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Changing Agricultural Practices in Cowpea Production: The Impact of New Innovation

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Abstract:
This paper provides details of cowpea production, storage and treatment by focusing on cowpea innovations, paying particular attention to the FFS, IPM innovations and related processes. It draws on data collected during 12 months of fieldwork in northern Ghana. The communities in which the research was conducted sit some 102km and 15km from Tamale. The fieldwork also researched three agricultural development agencies: Savanna Agricultural Research Institute (SARI), the Ministry of Food and Agriculture (MOFA) and World Vision Ghana (WVG). Data collection was achieved through formal surveys, Focus Group Discussions (FGDs) and observations. A total of 120 individual interviews were conducted for the formal survey guided by the questionnaire. Thirty individual questionnaire- 10 each- were administered to the three Agricultural Development Agencies –SARI, WVG, and MOFA. While 275 community members made up of both male and female farmers, elders, the youth and traders were involved in five Focal Group Discussion Workshops. Results indicates that only a few farmers cultivate the local varieties, to ensure that they do not disappear, because of characteristics such as the taste, appearance and the unique taste of the leaves which is used for soup. Improved varieties were taking over the local varieties because, they quick to develop, mature within two months such that increased yields are a distinct possibility unlike local varieties and can be planted twice in the rainy season. Adopting the cultivation of improved varieties also meant adopting improved methods of cultivation.

Keywords: *Northern Ghana, cowpea, production, pest control, integrated pest management, farmer field school*

1. Introduction

The research for this study was carried out in two districts of the Northern Region of Ghana and with three agricultural agencies - Savanna Agricultural Research Institute (SARI), the Ministry of Food and Agriculture (MOFA) and World Vision Ghana (WVG) in northern Ghana. The research made use of interviews, observations and group interviews, which was critical in the examination of agricultural development which allowed access to the thoughts, experiences and processes involved in agricultural development. The objective of this paper is to examine the crucial role IPM innovations play in reducing cowpea field and storage pests which can lead to post harvest loss.

Post-harvest loss in cowpea production in Africa is a critical issue. Inadequate storage facilities or innovations, poor harvesting innovations, lack of resources to minimize field and storage pests contribute to cowpea storage losses. Losses of cowpea to insects such as bruchids/weevils (*C. Chinensis*) can be very high at storage. Some farmers may lose their entire cowpea production in storage which may affect household food availability and income (Inaizumi et al 1997). As a result, cowpea has been given priority attention in the research agenda and these efforts have yielded important dividends, such as the release of new and improved varieties of cowpea, the introduction of improved or new cropping regimes, and the development of IPM innovations. These new and improved varieties, cropping regimes and IPM innovations are extended to farmers during Farmer Field Schools (FFS) by research institutions, non-governmental organisations, and the Ministry of Food and Agriculture (Lowenberg-DeBoer 1998).

The IPM FFS is one important recent contribution to agricultural development practice (Tripp, Wijeratne and Piyadasa 2005), which farmers, National Research Institutions (NRI), the Ministry of Food and Agriculture and some NGOs have embraced. The FFS approach is a concept that helps farmers decide on the best alternatives to tackle a problem by developing or adopting innovations that are beneficial and suitable to farmers (Nederlof *et al* 2004; Roling 2002; Roling et al 2004).

2. Method

2.1. Research Location and Sources of Data

This paper draws on data collected during 12 months of fieldwork in northern Ghana. The northern region, as one of the ten regions of Ghana, is divided into 13 districts and the research was conducted in two of them. The communities in which the research was conducted sit some 102km and 15km from Tamale, the Northern Regional Capital. The communities involved in the study in the two districts were; Kpasa and Tamalbila. Tamalbila is located in the Tolon Kumbungu district and had a population of around 1000 inhabitants. Kpasa, with a population of about 800, is located in the West-Mampusi district. Predominately agriculturally based, the study area relies on farming as a major source of income and food for household consumption.

The research was conducted in an atmosphere of confidentiality: participants' rights, privacy and interests were respected. Steps were taken to maintain confidentiality of the identity of the communities and research participants. Participants were given clear information and assurances of how data will be stored and about the confidentiality of information collected from them. These were read by those who could do so, and interpreted to those who could not read and write. The names of places are common knowledge but the informants were assured of confidentiality and especially where people could potentially be hurt now or in the future.

The fieldwork also researched three agricultural development agencies: Savanna Agricultural Research Institute (SARI), the Ministry of Food and Agriculture (MOFA) and World Vision Ghana (WVG).

The following methodology aims to collect data to determine how gender concerns raised in the 1970's has altered gender roles in recent times thereby documenting the gendered nature of productive and reproductive roles in the agricultural sector.

2.2. Methodology, Sampling Procedure and Data Collection

Questionnaires for the interviews were semi-structured and open ended. In the first instance, thirteen prospective communities were identified. These communities were Kasalgu, Tampie-Kukuo, Malsheigu, Kumbuyili, Gumo, Nwodua, Kpenjing, Cheyohi, Nwangbong-Yepala, Walewale, Logri, Kukua and Yendi. Out of this sample, two communities were randomly selected using an online random choice generator. The actual names of the communities involved were changed to Tamalbila and Kpasa; these are pseudonyms.

Thirty individual questionnaire- 10 each- were administered to the three Agricultural Development Agencies- SARI, WVG and MOFA. Seven household were observed in the study communities; three in Tamalbila and four at Kpasa. Households that had been involved in agricultural activities with the three Agricultural Development Agencies were numbered and randomly selected using an online random choice generator. Observations were structured to capture major points of interest such as the agricultural and non-agricultural roles played by all household members. A total of 120 individual interviews were conducted for the formal survey guided by the questionnaire while 275 community members (see table 1), made up of male and female farmers, elders and mostly female traders were involved in five Focal Group Discussion (FGDs) Workshops. The individual interviews were mostly for household heads or their representatives but the female respondents were either household heads or asked to be interviewed in place of the household head, this was to ensure that a good number of women participated in the study. This was achieved with the help of household heads. Without their permission, it would have not been possible to interview women in place of household heads when there were male headed households. There were only 5 female headed households in Tamalbila and 2 in Kpasa. Three FGD workshops were held in Tamalbila and two FGD workshops in Kpasa. Cowpea farmers were used because the three agricultural development agencies have done extensive work together on cowpea. Data obtained by the questionnaire and FGDs were analyzed using NVIVO

Community	Individual Interviews (II)	II Women	II Men	FGDs	FGDs Women	FGDs Men
Tamalbila	60	20	40	165	95	70
Kpasa	60	20	40	110	45	65
WVG 10						
MOFA	10					
SARI	10					
Total	150	40	80	275	140	135

Table 1: Participation in Interviews and FGD Workshops

3. Literature Review

3.1. The Development of Innovations/Technologies

The work of Rogers, Biggs, Okali and Boserup contributes to the past and current understanding of the processes involved in innovation development, diffusion and adoption. Rogers (1983) argues that the development of innovations begins with the recognition of a need or problem, which then stimulates research and development activities that are designed to solve that problem or need. According to Rogers (1983), a change agent is an individual who influences a client's decision to innovate in a way deemed desirable by a change agency. Mostly, a change agent points out new alternatives to existing problems, which clients then adopt. However, a change agent may also attempt to slow the process of diffusion to prevent the adoption of certain innovations deemed undesirable; for example in the case of farmers adopting chemical pesticides for the prevention of both field and postharvest insects. Innovations must be developed to match a client's needs or problem. For innovations to be developed to meet client needs, feedback from the client system must flow from client to the change agent and to the change agency so that it can make appropriate adjustment/developments on the basis of previous successes and failures (Rogers 1983). Change agents must have knowledge of their client's need, attitudes, and beliefs, their social norms and leadership structure, if programmes of change are to be tailored to fit the clients (Rogers 1983).

Where change agents have knowledge of their clients' needs, attitudes and belief technological development is considered a major tool for growth especially in African agriculture. As there is a pressing need to meet the demands of poor people in areas with resource constraints (Biggs 1990; Sumberg and Okali 1997). Due to increases in population, there is demand on land so severe that soil fertility is reduced unless greater input levels are made use of. Again, an increase in population puts pressure on land thus reducing farmers' chances of practicing the traditional fallow system; this eventually renders farmland infertile. The traditional fallow system allows farmers to leave their land uncultivated for a number of years so that soil fertility can recover before it is cultivated again. Thus potential for good agricultural productivity can be maintained. Where there is a reduced soil fertility level on the farms, more artificial chemical pesticides inputs have to be used and more innovations developed to increase agricultural production. As a result, rigorous agricultural innovations with higher purchased input levels and increased labour requirements have been initiated in several regions of Sub-Saharan Africa (Lawrence, Sanders and Ramaswamy 1999).

According to Okali, Sumberg and Farrington (1994), agricultural innovations come from a number of different sources, which are best discussed using the two main models outlined by Biggs (1990): that innovation is developed and transferred through either a central or multiple sources of innovation.

The ability of farmers to participate is of major interest. Concerns surrounding farmer participation in innovation typically concern farmers' understanding of new innovations, their participation in the development process, their empowerment, the role of local organisations and the comparative gain of diverse research and development institutions (Okali, Sumberg and Farrington 1994). Further to their discussions, Okali, Sumberg and Farrington (1994) made note of the fact that there is a rapidly growing literature that embodies debates around the theoretical and practical aspects of farmer involvement in research. Monitoring and evaluation strategies, tools and indicators were thought to play a vital role in assessing the impact of farmer participation and hence the development of innovations (Okali, Sumberg and Farrington 1994). For instance, looking at Ghana, in developing strategies for Cowpea Integrated Management Programmes, farmers could be consulted for their input as to how to tackle their development. In this instance, farmers' involvement is very essential as every region in Ghana is different in terms of geographic and cultural characteristics. Targeting farmers and getting them involved at an early stage is important; as they become part of the successes and failures of an innovation.

Furthermore, Biggs argues that some farmers might consider certain innovations as both 'old and new'. Some kinds of innovations are often seen as 'old and or new' depending on the individual farmer using or looking at them. For instance a farmer who learns how to cultivate cowpea using the Integrated Pest Management strategies in the south of Ghana, which is the first place for the dissemination of most innovations, will view them as 'old' innovations, when the innovation is transferred in the northern part of Ghana, whereas his colleagues will view them as 'new'. This is especially true for institutional innovations concerning the way research is structured, organised and managed (Biggs 1990). For example every institution behaves differently towards any innovation and the outcome of any given innovation depends on the nature of the innovation and the institutions involved and their location. Recent interest in developing and promoting new on-farm systems research methods has a wealth of people discovering, rediscovering, and labelling previously known approaches and innovations as 'new' (Biggs 1990). Whereas it is difficult to identify whether an innovation is really 'new', what is important is to actually recognise the actual use and potential for such an innovation (Biggs 1990). Okali, Sumberg and Farrington (1994) argue that in the 1970's there was already a move from the linear model. The linear model proposed that farmers should be provided with alternatives which they themselves have helped determine, and among which they can choose.

Practices in innovation, the development, transfer and adoption of new and improved innovations, need to increasingly acknowledge and value the role of local wisdom and solutions. Indeed innovations that are generated locally are not just more likely to be culturally appropriate, but also more likely to be utilised by the potential adopters. When adopters are externally persuaded to buy into the vision of an outside expert, they tend to demonstrate inertia and resistance, much like the Iowa farmers who for years resisted the adoption of hybrid seed corn (Rogers 1983; Biggs 1990; Rogers 1995). For Okali, Sumberg and Farrington (1994), to be effective, research cannot be disassociated from the increased awareness of the importance of local knowledge. Research has to focus on the nature and structure of local knowledge if it is to enhance farmer participation. Secondly, Okali, Sumberg and Farrington identified an important synergy through the interaction of formal agricultural research and farmer's own research. However the level of interaction between farmers and agricultural researchers vary depending on objectives and the specific innovations under study (Okali, Sumberg and Farrington 1994). According to Okali, Sumberg and Farrington (1994) described how the Pan-American Agricultural School dealt with the significant but complex to study categories of farmer knowledge, which, he argued, are especially challenging to address in a collaborative manner. Thus in the school's pest management programme, the emphasis was on two things a farmer does not generally know: how insects reproduce and what kills the insects. The research agronomists concentrated on enhancing farmer's knowledge rather than on telling them how to do experiments.

3.2. Diffusion of Innovations/Technologies

In this section, it is argued that the linear model is of only limited value in understanding the usefulness of the multiple model. The idea of communicating the use of new innovations from one person to another in a social setting is very important for development. These new ideas refer to innovations and the process of communicating innovations to modify the behaviour of the receiver is referred to here as diffusion (Rogers 1995:5). The theoretical perspective of 'diffusion of innovations' is concerned with how, why, and at what rate new ideas and innovation spread through cultures. According to Rogers, the diffusion of innovations describes the process by which an innovation is communicated through channels over time among members of a social system (Rogers 1995). The theory has potential application to information innovation ideas, artefacts and techniques, and has been used as the theoretical basis for a number of innovative research projects. Research in diffusion of innovations argues that disciplines ranging from agriculture to marketing have used diffusion theory to increase the diffusion of innovative products and ideas (Rogers 1995; Yates 2001).

Rogers (1995), recognizes four factors that affect, contribute or influence the diffusion and adoption of an innovation. These include; the information on which the innovation is based; communication used to spread information about the innovation; time; and the nature of the society within which it is introduced. When an innovation is diffused without prior investigation as to the needs and wants of the people, taking into consideration the norms and values of the people and innovations already in use, it may lead to low rates of adoption. Generally, information from the end users and the innovators (before and after the diffusion of innovation) is vital in achieving high adoption rates.

With information from the end users, it is easier to disseminate new or improved innovations. Thus it is important for researchers developing an innovation to know the channels through which information on a new innovation can be disseminated and easily digested by end users. This implies/assumes that if people are given information during the dissemination of a new innovation, they will adopt or reject it subject to the constraints identified during the innovation dissemination process. Rogers identified two ways through which change in behaviour through dissemination of innovation can occur. The first is imminent change, which occurs within and among members of a social system. The second, he identified as contact change which occurs when external sources to the system introduces new innovations (Rogers 1983:24; Rogers 1993).

Time is essential in the diffusion of innovation. Rogers (1995) argues that a vital factor in the diffusion process is the element of time, which is often ignored in behavioural research. When end users of an innovation are given much more time to understand fully the innovation being disseminated, it is more likely to yield good results. Langyintuo et al (2000) refer to the process of innovation adoption as the innovation-diffusion model, which holds that access to information about an innovation is the key factor determining adoption decisions. They further argue that if the innovation is appropriate, the problem of innovation adoption is reduced to communicating information on the innovation to the potential end users (Langyintuo et al 2000). This is a kind of technological solution to the problems of technological dissemination that might give people more knowledge about a new innovation. So when knowledge is disseminated to people it will not simply lead to behavioural change. This contradicts the model by Rogers that suggest that people will adopt or reject an innovation subject to the limitations identified during the innovation dissemination process.

An important component of the dissemination process which has received little research attention is discontinued adoption, where an innovation is rejected after having previously been adopted (Inaizumi et al 1997). Rejecting an innovation could arise as a result of new and more effective innovations being disseminated, the ineffectiveness of an innovation or inability on the part of users of an innovation to apply the innovation as required due to inadequate dissemination. Gedikoglu (2010) claims there were no theoretical models of innovation dis-adoption until his study titled, *Impact of Farm Size and Uncertainty on Technology Dis-adoption.* In this work he predicted that large-scale farmers were more likely to dis-adopt innovations if the cost of replacing an old innovation with a new one is the same.

Agricultural extension has been described as a channel of innovation dissemination (Sumberg and Okali 1997). The agricultural extension service, which concerns itself with giving instructions and practical demonstrations in improved farming practices, is the main avenue for disseminating to rural farmers in Ghana improved tools, the use of fertilizers and high yielding seeds (Date-Bah 1985). The agricultural extension service according to Opare (1979-1980) has been in operation in Ghana since 1890; its personnel are mainly male (Date-Bah 1985). Farmers who have regular visits from agricultural extension agents are considered to be more likely to accept new and improved innovations as they are exposed to how new innovations work through demonstrations; part of the dissemination process.

According to Nnanyelugo et al (1997) and Inaizumi et al (1997), there is a positive and significant association between age, farming experience, training received, socio-economic status, cropping intensity, aspiration, economic motivation, innovativeness, information source utilization, information source, agent credibility and adoption (Inaizumi et al 1997).

Innovation dissemination can be a formal or informal process and so individuals are involved in this process in their daily lives as they strive to a living. This literature thus brings to bear an understanding of how dissemination is undertaken by agents of innovation dissemination.

3.3. Adoption of Innovations/Technologies

When people adopt an innovation, Rogers intimates that the individual perceives the innovation to be an improvement over what already exist, to be consistent with existing values, past experiences and his/her needs. The innovation must also be less complex to enable it to be tried and be observed by others who are interested, if rapid and high rates of adoption are to follow (Rogers 1983). Rogers outlines an innovation-decision process which an individual goes through from first knowledge of an innovation, to forming an attitude towards it, to a decision to adopt or reject, to its implementation and to confirmation of the decision to adopt (Rogers 1983). Rogers further argues that the innovation decision process can lead to either adoption, a decision to fully use an innovation as the best alternative available, or to rejection, a decision not to adopt an innovation; although this can later be reversed. It is also possible for an individual to adopt an innovation after a previous decision to reject it. Such later adoption and discontinuance occur during the confirmation stage of the innovation-decision process (Rogers 1983:20).

Nagy and Sanders (1990) suggest that successful adoption of innovations requires a thorough understanding of the scientific concepts used and a multidisciplinary approach to understanding the complexity of the farmer's environment, farming systems, and decision-making process. They argue that agricultural scientists often do not investigate the complex systems and farmer's needs before carrying out their research. As such, when farmers do not adopt innovations recommended to them, the first reaction of the agricultural scientists is often that the problem is with the farmers, the extension service, or national economic policies, rather than the relevance or appropriateness of the innovations themselves (Nagy and Sanders 1990).

As already noted Rogers (1983) also observed that a time dimension affects the rate of adoption; the term refers to the relative speed with which different members of a social system adopt an innovation. At first, only a few individuals adopt the innovation, but as time passes, more and more people begin to adopt. The rate of adoption thus is usually measured by the length of time required for a certain percentage of the members of a system to adopt an innovation. However, there are also differences in the rate of adoption for the same innovation in different social systems (Rogers 1983).

Physical products such as the hybrid corn were among the first examples used by Rogers to illustrate the adoption theory (Rogers 1983). The term 'Diffusion of innovations' was used to describe the theory of adoption, which incorporates the understanding that changes in innovation can be linked to social change in society. Rogers portrayed the spread of innovation adoption as an 'S' curve, starting slowly from the bottom with the innovators and early adopters, then growing rapidly as the early and late majority adopted the innovation. The final tip of the 'S' curve, usually represented by a bell shaped curve indicates innovators and early adopters on one end, early and late majority adopters in the centre, with the laggards completing the final curve (Rogers 1983).

Socio-economic evaluation research suggests that farmers do not necessarily adopt innovations as a whole but rather, adopt parts of it (Lawrence, Sanders and Ramaswamy 1999; Nagy and Sanders 1990). It is argued that farmers are hardly in a position to adopt complete packages because of lack of resources and of risk aversion. Thus they do not adopt new ideas or innovations all at once, but a little bit at a time depending upon several factors. Farmers adopt innovations in a stepwise pattern based on profitability, riskiness, initial capital requirements, complexity and availability (Lawrence, Sanders and Ramaswamy 1999; Nagy and Sanders 1990). The innovations within the package that best exhibit the above attributes are selected first by the farmer, and other components are added if the experience from the first proves positive. Thus, while new innovations may be disseminated to farmers as a 'package' of innovations or new practices, they adopt elements over time, in a sequence logical to them and their own perceived needs. Information on the likely adoption pattern sequence of innovations is important in focusing research, extension, and government programs that aim at setting priorities for government policy and innovation adoption (Lawrence, Sanders and Ramaswamy 1999; Nagy and Sanders 1990). Besides the above-mentioned factors, Rogers noted that an individual is influenced to adopt an innovation by mimicking the behaviour of another individual who has already adopted the new idea. This is also the basis for social learning theory which states that an individual's observation of the overt behaviour of another individual often serves as a guide for the observer's behaviour (Rogers 1983, 131-132).

Rogers uses these ideas to categorise different individuals within society into five different types of adopters. The first to adopt, he argues, are the 'innovators' who he sees as desiring the hazardous, daring and risky nature of new innovations. They are willing to accept an occasional setback when one of the new ideas he or she adopts proves unsuccessful. Rogers argues that while members of a social system may not respect innovators, they play an important role in the diffusion process by launching new ideas in the social system through the importation of innovations from outside of the system's boundaries. Thus he refers to them as playing a 'gate keeping' role for the flow of new ideas into a social system (Rogers 1983).

The second category here refers to are the 'early adopters', who do not attempt to come up with new ideas as do the 'innovators', but who are looked up to by other potential adopters for advice and information about new innovations. They serve as role models for other members of a social system and are respected by their pears, which embodies the successful and discrete use of new ideas. As a matter of fact, one important role for the early adopter is to reduce uncertainty about new innovations by showing they can work (Rogers 1983).

Rogers identified the 'early majority' as the third category; these are those who adopt new ideas just before the average members of a social system. They interact with their peers but seldom hold leadership positions. The early majority may deliberate for some time before fully adopting a new innovation. As a result, their innovation-decision period is longer than that of the innovators and the early adopters (Rogers 1983). According to Rogers, earlier adopters are no different from late adopters in age as there is inconsistent evidence about the relationship of age and innovativeness. About half of the 228 studies conducted on adoption and reviewed by Rogers indicate no connection between age and innovativeness. Nineteen percent show that earlier adopters are younger, and 33 percent show that they are older (Rogers 1983: 251).

Rogers' see his fourth group, the 'late majority', as more sceptical. For them, adopting may be both an economic necessity and the answer to increasing network pressure. They approach innovations with caution and do not adopt until most of their peers have. In adopting innovations they weigh the system norms to be sure that the innovations favour them. The late majority are sometimes persuaded of the usefulness of new innovations, but peer pressure is necessary to motivate adoption. They may also have comparatively limited resources, which necessitates that almost all the uncertainty about a new innovation is removed for them to feel safe in adopting (Rogers 1983).

The last category Rogers categorises is the 'laggards', who he describes as the traditionally inclined; they are the last to adopt an innovation and possess almost no opinion leadership. They are in thrall to traditional values and mostly relate to people who think similarly; being frankly doubtful of change agents and innovations, their traditional orientation slows the innovation-decision process. Rogers describes the laggards to be far below the knowledge-awareness level due to their resistance to adoption. However, it may be purely rational from the laggards' viewpoint not to adopt, as their resources may be very limited and they must have positive certainty before adoption (Rogers 1983). Tessmer (1991) stresses the need to analyze the environment in which the potential adopter is expected to use the innovation to ensure actual and continued adoption. This in a way will enhance adoption of innovations by laggards, thereby changing their behavioural pattern.

Social learning theory contributes another important understanding to the innovation-diffusion process. Rogers (1983) argues that the main idea of social learning theory is that individuals learn from one another through observational modelling; where one observes what another person does and then proceeds to do something similar. This indicates that besides verbal communication in diffusing innovations, non-verbal communication is important in behaviour change.

The process of innovation adoption is as a result of the development and dissemination of appropriate innovations. If innovations are developed based on the needs of the end users, the likelihood of them being adopted will be high. Based on the literature reviewed here on innovation adoption, in-depth analysis can be made of the factors affecting innovation development in the study area based on primary data gathered. This literature will also help in analysing why women, the main focus of this study, adopt new innovations and how they influence adoption among their peers.

4. Results

4.1. Cowpea Production

It is useful to begin my discussion by outlining the production of cowpea in the study area. This section describes briefly how cowpea is planted, cultivated, cropped and dried. It argues that improved and newly developed cowpea innovations are widely used and serve as yardstick for increased cowpea cultivation and a higher standard of living. Improved cowpea innovations mainly target cowpea insects and diseases during the lifetime of the plant and enhance the effectiveness of storage. Such developments come in the form of improved seed varieties, more effective planting regimes, improved pesticides and better post-harvest techniques.

Cowpea production has a long history in Ghana, but since the late 1980s, the use of local varieties has been in decline. In contrast, improved cowpea varieties that have been developed to mature more rapidly, improve yield, taste and resistance to pests have expanded (PEDUNE 2000). Farmers from Tamalbila reported that improved cowpea varieties boast a higher quality than local varieties, but at the same time they are more expensive to buy and cultivate. The higher cost, however does not appear to deter farmers from their cultivation as the usually higher income derived from their sale is worth the time and effort involved in cultivation. Due to the importance of cowpea in Ghanaian diets there is a ready market for the crop especially in the south where cowpea production has almost ceased (Langyintuo et al 2000a). The need to dry cowpea grain or seed properly before storage and the fact that cowpea grows well in semi-arid regions, accounts for its lower popularity among southern farmers (Langyintuo et al 2000a). Again, as the incidence of pest and diseases increases in the southern zone, the crop moved north. The succulent cowpea leaves are not left to waste: they are eaten as green leafy vegetables cooked into soup and then eaten with a maize meal, though not extensively. The pods are also eaten just before they dry and turn yellowish.

Focus Group Discussions with the farmers in the three villages indicated that only a few cultivate the local varieties, to ensure that they do not disappear, because of characteristics such as the taste, appearance and the unique taste of the leaves which is used for soup. The cultivation of local varieties also demands the use of local innovations such as mixed cropping or intercropped as defined by Mortimore et al (1997), as the growing of two or more crops simultaneously on the same field , as shown in Figure 1 below. Mixed cropping is also one method of controlling pest and diseases especially in cowpea (Fatokun et al 2002). The local cowpea crop spreads on the ground and is mostly intercropped with maize, sorghum, or millet. .

Some of the improved cowpea varieties are quick to develop, maturing within two months so that increased yields are a distinct possibility unlike local varieties, they can be planted twice in the rainy season. These are some of the explanations given in the study villages for the popularity of improved cowpea varieties.

For improved cowpea varieties planting in rows and sole planting without intercropping, as shown in Figure 1 below, results in significant improvements in yield. When crops are planted in rows it is easier to manage because it reduces pests' thresholds in the fields and subsequently on the grain after harvests. When the crop is widely spaced (as required) the plant bears more grain/seed than when crowded on the fields because it is easy to weed and the plants have more space to spread out thus resulting in good yields. As a consequence planting new varieties of cowpea in rows is now a common practice. The Savanna Agricultural Research Institute (SARI) and the Ministry of Food and Agriculture (MOFA) transferred these practices to farmers about three decades ago and the practice is still in use and transferred among farmers. The sharing of knowledge on planting in rows was confirmed to be a common practice among farmers in all three villages studied.

The strong demand for cowpea in Ghana accounts for its popularity among farmers who continue to cultivate cowpea extensively. The willingness to change varieties and production methods can also be attributed to the increased demand for cowpea in the south of Ghana; pushing up production while tackling pest and disease problems. Abdul, a-50-year-old male farmer and household head from Kpasa explained,

'The high demand for cowpea has made many farmers adopt new cowpea farming innovations like planting in rows and the use of IPM innovations in controlling pest and diseases. I have taught so many people how to plant in rows and now I am a professor in teaching this method of planting'.

When asked why the change in attitude, he continued,

'People are simply realizing that technological advancement is good and will improve their lives. We have seen the difference in terms of yield and insect infestation. Before the implementation of the IPM programme, an innovation, average harvest per farmer was two bags but because of the innovation it is now about three bags per farmer.'

For Abdul there was a 50 per cent increase in production and this explains why most farmers are eager to adopt new and improved innovations. It also means that activities, which have taken place within the cowpea development programme, have resulted in an expected outcome.

Figure 1: Improved cowpea plants with fresh pods taken from SARI's Demonstrations Fields
Source: Field Data

Figure 2: Cowpea/Maize Intercrop
Source: IITA Image Library

4.2. Pest Control in Cowpea

Disease and pest control is a vital issue to consider in cowpea production, and a number of control methods are used. For 56 of the farmers interviewed, two main innovations were used to control cowpea field disease and pests: chemical pesticides and neem *(AzadirachtaIndica)* solutions. It was reported by respondents that both neem and chemical pesticides sprays are used on improved varieties of cowpea. Farmers thought that there was no need to use neem and chemical pesticides sprays on local cowpea varieties because these had not been used in the past. *Karate*™ was the most common chemical pesticides used for pest control. In a group discussions with five women from Tamalbila it was noted that some chemical pesticides (especially Karate™) are prohibitively expensive and thus beyond the reach of the average farmer, so in these cases most of the farmers resort to the use of neem solution combined with a chemical pesticide to reduce cost. However, it should be noted that *Karate* is a chemical pesticide that is used for cocoa production, and has over the years been subsidised because of the importance of cocoa to the Ghanaian economy (Konam et al 2011; Ayenor et al 2007; Pan International 1997). *Karate* is now used for pest control in other crops, including maize, and my study reveals that this is now spreading to cowpea.

The importance of using neem extract as a pest control innovation was clear from my fieldwork. Out of the 60 respondents, 57 of them described the process of neem solution preparation, where they explained that to prepare the neem solution for spraying on cowpea plants, women and children first pound neem seed/leaves with soap, and then mix them with water and are finally sieved. The neem and soap mixture is then left over night before spraying on the cowpea plant using a 'knapsack' sprayer. A 'knapsack' is a spraying machine consisting of a tank, a pressuring device, line and nozzle, and is used in spraying anti-insect chemical pesticides on plants. Approximately four sprays at different intervals is the common practice: a first spray takes place two weeks after planting, and is followed by other sprays at flowering and podding. There was some evidence that the use of neem seed solution is an effective way of controlling cowpea field and storage pests when sprayed or used consistently and frequently, as is often the practice. It was agreed during the group discussions (a group of five men from Tamalbila) that when neem solution is sprayed frequently and monitored, especially at crucial stages of plant development, yield levels could more than double. There is therefore the need to encourage the use of these practices in cowpea production.

Abatania et al. (1999) found neem to be of most benefit to the FFS participants while Nathaniels et al. (2003), in a study of the impact of cowpea FFSs in Benin found that farmers lacked interest in practices other than Neem. There was the indication, gleaned from the interviews, that neem seeds are more effective than neem leaves. Interestingly, many of my respondents felt that neem seeds are more effective than neem leaves as a method of pest control, although it is easier to access and prepare the leaves than the seeds. Neem seeds are not readily available all year round because the neem tree bears fruits only once a year during the dry season, between the months of November and March. As a result, the farmers prepare the neem extract combining the leaves and seeds, and this eases the burden of labour required in its preparation. As Amidu, a-29-year old male from Kpasa, reported, ‘because neem seeds are seasonal and scarce we use neem leaves but sometimes mix the leaves together with the seed’.

Prompt harvest minimises the incidence of insect pest infestation, and helps to boost yields. It was reported that harvesting is undertaken by hand and is mostly the work of women and children. The farmers further explained that drying of the pods after harvest is undertaken mainly on the bare floor of compounds. This is done on a daily basis until the pods are well dried and then the dryness of the pods is confirmed by cracking open a few pods and inspecting them. Cowpea is then threshed by women using a pestle and mortar and pounded until the pods have all cracked opened. Another method of threshing the cowpea is to place them in a sack and thresh it with a sizeable stick until all the pods are cracked opened and the seed/grain is separated from the pods. The grain is then separated from the chaff or husk by tossing it in the air using two pans or two big calabashes, before winnows the threshed cowpea. Winnowing is the process of separating the chaff from the grain by mean of air. When this is done the grain is then dried again on the bare floor or, in some instances, by the improved solarisation method.

This method of drying cowpea seed or grain kills the insect pest and pupae. The improved solarisation method of drying cowpea is an IPM technique which involves the use of local and improved drying innovations. Improved solarisation involves the use of white and black polyethylene sheets and rice straw. Rice straw is spread either on the bare floor or cemented floor and covered with a white polyethylene sheet. Cowpea grain or seed is then spread on it and covered with a black polyethylene sheet. The use of the black polyethylene sheet attracts heat to the peas, while the white sheet works to maintain the heat over a period of four to six hours. Cowpea grain are left to dry or mixed around from time to time depending on whether or not the farmer have other activities to undertake. The dried cowpea is then stored using different methods; local and improved. Thus effective cowpea production is vital for the household.

4.3. The Farmer Field School

Many cowpea innovations have been developed through the cowpea FFS. Cowpea innovations have undergone a generation of cumulative thought and action. These practices were efficient but with time have been developed and improved upon to suit the changing environment and increasing scientific knowledge. The FFS concept began as a creative reaction to the misuse of insecticides in rice irrigation schemes in Asia in the wake of the Green Revolution. A range of IPM extension approaches were developed and tested to tackle the problem, and the FFS concept began in Indonesia on a small scale in 1989–90 and was then developed (Roling and van de Fliert, 1994; Kenmore, 1996). The FFS has now been extended to other crops like cowpea, tomatoes, sorghum, yam and cassava (LEISA, 2003)

Due to cowpea’s volatile nature, cowpea innovations have undergone considerable development over time (PEDUNE 2000; Fatokun et al 2002). These developments, once undertaken keenly by the rural farmers in the past, have now received immense contributions from the three agricultural development agencies to help transform cowpea-cropping regimes. To manage cowpea pests through new innovations, farmers use chemical pesticides intensively sprayed on crops and applied on grain and seed for storage. The cowpea FFS was developed in the northern region of Ghana and based on an understanding that storage of crops is problematic if pests are not controlled in the field. As a result, effective pest control begins with controlling field pests and crop diseases. However, the FFS addresses all production and storage problems of the cowpea growing cycle (PEDUNE 2000).

Informants of this study detailed that the cowpea FFS is therefore concerned with teaching farmers to manage both field and storage pest and crop diseases. In a broader perspective, FFS focuses on the field as a classroom where farmers learn by observation, reflection and experimentation. Reports gathered from the two study area on the cowpea FFS indicated that, operationally, the cowpea FFS are organized in a season-long cycles of weekly meetings focusing on environmental science, agronomic and management topics, where farmers carry out agro-ecosystem analysis (AESA), identify problems and then design to carry out and interpret field experiments using IPM to non-IPM comparisons. Furthermore farmers are taken through the processes of the IPM innovations systematically, enabling them to ‘own’ the learning process and thus place a high value on their experiences, the new knowledge acquired, and their own knowledge. Moses, a-47-year-old male household head from Tamalbila, reported that, the IPM FFS experience allows farmers to make observations, comparisons and interpretations on the best methods to crop cowpea, both in the field and during storage. Again he made mention that the FSS were carried out on a common plot near the participating villages to allow for joint decision-making and exploration.

Farmers recalled, during the fieldwork, that during FFS they were placed into groups of about 20 to 30 to learn and explore cowpea IPM innovations facilitated by SARI and MOFA workers. The main purpose of the FFS was to support farmers to analyse the state of their crop in the fields and to raise awareness of disease and pest infestation. One of the ways to achieve this was through demonstration, and during the FFS, an experimental field would be divided into three plots: one utilising the IPM innovations, a second involving the usual cultivation methods undertaken in the villages, and a further plot managed with only botanicals[1]. The second plot was usually referred to as the 'farmer's practice field'. The farmers and the facilitators would then discuss and analyse the results of findings on the field and draw conclusions on and how to manage the IPM plot and that of the botanicals. The farmer's own practice fields were then managed as they would on their own farms.

Farmers reported that, during the FFS, they were taught how to scout for pest damage and disease, how to prepare and extract neem for spraying, using the insect threshold concept to determine when to spray neem and or chemical pesticides, and differentiating between natural enemies or insects and pest insects. Amuni, a-40-year-old male farmer from Tamalbila reported that the insect threshold concept is where farmers scout cowpea fields to determine whether or not to spray insecticide based on the level of insect infestation and the presence of biological insects[2]. Farmers from Kpasa reported that the FFS seeks to enable farmers to continue to expand their knowledge and to help others learn the IPM practices. This they referred to as the farmer-to-farmer training, where farmers who have had training on cowpea IPM innovations train colleague farmers on how to use those innovations. During the course of my research it was established that farmer-to-farmer training has been undertaken by approximately 75 percent of community members and in all three villages various IPM innovations, such as neem and double bagging, were in use. The farmer-to-farmer training has been reported to extend to other farmers in nearby villages that did not receive training through the FFS on the cowpea IPM innovations. The farmer-farmer training was said to enhance the spread and adoption of agricultural innovations.

4.4. The Innovations

An important aspect of the cowpea FFS is the use of improved cowpea varieties. During fieldwork farmers spoke of how they had adopted and now use improved cowpea varieties to help improve on both yields and the quality of grain produced. From reports gathered from the two main study areas, varieties that farmers adopt through the cowpea FFS included Vallenga, Blackeye, Browneye, Milo and Bengpla. These varieties had been developed and released by SARI and then disseminated to farmers through the MOFA (PEDUNE 2000). Several farmers told me they distributed the improved seed varieties to fellow farmers, further aiding their dissemination. The majority of farmers who cultivated improved varieties told me that they did not crop any of the local varieties; as mentioned, the exceptions were two farmers from Kpasa and four from Tamalbila. Their reasons for sticking to the cultivation of the local varieties were that they preferred the taste and their desire to keep old traditions alive.

Generally, my research established that there is a substantial knowledge of field and post-harvest cowpea pests and their methods of control in Tamalbila and Kpasa. My fieldwork also revealed that farmers use many pest control methods. Forty-three of the farmers claimed that tree barks, roots and leaves from plants other than neem were very effective; however they also pointed to problems with their continued use. One such event, according to male informants in Kpasa, is bush fires, which diminish the natural wild vegetation sources. They further argued that this is why bush fires are problematic for pest controls. Both male and female farmers from Tamalbila argued that increasing numbers of people farming are also leading to deforestation; there is growing pressure on farmlands, which makes it difficult for farmers to use botanicals other than neem. Respondents from the two main study areas asserted that, due to lack of access to some local botanicals, farmers' preferences have shifted towards new or improved innovation. As a consequence, they now use chemical pesticides rather than have to walk long distances to the forest in search of increasingly non-existent or difficult to find tree roots. This was confirmed in a discussion with a group of five farmers from Tamalbila, who again pointed out that bush fires have made some botanicals almost non-existent or increasingly difficult to find. Neem trees were said to be an exception to these difficulties described, because they are a recent introduction rather than a local wild plant, and have been planted within the cultivated and populated areas so can be cared for.

For botanicals, it was reported that their effectiveness was related to the strength of their odour and/or their bitterness, but their use has additional implications for the quality of the final produce. The stronger each of these (odour or taste) is, then the more repellent they are to pests. This explains why neem and chemical pesticide are used as protective measures against cowpea insects. The five-farmer discussion group explained that, to combat cowpea pests, the materials used (tree barks, chemical pesticides, roots, leaves etc) must be bitter, have a bad smell or be oily, characteristics thought to ward off insects. I must emphasise that these 'smelly' botanicals do have an effect on the taste of cowpea grain when used during grain storage. My findings suggest they are mostly used on cowpea seeds and not the final cropped peas. However, pepper and shea butter used for pest protection during storage of cowpea do not affect the taste of cowpea because, in fact, they are some of the ingredients used in cooking cowpea. This is evident where Adamu a 57-year-old farmer, trader, widow, group leader and household head said,

'We use the botanicals for seed but with the grain which is meant for consumption and/or for sale, we use pepper, shea butter oil, or heat the cowpea at moderate temperatures to kill the larvae. We cannot use the botanicals on the grain because it changes the taste of the cowpea when cooked. However, in the process of cooking cowpea, shea butter oil and pepper are some of the ingredients we use.'

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[1]A substance obtained from a plant and used on its own or as an additive in controlling field and storage pest and diseases.

[2]Biological insects are insects that hunt, capture, and consume insect pest in fields or at storage. They are harmless to people, animals, plants and farm produce.

Neem seed and leaves are among the popular materials used in cowpea production. Neem originated from Asia and planted in Africa and in the study area in and around the household compound. My study indicated that the FFS, where the use of neem was demonstrated to the farmers, taught them how to use neem leaves or seed, as in Figure 1 and 1.2 below, or neem oil to control field and storage pests. However, some of the respondents in my study discussed developing different ways of using neem leaves to store cowpea grain that could be used for consumption. Thus researchers developing an innovation should not only consider channels through which information on the new innovation will be easily digested by end users, to avoid rejection of the innovation, but also how farmers may undertake to modify it. As Awuni, a 62-year-old male household head, explained,

'I use neem seed and leaves to store cowpea seeds/grain. With the grain I use only the neem leaves. I dry the leaves, pound them and mix with the grain for storage. When I want to cook I have to winnow the neem out and wash very well before cooking. This has worked for me and I do not have to buy the neem as we have lots of them in this community.'

The use of neem has flourished in the study area, despite the fact that chemical pesticides are also commonly used. Indeed, most of the respondents who reported that they had never used neem spoke of plans to use it in the near future. Fifty of the respondent agreed that neem is easily accessible, has no additional cost to farmers, is effective and environmentally friendly. As compared to ten years ago, neem trees have now sprung up in most of the communities, where their shade is also used as resting places for farmers after a hard day's work or during the off season. Neem branches are further used as roof racks, for gardening and as firewood. Neem has worked for the farmers as a botanical particularly well and has been available to them at little or no monetary cost.

Figure 3: Neem Tree
Source: Natural Environmental Ecological Management

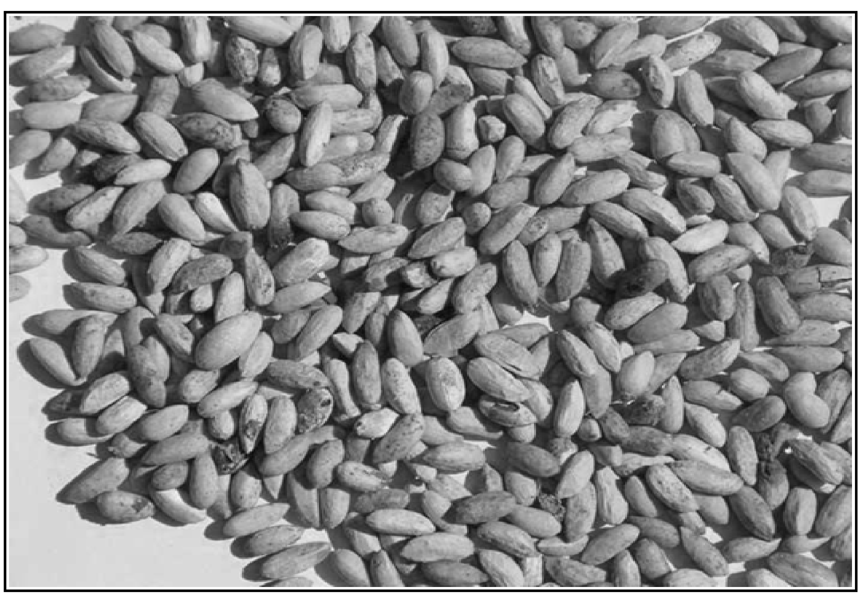

Figure 4: Neem Seed
Source: Taj Agro International

4.5. The Storage

Storage is a crucial part of the cowpea FFS. Where farmers have no means to store cowpea particularly well they become less motivated to implement the IPM innovations because at the time they are supposed to market it for profit they might not have it in storage due to insect infestation. Thus, good cowpea storage depends on the methods used. In the past, cowpea could be stored until needed for planting or consumption and there was no insect infestation as in Figure 3, but more recently cowpea must be particularly stored well to stay in storage for long. Cowpea storage has become more and more complicated as shown in Figure 4. This is because of improper use of storage chemical pesticides as indicated by most of the respondents from the two main study areas. This has brought about technological change to meet the growing storage demands. Azabu, a-42-year old male farmer from Kpasa commented,

'In the past technological innovation was done through trial and error. Though we now seek assistance from the MOFA, we still do trial and error using our own innovations and also experimenting on the innovations that we adopt from MOFA.'

This is an indication of the role of MOFA in innovation dissemination and in keeping farmers informed and up to date about alternatives.

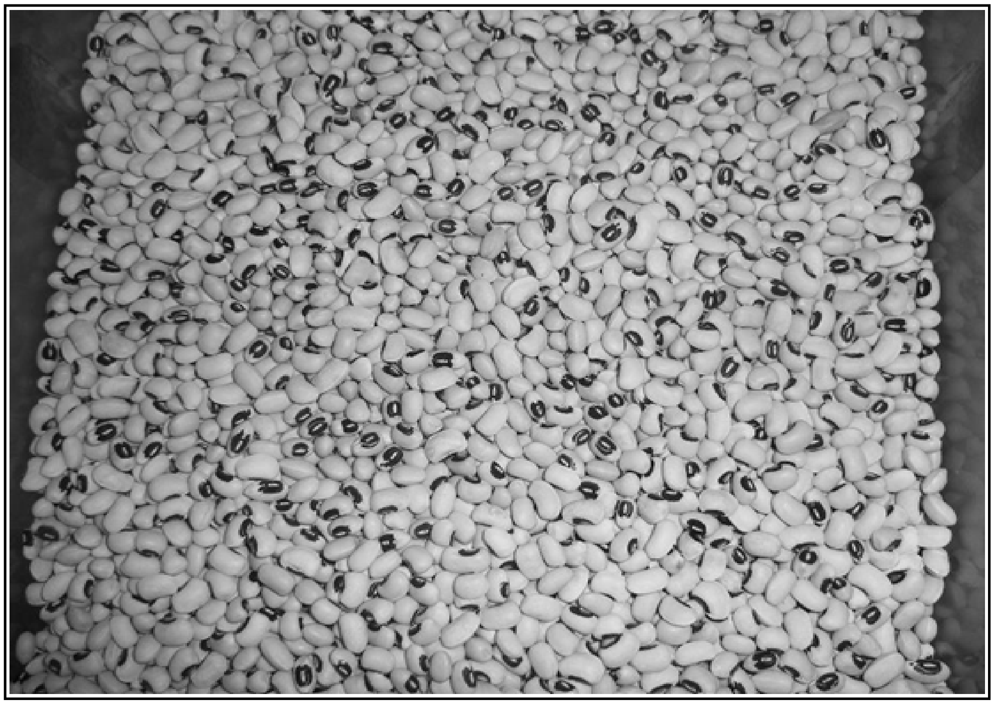

Figure 5: Treated cowpea grain
Source: Field Observation

Figure 6: Weevil or bruchid damage in cowpea
Source: Field Observation

4.6. The Adoption

In terms of other techniques, 12 of the respondents, four from Tamalbila and eight from Kpasa, are using the improved solarisation technique. In the case of cowpea bruchid/weevils, where cowpea is exposed to high temperatures of about 50 degrees Celsius for an hour, all the life stages of the insect pest are killed: eggs, larvae, pupa and adults. To achieve such temperatures, improved solarisation to dry seed and grain was thought to be effective, despite the fact that some farmers found it less cost effective because of the high cost of polyethylene sheets. For instance, Azabu, a-42-year-old male household head from Kpasa, said 'I use improved solarisation which is very efficient, however the polyethylene sheets are expensive to buy and just a few of us can purchase them'. There was widespread indication that the cost element was a very important issue for the farmers because one sheet cost about 25[3] Ghana pesewas. A farmer may need more than 10 black sheets and 10 white sheets to work with, and they may last just two years. As much as they desire an innovation which is seen as effective, cost is still a very important consideration. It is obvious from the statement made by Azabu that during the innovation transfer process, farmers may not have critically examined issues of concern to them but as they begin to practice the innovation, the practicalities of these issues begin to dawn on them.

Improved solarisation is used together with double bagging for effective storage of cowpea grain and seeds. Double bagging is a method of storing cowpea where two bags, a jute sack lined with a polyethylene sack. The ends of both bags are tightly sealed to make them airtight. Zakali, a-56-year-old household head argued that double bagging prevents larvae and insects from breathing so that they subsequently die. Indeed, it was found that 57 out of the 60 farmers use double bagging together with application of chemical pesticides for the storage of cowpea and maize. For example, Martha, a-36-year-old female farmer, uses the normal solar drying, chemical pesticides and double bagging for storing maize and cowpea. She is one among many of the respondents who used this combination of innovations. All the respondents said the normal solar drying was a common practice among the community members in the study areas. In the past years scientist and policy makers held the view that local farmers were resistant and reluctant to implement change. The truth, however, is that most of these farmers are peasant farmers and generally poor so any innovation which is costly will be treated with caution. The widespread practice of solar drying in spite of the availability of efficient alternatives is an indication that these under-resourced poor farmers want cheap and effective innovations for farm and storage activities.

An innovation that has proved to be efficient and valued is the 'Kunchuna', an improved barn, as shown in Figure 5 below. These were not built as part of the FFS programme but during an innovation diffusion programme, which proved relatively popular, in 2005 (in Tamalbila).The improved barns have been constructed to look like those used in the past, built of mud to provide rigid and impressive barriers against storage insects and pest, and they now play an important role in cowpea storage. Sanatu, a-40-year-old female from Tamalbila said,

'We store in bags and improved barns which were recently built for us. It was an innovation, which was transferred to us so we learnt how to build them. These are known as "Kunchuna". They are built of mud and in the form of a local storage barn.'

This shows that people will adopt innovations that are closely related to innovations already in use or which had been in use previously. These improved barns were found only in Tamalbila. Farmers in Kpasa who did not know about these improved barns used mainly jute sacks for storage. Farmers from Tamalbila had not started transferring the innovation beyond their community and this is clear from an interview with Tampuri, a-54-year-old male household head from Tamalbila who said,

'Opportunities Industrialisation Centre (OIC[4]) told us to wait for them to return so we can continue to learn how to build more barns. So we are still waiting for them. If they return we can start teaching others outside this community.'

This shows that there was the understanding that OIC will return. Discussions with OIC indicated that they had in fact asked the farmers to keep building local barns and to transfer the innovation to other farmers. Mr. Abraham of OIC said,

'OIC trained a master builder who then trained five farmers each from 150 communities in the northern region and about 3450 improved barns have been built over 5 years. The training was done as an income generating activity where the builders were to charge an amount of 30 GHS[5]. However, they were also obliged to train other farmers the innovation for a fee or based on their own agreement.'

From the discussions with Mr. Abraham, it seemed that farmers from Tamalbila are refusing to transfer to other communities due to financial reasons, but farmers were reluctant to discuss these issues further. They might not have reached any meaningful conclusion on the terms and conditions for the training or transfer of the innovation. This is an indication of a barrier of innovation transfer where financial agreement is a problem. Farmers from nearby communities might also think that the training was done for free and so expect it to be transferred to them for free. Assuming that they misunderstood OIC's instructions, it seems reasonable to conclude that there was lack of effective communication between farmers and development workers and this caused uncertainty as to whether or not to go ahead with transferring the innovation. Abuba, a-70-year-old household head from Tamalbila, captures this ambiguity in his statement,

'We were told that they will come back to teach other people but they have not yet come back. We have waited for three years and are still waiting. Some people know how to build them but they are very few and will not want to waste so much time teaching other people how to build them.'

This illustrates that farmers, when capable, may transfer knowledge not only to members of their community but to members of other communities.

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[3] For current purposes £1=Ghana cedis 4.7 (GHS 1=100 Ghana pesewas)

[4] Opportunities Industrialization Centre (OIC) is a non-profit organization that trains rural farmers; women, men and youth, in skills they need to transform their lives and their communities.

[5] GHS= Ghana Cedis

Figure 7: An improved storage barn (Kunchuna)
Source: Field Observation

Improved barns have become vital in Tamalbila. It became clear from observation and discussion during the fieldwork that, trained on how to build them by OIC, in fact 95 percent of households had built them for storage of their farm produce (in contrast to Abuba's claim above). All the 30 farmers I interviewed at Tamalbila agreed that the improved barns were very efficient, and so some had more than one in their compounds. The improved barns have therefore replaced the use of jute sacks, which were previously the main form of storage. The improved barns had a roof on top to protect the seed/grain from rain and harsh weather. Below is a Table showing the types of innovations that were and still are in use in all the study villages. It also shows whether or not an innovation is locally innovated or an improved innovation. Table 1.2 therefore summarises the discussions in the previous section.

Name of Innovation	Type of Innovation	Old	Most Recently Used/Improved
Neem (seed, leaves, bark or oil)	Improved		√
Improved solarisation	Improved		√
Sheabutter oil/residue	Local	√	
Local Botanicals	Local	√	
Chemical Pesticides	Improved		√
Double bagging	Improved		√
Normal drying	Local	√	
Jute sacks	Improved		√
Kunchuna (Improved barns)	Improved		√

Table 2: List of Improved and Local Innovations for Cowpea ever used or in use by Participants
Source: Field Data from Tamalbilla and Kpasa

4.7. Preference for Improved Cowpea Innovations

Farmers appear to be aware of the impact of insect pest losses, and have good perceptions of the degree of damage caused by both field and postharvest pest. The SARI and MOFA are also well aware of cowpea pest and diseases and have addressed it through research that has yielded results such as the release of new varieties, cropping regimes and the IPM innovations. These innovations, when implemented by farmers, can lead to the cultivation of healthy and quality cowpea grain as in Figure 5 above.

The effectiveness of an innovation is paramount and so farmers are selective in considering parts of innovations that are effective. When asked to list the factors that they will consider in adopting new methods of cultivating and controlling cowpea field and storage pests, 58 of the farmers said they would always consider the cost of materials, the time and the output. However, the farmers did not consider materials such as neem, which they did not have to buy. This was also agreed on in a discussion with a group of five women from Tamalbila.

For instance, improved solarisation is meant to be used with double/triple bagging but farmers are using chemical pesticides with double bagging, which means that they have made their own analysis before deciding on which innovation to use. Ababa, a-50-year-old farmer from Kpasa, uses 'normal drying, improved solarisation, chemical pesticides and double bagging'. He uses improved solarisation on smaller quantities of grain/seed as the costs of polyethylene sheets are more expensive than storage chemical pesticides. For instance a farmer may use about 12 GHS'worth of polyethylene sheets for two years whereas only about GHS 4.7 could buy chemical pesticides to store about 240Kg of cowpea. Farmers clearly thought through these costs and potential gains before deciding on what to invest in for improving cowpea storage and they adopt innovations based on their resources. For instance Martha said, 'improved solarisation is good but I cannot use it because it is expensive.'

Farmers in Kpasa argued that a small area of farmland could trigger preference for the way in which improved cowpea innovations are used. For example in the case of the use of neem as an insecticide, farmers cannot gather a lot of the seed and or leaves for large farms, nor will they have the time to process neem for over 5ha of cowpea. Thus farmers use either only chemical pesticides or small quantities of neem together with chemical pesticides.

The desire to use IPM or improved cowpea innovations depend on the size of one's farm said the farmers interviewed at Kpasa. They argued that where a farmer has a large farm he would have spent so much money ploughing, buying seeds and maintaining the farm that he might not be in a position to afford improved innovations. However, if the farm is not properly maintain through the use of improved innovations, the farmer will make losses and may not have the resources to cultivate such a farmland the following year. Whereas in Tamalbila the farmers argued that where a farmer has a small land for cowpea cultivation whether or not he uses improved strategies does matter to him, as he will not store cowpea harvested from such small fields. The two villages have similar perceptions about the use of cowpea innovations even though expressed in different ways.

The fact that farmers can acquire information on improved innovations makes them much easier to use. Though it is sometimes possible to acquire equally important information on local innovations, farmers indicated that they could easily practice improved innovations as they can source information when needed from any of the three agricultural development agencies. The acquisition of information on the use of an innovation therefore increases the confidence level of a farmer which may influence its use.

Chemical pesticides have increasingly been used to control field and storage pest of cowpea, since most of the farmers interviewed at Kpasa have often believed that chemical pesticide is the best way to ensure food sustainability all year round. However, it was also argued that field pest chemicals are more expensive than storage chemical pesticides. Chemical pesticides that farmers use for field pest and disease and post-harvest pest include *Dursban, Phostoxin, Sumithion, Karate, Actellic, CymethioteFenon C and Sumicombi. Actellic*is said to be used for field and storage pests, with *Phostoxin* used for only storage pests; the rest of the chemical pesticides identified by the farmers are used for field pests.

Chemical pesticides have been widely used in the study villages. All those interviewed were either using them at the time of interview (50 of the 60 interviewed at the two main study villages, or had used them in the past (57 of the 60, particularly for storage pests). However seven respondents, four from Tamalbila and three from Kpasa, had abandoned use of chemical pesticides because of their health implications.

In terms of chemical pesticides being hazardous to human lives, Agana, a 65-year-old male farmer, said; 'Chemical pesticides are hazardous to our health and most people have been poisoned as a result'.

Most of the farmers in the study area indicated that chemical pesticide use can be very effective but used to the detriment of the user. Dawuni, a-47-year-old male household head from Tamalbila said,

'We use improved solarisation, double bagging and chemical pesticides for cowpea storage. But chemical pesticides are mostly used. Storage chemical pesticides are mostly cost effective and efficient and can store cowpea for up to six months'.

'When chemical pesticides are used we store in jute sacks and poly bags [double bagging] with chemical pesticides which is placed in a warm and dry place' said Minu, a-35year-old male farmer from Kpasa.

Hazards caused by chemical pesticides are very common in rural communities in general, and in the villages under study. These chemical pesticides are available in dust or liquid based formulations that can easily cause food poisoning, but rural farmers continue to use them because they are seen as affordable and effective. Most farmers in rural areas of northern Ghana and in the study villages cannot read or write (UNFPA 1999 and UNICEF 2004), and so there is a greater probability of them misapplying them. Some farmers in the study area have some basic education, but Amadu a-20-year-old male student from Kpasa said farmers do not understand the written instructions on how to use the pesticides and most chemical pesticide traders can neither read nor write but do try to give out instructions on chemical pesticides use.

Furthermore, the evidence from interviews with farmers is that they buy chemical pesticides without being fully aware of what it is they are buying. Chemical pesticides use can pose several problems because they can be sold freely and with no restrictions,

'In the past there was nothing like the chemical pesticides, but now because of the use of chemical pesticides there is food poisoning here and there are people who do not understand the basics of using the chemical pesticides due to high illiteracy rates',

as Tampuri informed me. This is because Tampuri has had some formal education unlike most other community members.

From the fieldwork, it became clear that the motivation for the use of improved innovation for most farmers was its accessibility and ease of use. The use of chemical pesticides for field and storage pests was widely adopted because it was easy to use. Farmers only have to mix the chemical pesticides with water or they may use it as it is. This does not require much labour as they can use a knapsack to spray the chemical pesticides on the plants. However, the farmers noted also that the chemical pesticide used for cowpea storage is also available in the form of a tablet or powder which is concealed in plain cloth. This is buried in the grain and stored for as long as the chemical remains potent and does not require labour to implement. For example Tiana, a-55-year-old male farmer from Tamalbila said,

'It is easy to use chemical pesticide as we only need to mix it up and spray with our knapsacks or bury it in the grain. The fact that not so much labour is required made most farmers use it...'

The use of chemical pesticides against storage pests by cowpea sellers is also important to mention, for my observations in Tamale market indicated that chemical pesticides are widely used for storing the crops on sale. I observed cowpea sellers buy stocks from farmers who do not have the means to store their produce and from those who had immediate need for cash to solve their household financial issues. The cowpea sellers then store the cowpea and later sell to people such as the very same farmers who did not get good yields, who had earlier sold their farm produce to solve household problems, as well as buyers from urban communities. These grains almost have the risk of having chemicalresidues in them, because the retailer is often out to make profit. Sellers of cowpea are often not aware whether it is safe to sell/eat cowpea treated with chemical pesticides. According to Zakali, a-56-year-old farmer from Kpasa, 'a lot of people are using chemical pesticides and will sell at any time when they are in financial crises'. It was observed that chemical pesticides are also widely used by market wholesalers who buy from farmers to later resell. They buy and sell when there is the need to, without considering the length of time of storage before reselling to customers. According to Moses, a-47-year-old male household head from Tamalbila,

'Most people are now reluctant to store. They sell their produce off and buy again when needed, as it is difficult to store cowpea. But wonderfully enough, when cowpea is bought from the market, it is as clean as if it had just been threshed.'

Interviews with Sanatu, a-40-year-old female farmer from Tamalbila points to the fact that use of chemical pesticides on stored grain may also pose problems for other household members who might not know when the chemical pesticides was used on grain and will cook some to eat. This was found to be common in rural communities, when children in the absence of their mothers try to cook for themselves. She added that:

'There were very good storage innovations in the past but the materials are no longer available. In the past the natives used their own knowledge but now we use the white man's knowledge. We now use chemical pesticides, camphor and improved solar drying which has been efficient. The only problem is food poisoning. But with the introduction of the "Kunchuna" I can say that we are getting closer to the ultimate, which is insect free grain and seed. I can say that they are all good innovations if there were no chemical pesticides.'

Farmers in Tamalbila also mentioned that they prefer to adopt improved cowpea innovations due to the demand for improved cowpea varieties and for quality grain. For farmers who cultivate cowpea to sell, they must adopt improved cowpea innovations to make profit. Thus market forces determine what innovation a farmer prefers to use.

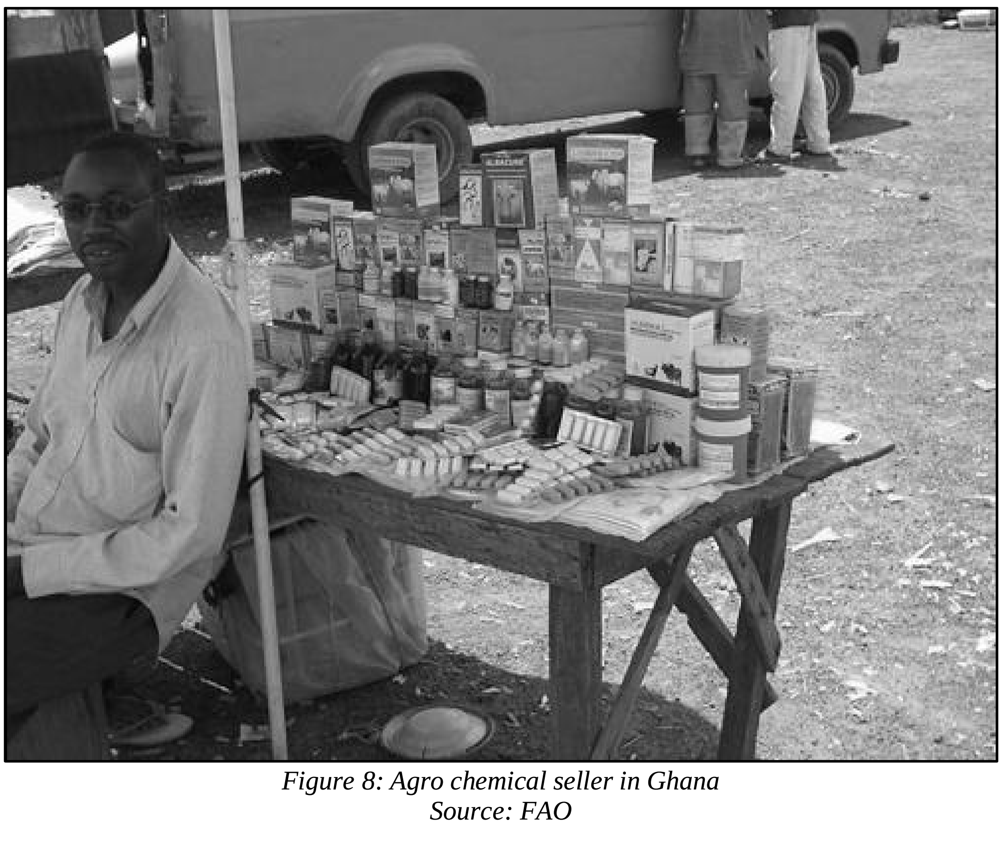

Figure 8: Agro chemical seller in Ghana
Source: FAO

5. Discussions

5.1. The Extent of the Adoption of New Innovations with Reference to Cowpea IPM Innovations

This section discusses findings on the adoption of innovations with reference to the cowpea IPM innovations and the FFS. The findings indicated that there are numerous cowpea IPM innovations in use in the study area but these varied in prominence. The innovations in use include neem, chemicals pesticides, double bagging and the use of improved silos. Double bagging, neem and chemical pesticides were the most commonly used innovations and were widely used in the two main study areas. Improved silo innovations were found in almost every compound, but only in Tamalbila. In contrast, improved solarisation was the least used among the available innovations. Interestingly, chemical pesticide use was considered by most of the famers as hazardous. The secondary literature indicates that the FFS was developed to promote IPM where harmful chemicals are used (Kenmore 1996) and that Ghana was the first place the FFS was used in Sub-Saharan Africa (Simpson and Owens 2002; Sones, Duveskog and Minjauw 2003).

There were also indications from the research findings that improved innovations are most often adopted where they are effective and cost efficient. The data indicated that whether or not an innovation is regarded as an appropriate innovation depends upon the attitudes, cultural norms of the user and the cost of using the innovation. Where the cost of a 'new' agricultural innovation is higher than the 'old' innovation, most farmers will often prefer to continue using the 'old' innovation. This supports Gedikoglu's (2010) assertion which suggests that, farmers are not encouraged to adopt innovations if the cost for its adoption is the same as the old one. This shows how important the cost of adopting an innovation is to farmers as they can make their own cost and benefit analysis between 'old' and 'new' innovations.

Again, much of the evidence indicated high rates of adoption for IPM innovations. This stemmed from the fact that the farmers were able to see the difference between innovation and their former practices, and so were able to make informed decisions as to whether or not to adopt and use an innovation. Perhaps more interesting is the fact that as a consequence of the success of IPM, farmers perceive improved or new innovations as key to achieving food availability all year round, with increases in both yields and crop quality. This pattern of behaviour is noted by Rogers who stated that farmers want or need to make informed decisions about adopting an innovation rather than simply accepting it because it is new or comes highly recommended (Rogers 1983). The fact that farmers repeatedly compared existing or 'old' innovation with 'new' supports the view of Rogers. Being able to notice differences between an 'old' innovation and a 'new' one shows that farmers go through stages of decision making before deciding to adopt a particular innovation.

It became obvious from the findings that for farmers to adopt an innovation, they look out for significant similarities between local and improved or new innovations. However, Date-Bah (1985) argues that in spite of high technical efficiency, an improved innovation can be rejected on the grounds of social and economic factors and not just resemblance to what was used previously. The research found out that improved solarisation bears some resemblance to the local drying techniques, often undertaken on bare floors. Meanwhile, improved solarisation is not highly adopted due to economic reasons. For the farmers, the prospect of buying polyethylene sheets reduces adoption rates of this cowpea IPM innovation: improved solarisation.

5.2. Contribution to Knowledge of Innovation Adoption and Diffusion among Poor Farmers

This section details what I regard to be the substantial and innovative contribution this paper has made to knowledge and thinking in my area of research on innovation development, adoption and transfer and gender in the agricultural sector. Concerted efforts are required to use fully the strengths and diversity of the rural people and their institutions to manage innovatively the risks and challenges associated with rapid changes in the agricultural sector. The findings from my research, I argue, can form part of the efforts required by contributing to debate and good practice in this area.

My study demonstrates (1) the significant gain to be made by the use of Farmer Field Schools (FFS) based on learning through experience and practice in Northern Ghana, and (2) the significant role of FFS graduates in knowledge dissemination, regardless of the lack of formal education and limited literacy skills amongst women participants.

This study demonstrates the possibility that women and men may share an interest in the same technology thus questioning what might be referred to as gender orthodoxy. As a result this study challenges the view of women and men as having different/separate needs and interests. In the cases I have investigated IPM for cowpea produced cash income that was of value to both male and female farmers.

The study also portrays the value of inter-agency cooperation both for achieving programme and policy objectives, but also for agency learning. Interestingly, none of the three agencies were what are conventionally regarded as private sector agencies. Private sector agencies are viewed by many development stakeholders as the only way to achieve efficiency improvements. Inter-agency cooperation - even inter-departmental cooperation is seen as different: Agencies and departments compete for funding rather than cooperate. This particular agency mix was especially valuable for embedding gender policies in programmes. Orthodox gender mainstreaming has failed in many agencies yet with collaboration between agencies with different skills, gender objectives can be achieved.

Theoretically, Rogers (1983) argues earlier adopters are no different from late adopters in age. In another study, Nnanyelugo et al (1997) and Inaizumi et al (1997) argue that, in contrast, there is a positive and significant association between age, farming experience, training received, socio-economic status, cropping intensity, aspiration, economic motivation, innovativeness, information source utilization, information source, agent credibility and adoption. In my study, women and men were found to adopt innovations but the influence of gender was in the rate at which the process of adoption takes place. Hence women were more willing to adopt improved innovations than their male counterparts, whereas the youth were more likely to adopt new innovations than older farmers. Thus age was found to have an impact on adoption rates for men but not for women. The suggestion, which became evident in the research, was that unlike men, women at whatever age appeared to be willing participants of an innovation dissemination programmes.

A further important contribution to this study is that collaboration is extremely important to innovation development and transfer. For instance, where the three agricultural development agencies come together to develop and transfer innovations, the mustering together of their varied expertise helps them undertake their activities in much more effective ways, as each agency can bring its own particular expertise in innovation development and transfer together with that of the other agencies. For instance, my study established that

SARI is very good in developing agricultural innovations for use in the field, while WVG and MOFA possess greater expertise in transferring these innovations and in addressing the barriers to their adoption stemming from gendered norms and values in the receiving communities.

A further key contribution of this research is that it is better for female farmers to work with female extension agents. I have argued that the use of female extension agents will enhance significantly the processes of innovation transfer to women who are actively involved in agricultural production. Interestingly, this contributes to a well-argued case - again questioning gender orthodoxy - although it does significantly compound the difficulties. Indeed, it became clear from the research that an increasing number of women have been participating in agricultural development programmes in recent years, despite the fact that most extension workers continue to be male. The agencies have tried to work around the lack of female extension workers by separating the male from the female farmers, and then transferring innovations to them through these separate groupings. However, with the more extensive recruitment and use of female agricultural extension workers the involvement of women farmers in innovation development and diffusion would be greatly enhanced.

The research also demonstrates that to ensure a fuller participation and adoption of agricultural innovation, there needs to be a bottom-up approach to diffusion programmes where participants are encouraged to use their knowledge and imagination during the diffusion programme. This also helps to encourage commitment to innovation adoption through grassroots participation. However, results from the study suggest that diffusion programmes, although participatory, fail to utilise to the full the rich local knowledge of farmers. There is the need to first of all understand the local knowledge of farmers and become fully aware of the important role local knowledge can play in agricultural development.

The research also demonstrated the interest of most farmers in the use of improved cowpea innovations; they can see their practical value and are keen to benefit from their higher yields and better grain quality. Having higher yields and improved grain quality means higher incomes and better nutrition. Seeing the practical benefits of innovations provides a powerful demonstration of the benefits of adopting improved agricultural innovations. Again there was the indication that farmers prefer improved innovations because they are easy to use and to find so far as an individual can afford them. Most new agricultural innovations in the study area are affordable and information on their use is also readily accessible at MOFA or SARI, the government research and development agencies.

Besides ensuring that new innovations have some direct connection with the use of older ones, sensitising farmers on the importance of an innovation also works. My research has found that the use of IPM developed from the misuse of chemical pesticides. Importantly, since the IPM FFS the incidence of the misuse of chemicals has been reduced considerably and my study indicates that chemical use on cowpea grain has been reduced due to the growing awareness of its health implication for the farmers and their communities in addition to cost savings by understanding more about the conditions under which spraying is/is not necessary or efficient. This awareness has been possible due to the efforts of the three agricultural development agencies in sensitising farmers on the dangers of the misuse of chemical pesticides, so that they are now used mostly on the field and on cowpea grain. A large proportion of the farmers reported that they had abandoned the use of chemicals on cowpea grain altogether. This shows that where new ideas are persistently demonstrated and their effects are clear to see, farmers are more likely to adopt them.

Despite the involvement of women in agricultural development programmes, improved innovation is mostly at the disposal of men in these locations in Northern Ghana. So it is important that innovations that are transferred to farmers to suit female farmers. The study indicated that where innovations that are difficult to manage by women are transferred, it hinders their participation since it does not address the concern or need of these women. Thus it is the role of the three agricultural development agencies to formulate carefully and implement the innovation transfer process, having in mind its impact on female as well as male farmers in farming communities.

The findings from this research support the view that women should be targeted as they tend to be fast adopters and can also spread innovations more effectively than men. Women often transfer innovation in their everyday situations and through their routine practices, such as when in the home, on public transport, at funerals, on the farm and at the market. For women to adopt, use and transfer innovation, both men and women should be made to understand that there is the need to include women in innovation diffusion programmes. This is because women are those who undertake most of the farm and postharvest activities, thus placing them in key positions when it comes to adopting and transferring innovation. Nevertheless women face significant gender-related constraints and difficulties when compared to men, because of the prevailing structures in rural households and societies. So ignoring gender inequalities comes at a great cost to the rural poor farmers and the society at large.

6. Conclusions and Recommendations

As a result of the high profile innovations in cowpea production, the use of improved cowpea varieties has now been a common practice among farmers. This has helped to improve on yield and quality of cowpea produced thus making the FFS a success. Technological innovation has indeed been improved in cowpea production. Improved cowpea innovations mainly target cowpea insects and diseases during the lifetime of the plant and enhance the effectiveness of storage. However, the variety of cowpea used is also of importance. For instance, the use of improved cowpea varieties that mature more rapidly, have an improved yield, taste better and are resistant to pests has expanded in the study areas. A 50 per cent increase in cowpea production with improved varieties explains why most farmers are eager to adopt new and improved innovations.

The popularity of improved cowpea varieties can thus be explained as a result of more effective planting regimes, improved pesticides and better post harvesting techniques. The local cowpea was devoid of these improvements because farmers wanted to maintain the local variety as it was to enable them make use of the leaves as leafy vegetable. Thus neem and chemical used on the local variety was non-existent. As such few farmers cultivate the local variety this goes to buttress the point that the improved cowpea varieties have a huge potential in the agricultural sector with more room to improve on the techniques used for its cultivation.

Disease and pest control is vital in cowpea production and chemical pesticides and neem *(AzadirachtaIndica)* solutions are mainly used in controlling cowpea pest and diseases especially in improved varieties in the two study areas. To effectively transfer new and improved innovations to farmers, the IPM FFS method was used. The IPM FFS therefore allowed farmers to make observations, comparisons and interpretations on the best methods to crop cowpea, both in the field and during storage. The farmer-to-farmer training of IPM techniques was also of importance in the processes of innovation transfer and adoption; where a lot more were trained in the IPM techniques by farmers who were involved in the FFS.

Storage was found to be a crucial part of cowpea production and the FFS. Farmers became less motivated to cultivate and to store cowpea for long where they have no means of a good storage technique. This is because at the time of marketing it for profit the grains, due to lack of good storage techniques would have been infested by insects. However, chemical pesticide is also a problem to deal with in cowpea production. Farmers find chemicals especially important in cowpea storage and so depend heavily on it without a better understanding of the instructions on the packages. In using chemical pesticides, it is important to understand the instructions for use as such chemicals could be dangerous to use without following instructions.

Most female farmers who were interviewed were also using the IPM techniques. They used different combinations of the IPM techniques to improve on cowpea production. The motivation for the use of these techniques for most farmers was its accessibility and ease of use and the demand for improved cowpea.

Cost has also been proven to play an important role in the type of technique commonly used. Integrated pest management techniques have proved to be very reliable and profitable techniques for farmers due to farmers' ability to vary the techniques. The use of double or triple bagging is most popular among farmers and has yielded many benefits in terms of grain preservation. In cowpea production, storage is very crucial as a farmer can lose close to 100 per cent of his harvest to storage pest, thus farmers take particular attention of storage techniques used. The most commonly used being double or triple bagging and storage chemicals.

7. References

i. Abatania, L., Atakori, D.O., Busagri, D., Custer, B.T., Campbell, B.K., Deluccy, J. and B. J. Van der Mey. (1999). 'Evaluation of Farmer Field Schools and Training of Trainers for Cowpea in Ghana: Preliminary Follow Up Findings and Implications.' Unpublished working document.

ii. Biggs, S. (1990). 'A multiple Source of Innovation Model of Agricultural Research and Technology Promotion.' World Development, 18(11): 1481-1499.

iii. Date-Bah, E. (1985). 'Technologies for Rural Women of Ghana: Role of Socio-Cultural Factors'. In Ahmed, I. (ed) Technology and Rural Women: Conceptual and Empirical Issues. London: George Allen and Unwin, 7:211-251.

iv. Fatokun, C. A., Tarawali, S. A., Singh, B. B., Kormawa, P. M. and M. T. Tamo (eds)(2002). 'Challenges and Opportunities for Enhancing Sustainable Cowpea Production' Proceedings of the World Cowpea Conference III held at the International Institute of tropical Agriculture (IITA), Ibadan, Nigeria, 2-8 September 2002. IITA, Ibadan, Nigeria.

v. Gedikoglu, H. (2010) 'Impact of Farm Size and Uncertainty on Technology Disadoption.' Selected Paper Prepared for Presentation at the Southern Agricultural Economics Association Annual Meeting. Orlando, FL.

vi. http://ageconsearch.umn.edu/bitstream/56431/2/Impact%20of%20Farm%20Size%20and%20Uncertainty%20on%20Technology%20Disadoption%20Main%20Text.pdf

vii. Accesses 20/07/2012

viii. Inaizumi, H., Singh, B. B., Sanginga, P. C., Manyong, V. M., Adesina, A. A. and S. Tarawali (1997). 'Adoption and Impact of Dry-Season Dual-Purpose Cowpea in the Semiarid Zone of Nigeria', Nigeria: IITA.

ix. Kenmore, P.E. 1996. 'Integrated Pest Management in Rice: Biotechnology and Integrated Pest Management'. Wallingford, UK: CAB International.

x. Langyintuo, A., Larry, M., Lowenberg-DeBoer, J., and Ntoukam, G. (2000a). 'The Market Value of Cowpea Characteristics in Cameroon and Ghana.' Paper presented at the World Cowpea Conference III. Ibadan: Nigeria, IITA.

xi. Langyintuo, A. S., Gyasi, K. O., Abatania, L. N. and P. Terbobri. (2000). 'Farmers Strategy for Sustainable Food Security: Determinants of the Adoption of Improved Rice Varieties in the Inland Valleys of Northern Ghana: A Tobit Model Application.' Bamako: SADAOC Foundation.

xii. Lawrence, P. G., Sanders, J. H. and S. Ramaswamy. (1999). 'The impact of agriculturaland household technologies on women: a conceptual and quantitative analysis in Burkina Faso'. Agricultural Economics, 20:203-214.

xiii. LEISA (2003). 'Learning with Farmer Field Schools.' Special Issue. LEISA Magazine, 19:1.

xiv. Lowenberg-DeBoer, J. (1998). 'Bean/Cowpea CRSP West Africa Economics Research.' Paper Presented at the PEDUNE/RENACO/IITA/CRPS Cowpea Review and Planning Meeting. Ibadan, Nigeria.

xv. Mortimore, M. J., Singh, B. B., Harris, F. And S. F. Blade. (1997). 'Cowpea in Traditional Cropping Systems.' Singh, B. B., Mahan Raj, D. R., Dashiell, K. E. and L. E. N. Jackai. (eds.) 'Advances in Cowpea Research.' Co-publication of Institute of Tropical Agriculture (IITA) and Japan International Centre for Agricultural Sciences (JIRCAS), Ibadan, Nigeria, 9:99-113.

xvi. Nagy, J. G. and J. H. Sanders. 1990. 'Agricultural Technology Development and Dissemination within a Farming Systems Perspective'. Agricultural Systems 32:305-320.

xvii. Nederlof, E.S., Tossou, R., Sakyi-Dawson, A. and D. K. Kossou. (2004). 'Grounding Agricultural Research in Resource-Poor Farmers' Needs: A Comparative Analysis of Diagnostic Studies in Ghana and Benin.' NJAS-Wageningen Journal of Life Sciences, 52(34): 421-442.

xviii. Nnanyelugo, D. O., Ngoddy, P. O., Okeke, E. C. and E. K. Ngwu. (1997). 'Impact of a Cowpea Research project in Nigeria Using the Rapid Rural Appraisal Technique.' Singh, B. B., Mohan Raj, D. R., Dashiell, K. E. and L. E. N. Jakai (eds) 'Advances in Cowpea Research.' Co-publication of Institute of Tropical Agriculture (IITA) and Japan International Centre for Agricultural Sciences (JIRCAS), Ibadan, Nigeria. 29, 333- 340.

xix. Okali, C., Sumberg, J. and J. Farrington. (1994). 'Farmer Participatory Research: Rhetoric and Reality'. London: Intermediate Technology Publications for Overseas Development Institute.

xx. PEDUNE. (2000). 'Activity Report.' Working Paper No. 01/99/TR/GH Ghana: International Institute for Tropical Agriculture and Agency for Swiss Development and Cooperation. Unpublished document.

xxi. Rogers, E. M. (1995). 'Diffusion of Innovations.' 4th ed. New York: Free Press.

xxii. Rogers, E.M. (1983). 'Diffusion of Innovations'. 3rd ed. London: Collier Macmillan.

xxiii. Roling, N.G. (2002). Issues and challenges for FFS: An Introductory Overview. Invited Plenary Theme Paper for the International Workshop on Farmer Field Schools (FFS): Emerging Issues and Challenges, held in Yogyakarta, Indonesia, 21-25 October.

xxiv. Roling, N.G., Hounkonnou, D., Offei, S.K., Tossou, R.C. and A. van Huis. (2004). Linking Science and Farmers' Innovative Capacity: Diagnostic Studies from Ghana and Benin. NJAS-Wageningen Journal of Life Sciences, 52(34): 211-236.

xxv. Roling, N. and van de Fliert, E. (1994). 'Transforming Extension for SustainableAgriculture: The Case of Integrated Pest Management in Rice in Indonesia.' Agriculture and Human Values, 11:2/3, 96–108.

xxvi. Sumberg, J.E. and C. Okali. (1997). 'Farmer's Experiments: Creating Local Knowledge'. Boulder: Lynne Rienner.

xxvii. Tessmer, M. (1990). 'Environmental Analysis: A Neglected Stage of Instructional Design'. Educational Technology Research and Development, 38(1):55-64.

xxviii. Tripp, R., Wijeratne, M., and H. V. Piyadasa. (2005). 'What Should we Expect from Farmer Field School? A Sri Lanka Case Study'. World Development, 33(10):1705-1720.Journal of Political Economy 104(5):1010–1046.

xxix. United Nation Fund for Population Activities(1999). 'Personalizing Populations.'

xxx. http://unfpa.org/focus/ghana

xxxi. Assessed on: 18/11/07

xxxii. UNICEF (2004). 'At a glance: Ghana.'

xxxiii. http://www.unicef.org/inforbycountry_statistics.html
Assessed on: 07/09/2008

xxxiv. Yates, B. L. (2001). 'Applying Diffusion Theory: Adoption of Media Literacy Programs in Schools'.

xxxv. http://www.westga.edu/~byates/applying.htm
Assessed 20/01/2009