AGRICULTURAL EXTENSION OFFICERS' KNOWLEDGE ABOUT THE ROLE OF COWPEA FLOWER INSECT VISITORS AND THE EFFECTS OF PESTICIDE CONTROL MEASURES ON THE INSECTS IN CENTRAL REGION OF GHANA.

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ABSTRACT

The study was undertaken to assess the knowledge of Agricultural Extension Officers about cowpea flower insect visitors and the effects of pesticide control measures on the insects in three districts in the Central Region of Ghana. Data were collected from 50 Agricultural Extension Officers of the Ministry of Food and Agriculture (MOFA) from three political districts by using questionnaire. The questionnaire which was developed using information from reviewed literature contained both open-ended and close-ended items on information pertaining to the personal data, knowledge on cowpea flower insect visitors and cowpea insect pest control measures. In each Ministry of Food and Agriculture (MOFA) district office, one officer was put in charge of administering and collection of the questionnaires. A random sampling technique was used. The Extension Officers considered bees (mean of 1.86) and lepidopterans (mean of 1.73) as the insects that most visited cowpea flowers. Also 90.91% (40) and 68.18% (30) of the Extension Officers considered bees and lepidopterans respectively as pollinators. Furthermore, 88.64% (39) of the respondents indicated that pollinators transfer pollen grains from the anther to the stigma. Majority of the respondents (mean of1.95) considered increased fruit set/increased crop yield as the benefit of pollination. Almost all the Extension Officers had low personal knowledge of pollinators. Therefore, government should include introductory courses on pollination and pollinators involving pollinator identification and conservation at all levels of education.

Key words: Agricultural Extension Officers, Knowledge, Pollination, Predator, Cowpea

INTRODUCTION

True farming system, defined as the establishment of an artificial ecosystem to yield a staple food supply (Reed, 1977) first emerged on earth during the Early Neolithic period in Northern Europe (Cowan and Watson, 1992). From this period onwards it seems clear that farming has continued to evolve and developed up to the present day, and no doubt will continue to do so (Jennings and Packham, 2001). Agricultural extension necessarily emerged after the establishment of "true" farming, but exactly when and what brought about its inception is unclear, or at least, is straying into unchartered territory (Jennings and Packham, 2001). The term "extension" and its use in the English language seem to have come into existence in Britain in the 1840s to describe the function of extending university research results to the community (Van den Ban and Hawkins, 1996). The potential for broad scale information transfer occurred for European agriculture with the commercialization of printing press (Porter, 2000). This was demonstrated in England where 20,000 published titles emerged during the publications in the 1790s (Porter, 2000). The proliferation of agricultural print media as an early form of agricultural extension contributed greatly to the emerging agricultural landscape up to the late 1700s (Jennings and Packham, 2001). The emergence of extension as an off-farm profession, along with the agricultural research and development sector, has caused the respective agenda for the on-farm domain and the off-farm domain to be separate entities that exhibit varying degrees of mutual independence and exclusivity (Jennings and Packham, 2001).

The primary responsibility of an Agricultural Extension Officer is to keep farmers informed about new developments in the agricultural sector. (Careers.co.za: http://www.careers.co.Za/displaycmetem.asp?strItemTypec=Occupations&strID=).It was further written at the website that as an agricultural extension officer, one needs to use a variety of methods to reach the farmers. For example, organizing study groups for farmers, farmer days, demonstrations, lectures and literature as well as informing the media. It further stated that the Agricultural Extension Officer also needs to make personal visits to farmers to discuss new developments. An Agricultural officer also propagates farming and development programmes aimed at reaching marginalized farmers or those who have little access to information and extension

services. This is done in collaboration with the farming communities, helping them to help themselves to become more self-reliant and independent (Careers.co.za: http://www.careers.co.Za/displaycmetem.asp?strItemTypec=Occupations&strID=.

The Extension Officer needs to think about the degree of participation that is appropriate for any programme. So what is the main role of the agricultural Extension Officer in the development of the community? Here, one can say that the Agricultural Extension Officer needs to identify strategies for the appropriate level of participation for different sections of the community. One of such strategies is to help farmers understand the role of flower insect visitors and pollinators on various crops in the community. Pollination is the transfer of pollen grains from an anther to a receptive floral stigma (African Pollinators Initiative, (API), 2003). Abrol (1997) described pollination as the transfer of pollen grains from male to female reproductive structures of plants. Pollination takes place by means of animals (pollinators), wind and water. Some plants also exhibit self-pollination. 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 or closely related species resulting in fertilization. Eardley (2002) considers biological pollinators as animals that provide pollination services. Thus, according to Eardley (2002) animals that provide plants the services that cause fertilization or movement of pollen to receptive stigma of another plant are called pollinators. No animal pollinates flowers deliberately. They visit flowers for food, in the form of nectar, pollen and plant oils. Pollination precedes fertilization and fertilization results directly in the plant producing seeds and fruits (API, 2003). Such pollinators can be insects such as bees, butterflies, moths, fruit flies, ants, wasps, and beetles (Abrol, 1997). Mammalian pollinators are mainly man and bats (Abrol, 1997).

Pollination is an essential ecosystem service. An estimated two-thirds of all flowering plants depend on animals, largely insects for pollination services. For these plants, the pollinator can be as critical as light and water (API, 2003). Therefore, pollination is a vital link in natural communities, connecting plants and animals in key and essential ways. Cross-pollination by insects is very key to the survival of many flowering plants. Teale (1957) also observed that insect pollination is an essential link in the ecological global chain. It has been estimated that more than 100,000 species of wild plants depend upon insects for pollination and reproduction (Teale, 1957). The absence of insect pollinators would have a drastic effect on non- cultivated areas, because most of the soil holding and soil enriching plants would disappear. Again, pollination may be needed by many wild species to produce fruits and nuts that are eaten by birds and small mammals. Thus, insect pollination is of utmost importance for continuation and propagation of plants, which maintain environmental quality.

With no reservation it can be said that the role of pollinators on cultivated plants is very important that Agricultural Extension Officers need to have in-depth knowledge in it so that they can appropriately advise farmers as to how they can deal with pollinators and flower insect visitors on the field without destroying them. In some communities, there will be significant population changes over different periods of time which will mean that an Extension Officer will need to embrace various strategies to achieve the appropriate level of participation in agricultural programmes. However, researchers consider Extension Agents and Institutions to be ineffective and unclear about their mandate. This makes researchers reluctant to work with them. However, when researchers work with Extension Agents, they tend to look down upon them and view them as little more than available manual labourers, and this attitude is strongly resented by the Extension Agents (Kaimowitz, 1992).

Statement of the Problem

There seems to be a controversy over the method of pollination of cowpea. Whilst one school of thought considers it to be self-pollinated (Bubel, 1987; Davis, Oelke, Oplinger, Doll, Hanson, and Putnam, 2003; and Asiwe , 2009) another school of thought has it that it undergoes cross-pollination (Mackie and Smith, 1935; Buchmann and Nabhan, 1996) whereas yet another school of thought has it that it undergoes both self- and cross-pollination (Vaz, De Oliveira, and Ohashi, 1998; and Asiwe 2009). For example, Purseglove (1974) asserted that cowpea can undergo both self- and cross-pollination. Therefore, in California with its dry climate cowpeas are considered almost entirely self-pollinated; in humid areas in the United States and Nigeria considerable cross-pollination occurs. The pollen is sticky and heavy, indicating that the plant is not wind-pollinated (Mackie 1946, and Purseglove, 1974). Furthermore, it has been established elsewhere that 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. Meanwhile, Mackie and Smith (1935) thought that bumblebees are the primary pollinators. Buchmann and Nabhan (1996) confirmed this statement by stating that bees pollinate cowpea. However, a further search through the literature does not reveal any current work indicating the actual mode of pollination of cowpea or the main insects that visit the flowers. The worst is that the

literature on cowpea pollination and flower insect visitors in Africa and for that matter Ghana is almost non-existent. This appears to worsen the confusion among African and Ghanaian research scientists as to what is the actual mode of pollination of cowpea and what are the insects that normally visit the flowers. Even if cross-pollination takes place what are the agents and to what extent. These questions appear not to have any emphatic answers from the African and Ghanaian scientists. In Africa for that matter Ghana, Agricultural Extension Officers depend on research scientists for scientific information that is made available to farmers. Hence, the question is once the research scientists themselves do not have any emphatic answer to the mode of cowpea pollination and the main flower insect visitors as well as to what extent cross-pollination can occur then what knowledge is available to the Agricultural Extension Officers to be transferred to the farmers. Furthermore, the concern is that if Ghanaian Agricultural Extension Officers have some knowledge at all about pollination biology and the types of insects that visit the cowpea flowers, how is it impacted to the farmers in order to promote high yields of cowpea. Hence, this study attempted to investigate Agricultural Extension Officers' knowledge about cowpea flower insect visitors and the effects of pesticide control measures on the insects in three districts in the Central Region of Ghana.

Objective

The objectives of the study were to find out the knowledge of Agricultural Extension Officers about:

- the role of cowpea flower insect visitors in three districts in the Central Region of Ghana,
- the effects of pesticide control measures on the flower insect visitors.
- Extension Officers' perceptions about the role of pollinators and pollination.

Research Question

What knowledge do Agricultural Extension officers have about cowpea flower insect visitors and the effects of chemical applications on the insect visitors?

Hypotheses

- All the Agricultural Extension Officers have the same level of experience.
- All the Agricultural Extension Officers have the same number of farmers under them.
- There is no difference in the response of the Agricultural Extension Officers concerning the knowledge of issues related to cowpea pollination as well as the effects of pesticide application on useful cowpea flower insect visitors.

METHODOLOGY

The population

The population of the study consisted of Agricultural Extension Officers of the Ministry of Food and Agriculture (MOFA) from three administrative districts (Agona, Ewutu – Effutu - Senya and Gomoa) in the Central Region of Ghana. The total number of Extension Officers from the three districts was 104 (32 from Agona District, 30 from Gomoa District, and 30 from Ewutu- Effutu- Senya District).

The instrument

The instrument for the study was questionnaire. The items were designed using information from reviewed literature. The first section of the instrument collected information pertaining to the personal data of the Extension Officers (respondents). The second section collected data on the knowledge of respondents on cowpea flower insect 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. 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 ratings of 1-1.4 = majority disagreed, 1.50 = 50% agreed and1.6- 2 = majority agreed were used.

Sample, sampling and data collection

Therefore, 14 Officers were sampled from Gomoa district (out of total of 30), 20 Officers from Ewutu-Effutu-Senya district (out of 42 officers) and 16 Officers from Agona district (out of 32 officers). Proportional random sampling was used where 16 respondents were sampled from Agona District (out of total of 32), 14 from Gomoa District (out of total of 30) and 20 from Ewutu-Effutu-Senya District (out of 42 officers). Hence, in all 50 respondents were sampled. The Extension Officers were located in the various farming communities of each district and the District offices. However, those in the communities visit the District Offices from time to time to report to their superiors. In each Ministry of Food and Agriculture (MOFA) District Office, one Officer was put in charge of administering the

questionnaires. The Officer randomly selected respondents from the district office as well as those in the communities who visited the offices. For those who visited the offices the lead Officer ensured that any of them that he/she met in the office was given a copy of the questionnaire. This was done until the required number from each district was obtained. The lead Officer again collected the filled questionnaires back from his/her colleagues. The researcher later went back to each District Office to collect the filled questionnaires. The instrument was pilot-tested with 10 Agricultural Extension Officers. Those items found to be inappropriate were either modified or dropped before moving on to administer the instrument to respondents. Out of the 50 questionnaires given out to the Extension Officers, 44 (88%) was retrieved.

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.

RESULTS

Majority (86.36) of the respondents were males. Also, majority were between 26 and 45 years of age.

From Table 1, majority of the respondents (81.82%) obtained Certificate in Agriculture followed by Diploma in Agricultural Extension (13.64%). For experience, 40.90% of them had been providing extension services for 6-10 years whilst 18.18% had been doing it for 16-20 years. The differences between the observed and expected responses were very highly significant (χ^2 = 41.46, P = 0.001) (Fig.2). Also, 45.45% of the Extension Officers claimed that they had 1-20 farmers under them whilst 22.73% did not know the number of cowpea farmers under their operational area. Differences between the observed and expected responses were very highly significant (χ^2 = 33.46, P = 0.001) (Fig. 3).

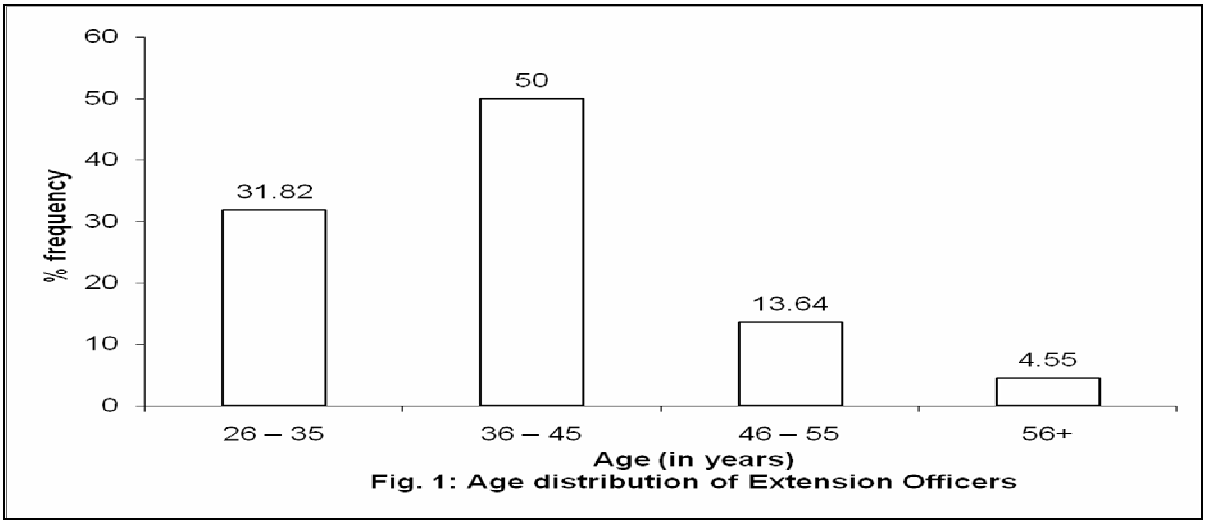

Fig. 1: Age distribution of Extension Officers

Table1: Highest academic/professional qualification of the Agricultural Extension Officers

Academic/professional qualification	Freq.	% Freq
General Certificate in Agriculture	36	81.82
Diploma in Agricultural Extension	6	13.64
B.Sc. in Extension in Farm Management	2	4.55

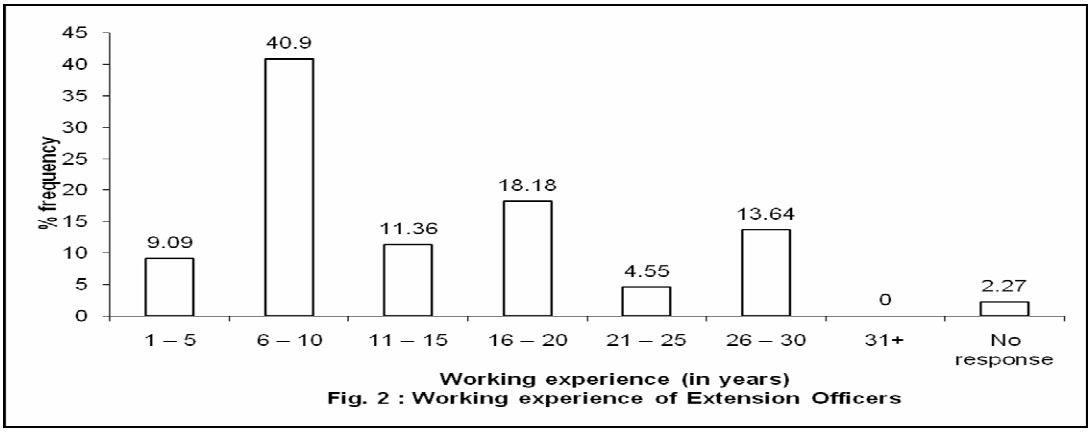

Fig. 2 : Working experience of Extension Officers

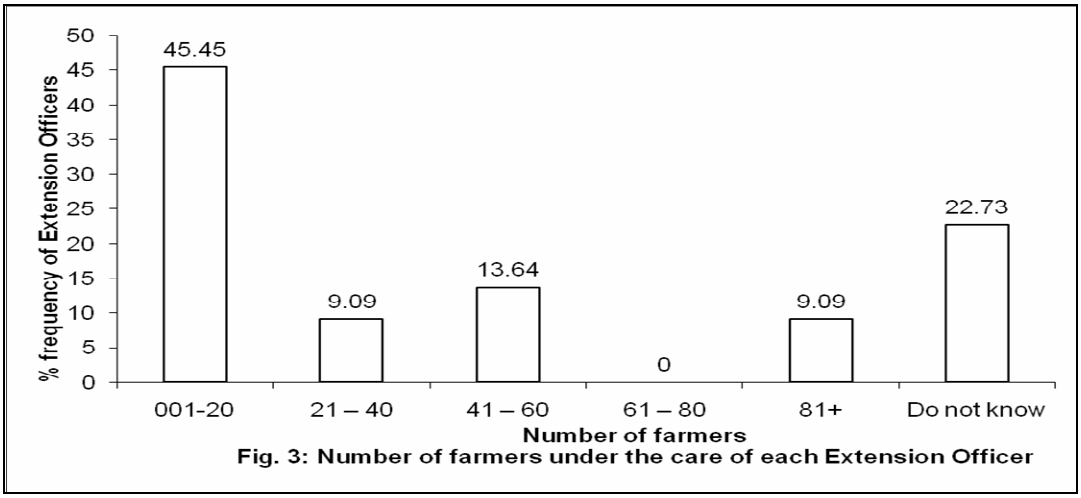

Fig. 3: Number of farmers under the care of each Extension Officer

Table 2: R**espondents' perceptions about insects that visit cowpea flowers**

Item/response	Mean	SD
This insect visits the cowpea flowers		
Bees	1.86	0.35
Lepidopterans (butterfly and moth)	1.73	0.45
Flies	1.23	0.42
Ants	1.45	0.50
Wasps	1.32	0.47
Beetles	1.32	0.47
Thrips	1.36	0.49

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

Concerning which insects do visit the cowpea flowers, bees registered a mean of 1.86 and lepidopterans registered 1.73. All the other insects registered means less than 1.5 (Table 2)

In responding to what specifically some selected insects do on the cowpea flowers, 90.91% (40), and 68.18% (30) of the Extension Officers considered bees and lepidopterans respectively as pollinators whilst 54.55% (24) and 68.18% (30) of them considered thrips and flies respectively as pests. Generally, large numbers of the Extension Officers did not respond to show whether some of the insects are predators, pollinators or pests. Also, low figures were scored in considering the insects as predators (Table 3). All the Extension Officers responded that they ever heard of pollinators (Table 4 a). Also, 88.64% (39) of the Extension Officers who agreed to have ever heard of pollinators indicated that pollinators transfer pollen grains from the anther to the stigma. Meanwhile, 11.36% (5) of the

Extension Officers were of the opinion that pollinators harm or destroy flowers (Table 4 b). All of them stated that insects cause pollination (Table 4 c).

Table 3: Respondents' views about the role of some cowpea insect flower visitors on the flowers

Item/response	Predator % Freq	Pollinator % Freq	Pest % Freq	Do not know % Freq
Bees	4.55	90.91	0	4.55
Lepidopterans	0	68.18	13.64	18.18
Flies (dipterans)	0	0	68.18	31.82
Ants	36.36	0	18.18	45.45
Wasps	13.63	13.64	18.18	54.55
Beetles	18.18	0	27.27	54.55
Thrips	4.55	0	54.55	40.91

Table 4: Respondents' Knowledge of pollinators.

Item/response	Freq	% Freq
a) Have you ever heard of pollinators?		
Yes	44	100
No	0	0
b) What role do pollinators play on flowers?		
They transfer pollen grains from anther to stigma	39	88.64
They destroy flowers	5	11.36
They feed on flowers	0	0
They guard flowers against pests	0	
c) Do insects also cause pollination?		
Yes	44	100
No	0	0

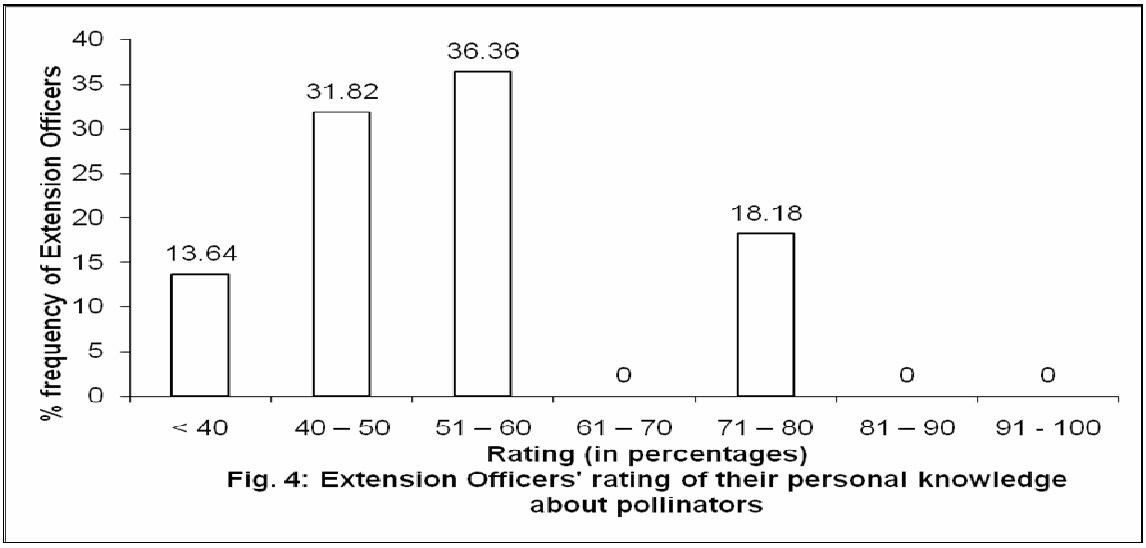

Fig. 4: Extension Officers' rating of their personal knowledge about pollinators

Table 5: Respondents' perceptions about benefits of pollinators

Item/response	Mean	SD
This is a benefit of pollination		
Increased fruit set / increased crop yield	1.95	0.21
Increased seed viability	1.50	0.51
Faster growth of plants	1.23	0.42
Reduction in fruit drop	1.14	0.35
Enhanced resistance to diseases	1.18	0.40
Increase in oil content in oil seed crops	1.0	0
Increase in the number and size of seeds	1.18	0.40
Formation of more nutritive and aromatic fruits	1.0	0

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

When asked to rate their knowledge about pollinators, 36.36% (16) rated themselves 51- 60%, 31.82% (13 people) rated it 40 -50% and 13.64% (6 people) rated it less than 40%. The differences between the observed and expected responses were very highly significant (χ^2 = 41.49, P=0.001) (Fig. 4).

In table 5 also, 1.95 of respondents considered increased fruit set/increased crop yield while 1.5 indicated fruit viability as benefits of pollination.

Talking about farming practices that are harmful to flower visitors/pollinators, pesticide application scored a mean of 1.95 while all the rest of the points scored less than 1.5 (Table 6).

Table 6: Distribution of Respondents knowledge about farming practices that ca causes harm to flower visitors / pollinators

Item/response	Mean	SD
This is a farming practice that causes harm to flower visitors / pollinators		
Pesticide application	1.82	0.40
Weeding the undergrowth of the crops	1.18	0.40
Mixed cropping	1.05	0.21
Harvesting	1.0	0

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

All the Extension Officers agreed that farmers need some training in the knowledge of pollinators and their usefulness. On whether the training is done for the farmers 86.36% of the Extension Officers responded in the affirmative while 13.64% responded in the negative. Concerning reasons why cowpea farmers should be given training in the knowledge of pollinators and their usefulness, the Agricultural Extension Officers indicated that it:

- will enable the farmers to know the importance of pollinators so that they will not destroy them through any pest control means,
- is because the farmers do not know the differences between pests and pollinators,
- will help the farmers to know how to identify pollinators and other useful insects, and
- due to the fact that farmers do not know much about pollinators and their usefulness.

The extension officers who agreed that they take the farmers through training on the importance of pollinators stated the following topics as those that they take the farmers through:

- insect pest control measures,
- types of pollination agents,
- the right time to spray chemicals,
- the right dose of chemicals to spray, and
- the need to carry beehives to farms during flowering.

The reasons given by the officers who indicated that they are not able to do the training for the farmers though they saw the need for it are that:

- they, the officers themselves have limited knowledge about pollinators and pollination.
- it is because they, the officers have limited time.

In response to what is done when pests infest the crops, 81.82 % (36) of the Extension Officers asserted that the crops are sprayed with chemicals. Out of the number who agreed on chemical applications, 19 (52.78%) and 11 (30.56%) indicated that chemicals are sprayed once and twice respectively (Fig. 5). About the effects of chemicals on insect pollinators, all the extension officers agreed that chemicals can kill insect pollinators (Table 7a). On the issue of whether other insects apart from pests are killed all the Extension Officers indicated that only the pests are killed (Table 7b).

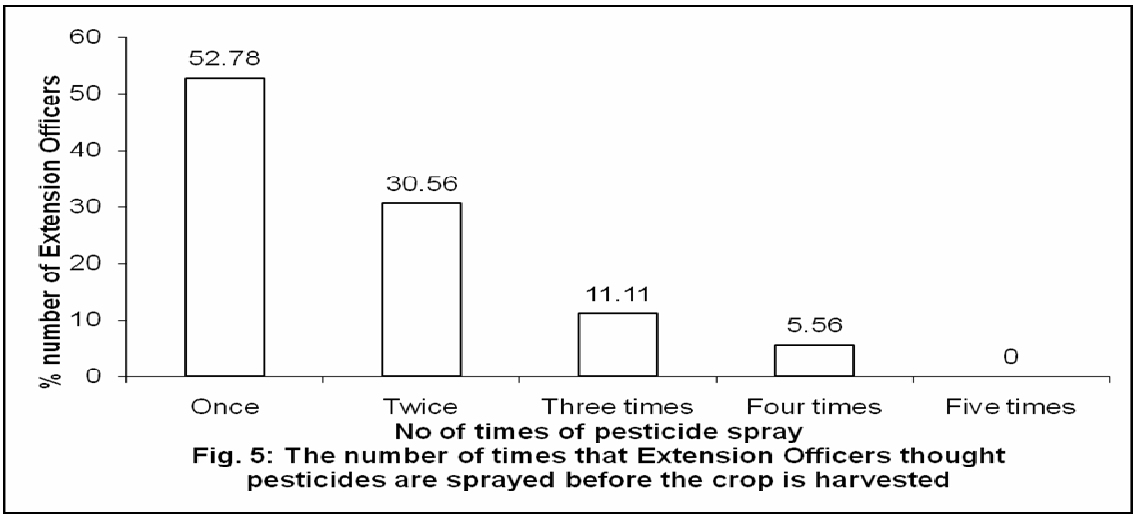

Fig. 5: The number of times that Extension Officers thought pesticides are sprayed before the crop is harvested

Table 7: Views of respondents about some facts concerning chemical application and its effects on insects in cowpea farms.

Item / response	Freq (SD)	% Freq.
a) What are the effects of chemicals on insect pollinators?		
Chemicals kill insect pollinators	44	100
Chemicals make insect pollinators to breed more	0	0
No effects	0	0
Do not know	0	0
b) After chemical application are other insects apart from pests killed?		
Only pests are killed	36	100
Other insects are also killed	0	0

Concerning flower visitors other than pests that are killed by chemical applications, extension officers generally agreed on all the insects except wasps (Table 8 a). They also agreed that farms are sprayed before flowering and at fruiting stages (Table 8 b).

Apart from chemical control, the Agricultural Extension Officers could not

agree on any other method presented to them as being available to the farmers (Table 9). Meanwhile, all of them agreed that the farmers are advised by agricultural officers on chemical applications.

All the Extension Officers agreed on all the topics presented to them as the topics on which they advise farmers (Table 10).

Karate, Dursban, Cymbus and Actellic were the most popular chemicals stated by Extension Officers as those that farmers use in the cowpea farms.

Table 8: Respondents' Perceptions about some other issues of chemical spraying in cowpea farms

Item / response	Mean	SD
a) This is one of the other flower visitors killed after spraying chemicals		
Bees	1.56	0.50
Lepidopterans	1.72	0.45
Wasps	1.44	0.50
Beetles	1.50	0.51
Flies	1.61	0.49
Ants	1.61	0.49
b) This is the stage of plants at which spraying is done		
Before flowering	1.68	0.47
At the initiation of flowering	1.32	0.47
At fruiting stage	1.55	0.50
Throughout cropping period	1.09	0.29
Any time pests emerge	1.14	0.35

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

Table 9: Respondents' knowledge about existence of other pest control measures available to cowpea farmers

Item/response	Mean	SD
This is a pest control measure available to farmers other than chemical application		
Biological control	1.32	0.47
Use of pest resistance crop varieties	1.41	0.50
Use of cultural practices	1.41	0.50
None above	1.05	0.21

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

Table 10: Distribution of thought of respondents about types of topics on which cowpea farmers are advised concerning chemical application

Item/response	Mean	SD
Yes farmers are advised on chemical application on the topic:		
Types of chemicals to apply for a particular pest	1.91	0.29
Concentration of chemicals to be applied	1.95	0.21
Number of times to spray chemicals before harvesting	1.91	0.29
Time of the day for application	1.91	0.29
Growth stage of the plants when chemical application can be done	1.73	0.45
Pest population demanding chemical application	1.50	0.50
TOTAL	44	

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

DISCUSSION

In this study, majority (86.36) of the Officers were males. This finding is similar to a research finding of Uganda Peoples Congress (1985) that almost all Agricultural Extension workers, cooperative extension workers and almost all veterinary extension workers are men. The fact that majority of the Extension Officers fall between the ages of 26 and 45 years (Fig.1) implies that they are still young and energetic to carry on with their work. Similar results were obtained by Munyua and Adams (2006) when they assessed the perception of Agricultural Extension Officers on Integrated Pest Management (IPM) in Uganda.

In this study majority of the Extension Officers (81.82%) obtained General Certificate in Agriculture (Table 1). Such low academic qualification of majority of the Extension Officers can make them a little deficient in understanding the scholarly findings of agricultural research officers. Hence, this can negatively affect their efficiency. This finding confirms what Muchena, Vodouhe and Atengdam. (1999) wrote that about 83% of Extension Professionals in Ghana hold only a Certificate in Agriculture and they are employed at the technical officer level and for most, the possibility of continuing their education is practically non-existent. FAO (1996) also contended that there is a shortage of well-trained Agricultural Extension staff in many developing countries. Zinnah *et al* (1999) also confirmed this by saying that Agricultural Extensionists constitute the least-trained group of staff in African agricultural organizations. Their initial formal training is usually inadequate, and where in-service training is provided it is often ad hoc and not responsive to the changing nature of extension tasks.

Experience of between 6 and 30 years of providing extension service by majority of the Officers (Fig.2) can be an advantage if the officers can learn on the job. That way, even the low professional and academic qualification of majority of them may not have much negative impact on their performance.

The findings indicate that some Extension Officers are having very large number of farmers (81+) under them (Fig. 3). With these large numbers if the Extension Officers are not able to devise any workable strategy then they may not be able to take good care of all the farmers. Hence, the farmers will be left to practice what they know best to the detriment of high productivity and the environment as well as probable pollinators. This finding seems to further deepen the assertion by FAO (1990) that in developing countries the estimated extension staff-to-farmer ratio was more than 1:2000. FAO/DFID/ODI (2002) also reported that in the Komenda-Edina-Eguafo-Abrem (KEEA) District of Ghana the Extension Officer to farmer ratio is 1:5000. Given the low numbers of extension staff, accompanied by low levels of training, it is not surprising that extension organizations are functioning poorly in Africa (Zinnah *et al*, 1999).). A more worrying situation under this study is the number of officers who do not know the number of cowpea farmers under their control (Fig. 3). This is difficult to explain, but only to say that it may mean that they have lost track of their professional job and are doing something else or they do not promote the cultivation of cowpea in their areas of control.

Boateng (2006) asserted that an effective knowledge management strategy for Agricultural Extension practice must aspire to bring the communities of extension experts and farmers together in all the knowledge management phase from knowledge creation to utilization. The results under discussion show that the Extension Officers do not have much knowledge about the kinds of insects that normally visit the cowpea flowers (Table 2).

Furthermore, they did not know or were not sure what exactly the insects presented to them do on the cowpea flowers (Table 3). Meanwhile, Purseglove (1974) asserted that the extra-floral nectarines at the base of the corolla of cowpea flowers attract ants, flies, and bees, but a heavy insect is required to depress the wings and expose the stamens and stigma. Tamp *et al* (1993) also stated that among cowpea pests the bean flower thrips, *Megalurothrips sjostedti* (Trybom), is the most destructive, attacking the reproductive structures of cowpea during plant development.

It is clear from this study that all the Extension Officers have knowledge of the existence of pollinators (Table 4a). This is not surprising at all because the Extension Officers are expected to have more formal knowledge of a subject matter such as pollination so that they can adequately educate the farmers on it (Rajasekaran, 1993). This is because; insufficient knowledge among Extension Officers and any pest control operators about pollinators and pollination processes can hinder the conservation and sustainable use of natural pollinators (Ahmad *et al*, 2006). It is encouraging to note that majority of the Extension Officers (88.64%) agreed that pollinators transfer pollen grains from the anther to the stigma (Table 4b). This is expected because one expects the Officers to have high level of explicit knowledge of the subject of pollination so that they can advise the farmers. However, it should be a source of concern when some Extension Officers (11.36%) indicated that pollinators destroy flowers (Table 4b). Generally, these are officers who have General Certificate in Agriculture implying that they lack knowledge so far as

the definition and the role of pollinators are concerned. However, it is consoling to note that all the Extension Officers agreed that insects also cause pollination (Table 4c). Meanwhile, another source of concern is the fact that some Extension Officers (13.64%) rated their personal knowledge of pollinators below 40% (Fig. 4). This is because if they do not know then the farmers cannot easily get the necessary advice that will enable them to derive the best benefit from pollinators.

In this study, though all the points presented to the respondents as benefits of pollination are correct and acceptable (Abrol, 1997) the Extension Officers only agreed on increased fruit set / increased crop yield as the benefit of pollination (Table 5). This implies that the other benefits of pollination presented are not popular with them.

The fact that Extension Officers agreed that pesticide application destroys flower visitors and pollinators (Table 6) suggest that they are aware of the negative effects of pesticide applications on beneficial insects in cowpea farms. This is good because if they can put this knowledge into use then they can appropriately advise the farmers not to indiscriminately spray pesticides. This will help to avoid killing beneficial insects in cowpea farms.

In this study, it is important to take note of the point that majority of the Agricultural Extension Officers 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 Extension Officers is training. Therefore their responses show the importance that they attached to the subject of pollination. However, considering the kind of response received from the Extension Officers pertaining to the knowledge covering insect pollinators, it will be advisable to do a number of weeks' intensive courses for the Extension Officers on the issue of insect pollinators. The outcome of such training should focus on improving the economic and social benefits through increasing yield and improving produce quality and management practices.

The Extension Officers advanced some cogent reasons why cowpea farmers should be given training on issues of pollination. Such points advanced by the respondents are very important because, if the farmers know the importance of pollinators and can identify them, they may make the attempt of preventing the destruction of them. The high percentage of Extension Officers (86.36%) who agreed that they do organize the training for the farmers is very refreshing. However, one is tempted to ask whether such trainings are actually done for the farmers. The reason is that a cursory look around shows that the farmers have very little knowledge if any at all about the kind of things the officers claimed they have been taking the farmers through. It is also odd to accept the explanation from some of the Officers that they do not organize the training for the farmers because of lack of time for them to do it. This is because training of farmers is one of the core businesses of Extension Officers. However, the idea of limited knowledge of the Officers themselves about pollination and pollinators needs to be taken seriously by the Ministry of Food and Agriculture to make sure that the Officers are given in-service training on the subject.

In a response to what is done when pests infest the crops, majority (81.82 %) of the Extension Officers asserted that the crops are sprayed with chemicals. Alghali (1991) suggested that applications of insecticides can control pests and increase cowpea yields. Fatokun (Internert -http://www.iita.org/details/cowpea-pdf/cowpea-1.-5.pdf) also asserted that relatively high grain yields can be obtained with two or three insecticide sprays. Efficient control of insect pests can increase grain yield five times or more (Ghana / CIDA Grain Development Project, 1988; Adu-Dapaah *et al*, 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). Ghana / CIDA Grain Development Project (1988) went on to state that 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.

Nineteen (52.78%) and 11 (30.56%) Officers indicated that chemicals are sprayed once and twice respectively (Fig. 5). In order to control pre-flowering insect pests, two chemical sprays are done (Ghana / CIDA Grain Development Project, 1988; Awuku *et al*, 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). Therefore it can be said that the cowpea plants can be sprayed at least three times or four times on average before harvesting. Judging from the results of this study it seems that Extension Officers do not know exactly how many times the cowpea plants need to be sprayed before

harvest. This does not augur well for high cowpea yield because it may be possible that wrong applications might be taking place which will not favour high yield. No doubt cowpea production is still at highly subsistence level in the research areas.

All the Extension Officers agreed that pesticides (chemicals) can kill insect pollinators (Table 7a). Buchmann and Nabhan (1996) also expressed similar views that pesticide application to control pests by farmers has become a big menace to pollinators. About the issue of whether other insects apart from pests are killed by the chemicals, all the Extension Officers indicated that only the pests are killed (Table 7b). This contradicts their earlier response that pollinators are killed when chemicals are applied. After all pollinators can also be insects. It also exposes the weaknesses of the Extension Officers. This is because pesticide application cannot kill only the insect pests but will definitely kill some of the other insects found on the plant including the beneficial insects. Concerning the specific flower visitors, apart from pests that are killed by chemical application the Extension Officers generally agreed on all the insects except wasps (Table 8a). However, it again contradicts the response that only pests are killed when chemicals are applied.

Majority of the Extension Officers agreed that the cowpea plants are sprayed before flowering and at fruiting stages (Table 8b). 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 the Extension Officers are aware of the right stage of the cowpea plant at which pesticide application in the cowpea agro-ecosystem should be done. Clearly, apart from insecticides, majority of the Extension Officers did not agree on any other pest control measures presented to them (Table 9). This shows that the methods presented are not popular with the Extension Officers.

The success of the Extension Service, to a large extent depends on how farmers are brought into the picture of knowledge management. However, the poor linkage between farmers and Extension Officers constitute a barrier for knowledge management to thrive (Boateng, 2001). The findings of this study showed that all the Extension Officers agreed on all the topics presented to them as the topics on which they advise farmers (Table 10). The findings further reveal that not all the chemicals stated by respondents are recommended chemicals. 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).

CONCLUSION

Generally, almost all the Extension Officers had very low personal knowledge of pollinators. It is also clear that the Extension Officers did not have much knowledge about the kinds of insects that normally visit the cowpea flowers. Also, apart from increased fruit set / increased crop yield, all the other benefits of pollination presented were not popular with the Extension Officers. Furthermore, the Extension Officers believed that training of farmers in the knowledge of pollinators and their usefulness is necessary to help the farmers to know the importance of pollinators and not to destroy them; for farmers to know the differences between pests and pollinators. Generally, respondents were aware that chemicals are sprayed when pests infest the crops. However, they did not know exactly how many times the cowpea plants need to be sprayed before harvest. Since pesticide application cannot kill only the insect pests but will definitely kill some of the other insects found on the plants including the beneficial insects, it can be said that the Extension Officers lack knowledge of the effects of chemicals on insects on the cowpea plants. Also, though some of the Extension Officers were aware of the right chemicals to apply against cowpea pests, others were not suggesting that they might be prescribing wrong chemicals to farmers. Looking at the overall results about the knowledge of Agricultural Extension Officers on cowpea flower insect visitors, it can be said that while the respondents up to some extent had the right knowledge of the activities of cowpea flower insect visitors and pollinators as well as the effects of chemical control measures on them, they equally lacked knowledge in some aspects which raise serious concerns.

RECOMMENDATIONS

- In order to help the Extension Officers with low academic qualifications to upgrade themselves academically, it is hereby recommended that the Government of Ghana should put in place distance education academic programmes in some of the universities for the Officers to take advantage of.
- Since almost all the Extension Officers had very low personal knowledge of pollinators the Ministry of Food and Agriculture should include introductory courses on pollination and pollinators involving pollinator identification, biology and conservation using an ecosystem approach in Primary, Junior High Schools, Senior High Schools, Agricultural Colleges and University curricula.
- Since some of the Extension Officers are not able to organize training for farmers on

  pollinators because of limited knowledge of pollination and pollinators themselves there is the need for the Ministry of Food and Agriculture to make sure that the Officers are given in-service training on the subject so that they can in turn train the farmers.
- Also, since some of the Extension Officers were aware of the right chemicals to apply against cowpea pests but others were not, suggesting that they might be prescribing wrong chemicals to farmers then there is the need for prompt and well planned action from the Ministry of Food and Agriculture (MOFA) to correct the harm that might be caused before it is too late.

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