod diseases and pests of cocoa. For the sake of comparative study, there were actually no clear distinction as to the level of education amongst farmers across all the study zones especially at the level of secondary and upper secondary education. Thus at this point the researcher could not determine which zone was presumed to better control black pod diseases and pests of cocoa by farmers in the Southwest province based on the level of education.

D) Organization types

This is a form of farmer's participatory learning where farmers involved themselves in farming groups or organization because they want to learn new ideas or brings out new innovations on how to combat diseases and pests of their crops. Farmer's participatory learning was investigated to understand the various proportions of farmers involved in farming groups or organizations and to see how to proportionate the number to controlling black pods and mirid attack in the Southwest province.

Out of a total of 32 respondents in Zone 1, 50 % were involved in groups or organization. These proportions were either involved in a farming group (12), research group (1), cooperative society (1) and Common Initiative Group (CIG) (2). Likewise, in Zone 2 and Zone 3, 67.8 % and 50 % of the respondents respectively were involved in either groups or organization (Table 4.2).

From the results, very little proportion of the farmers were actively involved in research groups, a group that could better educate the farmers on new agricultural technologies or innovations through learning. None the less, the few involved are more likely to learn and implement new technologies or innovations and thus more likely to control pests and diseases of their cocoa in a much better way than those belonging to farmer's groups only.

Most of the farmers across all 3 zones were actively involved in farming groups, probably because it is just a social gathering that was understood to hold usually on Sunday were most of the farmers do not go their farms.

Table 4.2 Proportion of farmers (%) involved with farming groups or organizations

	N=100			Proportion of farmers (%) across all zones
Groups/Organizations	Zone1 n=32	Zone 2 n=28	Zone 3 n=40	
Farming	12	13	13	38
Research	1	1		2
Cooperatives	1	2		3
CIG	2	3	7	12
Total (%)	16 (50 %)	19 (67.8 %)	20 (50 %)	45 %

Figure 6 Farmers' participatory learning in farming group

Considering Sunday usually as an off day for farmers, they come to together, eat, drink palm wine and converse and device possible ways of controlling pests and diseases, and also, ways to minimize input costs. This farming group that brings farmers together is cheaper and incurs no cost for formal registration as will be the case with those involved in research, cooperatives and CIG. Some farmers are not willing to spend time and cost attending lectures during seminar involved with research and so on, thus this is for the reason why you will find very few of then involved in research groups, cooperatives and CIG that is believed to involve so much learning. It is on this note that farmers in this region tend to keep away from the standard ways of managing pests and diseases. They consider the standard ways to be very costly and therefore are seeking only ways that will enable them to incur as little cost as possible.

It is understood that farmers involved in farming groups could device new ways that could very much benefited them in controlling pests and diseases. None the less, there are also associated malpractices among other things. But they are better than those who do not involved themselves in any form of learning, and majority of the farmers do not belong to any farming group or organization.

Thus from the results of this study, it could be judged that most of the farmers do not keep to the standards and recommended ways of applying pesticides to control pests and diseases of their cocoa since majority belong to farmer's groups.
Figure 6 shows farmers in group sharing knowledge on how to use sprayer while spraying.

4.1.2 Land tenure situation

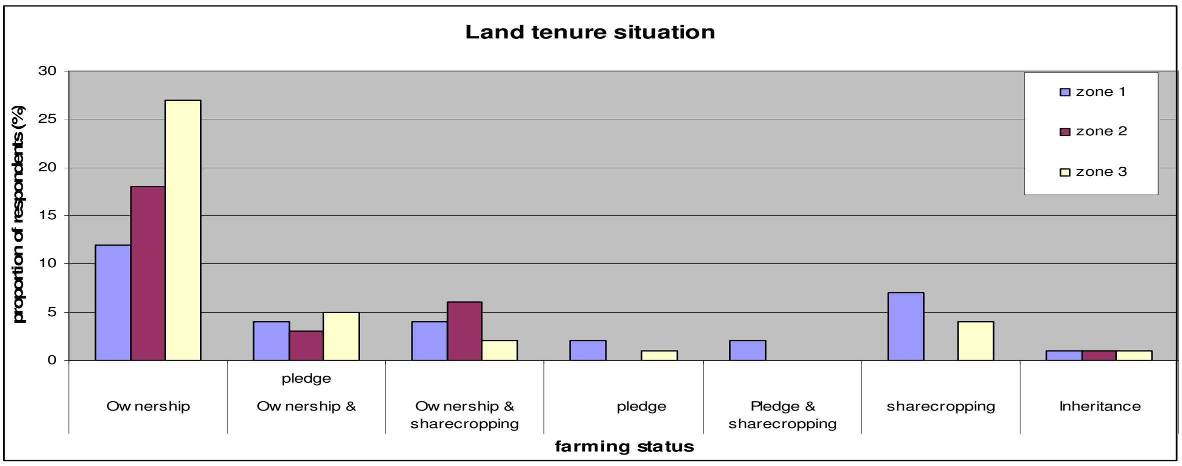


Figure 7 Proportion of respondents (%) with varying farming status

In the Southwest province, though the soil is generally fertile, there are some areas that are more fertile. In such places, productivity depends on the hectare of land the farmers occupy.

A) Total number of cocoa farmlands (hectare) controlled by farmers

Farmers in the Southwest province can occupy farmland close to 27 ha (Table 4.3). Thus the more cocoa farmland you have, the more expected will be your production everything being equal[1].

Looking across the study zones in figure 7, 57 % of the total respondents owned farms, farmers status on their farming land were recorded across all the 3 zones, 12 % owned farms and were also involved in pledge farming, 12 % owned farms and were involved in sharecrop farming, 3 % were involved only in pledge farming, 2 % were involved in both sharecrop and pledge farming, 11 % were involved only in sharecrop farming and 3 % were managing farms they inherited.

Thus, there were some farmers with both land titles and land user rights while there were others who had only land user rights. It is hypothesized that those who are involved in pledge and sharecrop farming managed cocoa farms better than those who owned farms. This is because they want to maintain their land user right and also to grip some benefits at the end of the farming season.

B) Distant (km) and accessibility to cocoa farmlands

Distance from farmer's home to cocoa farms could go up to 16 km and could have an impact in controlling pests and diseases of cocoa especially in the rainy season where accessibility to farmlands could be very bad (Table 4.3)

[1] Equal here means, fungicide is not outdated and the working equipments like the knapsack sprayer are all in good working condition.

Table 4.3 Descriptive statistics of variables for land tenure situation defined during data collection

Variables	Description	Mean	Std dev	Minimum	Maximum
Origination	Farmer's origin, that is, if whether originate from the Southwest province or not 1= native, 2=migrant	1.6500	0.4794	1.0000	2.0000
Distant	Farmer's distant from home to farm in Kilometer	2.619	2.202	0.200	16.000
Accessibility	Farmer's accessibility to farm 1=very bad 2= bad 3=easy	1.8182	0.8615	1.0000	3.0000
Farm area	Farmer's total hectare of farm	3.871	3.835	1.000	26.600

C) Origination

During data collection, the researcher was also interested to know the origin of the farmer interviewed, that is, if the farmer was a native of the province or a migrant. From the results of this study, 35 % of the farmers interviewed were natives while 65 % were migrants (Table 4.3).

In the Southwest province, most of the land owners are natives though some could also be involved in shared cropping and pledge. Most of those who were involved only in shared cropping and pledge were migrants. Past studies in Africa, show that migrants are more active, more entrepreneurial and willing to learn new agricultural technologies (Polson and Spencer, 1991; Adesina and Chianu, 2002) than the natives. Thus they are hypothesized to better manage pests and diseases of cocoa than the natives.

4.2 Labor force

A) Household proportion

This defines the proportion per household actively involved in cocoa farming

Most of the farming activities were based on family labor

Table 4.4 Descriptive statistics of variables for labor force defined during data collection

Variable	Description	Mean	Std dev	Minimum	Maximum
Men actively involved	Men per household actively involved in farming	1.930	1.513	1.000	8.000
Women actively involved	Women per household actively involved in farming	1.375	0.879	0.000	5.000
Boys studying actively involved	Boys per household who were studying and actively involved in farming	2.267	1.839	0.000	8.000
Girls studying actively involved	Girls per household who were studying and actively involved in farming	2.093	1.411	0.000	6.000

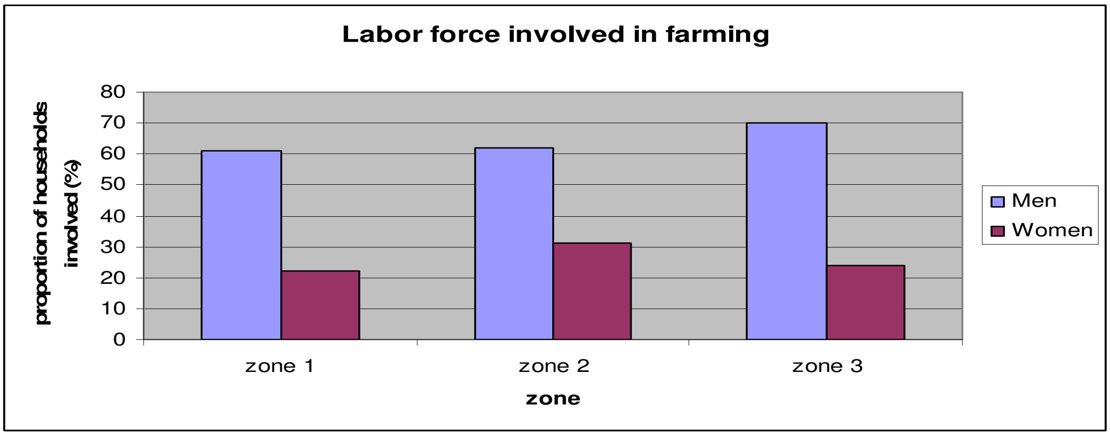


Figure 8 Proportion of household (>16 years of age) involved in cocoa farming

The total number of men and women greater than sixteen years of age were recorded per household. The age of sixteen years was fixed because any household member below this age was considered to be contributing child labor to the cocoa farming activity and adult labor if otherwise.

The proportion of labor input by women is low across all the study zones. This is because cocoa farming is not considered an activity greatly performed by women. Women are mostly involved in food cropping and only assist the men either by supplying them with water during the spraying periods or pod breaking during the harvesting periods. A woman is considered the next person in the family after the man.

Furthermore, household member below 16 years were considered children. And in this study, an average number of two boys and two girls attending schools were actively involved in cocoa farming (Table 4.4). These are children who after attending classes in school meet their parents in the farm to assist them in cocoa farming activity. These children are said to be fully involved in cocoa activities in the month of June, July and August were they are on vacation.

In addition to immediate family labor, there also exist farming groups called "njangi" were farmers come together, combine labor and work from one farmer's cocoa field and the next time to another farmer until the cycle is complete. They say, very little expenditure is involved here unlike if they were to hire labor. The 'njangi' activities involved mostly clearing of cocoa fields and spraying. Farmers with large farming plots are usually involved in 'njangi' to reduce work pressure if they do not want to hire labor.

4.3 Farm characterization

A) Age distribution (years) and area distribution (hectares) of farm plots

This was to determined the average age of cocoa trees in the Southwest province and also to determine on average the per hectare of land each farmer in the South west province can control (Figures 9-10)

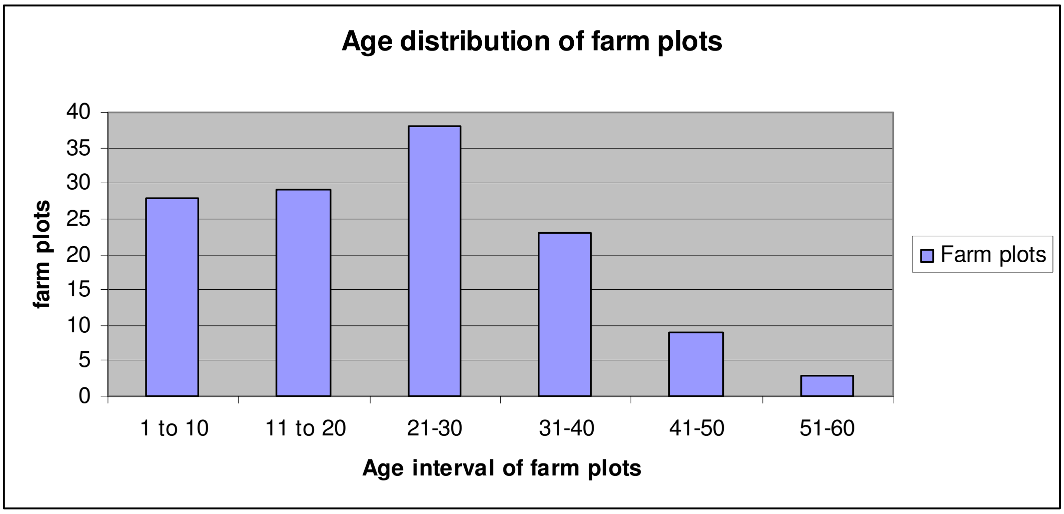


Figure 9 Average age of cocoa trees (years) across all the study zones

The average age of the cocoa trees recorded was 24 years with over 38 % of the farms between the ages of 21 and 30 years (Figure 9). The age of cocoa farms was not really a variable that could help much to determine the outcome of black pod disease and mirids control by cocoa farmers. None the less, the researcher wanted to understand to some extend if some farmers reluctantly or don't care much to control the black pod disease or mirids using pesticides because they felt their cocoa plots are too old and not productive enough.

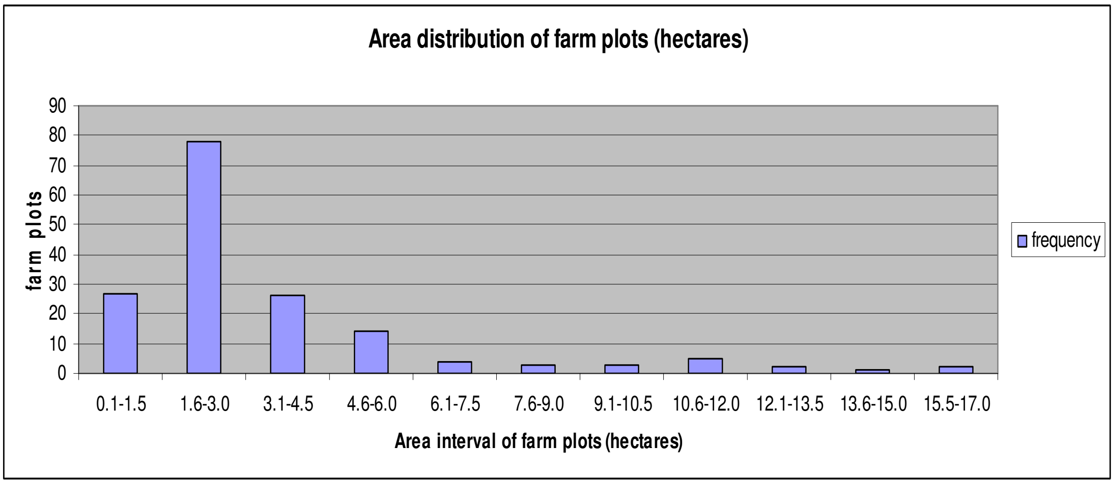


Figure 10 Average area distributions of farm plots (hectares) within class

Land holdings range from 0.5 ha to 26.6 ha with an average holding of 4.4 ha. Over 78 % of the household had farmland between 1.6 ha and 3.0 ha (Figure 10). Total number of cocoa trees per farm plot range from 100 to 10,000 tress with an overall average of 1500 cocoa tress from the 430 farms recorded. Some farmers only want to incur the least possible input cost to control black pod diseases and pests, thus the researcher wanted to find out if black pod disease and mirids control is dependent on the size of the farm plot that a particular farmer is in control of.

It was seen from this study that some farmers who were entitled to very large farm plots had difficulties to control black pod diseases and mirids. This is because before the could complete the spraying cycle from one farm plot to the other, some of the unsprayed plots have already been infected and could be too late to control. This failure has been particularly attributed to those farmers who are not willing to hire labor during the spraying season.

4.4 Sources of acquisition of working equipments and pesticide use for the 2006 cocoa season (February 2006- January2007)

Post liberalization of the cocoa sector in Cameroon has exposed farmers to acquire wherever and whatever equipments or chemicals of choice they want. This is very practical to cocoa farmers in the South west province of Cameroon

A) The proportion of respondents (%) who acquired working equipments from different sources

The acquisition of working equipments and pesticides prior to the beginning of the cocoa season is more or less a routine activity amongst farmers in the South west province of Cameroon. Farmers across the three zones prefer to buy their working equipments from village markets or in city markets where it is even cheaper than to take from cooperatives or local cocoa buying agents on loan to pay back at very high costs.

None the less, for those farmers who do not have money to buy equipments from the markets, most often take on loan from their customer's cocoa buying agents (7.5 %) as in Zone 3. Also, because of the high prices posed by the cocoa buying agents, none of the farmers in Zone 1 and Zone 2 could take working equipments on loan from the cocoa buying agents during the 2006 cocoa season (Table 4.5).

There were equally a reasonable proportion of farmers (42.8 %) across the 3 zones that claim used working equipments bought in the previous years. Most of the farmers in Zone 1 (68.8 %) bought spraying equipments from the city markets than in village markets probably because they were living in neighborhoods much closer to Kumba city market. Most of the farmers in Zone 2 (64 %) and Zone 3 (56.5 %) bought spraying equipments from villages markets. Konye and Ebonji were considered more or less village community in this study.

Table 4.5 Sources of acquisition of the different equipments types used during spraying

		Proportion of respondents (%) who acquired working equipments from different sources			
		Sources			
Zone	Items	Village markets	Cooperatives	City markets	Cocoa buying agents
1	Knapsack sprayer	3.1		6.3	
	Boots	3.1		37.5	
	Gloves	3.1		6.3	
	Goggles	3.1			
	Cap	3.1		15.6	
	Apron			3.1	
	Total	15.5	0.0	68.8	0.0
2	Knapsack sprayer			3.6	
	Boots	53.3		10.7	
	Gloves			3.6	
	Goggles				
	Cap	10.7			
	Apron				
	Total	64.0	0.0	16.9	0.0
3	Knapsack sprayer	2.5		2.5	5.0
	Boots	47.5		12.5	2.5
	Gloves				
	Goggles				
	Cap	7.5		7.5	
	Apron				
	Total	56.5	0.0	22.5	7.5

B) The proportion of respondents (%) who acquired pesticides from different sources

The acquisition of pesticides was a bit different from results of equipments acquisition. Most of the farmers (over 40 %) across the zones rely on fungicides from their customer's cocoa buying agents (Table 4.6). Unlike in Zone 1 and Zone 3, herbicide application is not a very common practice in Zone 2 were only 3.6 % of the respondents applied herbicides on their cocoa fields during the 2006 cocoa season.

Table 4.6 Proportion of respondents (%) who acquired pesticides from different sources

	Zone 1			Zone 2			Zone 3		
	Pesticides								
Sources	fungicide	insecticide	herbicides	fungicides	insecticides	herbicides	fungicides	insecticides	herbicides
Village markets	18.7	18.7	6.3	25.0	28.6		27.5	32.5	12.5
Cooperatives	3.1	6.3					5.0	5.0	
City	30.0	43.7	21.9	25.0	21.4		20.0	25.0	12.5
Cocoa buying agents	40.0	25.0	3.1	46.4	50.0	3.6	47.5	37.5	10.0
Other farmers	8.2	6.3		3.6					

4.5 Pesticide application and pesticides costs

Pesticides are reported in this study according to the trade names of the locally available products. The active ingredients of the various pesticides used have been outlined. This is important as we can be able to classified to which WHO class a particular pesticide belong. Pesticides infrequently used have been grouped as unclassified.

The figures (Figure 11 (A-F): Pesticide (fungicides, insecticides and herbicides) application and pesticide costs) below analyze how farmers across the 3 study zones apply pesticides and the cost they incur to have the pesticides.

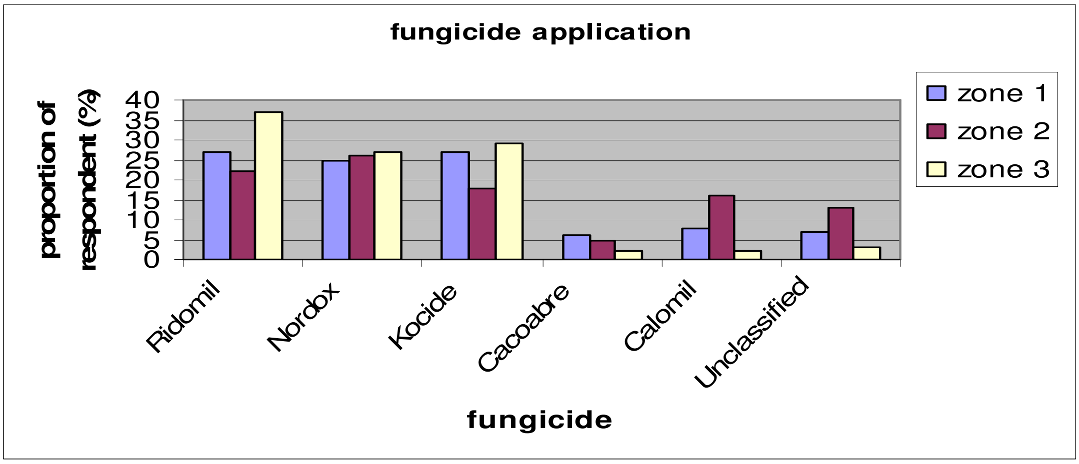


Figure 11 A Fungicide application

To control the black pod disease of cocoa, Ridomil (Metalaxyl) and Callomil (Metalaxyl) and Nordox (Copper oxide) have been noted to be the fungicides of choice relative to the others because they are more effective. None the less, the proportion of those using Callomil has been recorded very low (Figure 11 A). This is because at the time of the study, it was noted to be the most expensive pesticides. These fungicides (Ridomil, Nordox and Callomil) are usually applied during the rainy season when places are wet and humid to suppress *Phytopthora* development.

Eighty four percent (84 %) of the farmers use Ridomil (50 g/sachet) in 15 liter lever-operated knapsack sprayer containing water. This chemical, like Callomil, is usually applied during the early months of the second semester (i.e. July, August and September) were rainfall is highest. Most farmers (75 %) use 1 sachet of Ridomil per 15 liter knapsack sprayer (recommended dose for a 3-week spraying interval by Sygenta Crop Protection) in the month of July while 25 % say they use ½ sachet of Ridomil mixed with ½ sachet of other fungicides (preferably Nordox or Kocide) into a 15 liter knapsack sprayer.

In the month of August and September were the highest rainfall is recorded, some financially viable farmers may use up to 2 sachets of Ridomil per 15 liter knapsack sprayer. It could be very difficult to determine exactly the dose farmers use per knapsack sprayer because malpractices like mixing together various kinds of fungicides into a single container before spraying is being reported by a few farmers across all the zones. They say the "strength" of the resulting solution from the mixture is much better to combat the black pod disease than if they had used just a single type of fungicide.

To mix pesticide, 43 % of the farmers mix directly in the sprayer. They do this by first filling the sprayer with water to half the mark; secondly, they pour the Ridomil into the water, followed by 1 tin tomato cup (35-50 cl) of Callisulfan (Endosulfan). The lid is sealed and the sprayer thoroughly shaken to get a homogenous mixture. On this same note, 57 % of the respondents rather prefer to mix the chemical in a separate container before transferring into the knapsack sprayer. Seventy eight percent of the farmers use 1 sachet of Nordox (40 g/sachet) for a 15 liter knapsack sprayer.

Nordox is often applied prior to the onset of the heavy rainfall, that is, during the late months of the first semester (i.e. April, May and June). According to the manufacturer (NORDOX AS) instruction, preventive treatment should begin prior to the beginning of rainfall with spraying interval of 15 to 21 days.

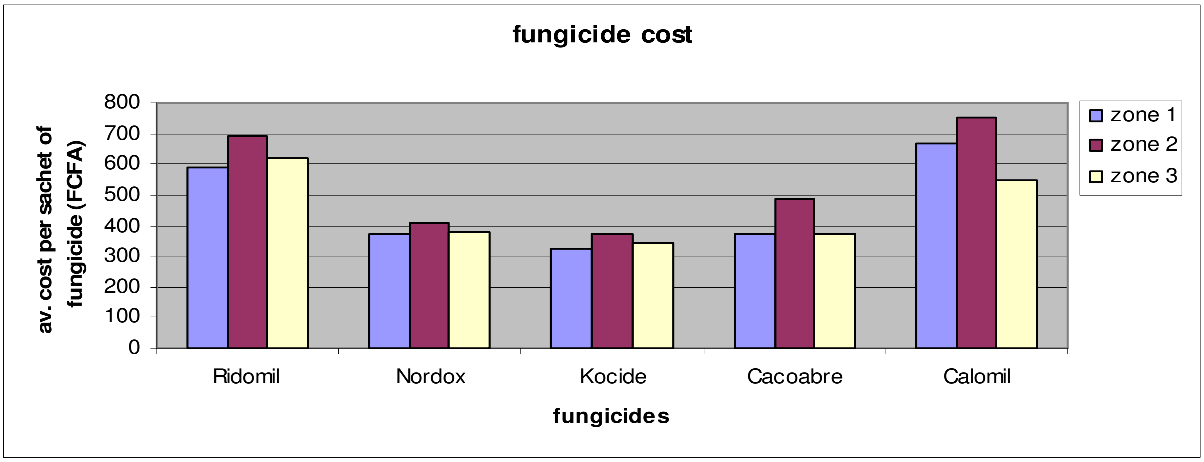


Figure 11 B Fungicide cost

Callomil is known by almost every farmer as a very effective fungicide against the black pod disease, nonetheless only a few (29 %) can afford to use it due to the high cost (an average cost of 735 FCFA[1] /50 g sachets). The market price ranged from 700 to 725 FCFA. Nordox has an average cost of 400 FCFA per sachet when farmers are taking on credit from cocoa buying agents. But the market price in 2006 range between 350 and 375 FCFA (Kumba central market).

Kocide 2000 (Cuprous hydroxide) is another fungicide of choice, 75 % of respondents apply this chemical. Application is mostly in the early months of the first semester (i.e. January, February and March) where places are still warm. The temperature within this period could reach an average maximum of 40.5 ^{o}C. Kocide 2000 is cheap and easily affordable, it keeps the tree moist and initiate flowering.

Caocobre (Cuprous oxide; 75 g/sachet) is only used by a very low proportion of farmers (13 %) to control black pod disease during the early month of March. It is the cheapest fungicide recorded in this study with an average cost price of 320 FCFA per sachet. It is often mixed with Actara 25 WG (a non-phototoxic insecticidal product) for treatment against capsids and bugs of cocoa.

In Zone 1, farmers could afford a sachet of Ridomil on an average cost 600 FCFA in the market (Figure 11 B) or 625 FCFA if they have to take on credit from a cocoa buying agent. This is not same with zone 2 and zone 3 which are a bit far off (40 km and 18 km respectively) from the central city market square in Kumba. Farmers in zone 2 and zone 3 get a sachet of Ridomil on an average cost of 650 FCFA from local markets or 675 FCFA if they have to take on credit from a cocoa buying agent. None the less, an average cost of 650 FCFA across all 3 zones has been reached

[1] 1 US$ = 495 FCFA was the exchange rate at the time of data collection.

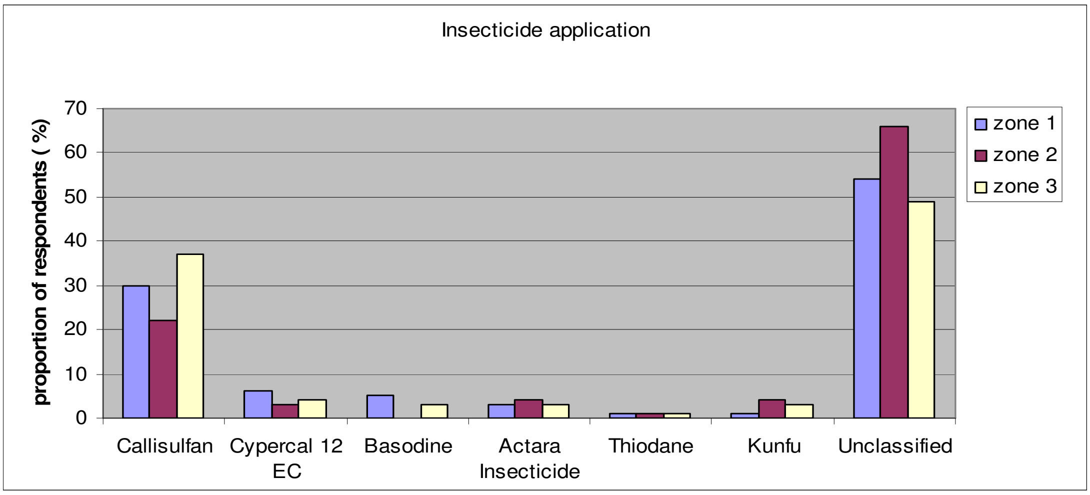


Figure 11 C Insecticide application

To combat pests of cocoa, 89 % of the respondents use the insecticide; Callisulfan (Endosulfan) to combat capsids, ants and other insects. Though very expensive (average cost of 6200 FCFA/liter), it is the most widely used and effective insecticide against capsids.

Quantification of liquid insecticides used by farmers were either by standardized measuring cup or by estimating using other measuring container like tin tomato cups. . Very few farmers (20 %) use standard measurement cup to quantify the required volume of insecticides into knapsack sprayer, majority (80 %) use tin tomato container approximately (35-50 cl) to quantify an estimated volume that a standard measurement cup will do. Most of the farmers say, it is not easy to retain the standard measurement cup either because it is easily destroyed by chemical or so small to be easily misplaced. This has accounted to the unreliable insecticide quantification by some farmers during spraying.

Calllisulfan, though very effective to control capsids attack, few farmers (20 %) prefer not to use it in the month of March and April especially. This is to avoid ripening of young shoots. They say the chemical has some heating effect and they prefer not to use during the early months of the rainy season when flowering of the cocoa tree begins. They use fungicides within this period instead to control pod diseases.

Chemical application is based on individual follow-up. Humidity varies from one cocoa field to the other, and so does application calendar vary from one farmer to the other.

Figure 11 D Insecticide Cost

Eight percent (8 %) of the farmers use Basodine (Diazinon) to control ants (Figure 11 D). Farmers say it is very effective against ants but too expensive to afford (average cost of 9300 FCFA/liter). Eight percent (8 %) use the insecticide, Kunfu, and has been very effective mirid attack, but farmers say it has developed resistance lately. Pest resistance has been a contributing factor for the switching from one insecticide to the other by cocoa farmers.

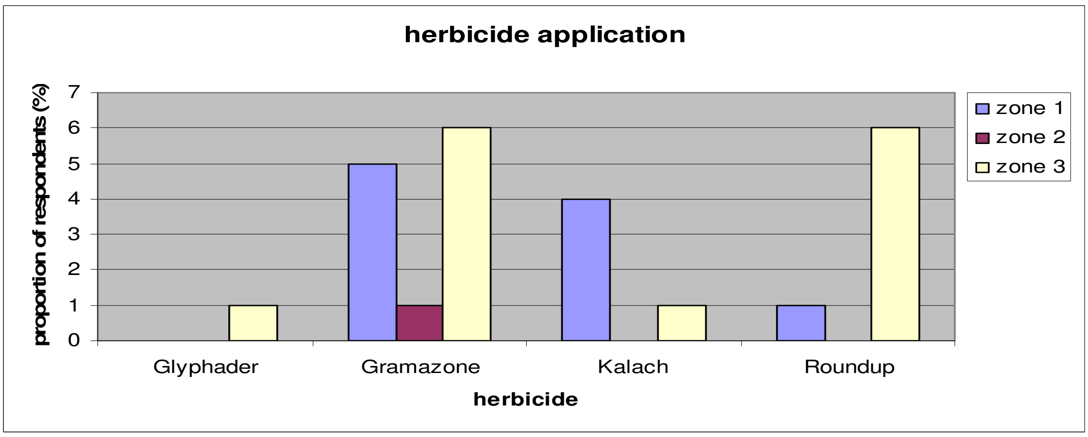


Figure 11 E Herbicide application

Herbicide use by cocoa farmers is not a very common practice especially in Zone 2 were only 1 % of the farmers use herbicides (Figure 11 E). It was noted that farmers in Zone 3 attempt to use all the different types of herbicides. Probably, the soil in this region is more fertile and favors weed growth. It is noted that, majority of the farmers prefer to take care of weed by coming together to form 'njangi' group, moving and clearing from one farmer's farm to the other until the cycle is complete. They prefer "njangi" because it saves time and incur little or no input cost. More so, a lot of farming activities like checking the cocoa tree for saprophytes and unwanted cocoa stems ('water tree') are done along side the group clearing.

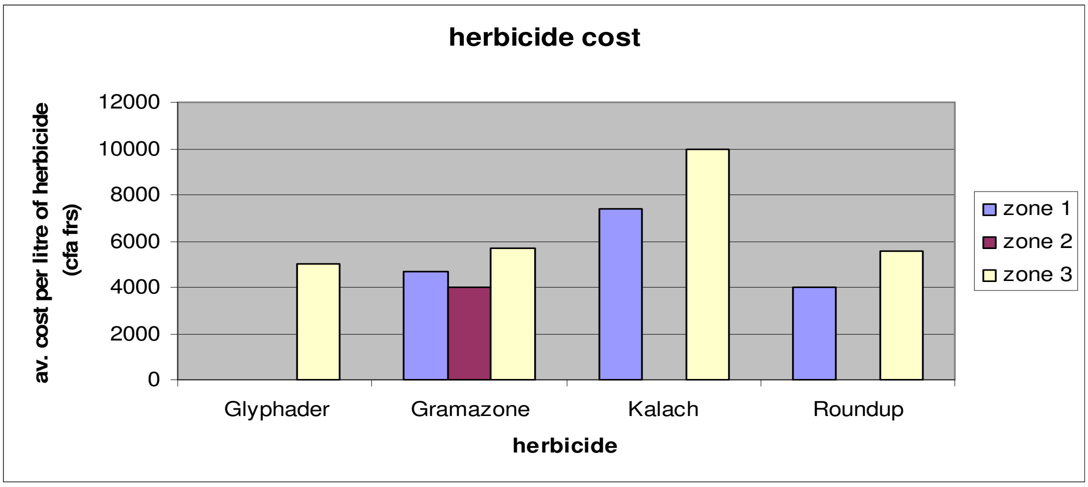


Figure 11 F Herbicide Cost

Gramazone and Roundup are cheaper and are preferably use by farmers (Figure 11 F). The various herbicide types were noted to be highest in Zone 3, probably because herbicide application has been noted by the farmers as a tool to control pod disease and pest attack on cocoa.

4.6 Pesticide application frequencies

This was conducted to understand how often farmers use pesticides on their fields and within which interval were pesticides applied. The investigation was purposely to understand if pesticide application frequency has an impact on controlling black pod disease mirid attack on cocoa.

The figures (Figure 12 A-I), pesticide (fungicides, insecticides and herbicides) application frequencies) below, shows how the frequency of pesticide application varies across the different zones. This is attributed to various factors ranging from input financial viability to ecological location of the cocoa fields.

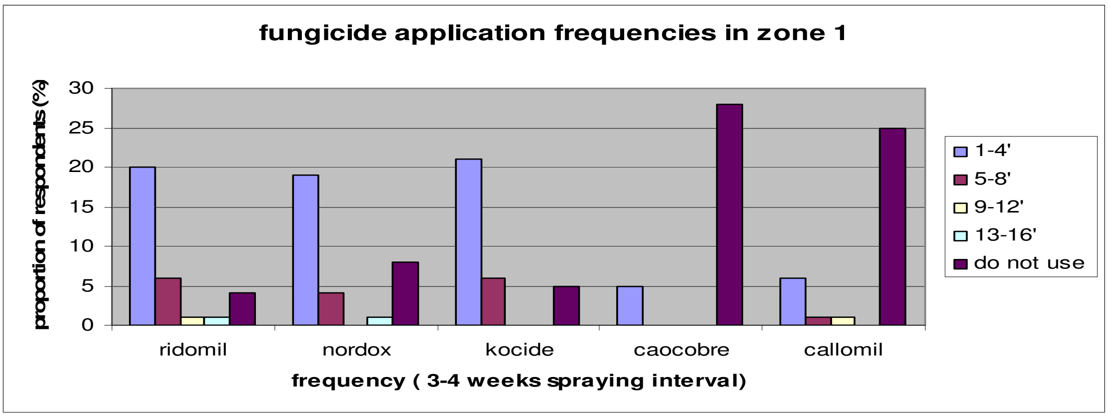


Figure 12 A Fungicide application frequencies in Zone 1

Over 60 % of the respondents in Zone 1 spray Ridomil, Nordox and Kocide, 1-4 times for a complete cocoa season with a 3-4 weeks spraying interval (Figure 12 A)

Most of pesticide manufacturers recommend a 3-4 weeks spraying interval to control pod diseases pest attack on cocoa. Thus these groups of farmers are likely to effectively control pod diseases and pest attack on cocoa in their fields considering everything being equal[1].

A few farmers (2 %) were noted to spray Ridomil and Nordox 13-16 times a year within a 3-4 weeks spraying interval. These are mostly the financially viable farmers who think the more frequent they spray their cocoa fields, the better the control against black pod disease and mirid attack.

[1] Equal here means, fungicide is not outdated and the working equipments like the knapsack sprayer are all in good working condition.

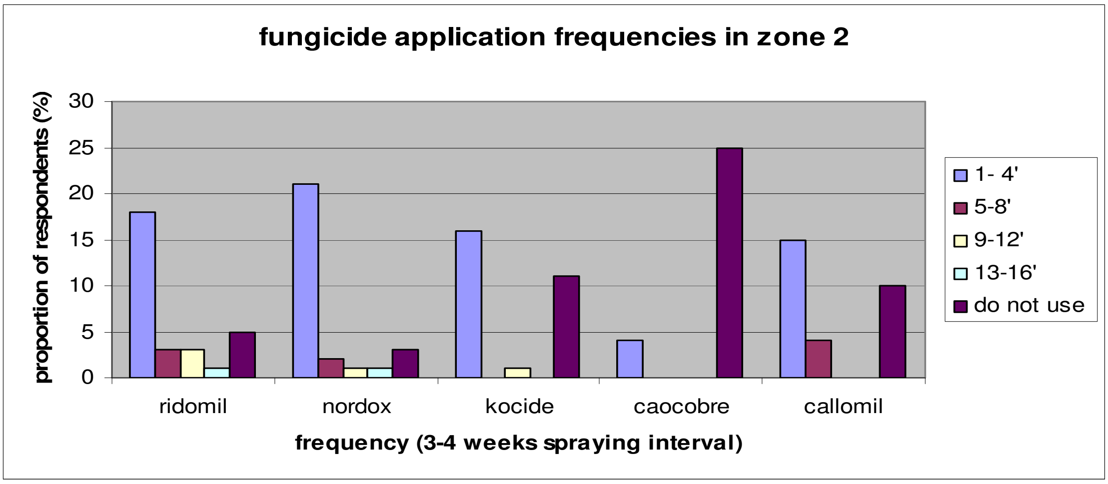


Figure 12 B Fungicide application frequencies in Zone 2

The frequency of fungicide application did not vary much in Zone 2 and Zone 3 (Figure 12, B-C) where Ridomil, Nordox and Kocide has also been noted to be frequently used.

Callomil is a fungicide known to effectively control black pod diseases of cocoa but it is not used by most farmers (70%) in Meme division because it is very expensive to afford. Pesticide application frequency is greatest in the month of June, July August and September (months that inter-phase the 1st Semester (January-June) and the 2nd Semester (July-December) of the year). During this period, places are cold and temperature may fall down to 21°C. More so, rainfall is heavy and the number of rainy days is increased.

According to the Barombi-Kang Meteorological station, a total rainfall of 1133 mm was recorded for 71 days within the 1st semester (January – June 2005) and 993 mm recorded for 99 days within the 2nd semester (July – December 2005).
Rainfall within the 1st semester of 2006 was not heavy compared to those recorded within the 1st semester of 2005. Obviously pesticide application frequency was less, compared to the application frequency within the 1st semester in 2005. The higher the humidity of the cocoa fields, the more chemicals farmers will use. This is because high humidity favors *Phytophthora* development.

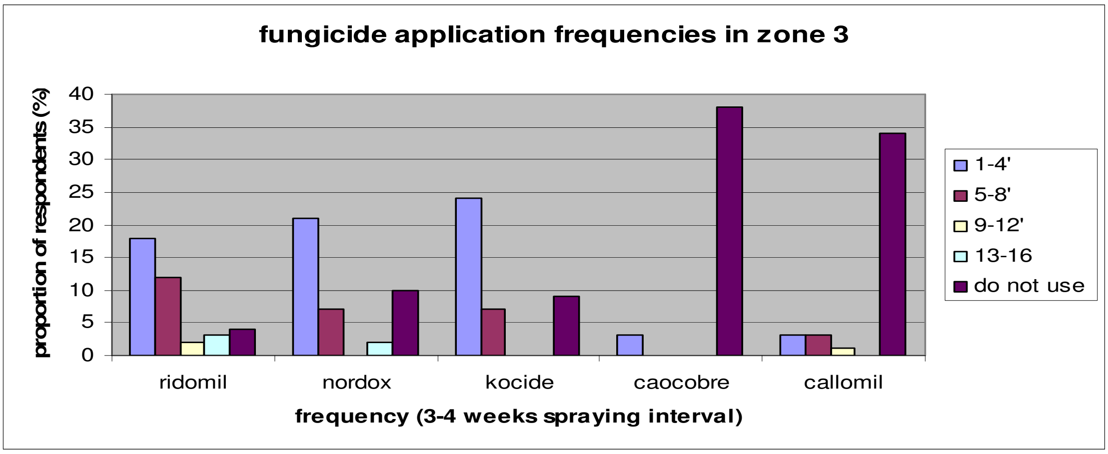


Figure 12 C Fungicide application frequencies in Zone 3

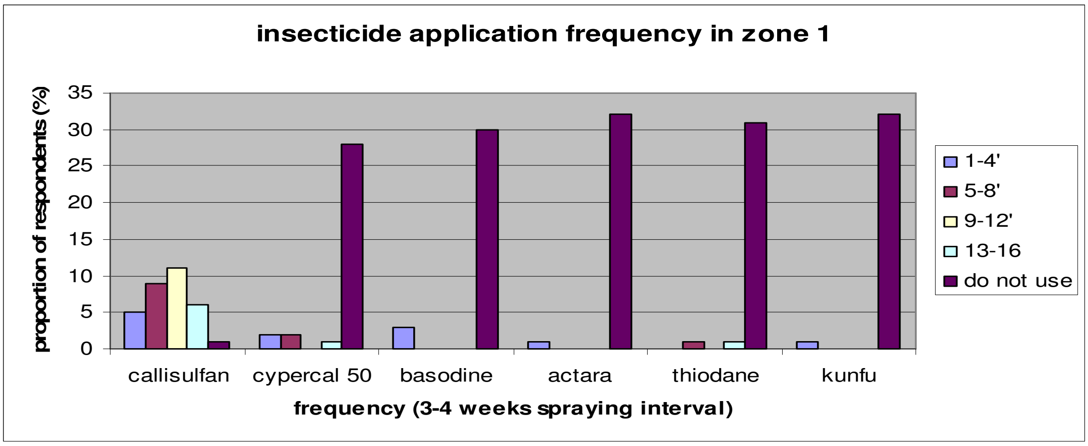


Figure 12 D Insecticide application frequencies in Zone 1

The proportion of farmers using Callisulfan (Endosulfan) is highest (Figure 12 D). This makes Callisulfan to be noted as the insecticide of choice amongst farmers in the Southwest province. In this study, insecticide application frequencies have been noted to be much higher than those of fungicides. This is because insecticides are both principally sprayed to kill capsids and to soften cocoa pods. Thus Callisulfan is not only mixed with fungicides during spraying to control black pods disease, but could be sprayed separately just to control pests and to soften cocoa pods just by quantifying a give volume and mixing with water in a knapsack sprayer. It is for this reason that, the frequencies of application is much higher.

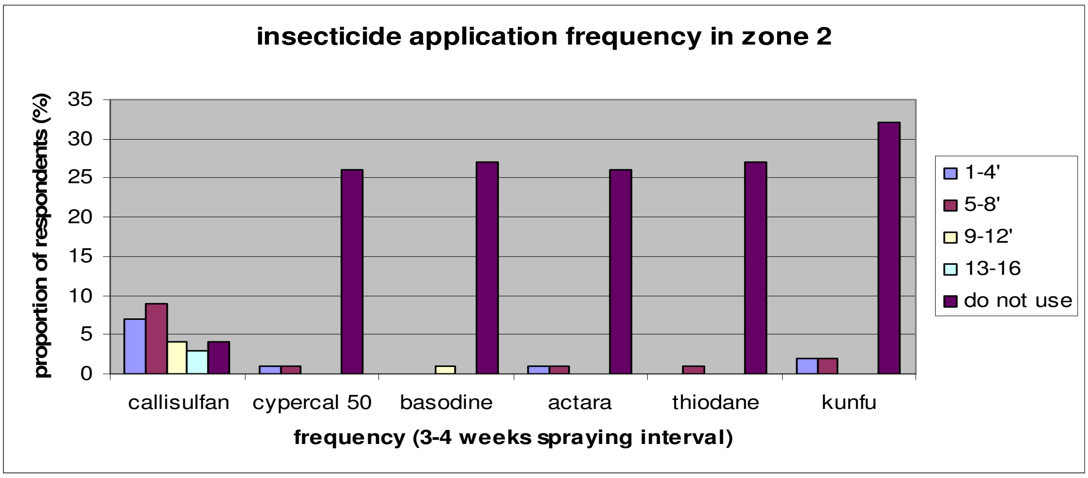


Figure 12 E Insecticide application frequencies in Zone 2

The frequencies of application were noted not to vary much across the 3 study zones except in Zone 3 where over 9 % of the respondents say they spray Callisulfan 13-16 times in a year (Figure 12 F). Probably, there are more capsids existence in this zone than those of Zone 1 and Zone 2. It is believed by the farmers that the more insecticides are sprayed against mirid attack, the better the results.

Though some farmers now complain of mirids gaining resistance against insecticides, it still remains as of now the only tool to combat mirid attack.

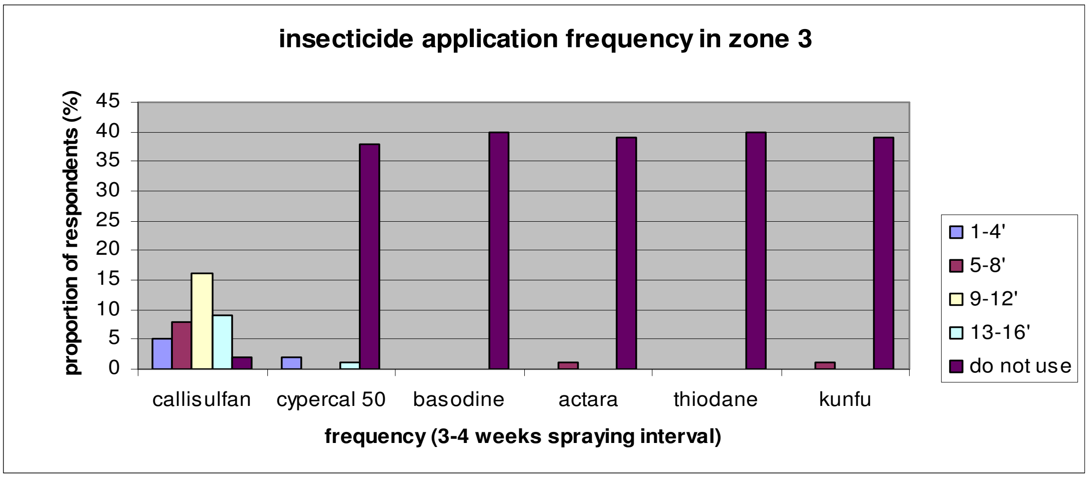


Figure 12 F Insecticide application frequencies in Zone 3

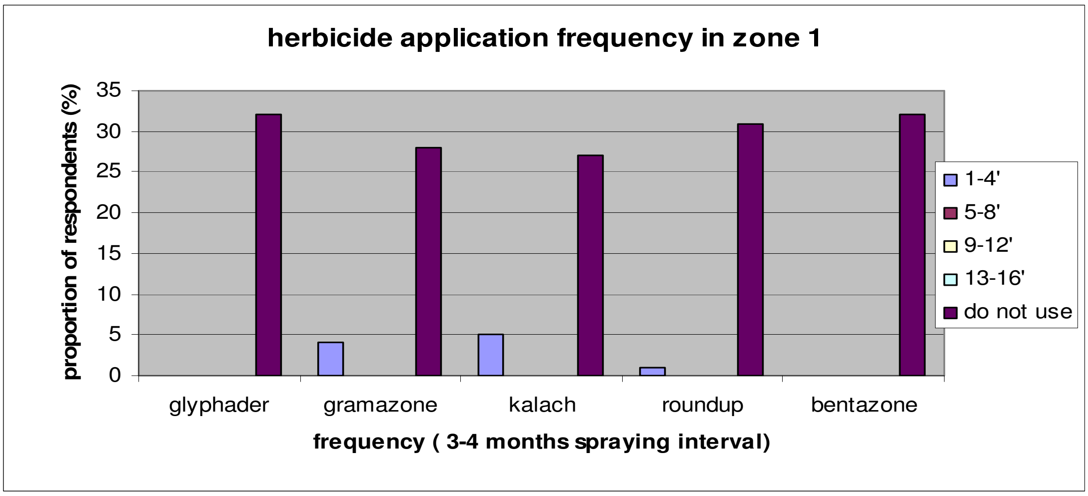


Figure 12 G Herbicide application frequencies in Zone 1

Herbicide application to control is more or less not a common practice by farmers in the Southwest province. In Zone 1, 10 % of the respondents say they use Gramazone, Kalach and Roundup to control weed 1 - 4 times in a year with a 3 - 4 months spraying interval (Figure 12 G)

As earlier explained, farmers in the Southwest province will preferably want to come together, form ‘njangi groups’ were they control weed by manual clearing, moving from one farmer’s farm to the next. They prefer the group clearing rather than buying insecticides at high cost to control weeds.

Weed control has also been noted to have a part to play in black pod control and mirid attack. Much weed makes the cocoa field airtight and humid favoring the development of *Phytophthora*, thus clearing the field to keep it clean and airy will lead to effective control of black pod and mirid attack.

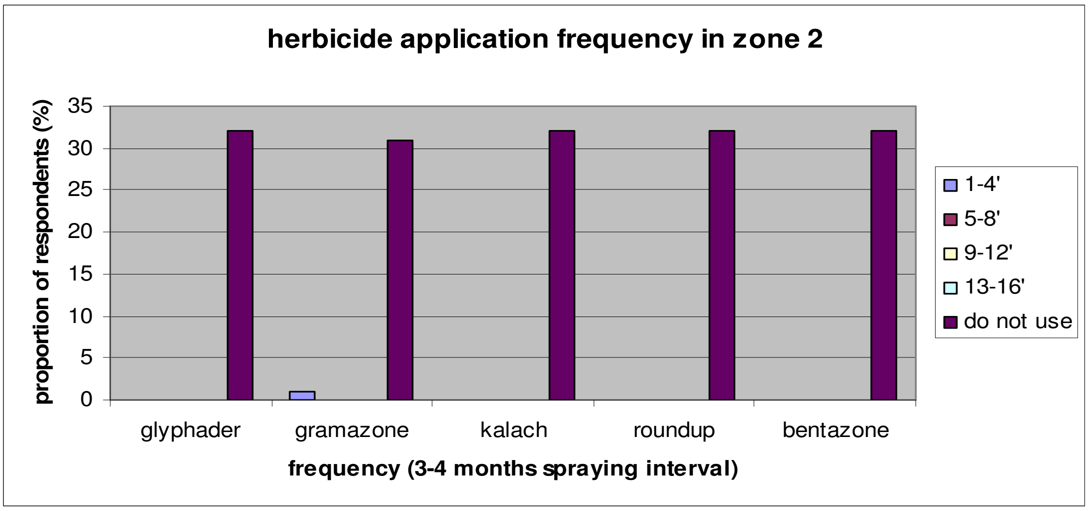


Figure 12 H Herbicide application frequencies in Zone 2

In Zone 2, weed control using herbicide was recorded very low with just 1 % of the respondent saying they use Gramazone to control weed (Figure 12 H). Similarly, only Gramazone and Kalach were noted to be used by some farmers in Zone 3 (Figure 12 I).

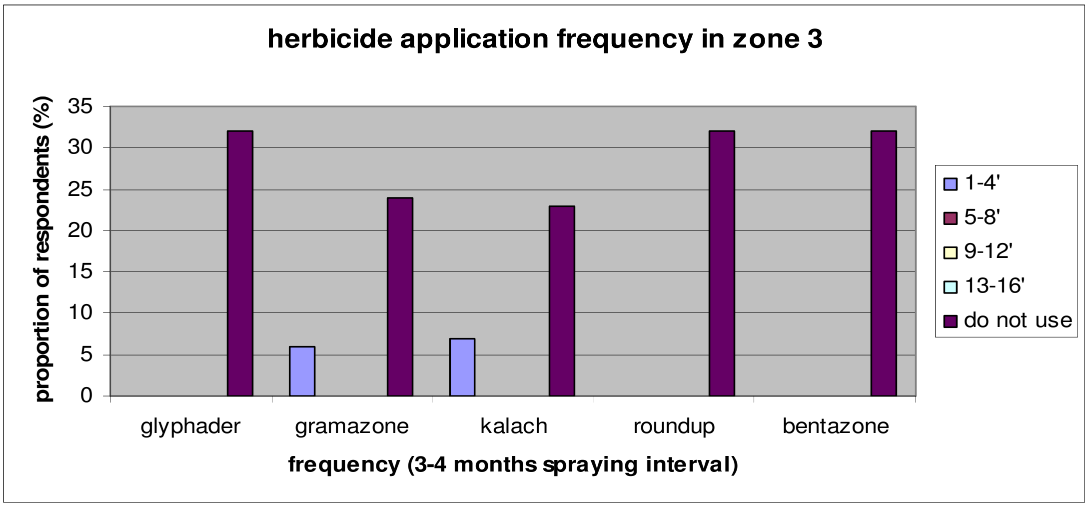


Figure 12 I Herbicide application frequencies in Zone 3

Table 4.7 Sources of information from where farmers get advices on how and what pesticide to use

	N= 100			Proportion of respondents (%) across all zones
Sources	Zone 1 n=32	Zone 2 n=28	Zone 3 n= 40	
Extension officers	5	13	13	31
Other farmers	19	12	21	52
Cocoa buying agents		1		1
Sachet instructions	8	2	6	16

It could be worth to ask the question that, if farmers do not understand the instructions displayed on pesticides labels, what strategies could they be adopting to effectively control cocoa diseases and pest attack, and also to prevent the risk from being poison by pesticides?

Sixteen percent (16 %) of the respondents could understand sachets instructions displayed on pesticide labels. This is as a result of the fact that some farmers had sound primary education, secondary and upper secondary education. Over 31 % of the farmers say they had received information on pesticide use from government extension officers. Most of the farmers (52 %) in the Southwest province get their information on how and which pesticide to use from other farmers (Table 4.7). This is easy to understand when farmers come to hold their regular.

Thus, it has been interpreted from the results that, 'farming group meetings', from where most of the information farmers share amongst them come, serve as the major source of information on pesticide use. To answer the above question, the researcher suggests that since most of the farmers' own knowledge to use pesticide is coming from 'farming group meeting' and serve as the best strategy by them, researchers and extension officers should humbly participate during farmer's group discussion and explain their standard views of pesticide use in the best possible lay man language since most of the farmers in the group are more or less illiterate.

4.7 Pesticide constraints and challenges

Cocoa farmers face a lot of constraints ranging from difficulties in acquiring pesticides to pesticide cost being too expensive.

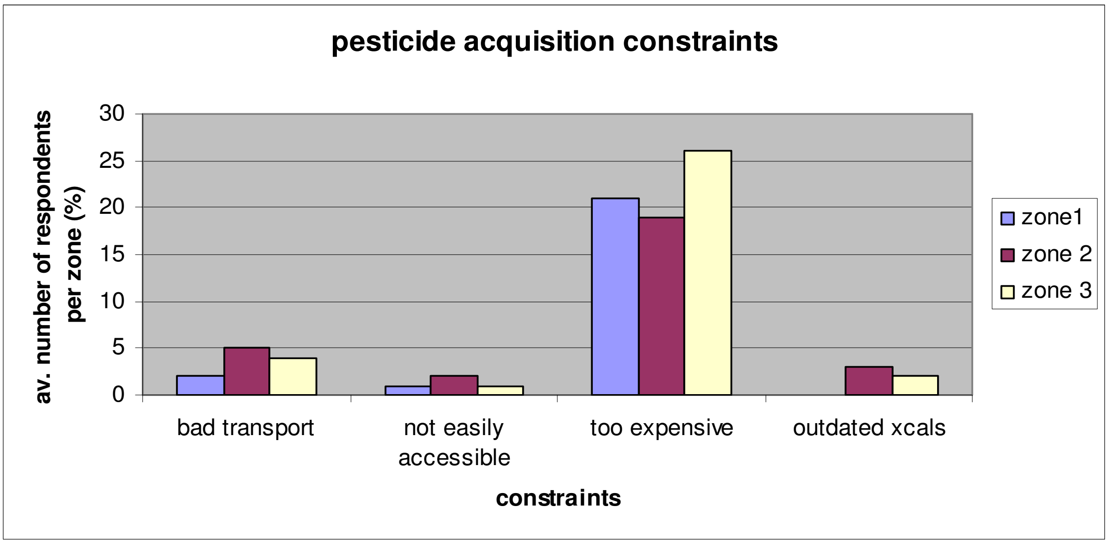


Figure 13 Pesticide acquisition constraints and challenges faced by farmers

Most of the villages in Zone 2 and Zone 3 have got bad roads which are usually very marshy and makes transport very difficulty for farmers to move to the central areas and buy pesticides at a much cheaper rate. The worst transport means are recorded during the rainy season were rainfall could reach 1132 mm with over a total of 71 as rainy days (Table 3.2 A).

Generally, over 70 % of the farmers say high pesticide cost has been a serious setback to controlling disease and pest attack of cocoa (Figure 13), and because they are afraid of not realizing benefits from their crops at the end of the season, they often tend to reduce the dose of pesticide application not to be left empty after input expenditures are been withdrawn. During the onset of the rainy season (March, April and May), most of the farmers are very poor and rely on loan for most of the farming inputs (pesticides and spraying equipments). The selling price of pesticides to farmers by LBAs and other local cocoa buying agents are often very high as these agents always determine the selling price. There are no solid price control institutions in the Southwest province that could interfere to see that farmers buy pesticides at the right price and not any price posed by the LBAs or local cocoa buying agents.

During the peak of the rainy season where disease and pest attack is highest, in order to control the situation some farmers (5 %) say, local cocoa buying agents supply to them expired pesticides together with non-expired ones. They say, they often realized the malpractice but have no choice other than using them if the suppliers are notified but claim that they haven't got any left to supply.

Generally in Cameroon, pesticide acquisition involve several persons in a chain; the chemical companies (e.g. FIMEX), the LBAs, the local cocoa buying agents, businessmen owning farmer's shops and the farmers. The schematic presentation below (Figure 14) shows pesticide flow from chemical companies to farmers.

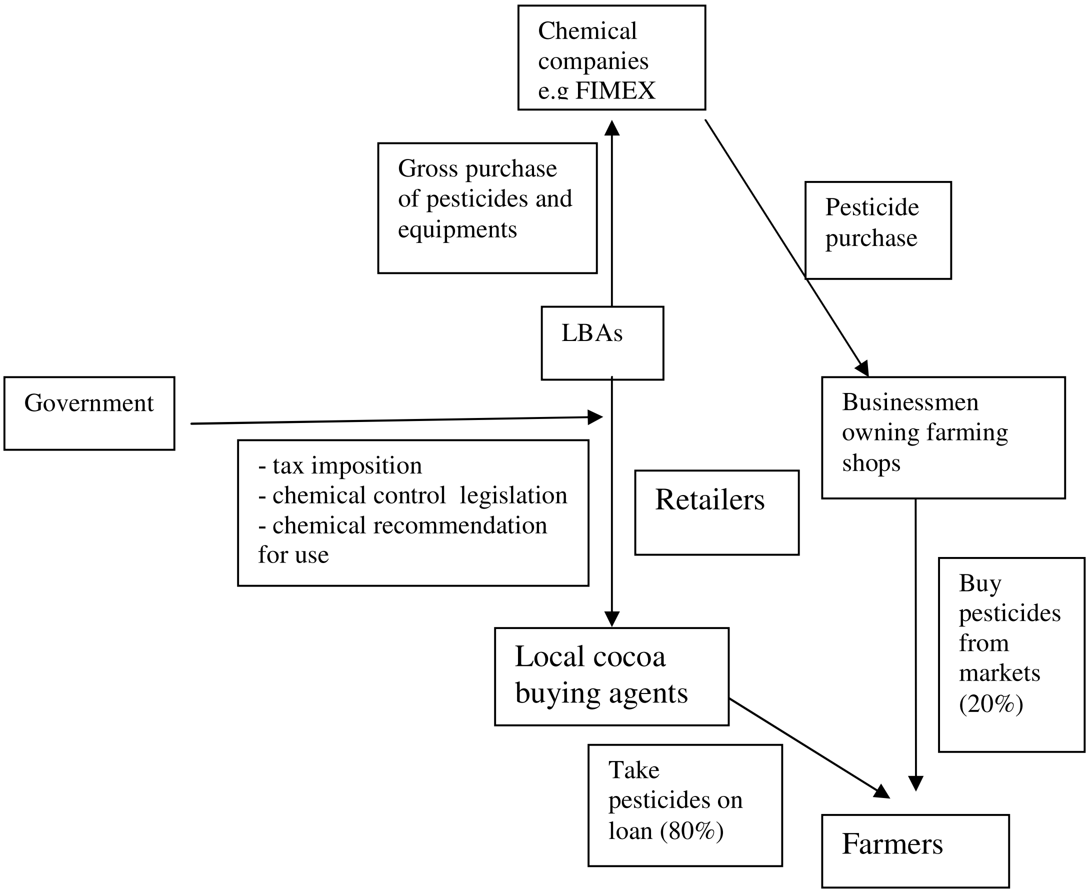


Figure 14 Schematic presentation of pesticide flow from chemical companies to farmers

Majority of the farmers (80 %) take pesticide from local buying agents. They are those whom they sell their cocoa beans. A few farmers (20 %) buy their chemicals from city and/or village markets. These are usually the averagely rich farmers living in villages of Zone 2 and Zone 3.

4.8 Health hazards related practices

4.8.1 Storage sites, mixing sites and disposal of pesticides

Most of the farmers across all 3 zones reported storing pesticides in their sleeping rooms (58 %). A place that could increase the risk of accidental poisoning by family members. Some farmers (35 %) also store pesticides in their farm store, a place where most farming tools are been kept. A few farmers (6 %) prefer to store the pesticides in the farm, probably to avoid risk exposure to pesticides by family members. None the less, this practice is uncommon (Table 4.8).

In the Southwest province of Cameroon, it is a common practice to see farmers creating ponds in their fields. This is to trap water for spraying. This is usually practice by those whose cocoa fields are far away from water source or those farmers who have got just springs or streams that could easily dry-off if there is no rainfall. The ponds restore water and serve as water source for sprayer their fields.

In Cameroon, many of the frequently used pesticide products are available in small sachets with formulations enough for one knapsack load. This makes it easier to mix pesticide directly in the sprayer. None the less, majority of the farmers (57 %) prefer premixing pesticides in other containers before transferring into sprayers. Mixing often takes place near the water source; this could be near water ponds dug in the farm by the farmers or near river running through the farm. Over fifty seven percent (57 %) of the farmers across all three zones have ponds in their fields while those who are fortunate to have rivers passing through their farms (43 %) carryout pesticide mixing nearby
(Table 4.8).

As farmers spray, the tendency to dispose empty sachets just nearby the mixing sites is not uncommon. Most of the empty sachets disposed by farmers (47 %) go into the farmland probably nearby the water ponds. Twenty one percent (21 %) discard into the nearby rivers while some farmers (19 %) say; they preserve the empty sachets to be used for as polythene bags for nursing cocoa seedlings. Recommended procedures for disposure like bury or burn of empty sachets/container is practice by a few, 10 % and 3 % for burn and bury respectively across all 3 zones (Table 4.8).

Farmers were also asked if they re-used insecticide and/or herbicide containers which are usually plastics of 5 liter or 10 liter. Over 60 % accepted using them to either store cooking oil, carry water for household use and to store fuels like kerosene or petrol. They say pesticides are very expensive, so they need the containers after use to substitute the cost of getting to buy containers from the markets for the above mentioned use.

Table 4.8 Storage and mixing sites of pesticides and disposal sites for pesticides sachets/containers

	N = 100			Total proportion of respondents (%) across all zones
	Zone 1 n=32	Zone 2 n=28	Zone 3 n= 40	
Place for pesticide storage				
In the kitchen	1			1
In the sleeping room	18	17	23	58
In farm store	11	10	14	35
In the farmland	2	1	3	6
Place for chemical preparation and/or mixing				
Near water ponds dug in the farm	16	18	23	57
Near the river channels	16	10	17	43
Somewhere else in the field				
Empty pesticide containers/sachets disposal				
Discard into farmlands	10	10	27	47
Discard into nearby river channels	16	3	2	21
Burn	3	3	4	10
Bury		2	1	3
Preserve	3	10	6	19
Source of drinking water during the spraying season				
Pipe borne water from home	15	7	22	44
Trapped water from trees in the farm	3		1	4
River water	9	15	8	32
Springs	4	6	10	20
Cleaning locations of equipments				
Water ponds	9	2	18	29
Trapped water from trees	4			4
Riverside	10	17	10	37
Clean at home	6	8	10	24
Reuse of pesticide containers				
To preserve cooking oil	12	6	15	33
Preserve water for household use	13	9	16	38
Carrying water during spraying	9	6	12	27
To preserve fuel/chemicals	9	4	4	17

4.8.2 Spraying related habits

Sixty three percent (63 %) of farmers in the Southwest province do calibrate[1] their sprayer before carrying out their spraying activities but the number was low in Zone 3 where only eight of the respondents say they do calibrate their sprayers. Almost every farmers interviewed said he/she has had more or less experienced leakage during spraying.

Over 95 % of the farmers experienced leakage during the 2006/2007 cocoa season. The various reports range from sprayer being too old in use to new sprayers bought but poorly made, they called them "imitation". Some complain that rubber cord that enables them to carry the sprayer on their back often cut quick, and because they tend to seek artificially made once, the sprayer would not align properly on their back thereby creating a lot of difficulty when spraying.

In addition, the lid sometimes easily gets damage especially when the rubber inside that prevents water from spilling outside is destroyed. If they cannot buy a new one, they are bound to experience even much greater leakage. Farmers complain of almost all sprayer parts becoming very expensive and because they cannot do without when need arises, they are bound to buy no matter the price.

For this reason, farmers now device various means to curb farm input expenses so that they can be able to realize some profits at the end of the cocoa season. Some of the means range from hitting nozzles or using nozzles from other sprayers that have a smaller 'eye' so that the droplet size of the pesticide can be reduced during spraying.

Over 37 % of the farmers in the Southwest province hit nozzle head and 20 % use nozzles from different sprayers. Not only limited to sprayers, 21 % of farmers in the Southwest province say they compose different types of pesticides in a common container from where they quantify and mix before spraying (Table 4.9).

[1] Calibrate means filling the tank of the sprayer with clean water and operating the pump to check for leaks, proper operation of the pressure gauge, and clogged or worn nozzles.

This practice is seen to be common amongst those poor farmers who cannot afford expensive pesticides known to be more effective. These groups of poor farmers are those that mix together more effective pesticides with less effective ones

All the above mentioned challenges and malpractices have been noted to have serious impact on the effective control of black pod and mirid attack using chemical pesticides.

Table 4.9 State of spraying equipment and pesticide application malpractices

State of spraying equipment	N=100			Total proportion of respondents (%) across all zones
	Zone 1 n=32	Zone 2 n=28	Zone 3 n=40	
Do calibration	29	26	8	63
Experience leakage	31	25	39	95
Hit nozzle	8	10	19	27
Use wrong nozzle (nozzles from other sprayers)	9	5	6	20
Malpractice in pesticide application				
Compose different pesticides together in a common container	3	8	10	21
Do not respect spraying calendar	6	9	7	22
Unable to distinguish one pest from the other	1	3	10	14

4.8.3 Effect of phytosanitory harvest of diseased pods over black pod disease control by chemical pesticides.

The generally concern here is to understand the effects of keeping the cocoa trees and its immediate surroundings clean (phytosanitory) on black pod disease control and mirid attack by chemical pesticides. Phytosanitory control principally involves the removal of black pods and unwanted cocoa stems. A study conducted in two different sites in Cameroon shows that removing diseased pods helped to reduce the black pod rate by 22 % and 31 % in the two sites in the first year, and by 9 % and 11 % in the second year, compared to a plot in which no preventive control measures were taken (Ndoumbe-Nkeng et al., 2004).

Some farmers in the Southwest province have the habit of removing diseased pods from cocoa trees. The various disposing sites vary from one farmer to the other (Table 5.0). Majority of the farmers (78 %) say they throw disease pods removed beneath the cocoa tree, a practice that could have a negative effect on controlling black pod disease using chemical pesticides in the sense that disposing diseased pods directly below cocoa trees could lead to black pod disease attack on uninfected pods. This is because the disposing site often acts as a reservoir for parasites. Rain drops on diseased pods or on the ground splash upwardly on healthy pods that has been sprayed by chemical pesticides and the pathogen zoospores from diseased pods thrown beneath the cocoa tree spread over and create a way for continuous attack (Muller, 1974; Gregory et al., 1984; Ristaino and Gumpertz, 2000). Thus the manner in which farmers disposed infected pods has also been noted to have an impact on repeated black pods disease attack.

Farmers usually do not have time to carry diseased pods away from their fields especially during the months were spraying becomes intensive. Thus it has be seen that most of that farmers do not follow the recommended procedure of disposing black pods which is that of digging a pit, off cocoa fields and burying the diseased pods. Based on this fact, the black pod disease control cannot be effective and mirid attack is bound to increase.

Table 5.0 Disposing cocoa black pods

Pack pods in heaps within cocoa fields	13
Throw pods beneath cocoa tree	78
Bury pods	6
Carry pods out of cocoa fields	3

4.8.4 Risk prevention strategies by pictogram demonstrations

It is understood that each time a farmer handle a pesticide, he or she is exposed to some risk. The amount of risk depends on two things; the toxicity of the pesticide and the farmer exposure to it. The amount of risk can be calculated from the formula below as outlined by OMAFRA (2002).

Risk = toxicity x exposure

Toxicity[1] is of two types; acute toxicity[2] and chronic toxicity[3]

Acute toxicity of a pesticide depends on the lethal dose 50 % (LD50); that is, it is the dose (mg of product per kg of body weight) that will kill 50 % of the test animals (usually rats or mice) within a stated period of time (24 hr. – 7 days).

Farmers in this region are constantly been exposed to pesticides. Most of the exposure is during the rainy season where much spraying is been done. They are exposed to pesticides in either of the three ways; dermal exposure, respiratory (inhalation) and oral exposure.

Pesticide labels and advisory pictograms are often illustrated on pesticide sachets for precautious reasons. To understand how protective farmers are during the spraying exercise, questions on the different protective wears were asked verbally and their responses recorded. Across all 3 zones, over 88 % of the farmers put on boots during the spraying exercise (Table 5.1).

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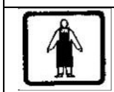
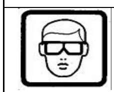
[1] **Toxicity** is a measure of how harmful or poisonous the pesticide is

[2] **Acute toxicity** - the toxic response that results from a **single exposure** to the pesticide

[3] **Chronic toxicity** - the toxic response that results from **repeated exposures** to small doses of a pesticide over a longer period of time

Table 5.1 Risk prevention strategies by pictogram demonstrations

Risk prevention strategies by pictogram demonstrations					
		N=100			Total proportion of respondents (%)
		Zone 1 n=32	Zone 2 n=28	Zone 3 n=40	
Children hazard warning					
	Keep locked away and out of reach of children	25	24	35	84
Advisory pictograms					
	Use protective gloves	4	0	1	5
	Wash immediately after pesticide spillage	2	1	1	4
	Wear a mask	2	0	0	2
	Wear a waterproof apron	2	0	1	3
	Wear protective eye glass	5	4		13
	Wear boots	27	28	33	88
Environmental hazard					
	Do cause harm for fish and water pollution	5	0	4	9
	Do cause harm for livestock and poultry	2	4	1	7

In this study, "boots" were considered any shoe that could cover the farmer's feet. Some farmers who said boots are expensive to afford put on 'slippers'. 'Slippers' are those usually used during bathing at homes. These ones ('slippers') highly expose the farmer to risk during the spraying exercise as all feet are exposed. In Zone 1 and Zone 3, 15.6 % and 17.5 % respectively put on slippers during the spraying. None of the farmers in Zone 2 say they put on “slippers” during spraying due to fear of risk exposure.

According to the recommended practice, all trousers are to be worn over boots (trousers outside boots), nonetheless farmers tend to wear trousers inside boots. They say it is protective enough as it prevents all forms of bites during spraying. Not withstanding, some farmers especially those involved in cooperatives and CIG use some protective clothing. This includes putting on rubber boots, impervious trousers, and coveralls with long sleeves, gloves, aprons and waterproof coats.

4.9 Environmental hazards related practices

It is a common practice for farmers in the Southwest province to prepare or mix pesticides closer to the water source from where they collect their water for spraying. Preparing and/or mixing of pesticides by these farmers occurs greatly near water ponds (ponds dug in the farms to trap water for spraying) or near river channels passing through their farms. All the farmers interviewed accepted preparing or mixing pesticides near one of the water sources just mentioned.

Most of environmental related pesticides hazards caused by farmers in this study are usually those associated with disposing pesticide containers into the environment or those caused by the pollution of land and water bodies by pesticides ranging from mixing sites, cleaning sites to application of insecticide in water to trap fish.

It was on this note that the researcher investigated how empty pesticide sachets/containers were being disposed after use by the farmers. It was observed that the preparation and/or mixing sites of pesticides were more or less the same sites where pesticide empty sachets/containers were disposed. Mixing pesticides in these areas allow pesticide to drift, run off or leach onto land and water bodies from which some of the farmers drink.

To prevent contaminating surface water, ponds and/or streams, the specific buffer zone distances usually written on product label should be respected. Farmers in the Southwest province during the spraying season never take that into consideration even if they read it from product label. For this reason, preventing surface water from pesticide contamination by farmers could be a very difficult issue to handle.

For farmers whose source of spraying water are springs and ponds, these groundwater sources are often contaminated since most of the pesticide mixing is done just beside the water sources. Forty seven percent (47 %) and 21 % of the respondents disposed pesticides empty sachets/containers after use into farmland and into nearby rivers respectively. Similarly, 10 % and 3 % of the farmers say they disposed the empty sachets/containers by burning and burying respectively.

Leaching of pesticides into the groundwater and soil are often the end result. Soil in the Southwest province is mostly volcano with a relatively high organic matter. This type of soil is highly absorptive and will therefore have a low leaching potential. Thus depending on pesticide type and the dose applied during the spraying exercise, it could be advantageous on one hand, that the volcanic soil will absorbed the pesticides thereby limiting groundwater contamination and on the other hand, disadvantageous because this volcanic soil may retain certain pesticides that could be harmful to certain plants.

Though it is not a common practice by farmers in the Southwest province to spray the insecticide Basodine, some few farmers still use the very toxic insecticide to control ants. Basodine is usually sprayed during the onset of the cocoa season when flowering of the cocoa crop has just begun. This insecticide tends to kill honey bees and other insects that serve as important pollinators of crops.

The financial difficulties cocoa farmers today are facing have put them to utilize some farming materials worth to be disposed into other uses. This is simply because they want to incur as little household expenditure on material items than necessary. Today, some empty pesticide sachets/containers are being preserved by some farmers (19 %) to be used for other purposes. Thirty three percent (33 %) of the farmers say they preserved insecticide containers to be used for storing cooking oil, 38 % of the farmers use containers to store water for household, 27 % of the farmers use container to collect water for spraying during the spraying season while 17 % say they use container to store fuel/chemicals. By convention, all pesticide containers are supposed to be got rid off and disposed accordingly because they are poisonous. But still not, they are still being used by farmers for household needs.

As a result of the malpractices of pesticide handling and use, natural resources are continuously being polluted and exploited to the point of compromising future productivity. Contamination of water sources is still principally a major environmental concern (Mancini, 2006). Over 15 % and 10 % across Zone 1 and Zone 3 respectively, say they pour insecticide (Gammalin) into water to trap fish for household consumption. This has been attributed to poverty because farmers themselves are aware of the danger of pouring pesticides into water bodies.

Some farmers do practice pesticide mixing at home before carrying the pesticide to the farms. A practice that could lead to accidental pesticide spillage into the environment causing harm to poultry farming known to be very common by small – scale farmers in the Southwest province. Also farmers who do have rivers in their farms or those who cannot sacrifice time to wash equipments in the rivers in their farms due to late finishing clean their sprayers at home. This practice has been noted to be very common with the farmers in this region especially during the peak of the spraying season where closing time for the spraying exercise is usually in the night and most of the cleaning of the farming tools are done at home.

5.0 CONCLUSION

Control of black pod and mirid attack from this study has been noted to be persisting. This has been greatly attributed to factors like irrational pesticide application, high pesticide and equipment costs and bad road network system. Irrational pesticide application has been as a result of the fluctuating weather and climatic condition of the Southwest province. This can be improved if modern meteorological stations are constructed and extension officers actively participating with farmers, helping them to schedule a better spraying calendar from weather forecast records from the station. High pesticide and equipment costs, complained by farmers can be improved by the government providing capital loan that can enable farmers to meet up with their basic farming needs rather than having to depend only on LBAs. An institution put in place, preferably a parastatal will be of help to coordinate the activity. Bad road network system has been a failure, farmers living in villages or suburbs often find it difficult to transport themselves to town during the rainy season to purchase pesticides and/or equipments at a cheaper cost because the roads are too marshy. This could be improved by the government providing loan for infrastructure development like farm to market roads and farm to farm roads.

If the above factors are given suggested solutions, we will be sure that, farmers will enjoy some benefits from their farms and will therefore be encouraged to keep the cocoa sector in the country alive.

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Appendices

Household Survey Questionnaire

CONTROLLING BLACK POD AND ATTACK OF MIRID ON COCOA USING PECTICIDE BY FARMERS IN THE SOUTHWEST PROVINCE OF CAMEROON

Date of Interview:____________________________

Starting time……………, Ending time……………..

Enumerator:____________________________

Study site (Locality):

1= Kongne (approx. 40km from Kumba)
2= Ebongue (approx. 18km from Kumba)
3= Kumba Central area fringe

A) Household characteristics:

1- Subdivision:
   Division:
   Province:
2- Village___________________ Code of village ☐

3- Name of family head__________________________

4- Household number ☐

5- Sex (SEX): 1=M 0= F ☐
   Age= ☐

6- Marital status (MASTAT) ☐
Code: 1= Single 2= Married 3= Widow 4= Widower 5= divorce

7- Level of education (EDUC): ☐

Code: 0= None 1= Primary2= Secondary 3= High School 4= University 5=Others, specicy__________________

8- Are you member of any group or organization(s) (MEMORG)?
   1= Yes
   2=No
9- If Yes, which (ORGTYPE)?

Code: 1= Farming 2= Research 3= Cooperative 4=CIG 5= Others, specify_____________

10- Major occupation (MAJOCCU): ☐
Code: 1= Farmer 2= Business 3= Retired 4= Artist 5= Others, specify__________

11- Origination (ORIGNAT): ☐ Code: 1= Native 2= Migrant
If 2, specify tribe or clan (TRIB)
____

12- Which year did you start living in this village (YRLIV)? ☐

13- Number of persons in household:
13.1- Men (>= 16 years): active (MAC)______, non-active (MNAC)_____

13.2- Women (>= 16 years): active (WAC)____, non-active (WNAC)_____
13.3- Boys (<16 years): students (BSTU): _______, non-students (BNSTU) ____

13.4- Girls (< 16 years) students (GSTU) ______, non-students (GNSTU) ____

14- How many micro-families composed this household (MFMLY)? ______

B) Characterization of cocoa farm:

15- When did you start growing cocoa (CAOPRT)? ________

16- How many cocoa producing farm(s) did you managed last year, 2005 and how many are you managing this year, 2006,(including those of shared-cropping and pledged)(NFARM)? 2005_______________ , 2006______________

17-What is your status on your current cocoa farming land(s) (FSTAT)? _________

Code: 1= Owner 2= Caretaker 3= Pledge 4= Sharecropping 5= others, specify________

18-When did you establish your cocoa farm(s), distance from house, total number of hectares (ha), the total number of cocoa trees in each farm, your accessibility, and the total harvested for each of the farm(s)?

Cocoa plots	Year of creation (YRCRTN)	Distance from house in Km (DISTKM)	Total number of ha (TONHAC)	Total number of tress (TONTRE)	Accessibility (ACCESI)
P1	YRCRTP1……..	DISKMP1…...	TONHAP1…….	TONTRP1…….	ACCESP1…...
P2	YRCRTP2……..	DISKMP2…...	TONHAP2…….	TONTRP2…….	ACCESP2…...
P3	YRCRTP3……..	DISKMP3…...	TONHAP3…….	TONTRP3…….	ACCESP3…...
P4	YRCRTP4……..	DISKMP4…...	TONHAP4…….	TONTRP4…….	ACCESP4…...

P5	YRCRTP5……..	DISKMP5…...	TONHAP5…….	TONTRP5…….	ACCESP5…...

Code: Accessibility (ACCES): 1= Very difficult 2= Difficult 3= Facile

C) Acquisition of equipments and chemical pesticides:

C1: Equipments

19-What are the different types of spraying tools/equipments you used this year on your cocoa farm (DIFEQMT)? ________________________

Types of equipment	When did you buy it?	What is the present working condition 1= Good 2= Average 3= Bad	Expected year for new purchase	Other comments
1= knapsack sprayer				
2= Boots				
3=Gloves				
4=Goggles				
5=Cap				
6= Apron				
7= Socks				
8= others, specify ________				

20- Can you evaluate the costs of the different types of equipments acquired this year, 2006 (EQMTCAA)?

Name of equipments (EQMTNAME)	Cost price per equipment, 2006 (EQMTCOST)	Total number of equipments (TOTEQMT)	Total cost of equipments (EQMTOCOST)	Acquisition (EQMTPROV) 1= Buy from village market 2= Buy from cooperatives in the village 3= Buy from nearby city 4= Take on credit from cocoa buying agents 5= Buy from other farmers 6= From religious groups 7= Others, specify________________

1= knapsack sprayer				
2= Boots				
3=Gloves				
4=Goggles				
5=Cap				
6= Apron				
7= Socks				
8= others, specify ________				

21) Do you usually check/test the status of your spraying equipment for the following before spraying (EQMTSTAT)? ____

Status	**1=Yes 0= No**	**Comments on any other abnormalities after testing**
Calibration		
Leakages		
Worn nozzle		
Others, specify		

22) If you answer **Yes** to question **21**, who does the checking/testing of the equipment (EQMTTES)? ___
Code:
1= myself 2= other farmers 3= extension officers 4= trained farm personnel
5= others, specify_____________

23- Do you think you are actually applying the appropriate quantity of pesticide required during spraying (EQMTACC)?
Code: 1= Yes 0 = No

24- From whom do you get advice(s) on the type of equipments to buy (TEQMT?) ___________
Code: 1= myself 2 = Extension officers 3 = Village cooperatives 4 = Other farmers 5= Cocoa buying agents 6 = Others, specify______________

25-1 -Do you buy your spraying equipments together with spare parts (SEQMT)? ____________
Code: 1= Yes 0= No,

25-2- If Yes, do you get them later as second-hand parts or new parts? _____________

Code:
1 = new parts, 2 = second-hand parts 3 = others, specify_____________

26-What are your major constraints of acquiring spraying equipments (CEQMT)?
____

Pesticides	Constraints 1= Bad transport roads 2= Too expensive to afford 3= Not easily accessible 4= Life span of spraying machine is too short 5= nozzles of spraying equipments supplied worn quickly 6= others, specify__________
FUNGICIDES	
1= knapsack sprayer	
2= Boots	
3=Gloves	
4=Goggles	
5=Cap	
6= Apron	
7= Socks	
8= others, specify ________	

C2: Chemical Pesticides

27-1- Do you still use chemical pesticides on your cocoa farms? ____________
Code: 1= Yes 0= No
27-2- If you answer No to question 27-1, outline your reason(s) from explanations below.

Pesticides types	**Explanations** 1= pesticides not available 2= pesticide not affordable 3= pesticide imported are outdated 4= black pod disease and capsids attack is not a problem in my farm 5= pesticides supplied are highly toxic 6= have too many little children in the house 7= others, explain______________________ (Multiple explanations are accepted

No fungicide application **(NFUNAPPL**)	
No insecticide application **(NINSAPPL)**	
No herbicide application (**NHERAPPL)**	

28- From whom do you get advices on the types of pesticides to buy/use (PESTADV)?

Code: 1= Extension officers 2= Village cooperatives 3= Other farmers 4= Cocoa buying agents 5= Others, specify_______________

29- How did you get chemical pesticides this year, 2006?

29-1 Fungicides

Name of fungicides (FUNNAME)	Cost per sachet, 2006(FUN PRIC)	Total sachets, (FUNS ACH)	Total cost, 2006 (FUNC OST)	Shelf-life of fungicides Legislation (FUNLEGS) 1=fungicide is worldwide recommended for use 2= fungicide is outdated and banned 3= fungicide is outdated but still been imported for use 4= fungicide is outdated but very cheap to afford 5= others, specify______________	Acquisition (FUNPROV) 1= Buy from village market 2= Buy from cooperatives in the village 3= Buy from nearby city 4= Take on credit from cocoa buying agents 5= Buy from other farmers 6= From religious groups = Others, specify_________
1=Ridomil Plus 66 WP					
2= Nordox 75 WG					
3= Kocide 2000					

4=Caocobre					
5=Callomil Plus					
6=Beauchamp 75% WP					
7= Galben Plus WP					
8=Hydrox					
9= Others, specify					

29-2- Insecticides

Name of Insecticides (INSNAME)	Cost per liter, 2006(INSPRIC)	Total quantity (Litres), (INSSACH)	Total cost, 2006 (INSCOST)	Shelf-life or Insecticides Legislation (INSLEGS) 1= insecticide is worldwide recommended for use 2= insecticide is outdated and banned 3=insecticide is outdated but still been imported for use 4= insecticide is outdated but very cheap to afford 5= others, specify_________	Acquisition (INSPROV) 1= Buy from village market 2= Buy from cooperatives in the village 3= Buy from nearby city 4= Take on credit from cocoa buying agents 5= Buy from other farmers 6= From religious groups 7= Others, specify__________
1=Actara					
2= Kart					
3= Callisulfan 350 EC					
4= Kunfu 5%					
5=Cyperdim 220 EC					
6=Thiodane 35 EC					
7=Cypercal 12					

EC					
8=callidim 400 EC					
9= Basodine					
10= others, specify					

29-3- Herbicides

Name of herbicide (HERNAME)	Cost per sachet, 2006 (HERPRIC)	Total sachets, (HERSACH)	Total cost, 2006 (HERCOST)	Shelf-life or herbicides legislation (HERLEGS) 1= herbicide is worldwide recommended for use 2= herbicide is outdated and banned 3=herbicide is outdated but still been imported for use 4= herbicide is outdated but very cheap to afford 5= others, specify_________	Acquisition (HERPROV) 1= Buy from village market 2= Buy from cooperatives in the village 3= Buy from nearby city 4= Take on credit from cocoa buying agents 5= Buy from other farmers 6= From religious groups 7= Others, specify__________
1= Paraquat					
2= Glyphosate					
3= Gramazone Super					
4= Bentazone					

29-4 What are you major constraints encountered acquiring chemical pesticides this year 2006 (ACHMPST)?

Pesticides	Constraints 1= Bad transport roads 2= inhale odor during transport 3= No material to protect pesticides 4= Not easily accessible 5= Too expensive 6= others, specify___________
FUNGICIDES	
1=Ridomil Plus 66 WP	
2= Nordox 75 WG	
3= Kocide 2000	
4=Caocobre	
5=Callomil Plus	
6=Beauchamp 75% WP	
7= Galben Plus WP	
8=Hydrox	
9= Others, specify	
INSECTICIDES	
1=Actara	
2= Kart	
3= Callisulfan 350 EC	
4= Kunfu 5%	
5=Cyperdim 220 EC	
6=Thiodane 35 EC	
7=Cypercal 12 EC	
8=callidim 400 EC	
9= Basodine	
10= others, specify_____________________	
HERBICIDES	
1= Paraquat	
2= Glyphosate	
3= Gramazone Super	
4= Bentazone	
5= others.specify____________________	

D: Transport and Storage of Equipment and Chemical Pesticides

D1- Transport of equipments and storage:

30-1-0 Do you transfer your spraying equipments wholly or you dismantled them from purchase area before carrying them home (TRAEQMT)? ___________________

Code: 1= Wholly 2= Dismantled

30-1-1- If 1, do you coupled or built the equipment yourself or you seek expertise assistance?

1= coupled myself
2= seek help from an expert
3= seek help form other farmers
4= others, specify________________

30-1-2- Where do you **STORE** your equipments when you carry them home (STEQMT)?

Types of Equipments	Where (EQMTWHE) 1= In my kitchen 2= In the ceiling of the house 3=Inside a pond closer to the house 4= in my sleeping room 5= farm store 6= others, specify________	How (EQMTHOW) 1= store with water inside 2= store with pesticides inside 3= store with corrosive items inside 4= store it empty 5= others, specify_________	Reasons for choosing whichever response(S). (RESPOSES)
1= knapsack sprayer			
2= Boots			
3= Gloves			
4= Goggles			
5= Apron			
6= Caps			
Others,			

specify______			

D2- Transport of chemical pesticides and storage:

30-2-0- Do some of your chemical pesticides get burst in the course of transferring them to your home? ________________

Code: 1 = Yes 0 = No

30-2-1- Do you transport them alongside or store them with foodstuffs or animal feed (PESTRAN)? ____

Code: 1= Yes 0 = No

30-2- 2- Do you store fungicides, insecticides and herbicides in the same place (FIHSTOR)? _______

Code: 1= Yes 0 = No

30-2-3- Do you place liquid formulations above powder or granule formulation or you pack them together in the same place (PESTPAK)? __________________

Code:

1= keep liquid formulation above powder and granule formulations

2= keep liquid formulation below powder and granule formulations

3= keep all pesticides in the same place and at the same level

4= others, specify_______________________

30-2-4- Can you give your reason(s) as to where and how you **store** your fungicides, Insecticides and herbicides for cocoa after purchase (PESTTOR)?

Pesticides (PESTNAME)	Where (PESTWHER) 1= In the kitchen 2= In the ceiling of the house 3=Inside a pond closer to the house 4= in my sleeping room 5= farm store 6= others, specify__________	How (PESTHOW 1= in an airtight container 2= in an air-free container 3= in a sunlight exposed room 4= others, specify_________________	Reasons for choosing whichever response(S). (RESPOSES)
Fungicides (FUNNAMES)			

1= Ridomil Plus 66 WP			
2= Nordox 75 WG			
3= Kocide 2000			
4= Caocobre			
5= Callomil Plus			
6= Others , specify___________			
Insecticides (INSNAMES)			
1=Actara			
2= Kart			
3= Callisulfan 350 EC			
4= Kunfu 5%			
5=Cyperdim 220 EC			
6=Thiodane 35 EC			
7=Cypercal 12 EC			
8=callidim 400 EC			
9= Basodine			
10= others, specify____________________			
Herbicides (HERNAMES)			
1= Paraquat			
2= Glyphosate			
3= Gramazone Super			
4= Bentazone			
5=others, specify___________			

E: Chemical Pesticide Application

31- Can you please indicate the types of pesticides you use this year, frequency of use, period of application, dosage as well as the area of land covered (PESTAPPL)?

Names of Pesticides (PESTNAME),	**Frequency of application (PESTFREQ)**	**Period of application; i.e. the months (PESTPER)**	**Dosage per sprayer (PESTDOE)**	**Total number of hectares in Farm(s) (PESTTOA)**	**Total number of cocoa trees in Farm(s) (PESTAREA)**	**Note**: If farmer applied pesticide but does not know the type, request for the container for identification or write unknown if otherwise. .
Fungicides (FUNNAMES)						
1= Ridomil Plus 66 WP						
2= Nordox 75 WG						
3= Kocide 2000						
4= Caocobre						
5= Callomil Plus						
6= Galben plus WP						
7= Plantomil 72 WP						
8= Beauchamp 72%WP						
9= Others , specify__________						

Recommended guide for pesticide application (from the sachet sold on the local market)	1 = -apply 1 sachet (50g) in 15litres of knapsack sprayer containing water. -apply at first appearance of the cherelles, prior disease occurrence. -repeat treatment during the rainy period (= period of highest disease pressure) at intervals of 21days. For period of maturation, it is recommended to use copper product like caocobre. Pre-harvest interval(PHI): 1 month
	2 = 1 sachet (40g) in a 15 litres of knapsack sprayer containing water. Spray every 15 to 21 days. Begin preventive treatment before the rainy season
	3 = 1 sachet (60g) for a knapsack sprayer of 15litres.
	4 = 1 sachet (75g) for knapsack sprayer of 15 litres clean water. -spray when rain season and continue at intervals of 2 to 3 weeks according to disease incidence. - spray preferably prior to pod maturation
	5 = 1 sachet(50g) in 15litres of clean water in knapsack sprayer -spray from onset of disease, repeat treatment after 21days interval in the rainy period
	6 = 1 sachet (50g) in 15 litres, 24 sachets in 1 ha of land Spray at the beginning of May let last for 4-6 weeks

	7 = 1 sachet (50g), mix well and complete to 15litres water Apply during onset of the disease Spray 21 days interval					
	8= I sachet(50g) in 15litres -spray from onset of disease, repeat treatment after 21days interval in the rainy period					
Insecticides (INSNAMES)						
1=Actara						
2= Kart						
3= Callisulfan 350 EC						
4= Kunfu 5%						
5=Cyperdim 220 EC						
6=Thiodane 35 EC						
7=Cypercal 12 EC						
8=callidim 400 EC						
9= Basodine						
10= others, specify__________ __________						
Recommended guide for Insecticide Application	1 = 1 sachet (40g) in 15litres, apply during high pressure of pest					
	2= 1 sachet (4g) in 15 litres, PHI= 1 month					
	3 = 1 spoonful (required spoon measurement provided) of product into a 15litres knapsack sprayer containing clean water. It is recommended to mix with particular fungicides before spraying					
	4 = -apply 1 sachet of required product into a 15 litres knapsack sprayer containing clean water, -apply product during incidence of insecticide					
	5= apply 1 spoonful of product into 15litres of knapsack sprayer containing clean water. Recommended for use with particular fungicides.					
Herbicides (HERNAMES)						
1= Paraquat						
2= Glyphosate						
3= Gramazone Super						
4= Bentazone						

5=others, specify__________						

Code:
PESTDOSE: number of sachets per quantity of water used
PESTTOHA: total number of hectares of all cocoa yielding plots
PESTAREA: total number of cocoa tress of all cocoa yielding plots
32-1-0 At what time of the day do you preferably apply pesticides (PESPERD)?
Code:
1 = early in the morning   2 = in the afternoon   3 = late in the evening

32-1-1- Do you use sachets containing sufficient spray pesticides (fungicides, insecticides, herbicides) for one knapsack sprayer or you quantify by estimate or using a standard measurement from a bigger sachet during mixing (PESTQTYA)? ______________

Code:
1= have prepared sachet for one knapsack sprayer   2 = quantify by estimate during mixing
3= quantify using standard measurement spoon provided   4 = others, specify________________

33- Do you do premixing in a separate container before transferring to the sprayer or you mix directly in the sprayer (PESTMIX)? ______________
Code:
1= do premixing in another container   2= mix directly in the sprayer
3= others, specify _______________

34-This cocoa season 2006/2007, can you evaluate and explain if your desire to use fungicides (FUNAPPL), insecticides (INSAPPL) and herbicides (HERAPPL) on your cocoa farm has increased or decreased?

Pesticide types	Evaluation 1= Increased 2= Decreased 3= Constant 4= Cannot judge 5= others, explain	Explanation/Reasons
Fungicide application (**FUNAPPL)**		

Insecticides application **(INSAPPL)**		
Herbicides application **(HERAPPL)**		

35- From which source do you principally get your information on how to spray your cocoa farm(s) (SPRTECH)? _________________

Code:

1 = Sellers in the market 2 = From agricultural extension officers 3 = From local cocoa buying agents

4 = Instructions on the sachets 5 = From other farmers 6= Others, specify________________

36- If you answer **4** to question **35**, do you understand the language on the sachets or you follow demonstrations on the sachets (LANGINST)? ______________

Code:

1 = Understand the language and demonstrations 2 = Don't understand language, only demonstrations

3= Others, specify_____________________

37-Where do you dispose the removed black pods from your cocoa tree (DISPODS)_________________

Code:

1 = throw beneath cocoa trees, 2 = bury, away from infected sites or

3 = carry completely out of farm 4 = others, specify____________

38- Do you use traditional control methods to control black pod disease and capsids in your cocoa farm(s)? _________

Code: 1= Yes 0= N

39- If you answer **Yes** to question **38**, can you please describe your methods and system of application?

Description of methods	Pest against	Frequency of application	Period of application	Reason for using each method. 1= Have products in my farm 2= It is easy to prepare and apply products 3= It is cheap and non-toxic 4= more efficient than conventional methods 5= others, specify.
Method 1				
Method 2				

40- Which method will you today give preference for future pest management (PESTMGT)?___________

Code:

1 = Chemical methods 2 = Traditional methods 3 = Both methods
4 = Cannot judge 5 = Other, specify________________

41- Do you practice or encounter any of the following during pesticide application (PESAPPL)? ________

Code:

1= using nozzles from another sprayer
2= sometimes mix herbicides and fungicides during spraying
3= unable to distinguish one pest from the other
4= do mixing anyhow maybe due to difficulty in understanding chemical formulation on the sachet
5= overdose and alteration of the period of application
6= reduce droplet size so as to serve large area of farm
7= use a different type of pesticide to substitute the appropriate but lacking one
8= experience leakage during spraying.
9= others, specify____________

42- Are you today using pesticides on other products than cocoa (ALTCROPS)? ________

Code: 1= Yes 0 = No

43- If **No** to question **42**, what are your reasons for not using them on other products (ALTREASON)?

____

____

44- If you answer **Yes** to question **42**, can you please give the names of the various types of pesticides, crops, when do you carryout the application and for what purpose.

Types of pesticides	Types of crops	Period of application (months)	Purpose (types of diseases/pests).

45- Can you please indicate the total quantity of cocoa harvested in 2005 and this year 2006 by you or your wife or wives as well as the price kg for each year (PRDTMONEY)?

Year	Total quantity (Kg)*	Price per Kg	Total amount realized by farmer
2005			
2006			
*** standard weight per bag x total standard weight harvested**			

Code:
PRDTMONEY= money realized from all cocoa farm(s)

46- What has been your major challenge this year to combat the black pod disease and capsids (PESTCHLG)?

Code:

1= Lack of some spraying materials and tools 2 = Bad state of spraying equipments
3= Insufficient pesticide application 4 = Insufficient labour force
5= Failure to respect spraying calendar 6 = Too much shade and high humidity in my farm
7= Others, specify______________________

47- If you answer **2** to question **43**, who does the repair of your spraying machine (EQMTREP)?
Code:

1= Local distributor of the equipment 2 = Mechanic at a cooperative in the village
3= Experienced/Trained Personnel 4 = Local repairer in the village
5= I repair myself 6 = Repair by local experience farmer
7= others, specify_______________

F- Pesticide Hazards

48- Were you unable to get some of your equipments or working tools needed for spraying your cocoa farm this year, 2006 (REQEQMT)?
Code: 1= Yes 0= No
49- If **Yes,** to question 39, why could you not get all (NALEQMT)?
Code:
1= some were not available 2 = some were not affordable
3= some were not necessary for me to have 4 = some are too time consuming to use
5= others, specify_________________
50- Do you read and understand from your pesticide sachet the precautions and first aid you need to know before you start spraying your cocoa farm (PESCAUT)?
Code: 1= Yes 0= No

51- Can you please list and explain the types of body wears you put on for body protection during pesticide handling, mixing and spraying (PESHAND)?

Body parts	**Protective wears**	**Reasons for wearing**	**Recommended wears for pesticide application by WHO**	
Feet			Rubber Boots -NEVER use Sandals.	Feet protection
Eyes			Eye shield	Eyes protection
Ears			Ear defenders	Required for motorized equipment

Nose			Respiratory Protective Equipment (RPE)	Required for fogging
Head			Light protective cap	Head protection
Mouth			Light disposable mask	Required for ULV spraying
Hands			Synthetic rubber gloves -e.g. nitrile rubber gloves **Note:** gloves should be worn tucked **INSIDE** the sleeves	Protect hands
Skin			Overall cloth (light weighted -long trousers should be worn **OUTSIDE** the boots -long sleeve upper garment.	Skin protection
			Waterproof Apron	Required during pesticide mixing.

(**NOTE:** Strive to know from the farmer if gloves are tucked inside the sleeve if at all they use, and also if their long trousers are worn outside the boots or not)

52- Do **you sometimes smoke, drin**k or eat while spraying or using this product (PESSACT)? ______
Code: 1= Yes 0= No

53- Are you sometimes exposed to pesticides spillage or contamination as a result of leakages during spraying (PESEXPO)? ___________
Code: 1= Yes 2= No

54- If Yes to question 33, through which routes do you get this contamination (PESROUT)? ________
Code:
1= through the skin

2= through the mouth
3= through the nose
4= through the ears
5= others, specify_____________
(Note: Multiple responses are permitted)

55- What do you do if pesticide spill on your cloth or skin in the course of spraying (PESPILL)?
Code:
1=wash immediately
2=wash after exercise
3= others, explain________________

56- Do you grow food crops in some areas of your cocoa farm(s) (FOODCRP)?
____
Code: 1= Yes 0= No

57- If Yes, to question 39, do pesticide spill on them during spraying your cocoa (FOODPOI)? _________
Code: 1= Yes 0= No

58- Do you use insecticide or fungicides as additives or prepare concoctions out of them to trap rodents that destroy your cocoa or food crops (ANIMTRA)?
____
Code: 1= Yes 0 = No

59- If Yes to question 49, what do you do with the animals trapped (ANIMPOI)?
____
Code:
1= use for household consumption
2= sell them to others
3= we dispose them into the farm
4= others, specify ___________________

G-Environmental Hazards

60= where do you usually get water for spraying (SPWATER)? ________________
Code:
1= from ponds dug inside the farm/ drums to trap water
2= from nearby rivers in the farm?
3= tapped water from tree/ palm trees
4= others, specify_______________

61- Where do you usually carryout mixing of pesticides (PESMIXG)? ___________
Code:
1= beside the water pond in the farm/ drums to trap water

2= at the riverside in the farm
3= somewhere else in the farm, not closer to the water source
4= others, specify_______________

62- Have you encountered any sort of breakdown of your equipment during spraying (EQMTBRK)? ____
Code: 1= Yes 0 = No

63- If **Yes** to question **53**, what do you do with pesticide in your spraying machine (PESUSAG)? _______
Code:
1 = splash it onto the cocoa pods 2 = carry it home to be used the next day
3 = pour it in another container to be used the next day 4 = discard it anywhere in the farm
5 = pour it in the river to catch fish 6 = others, specify_______________

64- What is your principal source of drinking water during the spraying season (DRINWATS)? _____________
Code:
1= pipe borne water brought from the house 2 = water tapped from farm/palm trees
3= water from the river in the farm 4= others, specify____________

65- Where do you dispose the empty sachets and used pesticide containers after spraying is completed (SACHDIS)?
Code:
1= discard them somewhere in the farm 2= bury them somewhere in the farm
3= throw them in nearby streams or rivers 4= Burn them somewhere in the farm
5= others, specify _______________

66- If you answer **2** to question **56**, do you wash and/or puncture the containers before burying them (CONDISP)?
Code: 1= Yes 0 = No

67- Are some of your pesticide containers re-used by you for any purpose (PESCONS)?
Code: 1= Yes 0 = No

68- If Yes to question 57, what purpose do the containers serve you (USECONS)?
Code:

1= to store some foodstuffs in them 2 = to reserve water for household use
3= to carry water during spraying 4= others, specify______________

69- Where do you usually clean your equipments after spraying (CLNLOCAT)?
Code:
1= clean them in the water ponds in the farm 2 = clean them with water tapped from trees in the farm
3= clean them in the river 4= clean them at home
5= others, specify____________

70- Are you aware that cleaning your equipments in the rivers after spraying can kill other living creatures in the water?
Code: 1= Yes 0 = No

71- Have you ever pour pesticide into water to trap fish (FISHTRA)?
Code: 1= Yes 0= No

Thanks for cooperation

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O/Ref.: № - 0140/L/IITA/HFC/07

INTERNSHIP ATTESTATION

=.=.=.=.=.=.=.=.=.=.=.=.=.=.=.

The International Institute of Tropical Agriculture hereby testifies that **M. Sufor Kingsly Ngengong,** student of Norwegian University of Life Sciences, carried out his **Internship** from 21st of November 2006 to 25th of January 2007, at the International Institute of Tropical Agriculture, The Humid Forest Ecoregional Center (IITA-Cameroon), under the supervision of Dr. Denis J. Sonwa.

The research activities of **M. Sufor Kingsly Ngengong** were on "Understanding Chemical Pesticide Use by Cocoa Farmers in Southwest Cameroon".

This attestation is delivered to serve where and when necessary.

International Institute of Tropical Agriculture IITA CAMEROON

Aboubakar Yacoubou
Resident Representative