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Knowledge of the Roles of Cowpea Insect Flower Visitors and Effects of Pesticide Control Measures on them by Farmers in Three Districts in the Central Region of Ghana

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Abstract: *This study was carried out to assess the perceived roles of cowpea insect flower visitors and the effects of pesticide control measures on them by farmers in three districts in the Central Region of Ghana. Using proportional stratified random sampling technique, 110 cowpea farmers were sampled to respond to issues on the subject in a questionnaire. In all, 104 (94.6%) questionnaires were returned and analyzed. The farmers agreed on only lepidopterans (butterflies and moths) as insects that visit the cowpea flowers. Generally, 59.6% (62) and 67.3% (70) of the farmers considered bees and lepidopterans respectively as pollinators. In all 98.1% (99) of the farmers agreed that pollinators transfer pollen grains from the anther to the stigma and 98.0% of them agreed that insects also cause pollination. Forty four (42.3%) farmers rated their personal knowledge of pollinators less than 40% whilst 36.5% (28) of them rated themselves 40-50%. The differences between the observed and expected responses were very highly significant (X^2 = 94.24, P = 0.001). Farmers considered increased fruit set/increased crop yield as the benefit of pollination. Apart from chemical control, farmers could not agree on any other pest control measures that were available to them. Majority of the farmers had low personal knowledge of pollinators. Therefore the farmers need to be given some technical training pertaining to the role of insects on cowpea flowers as well as the most appropriate ways of controlling cowpea pests.*

Keywords: *Pollinators, Lepidopterans, cowpea, knowledge, pesticide*

1. INTRODUCTION

Cowpea (*Vigna anguiculata* (L.) Walp) is said to have originated in Africa, where it has become an integral part of traditional cropping systems, particularly in the semi-arid West African Savanna Regions (Steale, 1972). Cowpea is high in protein, to the extent that the grain contains about 25% protein, making it extremely valuable where many people cannot afford animal protein. The young leaves, pods and peas are used as vegetables, whilst snacks and main meal dishes are prepared from the dried grain. The plant tolerates drought and fixes nitrogen, thus improving soil fertility. The ability of cowpea plants to tolerate drought and poor soils makes it an important crop in savanna regions where these constraints restrict other crops. However, though there are evidences of both self- and cross-pollination of the crop elsewhere, in Ghana very little is known about the mode of its pollination among research scientists.

Pollination is the transfer of pollen grains from an anther to a receptive floral stigma (African Pollinators Initiative, (API), 2003). Pollination takes place by means of animals (pollinators), wind and water. Pollinators are organisms that transfer pollen grains from the anther to the stigma of the same flower or different flower of the same plant or another plant of the same species resulting in fertilization. API (2003) asserted that pollination is a service that is very key to agriculture. Therefore, pollinators are extremely important to agriculture and nature conservation (Eardley, 2002). One major group of pollinators is insects. Because insects have become so adept at finding and identifying individual flowering plants, even rare plants may persist so long as pollination occurs (API, 2003). Just as pollination is pivotal to agriculture for quantity, quality and diversity of foods, fibres and medicines, it is also essential for maintaining biological diversity (Ahmad, Banne, Buchman, Castro, Chavarria, Clarke, *et al* (2006). Insect pollinators are

essential for many fruit and vegetable crops and the demand for pollinators grows as the need for agricultural productivity increases.

It is assumed that knowledge of pollinators and pollination services by cowpea farmers could help them to undertake farming practices that are safe to the existence of beneficial cowpea insects including pollinators. However, controversies exist about the method of pollination of cowpea, where some research scholars consider it to be self-pollinated **(**Bubel, 1987; and Asiwe , 2009) others thought it undergoes cross-pollination (Mackie and Smith, 1935; Buchmann and Nabhan, 1996) and yet another group thought it undergoes both self- and cross-pollination (Vaz, De Oliveira and Ohashi, 1998; Asiwe 2009). With the controversy surrounding cowpea pollination among research scholars who would have made scientific findings of pollinators and pollination services on cowpea available to farmers one cannot tell what level of knowledge cowpea farmers in three districts in the Central Region of Ghana have about pollination services on the crop.

Meanwhile, farmers' knowledge whether indigenous or formal, may be useful in understanding some of the plant-animal interactions such as pollination in cowpea farms in the three districts. Indigenous knowledge systems here refer to adaptive skills of local people usually derived from many years of experience that have been communicated through oral traditions and learned through family members over generations (Thrupp, 1989). Formal systems are the scientifically time tested agricultural practices.

Indigenous systems are often elaborate, and adapted to local cultural and environmental conditions (Warren, 1987). They are tuned to the needs of local people and the quality and quantity of available resources (Pretty and Sandbrook, 1991). They also pertain to various cultural norms, social roles, or physical conditions. They can also be time-tested agricultural and natural resource management practices which gave way for sustainable agriculture (Venkatratnam, 1990). The complex farming systems now being rediscovered by agriculturalists are proof of the innovative capacity of Third World farmers (GRAIN, 1990). Therefore, can it be that the cowpea farmers in the three districts have some indigenous knowledge of insect pollinators that can be useful to research scientists? Meanwhile, it is common to come across farmers in the three districts who indiscriminately apply agrochemicals which can be hurtful to useful agricultural insects including pollinators. Such phenomenon of indiscriminate spraying of chemicals by farmers in the districts under study suggest that the farmers might have very little or no idea of the effects of chemicals on pollinators and other useful insects in the cowpea farms. However, there is virtually non-existent of scholarly literature on what cowpea farmers in the research districts know about insect pollinators and chemicals on them. Hence, this research has been designed to undertake a scientific study of the perceptions of cowpea farmers about cowpea flower insect visitors and the effects of pesticide control measures on them. Hence, the main objective was to find out the knowledge of cowpea farmers pertaining to the role of cowpea insect flower visitors and the effects of pesticide control measures on the insect flower visitors in three districts in the Central Region of Ghana.

2. RESEARCH QUESTION

What knowledge do cowpea farmers in three districts in the Central Region of Ghana have about cowpea flower insect visitors and the effects of chemical applications on them?

3. HYPOTHESES

- All the cowpea farmers have the same level of education.
- There is no difference in the ratings that the farmers put on their personal knowledge of pollinators.

4. METHODOLOGY

4.1. The Population and Instrument

The population of the study consisted of cowpea farmers from three political districts (Agona, Ewutu – Effutu - Senya and Gomoa) in the Central Region of Ghana. The instrument for the study was questionnaire, which was developed using information from reviewed literature. The first section of the instrument collected information pertaining to the personal data of the farmers. The

second section collected data on the knowledge of respondents on cowpea flower visitors. Finally, the third section sought information on cowpea pest control in relation to cowpea flower visitors. The instrument contained both open-ended and close-ended items. Most of the close-ended items involved multiple choices where respondents were expected to choose the best option. In order to make the items as easy as possible for respondents to understand and respond to, some of the items demanded the respondents to simply agree or disagree with statements. In this case rating of 1 = disagree, and 2 = agree were used.

The instrument was pilot-tested with 20 farmers. Also, two experts in social research were made to go through the items. Items found to be inappropriate were either modified or dropped before moving on to administer the instrument to farmers (respondents).

5. SAMPLE, SAMPLING AND DATA COLLECTION

Before administering the questionnaire to the cowpea farmers the researcher went round 15 towns and villages in Agona, Ewutu-Effutu-Senya and Gomoa districts to find out where cowpea was cultivated. It was found out that cowpea was being cultivated in ten towns/villages. Hence, these ten villages/towns were selected and the cowpea farmers identified. One hundred and ten (110) cowpea farmers were selected from the ten villages/towns using proportional stratified random sampling technique. They were then given the questionnaires to respond to. Farmers who were literate responded to the items in the questionnaire without any assistance from the researcher. For those farmers who were illiterates or semi-literates, the items in the questionnaire were translated to them in Fante (local language in the area). The answers provided were ticked or written by the researcher at the appropriate place on the questionnaire.

6. ANALYSIS OF DATA

The data were analyzed using descriptive and inferential statistics. The descriptive statistics used were means, frequency distributions, and percentages. In some cases chi-square analysis was used to compare the differences in the responses between the observed and expected values.

7. RESULTS

Out of the 110 questionnaires given out to the farmers 104 (94.6%) were returned. Majority of the respondents (80.8%) were males. Respondents were mainly between 15 and 55 years of age (Fig.1). From the results, 43.3% of the respondents attended secondary school, 25.0% attended middle / junior secondary school and 19.3% attended the university. The differences between the observed and expected responses were very highly significant ($X^2 = 103.82$, $P = 0.001$) (Table 1). Thus, the farmers had different levels of education.

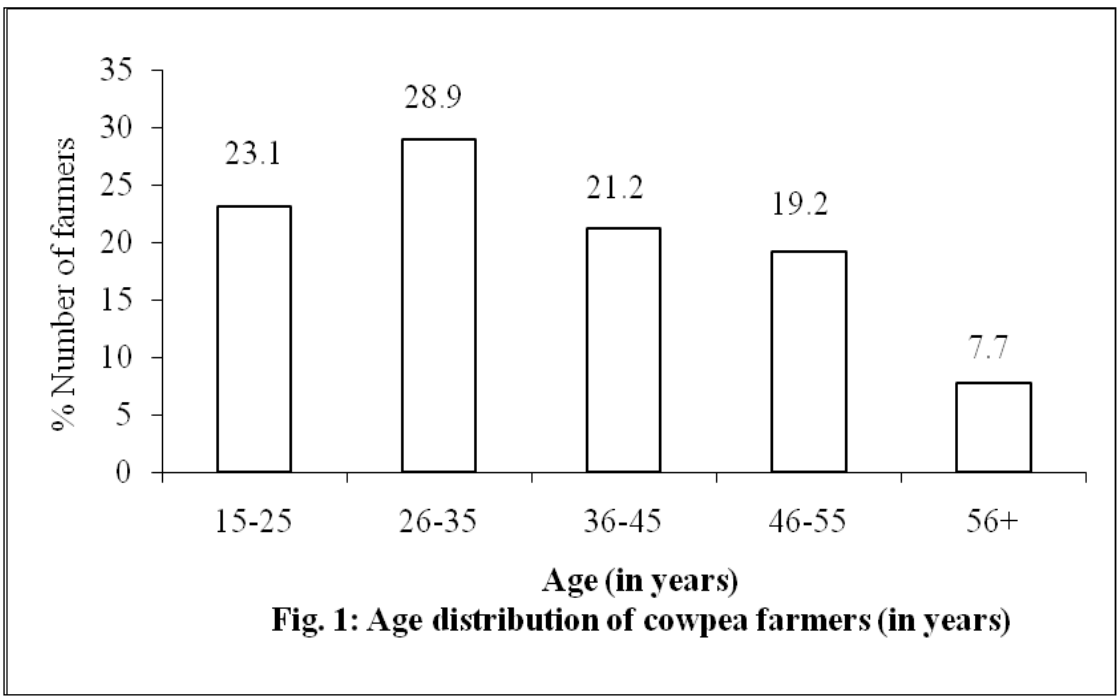

Fig. 1: Age distribution of cowpea farmers (in years)

Table 1: *The highest level of education of farmers*

Response	**Freq.**	**% Freq**
No formal education	0	0
Primary school	2	1.9
Middle school/ Junior secondary school	26	25.0
Secondary school	44	43.3
Agricultural Institute	6	5.8
Vocational / Technical school	6	5.8
University / Polytechnic	20	19.3
X^2 = 103.82		

Also, 71.2% of the farmers had been cultivating cowpea for between 1 - 5 years (Fig. 2). Again, 48.1% of the farmers were doing less than one acre of farm a year whilst 38.5% did 6-10 acres per year (Fig. 3). The differences between the observed and expected responses were very highly significant (X^2 = 137.41, P = 0.001).

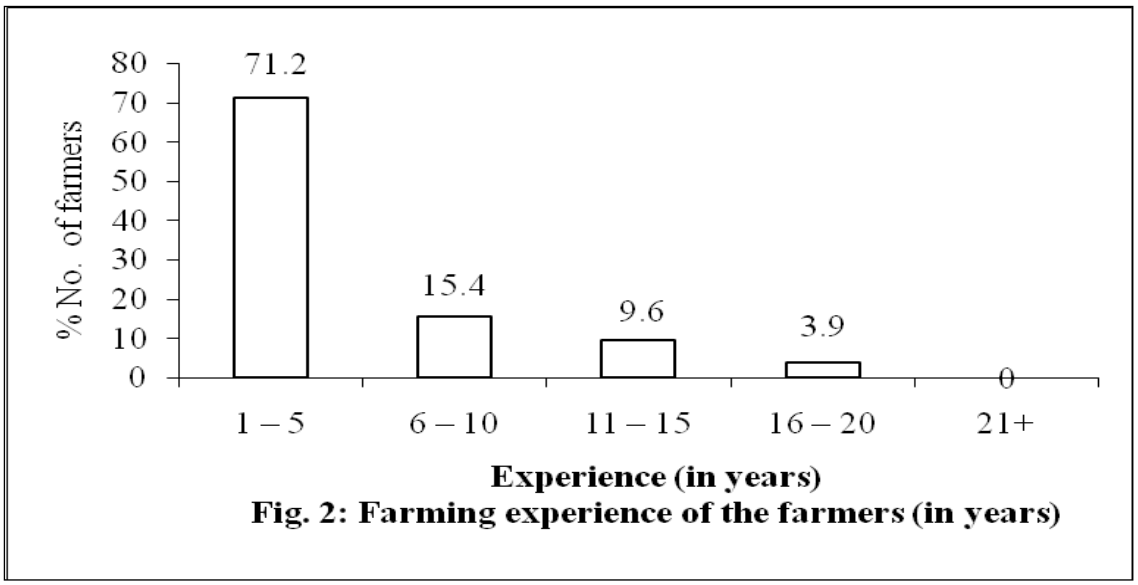

Fig. 2: Farming experience of the farmers (in years)

Concerning which insects do visit the cowpea flowers it is only lepidopterans (butterflies and moths) that registered a mean of 1.5. All the other insects were rejected by majority of the farmers as insects that visit the cowpea flowers. (Table 2).

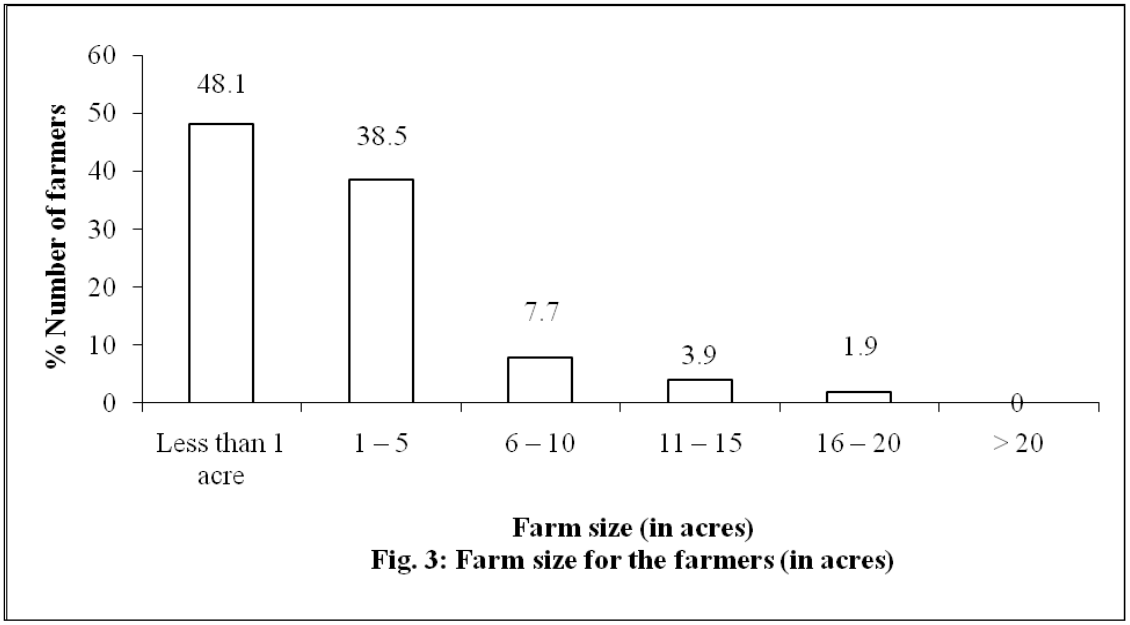

Fig. 3: Farm size for the farmers (in acres)

Table 2. *Respondents' knowledge about which insects visit cowpea flowers*

Response	Mean	SD
Bees	1.4	0.5
Lepidopterans (butterfly and moth)	1.5	0.5
Flies	1.4	0.5
Ants	1.2	0.4
Wasps	1.1	0.3
Beetles	1.3	0.5
Thrips	1.1	0.3

Key: *1 – 1.4 = Majority disagreed; 1.50 = 50% agreed; 1.6 - 2 = Majority agreed*

Generally, 59.6% (62) and 67.3% (70) of the farmers considered bees and lepidopterans respectively as pollinators of cowpea whilst 63.5% (66), 46.2% (48) and 34.6% (36) of them considered beetles, ants and flies (Dipterans) respectively as pests. Large numbers of the farmers did not respond to show whether some of the insects are predators, pollinators or pests (Fig, 4).

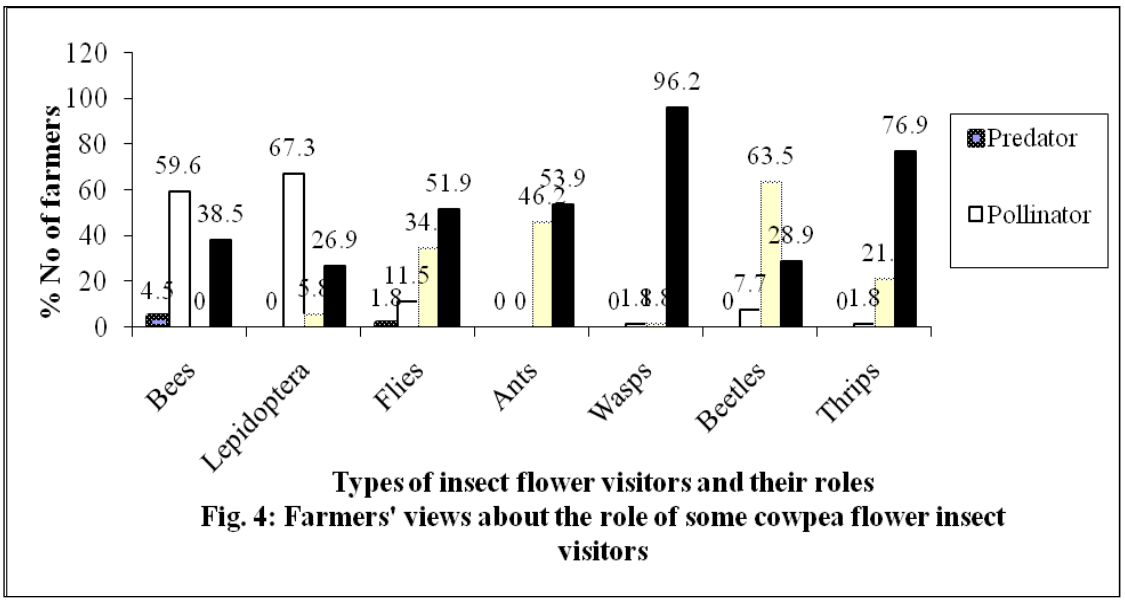

Fig. 4: Farmers' views about the role of some cowpea flower insect visitors

As many as 102 (98.0%) of the farmers claimed that they had some knowledge of pollinators and 98.1% (99) of these indicated that pollinators transfer pollen grains from the anther to the stigma. Meanwhile, 2.9% (3) of the farmers were of the opinion that pollinators harm or destroy flowers (Table 3). Hundred farmers (98.0%) stated that insects cause pollination. About knowledge of pollinators, 42.3% (44) of the farmers rated themselves less than 40% whilst 36.5% (28) of them rated themselves 40-50%. The differences between the observed and expected responses were very highly significant ($X^2 = 94.24$, $P = 0.001$) (Fig. 5). This implies that the farmers did not have the same level of knowledge about pollinators.

Table 3. *Respondents' Knowledge about the role of pollinators on flowers*

Response	Freq.	% Freq
They transfer pollen grains from anther to stigma	99	98.1
They destroy flowers	3	2.9
They feed on flowers	0	0
They guard flowers against pests	0	0
TOTAL	102	

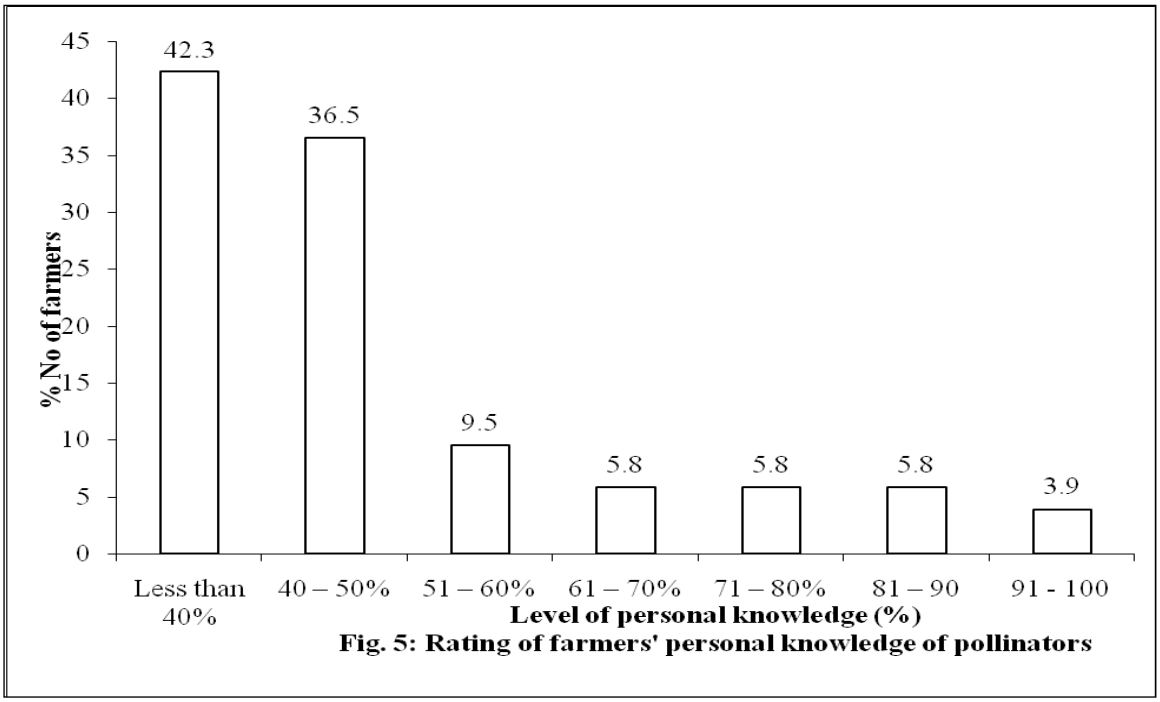

Fig. 5: Rating of farmers' personal knowledge of pollinators

Table 4. *Respondents' knowledge about some other issues of pollinators*

Item/response	Response (N = 102)	
	Mean	**SD**
This is a benefit of pollination		
Increased fruit set / increased crop yield	1.8	0.4
Increased seed viability	1.5	0.5
Faster growth of plants	1.1	0.3
Reduction in fruit drop	1.1	0.2
Enhanced resistance to diseases	1.0	0.2
Increase in oil content in oil seed crops	1.0	0
Increase in the number and size of seeds	1.1	0.3
Formation of more nutritive and aromatic fruits	1.0	0.1
This is a farming practice that causes harm to flower visitors / pollinators		
Pesticide application	1.9	0.3
Weeding the undergrowth of the crops	1.1	0.3
Mixed cropping	1.1	0.2
Harvesting	1.0	0

Key: *1 – 1.4 = Majority disagreed; 1.50 = 50% agreed; 1.6 - 2 = Majority agreed.*

Concerning what is done when pests infest the crops, 90.4% (94) of the farmers asserted that the crops are sprayed with chemicals. Out of the 94 farmers 47 (50.0%) and 31 (33%) stated that chemicals were sprayed twice and once respectively during a cropping period.(Fig. 6). Meanwhile, 60 (57.7%) farmers indicated that they did not know the effects of chemicals on insect pollinators whilst 32 (30.8%) claimed that chemicals kill pollinators and12 (11.5%) indicated that chemicals do not have any effects on pollinators. While 52 (55.3%) of the farmers agreed that apart from pests other insects die from chemical application 42 (44.7%) indicated that only the pests are killed (Table 5). The farmers agreed on ants, beetles and flies as the other insects that are killed through pesticide applications. Furthermore, they agreed that the cowpea plants are sprayed at the beginning of flowering. Apart from chemical control, farmers could not agree on any other pest control measures that were available to them. In all, 56 (53.9 %) of the farmers agreed that agricultural officers advised them (farmers) on chemical control whilst 48 (46.2%) disagreed. However, majority of those who agreed could not state any specific topic on which the training was centered (Table 6).

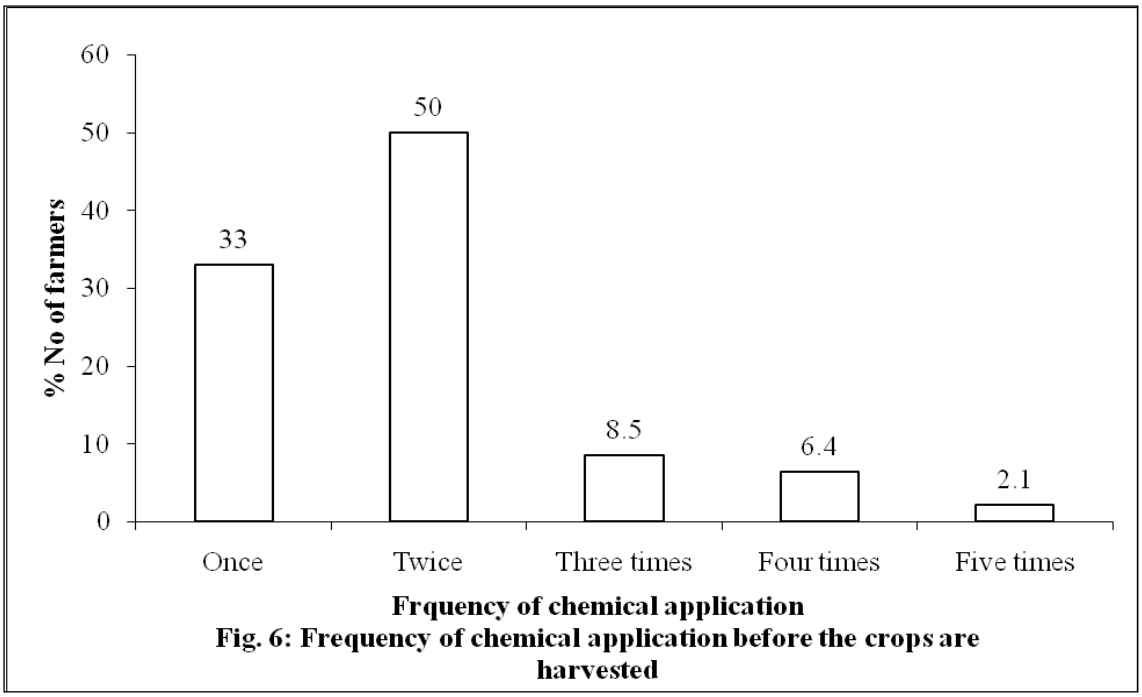

Fig. 6: Frequency of chemical application before the crops are harvested

Table 5. *Farmers' knowledge about chemical application and its effects on insects in cowpea farms.*

Item	Response	
What are the effects of chemicals on insect pollinators?	**Freq.**	**% Freq**
Chemicals kill insect pollinators	32	30.8
Chemicals make insect pollinators to breed more	0	0
No effects	12	11.5
Do not know	60	57.7
TOTAL	104	
After chemical application are other insects apart from pests killed?		
Only pests are killed	42	44.7
Other insects are also killed	52	55.3
TOTAL	94	

Table 6. *Farmers' knowledge about some other issues of chemical spraying in cowpea farms*

Item	Response	
	Mean	**SD**
This is one of the other flower visitors killed after spraying chemicals		
Bees	1.2	0.4
Lepidoptera	1.4	0.5
Wasps	1.0	0
Beetles	1.6	0.5
Flies	1.6	0.5
Ants	1.8	0.4
This is the stage of plants at which spraying is done		
Before flowering	1.4	0.5
At the initiation of flowering	1.6	0.5
At fruiting stage	1.1	0.3
Throughout cropping period	1.0	0.2
Any time pests emerge	1.1	0.3
This is a pest control measure available to farmers other than chemical application		
Biological control	1.2	0.4
Use of pest resistance crop varieties	1.2	0.4
Use of cultural practices	1.4	0.5

None above	1.3	0.5
Yes farmers are advised on chemical application on the topic (N=56):		
Types of chemicals to apply for a particular pest	1.4	0.5
Concentration of chemicals to be applied	1.3	0.4
Number of times to spray chemicals before harvesting	1.3	0.5
Time of the day for application	1.3	0.5
Growth stage of the plants when chemical application can be done	1.3	0.4
Pest population demanding chemical application	1.1	0.3

Key: *1 – 1.4 = Majority disagreed; 1.50 = 50% agreed; 1.6 - 2 = Majority agreed***.**

The common chemicals that respondents used to spray were: Karate, Actellic, Pawa, Cymbush, which are the most popular; Delsis, dithane, wreko 25, dursban, which are more popular; and Gammalin 20, DDT, smithrin, cypercel, wood ash, ambush, round up, kacide, kaside, harvest more, champion, pothene, and sharp, which are also popular

8. DISCUSSION

In this study majority (80.8%) of the farmers were males. This finding is similar to what Uganda Peoples' Congress (1985) stated that very few women have been trained in agriculture and food technology and very few women own the means of agricultural production and processing. The findings showed that many of the cowpea farmers are still young and energetic. It is heartwarming to note that 19.3% of the farmers had university or polytechnic education. This is so because they may need very minimum exposure on issues of pollination and effects of chemical application on them to observe the right practices that would conserve useful insects including pollinators. However, the fact that majority of the farmers (80.7%) had lower levels of education, especially those below Senior High School level calls for concern. This is because they may not easily understand some of the scientific issues about pollination and effects of chemical application and as a result do things that would alter the population of useful insects including pollinators. The findings also suggest that the farmers had different levels of education. Clearly, majority of the farmers (71.2%) have very few years of experience in cowpea farming (1-5 years). Therefore, if they cannot get the needed advice then they may be tempted to adopt farming practices that will not lead to high yields and can negatively affect the environment including probable cowpea pollinators.

Cowpea is mainly cultivated at a subsistent level in the research areas because majority of the farmers do less than 11 acres of cowpea farm a year. Arodokoun (1996); Bottenberg, Tamo, Arodokoun, Jackai, Singh, and Youm (1997) observed that in West Africa, cowpea is cultivated on small scale mainly as rainfall crop from April to November, depending on the location. Therefore, the current finding is not too much surprising.

The cowpea flowers are often visited by honeybees or bumble bees (Robbins, 1931) and various other insects that forage upon both the nectar and pollen. In this study, it is only lepidopterans (butterfly and moth) that approximately 50% of the farmers claimed to visit the cowpea flowers. Since all the insects presented are known to one time or the other visit the cowpea flowers then it is clear that the farmers lack information as to which insects visit the cowpea flowers. Dziwornu (2003) stated that in Ghana information gap is wide and has affected farmers to the extent that farm holdings are shrinking on annual basis. Therefore, the cowpea farmers need to be supplied with the necessary information related to the types of insects that commonly visit the cowpea flowers so that they can differentiate the useful ones from pests.

Though majority of the farmers accepted bees and lepidopterans as pollinators, low figures were scored in considering the insects as predators. These responses suggest that respondents did not know or were not sure of what exactly the insects presented to them do on the cowpea flowers. Meanwhile, the flower thrips, *Megalurothrips sjostedti* (Trybom), is considered as the most destructive cowpea flower visitor (Tamp, Baumgantner, Deluchi, and Herren 1993). For an insect to be able to pollinate the cowpea flower, it must be heavy and should be able to depress the wings and expose the stamens and stigma (Purseglove, 1974). However, this description does not fit any of the insects presented to the farmers as a pollinators.

The findings revealed that most of the farmers (98.02%) were aware of the existence of what are called pollinators. This appears very encouraging because insufficient knowledge among farmers about pollinators and pollination processes can hinder the conservation and sustainable use of natural pollinators (Ahmad *et al*., 2006). The high percentage of the farmers having knowledge of the existence of pollinators may be due to the fact that almost all of them have had one kind or the other of formal education. However, it may also be due to their practical experience over the years, which is classified as indigenous knowledge. Indigenous knowledge is local knowledge that is unique to a given culture of society (Warren, 1987). Such knowledge can be formal (explicit) or informal (tacit). Formal knowledge is based on scientific evidence, whose validity and reliability can be tested over a reasonable period of time. Informal knowledge is experiential in nature and it is acquired after an exemplary practice has been put to use over a period of time (Boateng, 2006).

Abrol (1997) described pollination as the transfer of pollen grains from male to female reproductive structures of plants. It is encouraging to note that majority of the farmers (98.1%) agreed that pollinators transfer pollen grains from the anther to the stigma. This may also be due to the formal education that many of the farmers had or their field experience. A source of concern is the fact that many of the farmers (42.3%) rated their personal knowledge of pollinators below 40%. This finding points to the need expressed by Ahmad *et al*. (2006) which emphasizes training in introductory courses in pollination and pollinators in agriculture for primary and secondary schools. They also recommended introductory courses in pollinator identification, biology and conservation using an ecosystem approach in agricultural colleges

Cross-pollination brings about hybrid effects in plant progeny leading to qualitative and quantitative changes in the development of the plants (Abrol, 1997). In this study, though all the options presented to the farmers as benefits of pollination were correct and acceptable (Abrol, 1997) the farmers mainly agreed on increased fruit set / increased crop yield as the benefit of pollination. This implies that the other benefits of pollination presented were not popular with respondents.

The fact that the farmers agreed that pesticide application destroys flower visitors and pollinators suggests that the farmers were aware of the negative effects of pesticide applications on beneficial insects in cowpea farms. This is good because if they could apply this knowledge, they may not indiscriminately spray chemicals but may take precautions to avoid killing beneficial insects in cowpea farms. Furthermore, it is important to take note of the point that majority of the farmers (96.2%) agreed that farmers should be given training in the knowledge of pollinators and their usefulness. After all, one important factor that can bring about new ways of thinking and innovation among farmers is training. Therefore their responses show the importance they attached to the subject of pollination. Hence, it is important for the Ministry of Food and Agriculture (MOFA) to see to such training for the farmers.

The finding where 90.4% (94) of the farmers asserted that the crops are sprayed with chemicals when pests infest them is similar to what Alghali (1991) stated that applications of insecticides can control pests and increase cowpea yields. Efficient control of insect pests can increase grain yield five times or more (Ghana / CIDA Grain Development Project, 1988; Adu-Dapaah, Afum, Asumadu, Gyasi-Boakye, Oti-Boateng and Padi, 2005). In addition to following recommended cultural practices and practicing crop rotation, it is important to spray the crop with insecticides to protect against insect pests (Ghana / CIDA Grain Development Project, 1988). Furthermore, the use of insecticides on the improved varieties of cowpea is strongly recommended. Therefore, farmers who do not spray their fields risk a total crop failure. Hence, the farmers may be doing the right thing by spraying with chemicals when the crops are infested by pests.

Out of the 94 farmers who agreed on chemical applications, 47 (50.0%) and 31 (33%) stated that chemicals are sprayed twice and once respectively during a cropping period. However, it has been documented that in order to control pre-flowering insect pests two chemical sprays are done (Ghana / CIDA Grain Development Project, 1988; Awuku, , Brese, Ofosu, and Baiden , 1991 and Adu-Dapaah *et al.*, 2005) for extra early, early and medium yielding varieties. For medium maturing varieties post-flowering sprays can be done once (Adu-Dapaah *et al.*, 2005) or twice (Ghana / CIDA Grain Development Project, 1988, and Awuku *et al.*, 1991). Thus, the cowpea

plants can be sprayed at least three or four times on average before harvesting. Hence, the responses in this study clearly showed that the farmers did not know exactly how many times the cowpea plants should be sprayed before harvest. This does not augur well for high cowpea yield because it may be possible that wrong applications will be taking place which will not favour high yield. No doubt cowpea production is still at highly subsistence level in the research areas. Since, chemical application goes with a lot of environmental hazards including destruction of pollinators, it will be very prudent if the Ministry of Food and Agriculture can empower agricultural extension officers professionally and logistically to train the farmers in the best practices of cowpea pest control.

The findings revealed that 69.2% of the cowpea farmers were not aware that synthetic pesticides can cause the destruction of insect pollinators. However, it is known that pesticide application to control pests by farmers has become a big menace to pollinators (Buchmann and Nabhan, 1996). Considering the low grading the farmers put on their personal knowledge in pollination and pollinator services, it is not so surprising that majority of them did not know that chemical pesticides can kill insect pollinators. About the issue of whether other insects apart from pests are killed by the chemicals, 52 (55.3%) of the farmers agreed. However, the fact that 44.7% responded in the negative raises concern. After all pollinators can also be insects. Therefore, they can also be killed by pesticides.

Majority of the cowpea farmers agreed that the cowpea plants were sprayed during flowering stage. For maximum yield, pesticide sprays are done against pre-flowering pests and post-flowering pests (Ghana / CIDA Grain Development Project, 1988; Awuku *et al*, 1991; and Adu Dapaah et *al*, 2005). Therefore, it can be said that majority of the farmers were not aware of the right stage of the cowpea plant at which pesticide application should be done. Also, apart from chemical control farmers could not agree on any other pest control measure available to them. Meanwhile, the most economical and environmentally friendly way of controlling legume pod borer and pod sucking bugs would be through the host plant resistance (Fatokun, http://www.iita.org/details/cowpea-pdf/cowpea-1.-5.pdf).Therefore, Integrated Pest Management (IPM) practices as prescribed by Adu- Dapaah *et al.* (2005) should be recommended for effective control of cowpea insect pests. This can include following recommended cultural practices. If that is done insecticide application should be done only when the pest population or damage is above economic threshold (Adu Dapaah *et al*., 2005). Furthermore, plant based extracts such as neem seed water extract (NSWE) which has been attested to by many authors as being very potent against pests and friendly to useful organisms in the field (Williams and Mansingh, 1996; IPM of Alaska, 2003; USA Biopesticide and Pollution Prevention Division, 2005; Annobil, Afreh-Nuamah, and Obeng-Ofori, 2006) can be used. Therefore, NSWE may be introduced to the cowpea farmers to experiment with to find out if cowpea pests can be controlled with minimal or no effect on pollinators.

Farmers who indicated that agricultural officers advised them on chemical control measures could not agree on any specific topic on which the training was centered. This makes the response very questionable as to whether the farmers actually received any training at all.

The findings reveal that Karate, Actellic and Cymbush are the very popular chemicals that the farmers spray when pests infest the crops. Meanwhile, apart from lambda cyhalothrin (Karate and PAWA), Cypermethrin (Cymbush, Cypercal), deltamethrin (Decis) all the other names given by the farmers are not recommended chemicals. Even DDT and Gammalin 20 are banned chemicals. It is also known that pre-flowering and flower insects are effectively controlled by spraying synthetic pyrethroids such as alphamethrin (fastac), Cypermethrin (Cymbush, Cypercal, Cypertex, Falcon), deltamethrin (Decis) and lambda cyhalothrin (Karate, Cyhalon, PAWA, Perfect) (Adu-Dapaah, *et al.*, 2005). Post-flowering insect pests can be controlled by applying endosulphan (thiodan, Thionex) or dimethoate (Perfekthion, Roxion). Endosulphan is preferred to dimethoate because it is effective against a wider range of post-flowering pests. Where available, Cymethoate, a combination of synthetic pyrethroid and dimethoate can be used for controlling all the insect pests. To control pod-sucking bugs application of a mixture of synthetic pyrethroid and Dimethoate was recommended (Adu-Dapaah *et al.*, 2005). Meanwhile, Actellic (pirimiphos-methyl), Elocron (dioxacarb) and Unden (a carbonate) are not effective in controlling cowpea field pests (Ghana / CIDA Grain Development Project, 1988; Adu-Dapaah *et al.*, 2005). Also,

Dursban (chlorpyriphos), Nogos (DDVP, dichlorvos) and sumithion (Fenitrothion) are not effective in controlling cowpea field pests. Kocide (a fungicide) is not an insecticide; therefore it should not be used against insects (Adu-Dapaah *et al.*, 2005). Meanwhile these are some of the chemicals stated by the farmers. In some cases even though the chemicals stated by respondents were the recommended ones, the spellings of the names were wrong making it difficult for one to know exactly what chemical was being mentioned. The use of the wrong insecticide will result in little or no insect control (Adu-Dapaah *et al.*, 2005). This will rather aggravate the insect pest problem and can also cause contamination of the cowpea. Hence, it can be said that it is not safe for farmers to be using such wrong chemicals.

9. CONCLUSION

It can be concluded that the farmers had different levels of education. It is clear from the study that most of the farmers have some kind of knowledge of pollinators to the extent that they are aware that pollinators can transfer pollen grains from the anther to the stigma of flowers. However, majority of them have very low personal knowledge of pollinators. Also, not all the farmers had the same level of knowledge about pollinators. The farmers did not have much knowledge about the kinds of insects that normally visit the cowpea flowers. It can also be said that farmers were only aware that pollinator cause increased fruit set / increased crop yield as the benefit of pollination. Indications are that the farmers were in favour of training for them covering the subject matter of pollinators and their usefulness. The farmers spray chemicals when pests infest the crops. However, they did not know exactly how many times the cowpea plants need to be sprayed before harvest. Further, majority of the farmers did not know the right times of pesticide application in the cowpea agro-ecosystem. Generally, farmers also did not know of any other pest control measures apart from chemical control. Though some of the cowpea farmers were aware of the right chemicals to apply against cowpea pests, others were not aware and used the wrong chemicals.

10. RECOMMENDATIONS

- Since cowpea is mainly cultivated at a subsistent level in the research areas, then in order to raise the production level of the crop to a substantial level in the research areas there is the need for the stakeholders to brainstorm to find out the constraints to the production of the crop on large scale. The solution to such constraints to be identified may help to solve the problem to some extent.
- Once some of the farmers have low personal knowledge of pollinators then, it will be very important for government to include introductory courses in pollination and pollinators involving pollinator identification, biology and conservation using an ecosystem approach in Primary, Junior High, Senior High Schools, Agricultural Colleges and University curricula.
- Considering the fact that over ninety percent of farmers agreed that farmers should be given training in the knowledge of pollinators and their usefulness, it is important for the Ministry of Food and Agriculture (MOFA) to see to such training for the farmers. The expected outcome of the training should be targeted at improving the economic and social benefits through increasing yield and improving produce quality and management practices.
- It is also hereby recommended that the Ministry of Food and Agriculture should contract experts to train the farmers in the best practices of cowpea pest control.
- Furthermore, it is important for farmers to use promising natural alternative insecticides that are effective in cowpea pest control but more friendly to beneficial insects than synthetic insecticides. A useful example is neem seed water extract (NSWE). Therefore the Ministry of Food and Agriculture together with the universities and research institutions in Ghana should undertake a vigorous research into the use of NSWE for better understanding of its effects on insect pests and pollinators. This will enable farmers to use it as a substitute for synthetic pesticides in the control of cowpea field pests in integrated pest management programmes.

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