Knowledge and perception of Ghanaian cocoa farmers on mirid control and their willingness to use forecasting systems

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Knowledge and perception of Ghanaian cocoa farmers on mirid control and their willingness to use forecasting systems

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(***Running title*****:** Forecasting systems for mirid control)

Abstract

Annual losses of cocoa in Ghana to mirids are significant. Therefore, accurate timing of insecticide application is critical to enhance yields. However, cocoa farmers often lack information on the expected mirid population for each season to enable them to optimise pesticide use. This study assessed farmers' knowledge and perceptions of mirid control and their willingness to use forecasting systems informing them of expected mirid peaks and time of application of pesticides. A total of 280 farmers were interviewed in the Eastern and Ashanti regions of Ghana with a structured open and closed ended questionnaire. Most farmers (87%) considered mirids as the most important insect pest on cocoa with 47% of them attributing 30-40% annual crop loss to mirid damage. There was wide variation in the timing of insecticide application as a result of farmers using different sources of information to guide the start of application. The majority of farmers (56%) do not have access to information on the type, frequency and timing of insecticides to use. However, respondents who are members of farmer groups had better access to such information. Extension officers were the preferred channel for information transfer to farmers with 72% of farmers preferring them to other available methods of communication. Almost all the respondents (99%) saw the need for a comprehensive forecasting system to help farmers manage cocoa mirids. The importance of accurate timing for mirid control based on forecasted information to farmer groups and extension officers was discussed.

Key words: Extension, questionnaire, farmer groups, insecticides, mirid, cocoa

Introduction

Mirids (*Sahlbergella singularis* (Haglund), *Distantiella theobroma* (Distant), *Helopeltis* spp. and the *Bryocoropsis* spp.) are economically significant insect pests in cocoa production, particularly in West Africa (Padi and Owusu, 1998, Anikwe et al., 2009), where around 71% of the world's cocoa is grown. Mirid damage is caused by both adults and nymphs, which pierce their feeding mouth parts into pods, chupons and soft portions of branches. This creates a characteristic vivid circular lesion which turns brown and later black after a couple of hours on pods and elliptical dark lesions on chupons and young stems (Entwistle, 1975). In Ghana, mirid damage is a contributory factor to low yields (Dormon et al., 2007). It is estimated that approximately 30% of cocoa beans in Ghana is lost to mirids annually (Adu-Acheampong et al., 2014). Control of mirids has mainly been through the use of conventional insecticides applied to mature cocoa with a motorised knapsack spraying machine (Eguagie, 1973, Awudzi et al., 2009, Sonwa et al., 2008). The current recommended time for the start of insecticide application is August since historical reports have shown that the pest increases in numbers in that month (Owusu-Manu, 1995). Recent mirid population studies carried out by Awudzi (2014) suggests that rapid mirid population build-up starts from June and not August. This may be due to the use of hybrid (progenies from bi-parental crosses made in seed gardens) materials producing pods all year round and changes in climate over the years. Adu-Acheampong et al. (2014) also studied the population dynamics of the major mirid species in 1991, 1999, 2003 and 2012 to determine the appropriate timing for the application of insecticides for the control of the pest. They recommended a needs-based system for pest control on cocoa, a shift from the current calendar-based recommendation.

Over the years, various insecticides with different active ingredients have been used for mirid control (Entwistle et al., 1959, Eguagie, 1973, Awudzi et al., 2009). Most of the insecticides used in the 1960s are no longer in use because of their high mammalian toxicity levels and because of new maximum residue levels (MRL) introduced by the European Union (EU) (Raw, 1959, Prins, 1965, Bateman, 2009). Until recently, only three insecticides were recommended for the control of cocoa mirids in Ghana (Awudzi et al., 2009). Their active ingredients are bifenthrin, thiamethoxam and imidacloprid. The Cocoa Research Institute of Ghana (CRIG) conducts research into the safe use of these insecticides and gives recommendations on dosage and application techniques. However, since coverage of extension services in Ghana is limited (Baah, 2002), it is not clear to what extent farmers have access to such information. Lack of adequate information may result in incorrect timing of insecticide applications and mirids numbers reaching their economic thresholds before insecticides are applied. Furthermore, the use of unapproved insecticides, resulting in unacceptable residues in beans and other health problems, can arise if farmers feel their crop is threatened by severe mirid damage. Mirids have developed resistance to some insecticides in the past due to incorrect application (Dunn, 1963, Prins, 1965, Owusu-Ansah et al., 2010). The excessive use of insecticides without any advisory service can impact negatively on the economic viability of cocoa farming as the cost of pesticides may outweigh crop sales as well as destroy beneficial and other non-target organisms (Rejesus et al., 2009).

It is not clear whether membership of farmer associations/ cooperatives improves access to information. Most farmers in Ghana do not use research recommendations from CRIG for the control of cocoa mirids because of the difficulty in accessing the information (Gerken et al., 2001). There is evidence to show that farmers get the bulk of their information on how to access and use farming innovations and techniques from other farmers (Pomp and Burger, 1995). There is also a strong peer effect on farmer adoption of innovation in Ghana, with ethnicity and religious affiliation playing a role (Munshi, 2002). In Ghana, a cocoa disease and pest control programme, CODAPEC, was introduced in 2001 to help manage diseases and pests on cocoa to enhance yield (Asante et al., 2002). This involves the application of recommended insecticides and fungicides on farms at no direct cost to the farmer. Farmers are to ensure that their farms are not weedy and cocoa trees well pruned for good aeration. Water must also be made available for CODAPEC sprayers to make up insecticide and fungicide solutions for application. Even though the programme has helped to increase yields, it is challenged with a late start in some areas and some farmers are not carrying out the needed cultural practices before application is done (Adjinah and Opoku, 2010, Kumi and Daymond, 2015). The perception that some farmers are not always able to afford recommended pesticides to complement CODAPEC's efforts could be another drawback to the pest control programme.

In the quest to develop forecasting systems to provide information for effective mirid control, there is a need to investigate farmers' willingness to use such information. The most acceptable mode of conveying this information must also be investigated since the farmer may not access an innovation if the medium of information transfer is not appropriate. A forecasting system for this study is defined as a method of collecting data, processing it and sending the resultant information to the end user (cocoa farmer) for decision making and farm management. For mirid control on cocoa in Ghana, such information might be provided on the basis of the phenology of the crop, climate and/or monitoring of mirid populations.

A survey on farmers' access to such information for mirid control, its implications on yield and the acceptability of a forecasting system to inform pest management decisions then becomes necessary.

The specific objectives of this study were:

1. To assess farmers' knowledge on insecticide use for mirid control.

2. To examine whether farmers who are members of farmer association/co-operatives have better access to information on mirid control.
3. To test farmers acceptability of a forecasting system to inform pest management decisions for the control of cocoa mirids.
4. To identify the most appropriate medium to send information to cocoa farmers to aid mirid control.

Methodology

Study area

A total of 280 farmers were interviewed from the Ashanti and Eastern Regions of Ghana. District cocoa officers in the regions were contacted to provide names of the major cocoa growing communities. Farmers were then interviewed in these communities.

Design of questionnaire and interview

A structured questionnaire with open and closed ended questions was designed for the study. At the end of each working day, completed questionnaires were cross-checked to ensure they were fully completed. All incomplete or doubtful entries were sent back to the respondent for clarification. This ensured that the views of each respondent were correctly represented, enhancing the reliability of the data collected and information to be deduced from it (Baah, 2006). In most cases, questions were translated to the local language of the area (Twi), taking care not to lose any information. Selection of farmers for interview was not biased towards any gender, religious or political affiliation. Village chiefs, chief farmers and other appropriate opinion leaders in each selected community were briefed on the purpose of the study before any farmer was interviewed. This ensured that farmers received the interviewers through the proper chain of command in each community to enhance the accuracy of information given. The following variables were used to assess the socioeconomic background of farmers: gender, age, education, marital status, farm ownership status, age and size of farm as well as membership to a farmer group or association. Farmers were also assessed on their knowledge on mirid control, access to information for mirid control, effect of timely insecticide application on mirid numbers and yield, and percentage crop loss to mirid damage. An assessment of insecticides used by farmers was made as well as the timing of applications. Finally, the questionnaire also covered the issue of willingness to use forecasting system for mirid control and the most preferred medium to receive this information. Willingness to use forecasting system was determined with a yes or no question.

Reliability of questionnaire

A pre-testing exercise was carried out in four communities in the Eastern Region (Nobi, Asafo, Obubanase and Tontro) in order to assess whether there were any ambiguities in the questions. A total of 30 cocoa farmers in these villages were interviewed from the 15th November to 6th December, 2011. Any questions that were not easily answered by most farmers due to lack of clarity were modified. The actual surveys with the final questionnaire started on the 26th December, 2011 and were completed on the 6th April, 2012.

Data analysis

The data was analysed with SPSS statistical package version 16. Variation in responses was analysed to show frequencies and their percentages. Relationship analysis was conducted using a chi-squared test to find out if personal and farm characteristics were associated with farmers' access to information on mirid control, willingness to use a forecasting system for mirid control and the most preferred medium for information transfer. Relationships were also explained between personal/farm characteristics and membership of a co-operative/farmer association.

Results

Farmers' personal and farm characteristics

Of the farmers interviewed 76% were males and 24% females; their ages ranged from 20 to 80 years. The age group 40-60 years was the most represented accounting for 51% of respondents. In contrast, 18% of respondents fell within the age group 20 to 40 years. A greater percentage of respondents were farm owners (87%). Respondents with a Middle School Certificate /Junior High School (MSLC/JHS) educational qualification were the most represented (61%) with 15% having no formal education. A summary of the personal characteristics of farmers is presented in Table 1.

Farmer associations and farm practices

Most farmers interviewed (71%) were not part of any farmer association, certification scheme or cooperative society. Approximately 81 farmers are part of a farmer group. Among farmers that were part of a farmer group, 90% belonged to local farmer associations or cooperative societies. The remainder had some association with Organic Cocoa Certification (4%) and the Cadbury Livelihoods Programme (now Cocoa Life) (6%). The majority of farmers that were part of farmer associations were motivated to do so because of the training they received on Good Agricultural Practice (GAP) (72%) with 16% motivated by access to credit. The sources of motivation for joining a farmer association are presented in Figure 1. Access to training was by far the most cited reason for joining an association. Neither gender (χ^2 = 0.043, p=0.84), age of farmer (χ^2 =1.96, p=0.91), marital status (χ^2 =4.46, p=0.35), educational status (χ^2 = 7.79, p=0.17) or farm ownership (χ^2 =1.36, p=0.71) had any significant relationship with membership of farmer group, farmer association or cooperative society.

The largest proportion of farmers had hybrid cocoa (progeny of bi-parental crossed produced in seed gardens) on their farms (38%) whilst 14% had Amelonado (a traditional variety), 29% “Amazon” (early generation hybrids) and 19% mixed materials. The most frequently cited source of planting materials for respondents is pods from neighbouring farms (48%) followed by the cocoa seed gardens (39%) (Figure 2). Cocoa in most farms was not planted in regular lines (78%), however, the proportion planted in lines was greater amongst those farmers who were members of farming groups (χ^2 =6.55, p=0.01). Furthermore, members of farmer groups/associations were more likely to grow hybrids (χ^2 =8.43, p=0.04) and source planting materials from a recommended outlet (i.e. Seed production Unit and CRIG) (χ^2 =19.69, p<0.001). A relationship was also observed between farmer age and variety grown in that the highest proportion of the farmers that had hybrid cocoa trees on their farms (49% of farmers) were between age 20 and 40 years (χ^2 =12.32, p=0.05). A significant association between the age of farm and planting material was observed (χ^2 =30.36, p<0.001) such that a large proportion (85%) of more recently established farms (>20 years) were planted with hybrid trees sourced from recommended outlets (e.g. seed production units and CRIG). Furthermore, a greater proportion of trees were planted in lines (as opposed to uneven planting) on more recently established farms (χ^2 =22.82, p<0.001) (79% on farms up to 20 years old compared to 26 on farms older than 20 years).

(Table 1 here)

(Figure 1 here)

(Figure 2 here)

Insect pests on cocoa and insecticide application

The majority of farmers (86.8%) considered mirids to be the most economically important insect pest on cocoa. A pest gaining importance is *Bathycoelia thalassina* (stink bug) (‘Atee’ in the local Twi language), which ranked second with 12% of farmers considering it as critical to yield losses. A pictorial presentation of respondents’ perception of the most economically important insect pests on cocoa is shown in Figure 3.

(Figure 3 here)

The vast majority of farmers (92.9%) applied insecticides for mirid control on their farms. Only 7.1% did not apply any insecticide mainly due to logistical problems on the farmer's part or on the part of the cocoa pest and disease control (CODAPEC) programme. Confidor (Imidacloprid 200 SL) was the most widely applied insecticide (50.8% of respondents) with Actara (Thiamethoxam) used by 25.8% and Akatemaster (Bifenthrin) by 18.8% of respondents. A small proportion (1.1 %) of respondents used unapproved insecticides for mirid control and 3.5% of respondents (under Organic certification) applied crude aqueous neem extract. The vast majority (93.9%) of respondents graded the performance of insecticides applied as very effective against mirids whilst 3.8% and 2.3% judged them as providing no change or as not being effective against the pests respectively. Among respondents who recalled the timing of insecticide application, August was the month in which most respondents (30.3%) applied insecticides for the first time in the season with 19.2% spraying in September, 11.9% in June and 7.3% in May (Figure 4).

(Figure 4 here)

The issues that inform farmers' choice of the month to start insecticide application for mirid control are summarised in Table 2. The start of the CODAPEC spraying programme was the most cited reason (49.2% of respondents), whilst 19.4% farmers also relied on the visual presence of mirids to start insecticide application. The majority of farmers (90.8%) interviewed stated that they had benefited from the CODAPEC programme.

(Table 2 here)

Source of information on insecticide usage

Less than half of the farmers interviewed (43.6%) received information on which insecticide to use for mirid control. Amongst these, 85.2% of them did so through extension officers, 4.1% from CRIG, 4.9% from certification officers and the rest (5.8%) received their information from other farmers and input suppliers. In terms of timing of insecticide application 43.6% of farmers received information on the appropriate time of the year to apply insecticide. Amongst this group of farmers, 86.1% cited extension officers as the source of that information whilst fewer farmers cited certification officers (5.7%), CRIG (3.3%) and contributions by other farmer and suppliers (4.9%). With regards to the frequency of insecticide application, 43.9% of farmers were able to access information and, amongst these most farmers (86.1%) received such information from extension officers. Amongst those farmers who had access to information on which insecticide to use as well as timing and frequency of application the vast majority (95.9%) found the information useful for mirid control. Detail of farmers' sources of information on insecticide use is presented in Table 3. A significant relationship was observed between a farmer's age and access to information on insecticide use. Farmers between 20 to 40 years were more exposed to information on insecticide use (57% of farmers: χ^2 =5.65, p=0.05) than any other age group. Furthermore, ability to access information on which insecticide to use was significantly greater for those farmers in a group or association (χ^2 =75.58, p<0.001). This was also the case regarding information on time of application (χ^2 =75.56, p<0.001), frequency of application (χ^2 =78.76, p<0.001) as well as factors influencing the choice of the when to start insecticide application for mirid control (χ^2 =41.77, p<0.001). Farmers who are members of farmer associations rely mostly on CRIG recommendations and the level of mirid damage in farms to decide on the month to start insecticide application while non-members rely to a greater extent on the start of the CODAPEC spraying programme.

Meetings held by farmer groups become the platform for extension service personnel to be invited to provide such information or give training. Cocoa farmers acknowledged the importance of timely application of insecticide as 97.1% of them suggested increased mirid damage and a reduction in yield when insecticide is applied later than required. The largest proportion of farmers (47%) attributed 30-40% of cocoa losses to mirid damage annually.

(Table 3 here)

Forecasted system

Almost all farmers interviewed (99.6%) thought that it would be useful to have forecasting systems to inform them of expected mirid peak periods in each year, which insecticides to use, time to start insecticide application and the required frequency of applications. The reason cited by farmers for the need for an information system are as follows (with corresponding percentages): to enhance production (52.3%), reduction in mirid damage to cocoa (25%), broadening farmers' knowledge base on mirid control (15.9%) and for effective control of mirids (6.8%). Most farmers (70%) preferred to receive information on mirid control on a quarterly basis. Some 14.6% preferred to be informed twice a year with 10% as and when necessary. The majority of farmers (89.6%) would be willing to support (financially) a forecasting service if COCOBOD is unable to meet the full cost.

Channel for dissemination of information

The majority of farmers interviewed (89.3%) preferred extension services as the medium to relay information on insecticide usage for mirid control to them. Farmers' preferences for access to information are presented in Table 4.

(Table 4 here)

The main reason for the choice of extension service as the most preferred medium for information transfer was the opportunity to see demonstrations (72.1% of farmers), followed by reliability and ease of access (26.1%), affordability (1.1%) and avoidance of language gap problems (0.7%).

Discussion

Access to information is a key component that enables cocoa farmers to optimise their management and hence increase yields. In many developed countries, both public and private institutions provide farmers with farm management information through a range of systems (Just and Zilberman, 2002). However, in Ghana and other cocoa growing countries in West Africa, the lack of such systems to provide accurate, easily accessible and timely information on pest management presents a number of challenges to cocoa farmers. Farmers sometimes rely on 'word-of-mouth' for decision making which may not be accurate or timely.

Forecasting systems consist mainly of data that have been processed to be meaningful to the end user (Acebedo et al., 2008). A forecasting system is therefore a system to collect data, process it to be meaningful and transmit it to the end user (cocoa farmer) for effective decision making and farm management. The study therefore examined the willingness of cocoa farmers in Ghana to use such forecasting systems for mirid control and whether particular groups of farmers are more willing to take up such information.

The survey showed that cocoa farming is a male dominated profession. This is the case for most cocoa growing countries in West Africa (Olujide and Adeogun, 2006). Most cocoa farmers interviewed were also over the age of 40 highlighting the need to encourage young people to take up cocoa farming as a profession. The aging farmer population has sometimes led to cocoa farms being abandoned after the death of their owners (Asante et al., 2002). The current economic status of cocoa farmers in Ghana makes it difficult for them to encourage their children to take up the enterprise after school since they are often more interested in non-agricultural employment in the cities. This study also showed that farmers' age is very important when it comes to adopting innovative practices; most of the farmers between 20 and 40 years had more access to information on insecticide use and have adopted the use of hybrid materials and planting them in lines on their farms. The results suggest that more effort needs to be made to encourage older farmers to adopt new innovations.

West Africa is responsible for approximately 71% of world cocoa (ICCO, 2012/13), produced mostly by smallholder farmers as exemplified in the present study (70% of farms surveyed were less than 1.5 hectares). Many of these smallholder farms are aging and require some rehabilitation or replanting. The study showed that at least 14% of farmers still grow traditional Amelonado cocoa, and less than half grow the recommended hybrid varieties. Replacing old, low yielding trees with recommended hybrid materials is an important step to enhanced cocoa production. However, when replanting, nearly half the respondents obtained seed from neighbouring farms. A survey of cocoa seed gardens in Cameroon, Ghana and Nigeria suggests that the majority of farmers used seeds from neighbours' farms due to lack of nearby seed gardens (Asare et al., 2010). The amount of hybrid seed available from seed gardens to cocoa farmers in Ghana is considered inadequate. Asare et al. (2010) estimate that less than 60% of the demand for seed for new planting material in Ghana is met by seed gardens. As a result, cocoa farmers are using inappropriate, segregating F3 and F4 seed populations as planting materials. Farmers' lack of understanding of the development of hybrid materials is also a reason for the use of segregated seeds. It is therefore important that new planting materials are made available for replanting through increased availability of hybrid seed/ seedlings from seed gardens in Ghana.

Replacing old materials with high yielding varieties will only produce higher yields if pest and disease challenges of the crop are well managed. Cocoa mirids have been cited as the most important insect pest on cocoa in Ghana (Awudzi et al., 2009, Padi, 1997, Owusu-Manu, 1995). The majority of farmers (87%) interviewed agreed with this assessment with 47% of farmers attributing a 30-40% loss in yield to mirids. This perception is similar to published estimates of losses to mirids in the region of 30% (Owusu-Manu, 1995). Over 90% of farmers applied insecticides in the 2011/2012 cocoa season. The month during which most respondents (30.3%) first applied insecticides for mirid control was August. This could be due to factors such as the start of the CODAPEC spraying programme (which is scheduled to start in August) or the perceived increase in mirid numbers and damage in farms. The results of the survey showed that, most farmers rely on the start of the CODAPEC programme (49.2%), presence of mirids (19.4%) and the weather (10.1%) to decide on the month to first apply insecticides each season. It was noted that not all farmers follow recommendations or labelled instructions on recommended insecticides. There is the perception by some farmers that the higher the concentration of insecticide solutions, the greater the efficacy (Matthews et al., 2003). The inconsistencies in the dosages of insecticides applied in cocoa farms could increase the risk of mirid resistance to approved insecticides. Effective farmer education on pest identification and accessibility to information on insecticide usage is therefore important.

The survey also showed that less than 30% of farmers' interviewed were members of a farmer or cooperative groups. Farmers associations like cocoa Abrobopa, Kuapa Kookoo and the Cadbury Livelihood Programme (now Cocoa Life) are training farmers on best cultural practices. These practices are geared towards improving farm sanitation to minimize pest and disease damage to enhance yield. Some farmer associations also support farmers with inputs such as fertilizers, insecticides and fungicides on credit

(Baah, 2008). Recent certification of cocoa has led to the development of certification schemes such as Rainfall Alliance, Naturland (organic certification) and UTZ certification who train farmers to meet particular standards. According to Baah (2008), farmer associations have helped the expansion and growth of the cocoa industry in Ghana through farmer training. In this study, most farmers who were members of farmer associations also had easy access to information on insecticide use, time of application and frequency of applying insecticides for mirid control. This study also demonstrated the effectiveness of membership of a farmer group in the adoption of innovations such as the use of hybrid materials, planting in lines and sourcing planting materials from recommended bodies, thereby demonstrating the potential of such associations to play a part in increasing cocoa production. Another reason why encouraging the formation of farmer groups across the entire cocoa landscape could boost production is that most farmers are able to learn and adapt new farm practices easily from fellow farmers who can recognize their needs (Baah, 2008). Membership of a farmer association was closely related to the farmer's choice of month to start insecticide application, with a greater proportion relying on the presence of mirids (21%) and the Cocoa Research Institute of Ghana (CRIG) recommendations (16%) compared to those who were not part of a farmer group who relied mainly on the start of the cocoa pest and disease control (CODAPEC) programme. Relying on the start of the CODAPEC programme is not the best approach as the start of the programme may be delayed due to logistical problems such as late arrival of pesticides at various districts and the frequent breakdown of spraying machines (Baffoe-Asare et al., 2013). Significant losses of cocoa can occur due to mirid damage when there is a delay in the start of the programme.

An overwhelming response from farmers for the need for a forecasting system for mirid control was demonstrated. Farmers were aware of the difficulty in managing cocoa mirids and the need for accurate information for effective pest management. Information could be sent to farmers on when to apply recommended insecticides and at what frequency. This would ensure that insecticide application is carried out on a need-based system and not the blanket application system currently in use. Such an approach would help reduce insecticide residue problems in cocoa beans as well as addressing health issues related to insecticide use. The fact that farmers were willing to pay towards an information system is indicative of the importance that they attach to a more targeted mirid control system. Farmers' willingness to help sustain a forecasting system for mirid control stems from the need to get accurate information for mirid management to produce more and to contribute to the enhancement of their living conditions and also ensure that a programme of that nature does not eventually "breakdown" due to national budgetary constraints.

Extension services appeared to be the most preferred means of information and technology transfer to cocoa farmers in Ghana with 89.3% of respondents opting for this route. For extension to be effective, extension services need to develop farmer centred information technologies which are interactive. Furthermore, Adu-Acheampong et al. (2014) point to the relatively low number of extension officers currently in the cocoa sector in Ghana. Even though radio is reported to be the most important medium for communicating with rural populations in developing countries (Odame and Kassam, 2002), it is limited in its "one-way" communication channel. In Ghana, this limitation has been improved with farmers calling into radio programs for clarification when necessary. Recently, the Ghana Cocoa Board in partnership with Cadbury, "Kuapa Kookoo" (a co-operative) and West Africa Fair Fruits Limited has agreed to support cocoa extension as well as implement interventions to enhance the livelihood of cocoa growing communities in Ghana (Government of Ghana, 2011). Cocoa extension in Ghana has also been revived under the Cocoa Health and Extension Division (CHED) (a division of the Ghana Cocoa Board); extension could be used as a tool in any information system to disseminate information on mirid management to cocoa farmers. From the results of the survey, the success and adoption of any information system depends critically on the inclusion of extension services and local famer organizations. The CODAPEC programme in Ghana could further be enhanced with the addition of an information system to provide forecasted information on expected pest situations to improve the effectiveness of the programme.

Conclusion

Cocoa mirids continue to be the most important insect pest on cocoa in Ghana and other cocoa-producing countries in West Africa. Control has mainly been achieved with blanket application of conventional insecticides based on a specific calendar date. This has led to the development of residue problems as well as changes in the status of some pests which hitherto were regarded as minor. The root of this problem is inadequate farmer knowledge on approved insecticides, timing and the frequency of application within a growing season. It is clear from this study that even though information on insecticide use and mirid management on cocoa is available, many farmers have little or no access to such information. Farmers overwhelmingly accepted (over 99%) that there is a need for a forecasting system through which they could be informed of mirid activity on their farms as an early warning system and how to effectively manage the pest in a more environmentally sensitive manner. The study has also showed that local farmer groups and extension services will be vital for the success of a forecasting system for mirid control in Ghana.

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Table 1: Farmer and farm characteristics: Frequency distribution

Characteristics of farmers	***Frequency***	***Percentage***
Age (years)		
20-40	51	18
41-60	143	51
>60	86	31
Total	***280***	***100***
Marital status		
Single	12	4
Married	229	82
Divorced	9	3
Widow	20	7
Widower	10	4
Total	***280***	***100***
Farm ownership status		
Owner	244	87.1
Share cropper (Abunu)	20	7.1
Share cropper (Abusa)	15	5.4
Share cropper (Abunan)	1	0.4
Total	***280***	***100***
Numbers of cocoa farms operated		
1-2	198	70.7
3-4	76	27.1
5-6	2	0.8
>6	4	1.4

Total	***280***	***100***
Farm age (years)		
1-10	94	33.6
11-20	115	41.1
21-30	49	17.5
>30	22	7.8
Total	***280***	***100***
Farm size (hectares)		
<1.5	196	70
1.5-3	64	22.9
3-5	14	5
>5	6	2.1
Total	**280**	**100**

NB: Definition of Share cropper (Abunu, Abusa and Abunan): Proceeds from the farm are shared between caretaker and landlord with the caretaker getting 75% (Abusa), 50% (Abunu) or 25% (Abunan).

Table 2: Issues that informed farmer's choice of the month to start insecticide application

Issues	***Frequency***	***Percent***
Start of the CODAPEC programme	127	49.2
Presence of mirids	50	19.4
Weather	26	10.1
CRIC recommendation	17	6.6
Availability of inputs and machines	16	6.1
Level of damage	14	5.4
Availability of Neem	2	0.8
Production of pods	2	0.8
Another farmer/relative	1	0.4
Extension officer's advice	1	0.4
Previous yield losses in bags	1	0.4
Appearance of flowers	1	0.4
Total	**258**	**100.0**

Table 3: Farmers' source of information on insecticide usage: Frequency distribution

Insecticide usage	***Frequency***	***Percentage***
Ability to access information on insecticide to use		
Yes	122	43.6
No	158	56.4
Total	***280***	***100***
Source of information on insecticide to use		
Extension Officers	104	85.2
Certification Officers	6	4.9
CRIG	5	4.1
Chemical and input sellers	4	3.3
Other farmers	3	2.5
Total	***122***	***100***
Ability to access to information on time of application		
Yes	122	43.6
No	158	56.4
Total	***280***	***100***
Source of information on time of application		
Extension Officers	105	86.1
Certification Officers	7	5.7
CRIG	4	3.3
Chemical and input sellers	4	3.3
Other farmers	2	1.6
Total	***122***	***100***

Access to information on frequency of application		
Yes	123	43.9
No	157	56.1
Total	***280***	***100***
Access to information on frequency of application		
Extension Officers	105	86.1
Certification Officers	7	5.7
CRIG	4	3.3
Chemical and input sellers	4	3.3
Other farmers	2	1.6
Total	***122***	***100***
Frequency of receipt of information per year		
Once	14	11.5
Twice	18	14.8
Three times	35	28.7
Four times	30	24.6
>Four times	25	20.4
Total	**122**	**100**

Table 4: Farmers' preference for medium of information transfer

Medium	Frequency	Percentage
Radio	13	5
TV	4	1
Extension services	**250**	**89**
Cocoa farmers news paper	2	1
Mobile phone	6	2
Community information system (PAS)	5	2
Total	**280**	**100**

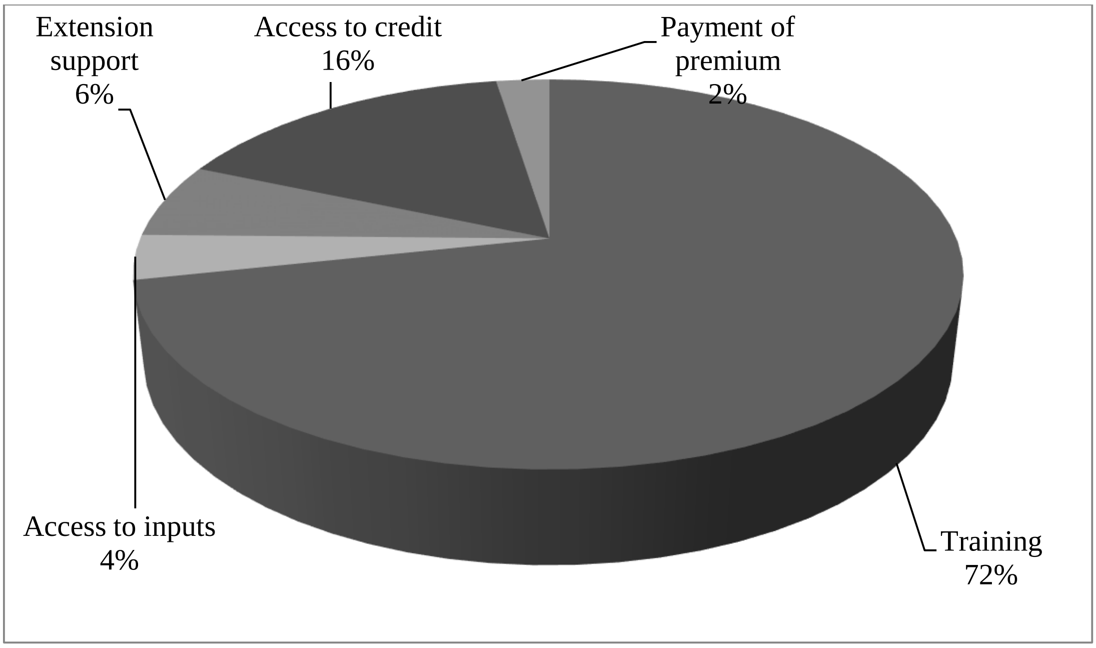

Figure 1: Farmers' motivation for joining farmer associations (n=81)

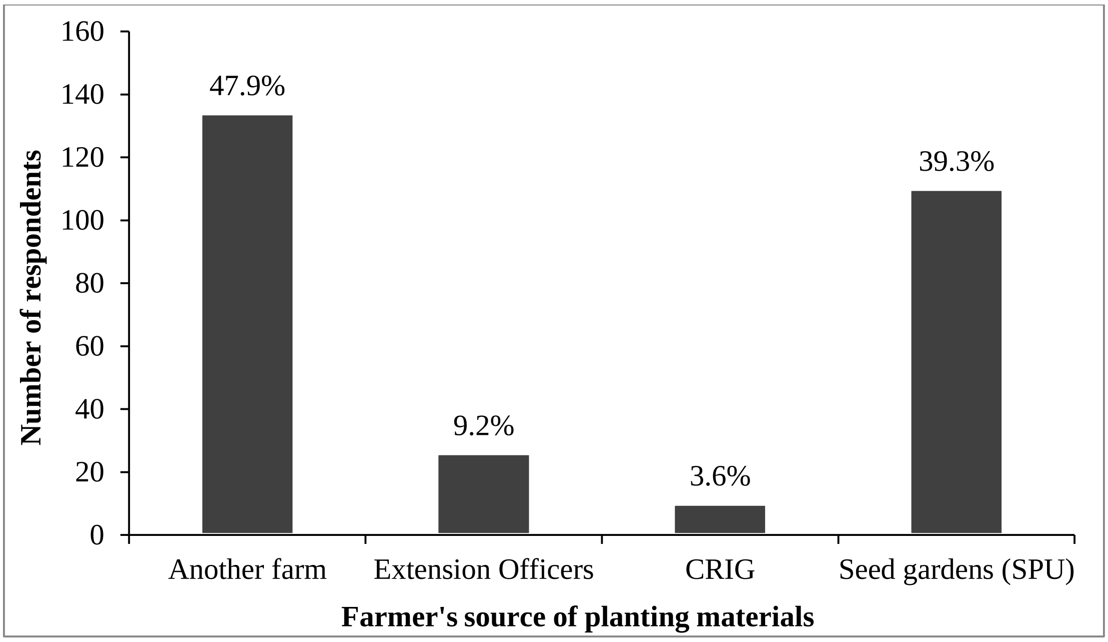

Figure 2: Farmers' source of planting materials (n=280)

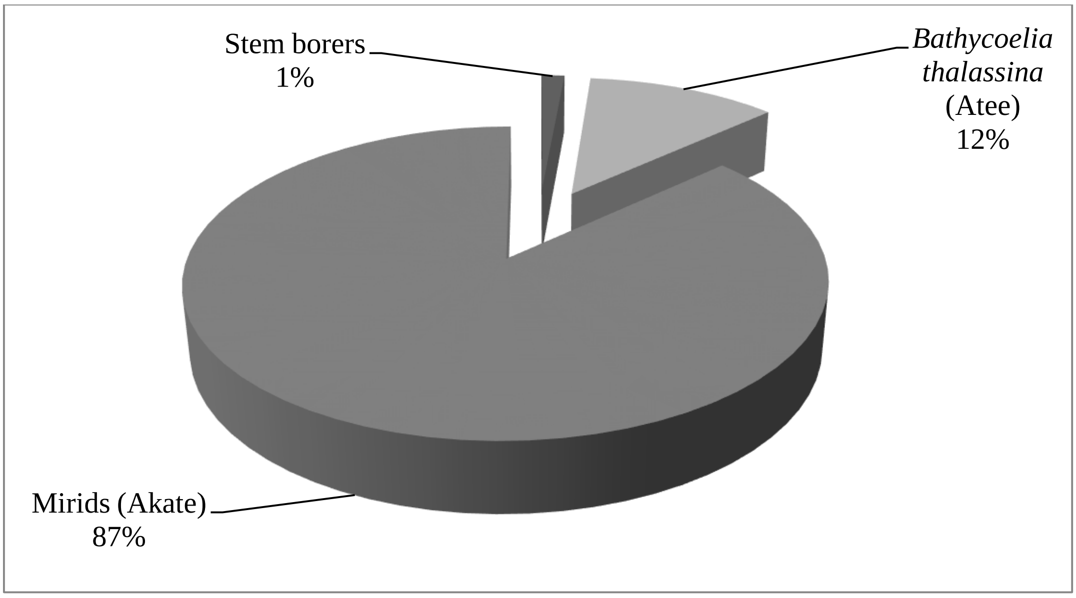

Figure 3: Farmers' perception of the group of pests that they consider to be most economically important (n=280)

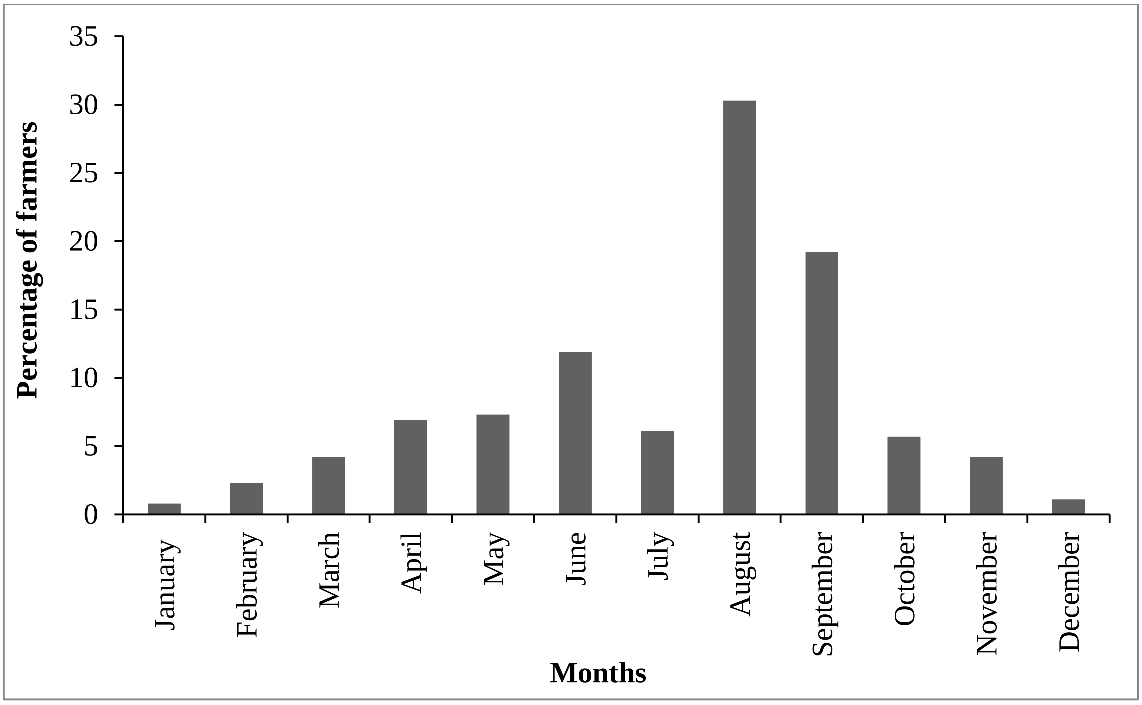

Figure 4: Frequency distribution of month in which respondents first applied insecticides (n = 261)