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Assessing the effectiveness of a Local Agricultural Research Committee in diffusing sustainable cocoa production practices: the case of capsid control in Ghana

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The conventional method of 'delivering' technologies recommended by researchers to farmers through extension has proved ineffective, resulting in a persistent low (3.5% over ten years) adoption of research-based cocoa technologies. The present study was conducted in the Eastern Region of Ghana and assessed the impact of the Local Agricultural Research Committee (LARC) approach on the diffusion of capsid management knowledge and practices, developed with the LARC, to others in the community. Capsids (*Sahlbergella singularis* and *Distantiella theobroma*) were diagnosed as the most serious production constraint. LARC members engaged in intensive interactive learning and experimentation to control them. The interactive approach developed by the International Centre for Tropical Agriculture was used to link the LARC with community farmers, a majority of whom aspired to produce organic cocoa for a premium. The LARC acquired vital agro-ecological knowledge on capsid management, including skills in scouting for capsids to determine their temporal distribution and systematic experimentation with control methods, before presenting its results to the community. This article reports on a survey comparing three categories of farmers: LARC members, exposed and non-exposed community farmers, so as to assess the diffusion and impact of LARC knowledge co-production. The results show that the LARC approach significantly influenced acquisition and diffusion of knowledge and practices.

Keywords: Integrated pest management (IPM), interactive learning, neem, *Oecophylla longinoda*, organic cocoa production, pheromone traps

Introduction

Nearly all cocoa beans exported from West Africa are produced by small-scale farmers. Involving them in the development of sustainable cocoa production requires a new interface with research (Vos & Krauss, 2004). Ensuring active farmer engagement in research and extension requires a paradigm shift from the prevailing top-down approaches to participatory learning approaches. Cocoa farmers' views would, for example, be regarded as a necessary ingredient in research and development decision-making. Discovery learning by farmers would be the result of using interactive tools for improving farmers' decision-making capabilities. Such

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approaches are now considered more effective than the linear approaches that often are still applied today (e.g. Meir & Williamson, 2005).

The benefits of integrated pest management (IPM)/farmer fields schools (FFS) as an approach to interactive learning, in terms of introducing more sustainable farming methods and in terms of empowering farmers, are well-documented (Bruin & Meerman, 2001; Van de Fliert, 1993). The FFS approach has amply demonstrated its ability to deeply affect the professional skills and their ability to apply principles to solve new problems or to capture opportunities in diversity (e.g., Röling & Van de Fliert, 1998). Despite the fact that the FFS approach has been very successful in improving farmers' decision-making processes and enhancing their analytical skills (Braun *et al.*, 2000), it has been criticized for having little impact on farmers other than the direct FFS participants (Feder *et al.*, 2004). This is because experience with FFS worldwide has shown that diffusion from the members of the FFS to other farmers is limited to simple ideas, practices and issues that can be easily observed. However, the understanding of the basic principles (like the action of natural enemies) and several skills do not get transferred easily. As such, the FFS has been branded cost-ineffective. This raises the question whether there are other approaches to interactive learning that would create space for non-participating farmers to benefit. Hence, the present study assesses the influence of the LARC approach, which does focus deliberately on the link between the farmers in the experimental learning group and the rest of the community. It evaluated the diffusion of knowledge, practices and attitudes acquired for effective capsid (a pest in cocoa) management from LARC members to the rest of the farmer community, and reflects on some complementary tools for effective farmer learning.

Ashby *et al.* (2000) indicated that the LARC approach was developed as a result of concerns regarding low adoption and limited impact of formal research on resource poor farmers. They reasoned that research that did not involve farmers as active participants in the early stages had a high risk of low adoption (Ashby, 1987). The LARC and the FFS are two approaches to interactive learning for promoting integrated decision-making and innovation for sustainable agriculture by small-scale farmers (Braun *et al.*, 2000). Both the FFS and the LARC focus on identifying concrete solutions through discovery learning, and on enhancing the capacity of individuals and local groups for critical analysis and decision-making. They also stimulate local innovations and focus on principles rather than recipes or technological packages (Braun *et al.*, 2000). The LARC and other interactive learning methods such as the FFS are ways of approaching agricultural research and development with the aim of fully involving farmers as partners in all or key stages of technology development and or dissemination processes, including strengthening their capacity to experiment and innovate (Van Veldhuizen *et al.*, 2002). These interactive approaches are often referred to by the umbrella term Participatory Technology Development (Van Veldhuizen *et al.*, 1997).

Whereas FFS often focuses on gaps in agro-ecological knowledge that are not easily observable, the LARC approach focuses on active participation of farmers in systematic evaluation of technological alternatives through research. One of the other most striking differences is the selection of the participants. With the LARC platform, the larger community selects between two to four farmers who represent it in the research effort and who report back to the entire community. FFS usually have about 20–25 participants who are normally not selected by the community and who do not deliberately report to them. At best, some neighbours and close family members learn informally some of what was experienced (Feder *et al.*, 2004). Although the FFS and LARC have similar approaches to farmer learning, such as the styles of facilitation, motivation and the village diagnostic meetings, the purposes of diagnosis are different. The main objective for the diagnostic meeting prior to the establishment of FFS is to determine whether the location meets some given criteria and to help the facilitators adapt activities to suit local agro-ecosystems. The main aim of a diagnostic meeting with the use of the LARC platform is to define the agricultural research topic that the community entrusts to the committee (Braun *et al.*, 2000). Another evolving platform is community IPM that sees FFS as a first step in the sustainable development and management of community resources. The goal of this strategy is to institutionalize IPM at the local level and consequently, it has three basic overlapping elements: learning, experimenting and organizing (Van de Fliert *et al.*, 2002).

In view of the specific needs of study area, and the low adoption of pest recommendations in cocoa, the LARC approach was chosen as the main platform to test three alternative capsid control methods: neem as a botanical (organic) pesticide (Padi *et al.*, 2004), pheromone traps as a lure and kill method (Padi *et al.*, 2001), and enhancing *Oecophylla longinoda* (ants) populations as natural predators (Ayenor *et al.*, 2004). During diagnostic studies conducted in the study area (Ayenor *et al.*, 2004), it appeared that cocoa farmers had erroneous ideas about which capsid species caused most damage. Therefore, we employed discovery learning tools (cage experiments traditionally used in the FFS) to help fill LARC farmers' agro-ecological knowledge gaps. To meet the aspirations of the local community to engage in organic cocoa production so as to capture premium prices, the LARC farmers were encouraged systematically to share their knowledge with the community so that the association of organic cocoa farmers could use its new understanding of the ecology and sustainable capsid control measures to convince other interested farmers and expand its membership. This aspiration was the basis for importing some community IPM development tools into the LARC.

However, the extent to which LARC farmers passed their knowledge on to the rest of the farmers in the community was not known. Two questions were of particular interest to us. Did the use of LARC, as applied in this study, create the capacity to significantly influence knowledge, attitudes and practices of cocoa farmers in the wider community? Based on the circumstances of the study area, can the LARC successfully integrate other learning tools to meet the holistic learning and action goals of the cocoa farming community?

To answer these questions, a survey was conducted to assess the potential of the LARC approach to generate, develop and share cocoa pest management information and practices with farmers at large. The survey was also meant to assess the potential of LARC to integrate research and extension concerns in cocoa crop management.

Context

The Cocoa Research Institute of Ghana (CRIG) develops pest management technologies, which are expected to be transferred to farmers through the Extension Service. However, a number of reports show low adoption by cocoa farmers of pest management practices recommended by CRIG (Donkor *et al.*, 1991; Henderson *et al.*, 1994; Padi *et al.*, 2000). Therefore, Ayenor *et al.* (2004) made suggestions to involve farmers actively in decision-making processes about technology development and in dissemination. The goal of the Cocoa Services Division – now ceded to the Ministry of Food and agriculture (MoFA), is to offer cocoa extension services, including crop protection advice, to farmers. The public extension service (MoFA) organizes seasonal training sessions on crop protection for its Agricultural Extension Agents (AEA), prescribing calendar-based application of conventional insecticides for the control of cocoa capsids (Gerkern *et al.*, 2001). In 2001 the Ghanaian Government introduced a 'free' Cocoa Disease and Pest Control Programme (mass spraying). In effect, cocoa capsid control in Ghana is mainly the responsibility of the central government and not of farmers. It is the government that manages the programme to spray cocoa farms with conventional pesticides within a pre-determined peak capsid period (August to December). And it is the government that allocates revenue from cocoa exports to this mass spraying, sometimes using pesticides produced in Ghana.

Most of the farmers in our study area had made a decision to produce organic cocoa to capture the premium prices that would be offered once the organic export chain had been set up and certification had been assured. At the inception of our research project, a diagnostic study on cocoa identified capsids damage, mainly by *Distantiella theobroma* (DT) and *Sahlbergella singularis* (SS), as the most serious constraint to cocoa production. In order not to frustrate the farmers' plans to produce organic cocoa, key stakeholders involved in the project convinced the authorities to use crude aqueous neem seed (*Azadirachta indica*) extract (ANSE) for the mass spraying in the study area. The key stakeholders were the Traditional

Organic Farmers Association (TOFA) in the study area, MoFA, and CRIG. The process was facilitated by the principal author who represented the Convergence of Sciences (CoS) project, as part of his PhD research study.

In Ghana, an IPM/FFS strategy in cocoa production was primarily pursued by a non-governmental organization (NGO), Conservation International and other stakeholders including CRIG and MoFA, in the Kakum forest reserve area (Baah, 2002). By the end of 2002 the cocoa mass spraying had taken over the farms used for the IPM/FSS experiments. Currently, the Sustainable Tree Crops Programme (STCP) of the International Institute of Tropical Agriculture (IITA) also conducts Farmer Field Schools in Ghana (Vos & Page, 2005). The STCP is a sub-regional project in Ghana, Côte d'Ivoire, Nigeria and Cameroon. The control of capsids is included in its FFS curriculum. However, given the repeated concerns expressed about the low adoption of pest management technologies in cocoa, the FFS/IPM approach alone is not likely to improve the situation.

After the diagnostic study was conducted with 22 farmers, the community was asked to select seven farmers from the 22 to represent them in a research endeavour aimed at testing three alternative capsid control methods (see Ayenor *et al.*, 2004). The seven became the initial LARC farmers made up of six men and one woman. In less than a year into the process, as a result of the performance of the LARC female-farmer as against the lack of commitment of two male LARC farmers, the community reconstituted the LARC with five men and five women. The LARC became the official research committee that linked the activities of the CoS research team and the community, most of whom were either members of the TOFA or had an interest in the association because of an anticipated premium price for organic cocoa.

The LARC farmers were organized and trained in the identification of key cocoa pests in the study area. They were also exposed to basic concepts such as *treatments*, *control* and *replications* in research and experimental design, as well as to some information and practical skills required for field data collection. The major contributions of the LARC farmers included the design, execution and data collection for the field experiments and the invitation of the community to offer its indigenous knowledge and experience, and their values and socio-economic interests that could affect the research. They also assisted in the preliminary interpretation of what was observed based on their local experience, and were assisted to present the results of the field experiments to the rest of the community.

Materials and methods

The study area and procedures

The study area covers cocoa farms in the township of Brong-Densuso and the surrounding farm communities. Brong-Densuso is a small town on the main road that connects Suhum, the district capital of the Suhum-Kraboa-Coaltar District, and Koforidua, the capital of the Eastern region of Ghana. A local forum for decision-making was established consisting of LARC farmers, an AEA and, depending on the activities and topic for discussion, scientists from the CRIG. These stakeholders met twice a month during the key stages of the research dealing with the three capsid control methods. After each major stage of the research process, we tried to reflect on the learning that had taken place.

Conceptual disagreements among stakeholders that emerged during the implementation of the field research were resolved through discussion and negotiation. LARC farmers learned to identify the capsids, recognized the damage they caused, and understood their life cycles through a self-discovery learning process using cage experiments that made visible processes that were unknown to them before (Table 1).

All cage experiments had three treatments and an untreated control, all replicated three times. The experiments were placed under trees close to the hamlet of one of the LARC farmers. In each case, the experiment was initiated with joint discussion on what to look for, why, how, for how long and what specific indicators to use. The discussions also covered the results, the lessons learnt and how they could be applied in the capsid control experiments conducted on the farms. It also focused on how to communicate the obtained experiences to other

Table 1 Cage experiments on cocoa capsids* conducted with LARC farmers

Cage experiment	*Objective*	*Conclusion*
Damage caused by capsid species	To know the nature of lesions by specific insects and their effects on cocoa	*SS* and *DT* most destructive
Feeding preferences of capsid species	Compare feeding preferences for certain plant parts	*Helopeltis* sp. on pods only; SS and DT on pods and leaf parts
Ant predation on capsids	To verify ant predation on capsids	*O. longinoda* preys on capsids
Effective dosage of neem	Determine effective dosage	Dosage of 20% efficacious and cost-effective

*Capsids species: *Sahlbergella singularis* (SS); *Distantiella theobroma* (DT); *Helopeltis* sp.

farmers. The discussions provided an opportunity for the researcher/facilitator to learn about cocoa capsids, as it was the first time he dealt with the impact of these pests on farms. This made it easier for him to play a facilitating role between stakeholders rather than being a 'typical biological research scientist' or a resource person.

Experiential learning conducted with farmers focused on the identification of cocoa insect species. Concerning capsids, we studied their life cycle, their behaviour, the damage they cause, their location on the cocoa plant and their predation by the ant, *O. longinoda*. Farmers were encouraged to observe and document interactions between the cocoa tree, capsids and ants. The information generated helped to develop the LARC farmers' skills at scouting for capsids. Together with scientists, they recorded data on the temporal distribution of the insects, which enabled them to decide on need-based spraying. Other learning experiences included weed management, sanitation measures to control black pod disease, restoration and conservation of soil fertility, etc.

In four different sessions, the LARC farmers presented the knowledge they had acquired to the community. The first presentation dealt with the identification of cocoa pests using specimens and pictures, and with their newly acquired knowledge about the ecology, biology and the behaviour of cocoa capsids. The second presentation focused on where, and when to scout for capsids. The third presentation dealt with control measures, and with their effects on capsid numbers and yields. The fourth presentation was about the advantages and disadvantages of each method. Farmers also showed results with respect to the advantages of adopting some agronomic practices including black pod management. They further shared their views and experiences in working with other stakeholders on the research project. Apart from the four co-organized community meetings, in the farmers' own meetings, the LARC farmers were asked questions about the research. During both formal and informal meetings, the village audience made suggestions regarding the experiments and other related issues (e.g. to look into marketing of organic cocoa) to the research team.

Survey on the use of the LARC approach

Different types of farmers, depending on their participation in, or exposure to, the LARC approach, were identified and interviewed using a questionaire. The three types of farmers identified were the LARC farmers themselves (direct beneficiaries), the exposed farmers (those who attended the LARC presentations) and non-exposed farmers consisting of farmers who had not participated in the study or LARC farmers' presentations and meetings.

Eight out of the ten LARC farmers who were available during the survey were interviewed. A total of 40 out of 60 farmers who participated in the LARC presentations were selected and interviewed as exposed farmers. The exposed farmers live in four different communities within a radius of 5 km. However, in the sampling of the exposed farmers, the community they lived in was not used as a criterion. It was rather from a list of attendants at the LARC presentations, including males and females, that the 40 were selected from the 60 by leaving out every third farmer. Another 40 non-exoposed farmers who had not been involved were selected. In this case, living in different communities was the key criterion. Ten non-exposed farmers were selected from each of the following four communities: Ayisa-Brong No 1, Akwadum, Brong-Densuso and Brong No 2. In each community, a meeting was held to assemble 25 farmers comprising both males and females. The ten were selected by leaving every third on the row out. During the sampling, questions were asked to verify their status as cocoa farmers and their non-involvement in any of the LARC presentations or meetings.

The questions in the questionnaire were mainly based on the LARC farmers' earlier presentations. They included questions on the conclusions from the cage experiments, on major findings from joint ecological analysis and on data collected from the experimental cocoa fields. The questionnaire was administered by three enumerators after their training, and after field pre-testing and fine-tuning the instrument. The data were analysed with the statistical package SPSS. The preliminary findings were shared with the interviewees in a separate meeting for collective validation, criticisms, suggestions and corrections. The key variables used were *Knowledge, Attitude*, *Practice* and *Intentions* in order to determine whether the LARC approach and the efforts of farmers' in presenting lessons and experiences to other farmers in their community can be considered as a practical approach to cocoa information and technology generation and diffusion.

Results

The survey comparing three groups of farmers with different levels of exposure to the technology development and diffusion processes allowed us to test for impact. The main subjects farmers were assessed on were their knowledge about identification, ecology, biology and behaviour of cocoa capsids. Others were information and skills required for scouting for capsids, their control measures as well as a the farmers' attitudes and intentions toward the control measures.

Farmers' knowledge on cocoa capsids

All cocoa farmers interviewed agreed that cocoa capsids pose a serious threat to high yields and referred to capsids as 'cocoa farmers' enemy'. However, at the beginning of the study, farmers had poor or, at best, incomplete knowledge about cocoa capsids (Ayenor *et al.*, 2004). Many farmers in the area, including those who later became LARC farmers, could not identify the species correctly. Basic and essential knowledge about the ecology, biology and behaviour of capsids was extremely limited. In order to control their 'enemy', farmers needed to be able to identify the capsid species. As a result, efforts were made with the stakeholders (including the LARC farmers) to collectively learn how to identify capsids and understand their ecology, biology and behaviour.

Concerning the level of knowledge acquired about capsids, the LARC farmers seem to have influenced the exposed farmers (Table 2).

The exposed farmers scored an average of 57% correct answers as compared to 33% for the non-exposed farmers. Although the exposed farmers were more knowledgeable on capsids ecology and behaviour than the non-exposed, the difference between them with regards to the biology was not that pronounced.

It is believed that collective sharing of problem-based information and systematic delivery of theoretical knowledge as a prelude to engaging in desired practices is critical for effective application of solutions. Information required for effective capsid monitoring and decision-making preceded the actual practice of scouting for capsids (Table 3).

The transfer of information on scouting by LARC to the exposed farmers seems to have been effective. There was no significant difference between categories of farmers about the knowledge of how often to scout; at least three-quarters of the farmers had correct answers. This is because the frequency of scouting is simple and logical; as often as possible, but at least, once a month. Although 33% of the exposed farmers and 18% of the non-exposed farmers know how to scout for capsids, only 23% and 8% respectively claim to practise scouting before spraying. Most of the LARC farmers had experiments mounted in their fields and the decision to scout before spraying was according to what the stakeholders in the research had collectively agreed upon. Therefore this question was not applicable to them.

Table 2 Knowledge of LARC, exposed and non-exposed farmers about cocoa capsids (% of farmers giving correct answer)

Main topics	***Questions dealing with:***	***Farmers***			***Chi-square test (P)***
		LARC (n = 8)	***Exposed (n = 40)***	***Non-exposed (n = 40)***	
Pest Identification	*S. singularis*	88	31	8	<0.05
	D. theobroma	75	38	15	<0.05
	Helopeltis sp.	100	65	32	<0.05
	B. thalassina	75	30	5	<0.05
Ecology	Location: under pods	100	93	74	>0.05 NS
	Preferred location	88	58	33	<0.05
Biology	Developmental stages	88	20	15	<0.05
Behaviour	Feeding by adults and nymphs	88	70	33	<0.05
	Cryptic	100	90	39	<0.05
	Dropping when touched	100	79	76	>0.05 NS
Mean percentage (%)		90	57	33	

Farmers in all categories knew about conventional insecticides (CIs) (Table 4). All LARC farmers were aware of the disadvantages associated with the CIs, against three-quarters of the exposed and only about one-quarter of the non-exposed farmers. Some of the common disadvantages mentioned include: being harmful to humans; high costs, contaminating food such as leaves of the cocoyam (*Kontomire*), a crop grown under the cocoa trees; easy means for committing suicide, etc. The use of neem (ANSE) and *O. longinoda* to control capsids are known to all LARC and exposed farmers; these percentages were 69% and 51%, respectively for the non-exposed farmers (Table 4). With regard to farmers' knowledge on the existence of sex pheromone traps, 73% of the exposed farmers had either heard about it or seen it during LARC farmers' presentations in the community. However, almost none (5%) of the non-exposed farmers knew about it.

The actual control measures farmers apply on cocoa farms

No LARC farmer, but 15% of the exposed and 87% of the non-exposed farmers received the capsid spraying with conventional pesticides within a government-sponsored programme (Table 5). However, for some of the farmers within the study area who are mainly TOFA members, the government, through the collective efforts from CoS and CRIG, agreed to spray neem for them because they rejected the synthetic pesticides.

About 60% of the LARC and the exposed farmers in principle apply or will accept the use of neem on their farms, against only 13% of the

Table 3 Knowledge of LARC, exposed and non-exposed farmers about scouting for capsids (% of farmers)

Questions	***LARC (n = 8)***	***Exposed (n = 40)***	***Non-exposed (n = 40)***	***Chi-square test (P)***
Reasons	100	80	42	<0.05
Where on farm	100	98	63	<0.05
When	100	85	61	<0.05
Frequency	100	90	74	>0.05 NS
How	100	33	18	<0.05
Control decision based on scouting	N/A	23	8	<0.05

Table 4 Knowledge of LARC, exposed and non-exposed farmers on measures to control capsids (% of farmers)

Knowledge	*Farmers*			*Chi-square test (P)*
	LARC (n = 8)	*Exposed (n = 40)*	*Non-exposed (n = 40)*	
Conventional insecticides	100	95	97	>0.05 NS
Disadvantage of conventional insecticides	100	78	27	<0.05
Neem extract	100	100	69	<0.05
Ant predation by *O. longinoda*	100	100	51	<0.05
Sex pheromone traps	100	73	5	<0.05

non-exposed farmers. LARC farmers were most (37%) in favour of using both neem and ants, followed by the exposed farmers (27%), while none of the non-exposed farmers knew of the advantageous integration of the two methods.

As the idea of controlling capsids is acceptable to all farmers interviewed (Table 6), they all have strong positive attitudes toward learning to identify capsids and the corresponding damage. However, about half of the non-exposed farmers were either not decided (39%) or had some negative reservations (10%) on the practicality of counting capsids numbers on cocoa as an appropriate action to control this pest. As compared to the LARC and the exposed farmers, the non-exposed farmers have a different attitude towards the practice of scouting as a decision-making tool. This had mainly to do with doubts about the possibility of counting the insects, which are cryptic and can also fly into the upper storey of the cocoa canopy.

About 90% of the exposed farmers have strong positive attitudes towards the use of neem and *O. longinoda* as compared to 13% and 35% respectively, for the non-exposed farmers. LARC and exposed farmers expressed strong positive attitudes toward alternative methods, except that the exposed farmers had some concerns about the adoption of sex pheromone traps. The majority of the non-exposed farmers did not have favourable attitudes towards the use of neem; a third expressed strong positive attitudes towards the use of *O. longinoda*, while about 80% had no opinion on the use of sex pheromones. This attitude is most likely to result from lack of information on the method, rather than from rejection. All farmers irrespective of their categories, favoured cultural control practices such as regular pruning, shade management, removal of mistletoes and infested pods and weeding (Table 6). More than 85% of the farmers in all categories wanted to learn and experiment with other stakeholders rather than taking on ready-made technologies from researchers.

To get some idea about the opinion of farmers on state-sponsored blanket spraying with conventional insecticides, questions were asked with the following prefix 'Given that the Ghanaian Government stopped the "free" mass spraying, how likely is it that you will use/adopt ...'. The results of this probing exercise are presented in (Table 7).

All LARC farmers, 65% of exposed farmers and only 10% of non-exposed farmers are very likely to scout for capsids before control, in case the

Table 5 Capsid control measures applied by LARC, exposed and non-exposed farmers (% of farmers)

Categories of farmers	*Control measures*		
	Neem	*Neem and ants*	*Conventional insecticides*
LARC (n = 8)	63	37	0
Exposed (n = 40)	58	27	15
Non-exposed (n = 40)	13	0	87
Chi-square tests (P)	<0.05	<0.05	<0.05

Table 6 Attitudes towards capsids management practices by LARC, exposed and non-exposed farmers (% of farmers)

Main topics	***Farmers***												***Chi-square test (P)***
	LARC (n = 8)				***Exposed (n = 40)***				***Non-exposed (n = 40)***				
	SPA	***PA***	***NO***	***SNA***	***SPA***	***PA***	***NO***	***SNA***	***SPA***	***PA***	***NO***	***SNA***	
Controlling	100				100				100				
Identifying damage	100				98	2			85	13	2		>0.05 NS
Scouting	100				80	15		5	31	20	39	10	<0.05
Use of neem	75	12.5	12.5		88	5	2	5	13	8	37	42	<0.05
Use of *O. longinoda*	100				90	8	2		35	10	38	17	<0.05
Use of pheromone	100				30	28	40	2	2	5	80	13	<0.05
Crop practices	100				100				100				
Organic production	100				87	11	2		2	5	80	13	<0.05
Alternative control	100				92	8			23	15	50	12	<0.05
Joint learning for solutions	100				97		3		85	5	10		>0.05 NS

Strong Positive Attitude (SPA); Positive Attitude (PA); No Opinion (NO); Negative Attitude (NA); Strong Negative Attitude (SNA).

government stopped the mass spraying. About half of the LARC and exposed farmers and about a quarter of the non-exposed farmers intend to use neem to control capsids. Whereas 60–70% of LARC farmers and exposed farmers are very likely to use *O. longinoda*, only 25% of the non-exposed farmers would do so. Concerning the use of sex pheromone traps, none of the farmers is likely to use them mainly because of lack of information about their availability, a situation CRIG intends to address. Most (60–90%) of the farmers in the different categories have intentions to apply crop management practices, but the differences among the categories are not significant.

Major sources of information of community farmers

We wanted to find out the sources of information of the exposed farmers on alternative control methods to verify the role of the LARC farmers' presentations. To establish this, we identified and compared the primary sources of information of the three categories of farmers (Table 8).

Seventy per cent of the exposed farmers and one-third of the non-exposed farmers had heard about the use of neem for capsid control, indicating LARC as the primary source. Five out of the eight LARC Farmers learned about the use of *O. longinoda* from

Table 7 Intentions to use alternative capsid management practices, assuming the government terminates the cocoa mass spraying programme, by LARC, exposed and non-exposed farmer (% of farmers)

Main activities	***LARC (n = 8)***					***Exposed (n = 40)***					***Non-exposed (n = 40)***					***Chi-square tests (P)***
	VL	***L***	***DK***	***UL***	***VU***	***VL***	***L***	***DK***	***UL***	***VU***	***V L***	***L***	***DK***	***UL***	***VU***	
Scouting	100	0	0	0	0	66	26	0	5	3	10	35	18	30	7	<0.05
Neem	50	50	0	0	0	57	35	0	3	5	22	20	15	43	0	<0.05
O. longinoda	63	25	0	12	0	68	24	3	3	2	25	17	10	43	5	<0.05
Sex pheromone	0	25	25	38	12	5	32	30	30	3	0	16	50	32	2	>0.05 NS
Crop practices	63	37	0	0	0	90	5	3	2	0	80	15	5	0	0	>0.05 NS

Very likely (VL); Likely (L); Don't Know (DK); Unlikely (UL); Very Unlikely (VU).

Table 8 Primary sources of information on alternative methods of capsid control, by LARC, exposed and non-exposed farmers (% of farmers)

Categories of farmers	*Sources identified*	*Alternative capsid control methods*		
		Neem	*O. longinoda*	*Sex pheromones*
LARC (n = 8)	Own family	0	37	0
	CRIG	25	0	25
	LARC	75	63	75
	Extension	0	0	0
	Fellow farmer	0	0	0
Exposed (n = 40)	Own family	0	8	0
	CRIG	26	0	0
	LARC	69	88	68
	Extension	3	2	0
	Fellow farmer	2	0	0
Non-exposed (n = 40)	Own family	0	8	0
	CRIG	5	5	0
	LARC	30	25	5
	Extension	5	10	0
	Fellow farmer	23	2	0

Own family; research (CRIG); LARC Farmers; Extension; Fellow Farmers.

the other LARC farmers; the remaining three knew it already by own experience. About 90% of the exposed farmers and 25% of the non-exposed farmers traced their source of information on the use of ants to LARC farmers. Sex pheromone traps as a capsid control method is the least known (5%) among the non-exposed farmers.

LARC farmers are most likely to use information from each other, fellow farmers, CRIG and extension staff. According to the exposed farmers, CRIG is their ideal source of information followed by LARC and extension before fellow farmers (Table 9). On the other hand, the non-exposed farmers preferred extension and CRIG, ahead of LARC and fellow farmers. Many of the cocoa farmers interviewed, irrespective of their category, are not likely to use information from a fellow 'average' farmer who has no special training, position or skills. CRIG as an institution seemed to have a good reputation among the farmers interviewed. CRIG however, normally, does not provide extension services to cocoa farmers. Between LARC and extension as the likely sources of information, there was no clear preference expressed by exposed farmers. Hence we probed further by asking the exposed farmers who have experienced both LARC and extension approaches to compare them in terms of conviction, trust, reliability, etc. (Table 10).

The majority of the exposed farmers were convinced that the use of the LARC approach was the most appropriate for generation and 'delivery' of information and knowledge among cocoa farmers.

Adoption of calendar-based spraying

All LARC farmers, almost all exposed farmers (97%) and 68% of non-exposed farmers claim to have been advised by CRIG or MoFA to spray four times (between August and December) a year to control capsids (Table 11). This same recommendation was what farmers interested in the use of neem claimed to have been given. However, only one LARC farmer and four exposed farmers appeared to have adopted calendar-based spraying. Further probing revealed that three of the five farmers who actually applied the number of times prescribed were either part of a spraying team or had close relationships within

Table 9 Likelihood of use of information on capsids management from different sources, by LARC, exposed and non-exposed farmers (% of farmers)

Categories of farmers	*Sources identified*	*Likelihood*				
		Very Likely	*Likely*	*Don't know*	*Unlikely*	*Very unlikely*
LARC (n = 8)	CRIG	75	25	0	0	0
	LARC	75	25	0	0	0
	Extension	50	25	12	13	0
	Fellow farmer	25	63	0	12	0
Exposed (n = 40)	CRIG	95	3	0	3	0
	LARC	90	10	0	0	0
	Extension	87	10	0	3	0
	Fellow farmer	42	32	13	13	0
Non-exposed farmers (n = 40)	CRIG	95	3	2	0	0
	LARC	53	17	7	23	0
	Extension	95	3	2	0	0
	Fellow farmer	49	28	5	15	3

them. The results show that irrespective of the category of farmers, the recommendation to spray four times according to the calendar is not followed. The government sprays once or twice for the farmers 'freely', and expect the farmers on their own to undertake two or three additional rounds of insecticide applications to complete the four times recommended within the peak capsids period (August to December). This recommendation has hardly changed since the 1960s.

Table 10 Views of exposed farmers (n = 40) when comparing the appropriateness of the LARC and the extension approaches in diffusing knowledge on cocoa capsids management (% of farmers)

Indicators of appropriateness	*LARC approach*	*Extension approach*
Convincing	64	36
Trustworthy	69	31
Practicality	80	20
Reliability	74	26
Suitability	72	28
Availability	95	5
Accessibility	95	5
Affordability	95	5
Acceptability	85	15
Overall-sustainability	85	15

Discussion

Diffusion of knowledge and practices on capsids control

The knowledge transferred by LARC farmers to the exposed farmers was significant. LARC farmers had a great influence in enhancing the awareness of the exposed farmers on ecological and sustainable control measures.

Simple knowledge (ideas that were observable, etc.) diffused to both the exposed and non-exposed farmers, or they had already acquired such knowledge through their own experiences. For instance, farmers in each category knew *Helopeltis* sp. best. The easy identification of *Helopeltis* is because they are highly visible and farmers cannot fail to notice them due to the unsightly lesions they cause on the cocoa pods. Similarly, all farmers know about the use of conventional insecticides to control capsids (Table 4), and are equally aware of the simple message from extension as to when they should spray (Table 11).

On the other hand, complex ideas did not diffuse to the non-exposed farmers. For instance, the non-exposed farmers, significantly disagree with the other farmer categories as to whether scouting for capsids before control is realistic for effective cocoa capsid management. This shows how

Table 11 Percentage of LARC, exposed and non-exposed farmers being aware of calendar-based spraying, and applying it (% of farmers)

Calendar based spraying	*LARC (n = 8)*	*Exposed (n = 40)*	*Non-exposed (n = 40)*	*Chi-square test (P)*
Awareness	100	97	68	$<$0.05
Application	12.5	10.5	0	$>$0.05 NS

learning about the ecology of capsids can change farmers' (in this case the exposed farmers') attitudes towards a more positive ecological approach to pest management. The exposed farmers, as compared to the non-exposed farmers, have a better understanding of capsids and how to manage their populations; and are also aware of the disadvantages of using conventional insecticides and of the need to conserve the predatory ants. Therefore, the exposed farmers have favourable attitudes and intentions toward scouting as a decision tool, and are more likely to adopt ecologically sustainable practices involved in organic cocoa production than the non-exposed farmers.

Capsid control by mass spraying

Regardless of farmer category, very few farmers practise the recommendation to apply synthetic or botanical pesticides four times based on the calendar (Table 11). Farmers reasoned that applying the costly pesticides even once or twice was difficult. They also consider that since the government has fixed the price for cocoa at an amount they perceive to be low; it should bear the full cost of pest management, and assist them with labour costs for other crop management activities. Farmers see themselves as labourers who produce cocoa for the government. They do not see themselves as independent entrepreneurs. This attitude is strengthened by the government taking on the responsibility for pest management through 'mass spraying' gangs who are paid per area covered. Such contracted labour may also compromise the quality of application. Taking away the responsibility of pest management through mass spraying with blanket application of synthetic pesticides has several disadvantages. First, not making farmers responsible for their own pest management is contrary to integrated pest management principles, because spraying is calendar-based, and not need-based. Second, government does the spraying once or twice per year and the farmers are expected to continue to meet the rest of the prescribed recommendation, which they do not. Very few farmers were able to name any brand of the conventional pesticides, so they referred to them as 'DDT' or 'poison'. This indicated the possible danger of such products which often have complex instructions in a language (English) that most farmers cannot read.

It appears many farmers would rely on the control by the naturally occurring *O. longinoda*, which is a traditional pest management practice (Table 7). One of their reasons for this preference is the natural availability at no cost. They recognize that though the ants can be aggressive, working early in the morning in the cocoa farms is a way of going round the problem. For them, the benefits far outweigh the occasional painful bites. However, it is likely that the mass spraying of synthetic pesticides by the government negatively affects the abundance of the predatory ant (Van Mele & Cuc, 2003). Ecological conservation of biological control agents such as a predatory ant is one of the major components of integrated pest management. Therefore, the mass spraying may disrupt the natural biological control system, which is the cornerstone of the integrated pest management approach. This, and a number of other reasons, is why the method of 'free' cocoa mass spraying needs serious reconsideration.

Farmers will be best able to make their own decisions about pest management when empowered through intensive learning approaches such as the LARC. This may well be more cost-effective in the long term, and it does not disrupt the environment. Besides, for the government, it would be beneficial to leave the farmers with the pest management decision because even in Ghana, many civil society groups are becoming increasingly concerned about the economic and environmental implications of the mass spraying campaign with synthetic pesticides. Instead, it would be better to invest in learning by farmers on integrated pest management practices (Meir & Williamson, 2005).

Comparing LARC and extension approaches

Most farmers were concerned that extension workers are not easily available for them because they live in towns and cities and, in some cases, very far from the farms. The situation is aggravated by the problems of poor remuneration, lack of resources, and often the agents not having any means of transport. The views of the exposed farmers about extension are symptomatic of the general dissatisfaction with their services (Table 10). Extension successfully transferred the simple message of calendar-based mass spraying to farmers, but its application and subsequent sustainability within the context and conditions of most cocoa farmers is highly questionable (Table 11). The many disadvantages associated with the 'free' cocoa mass spraying campaign and the ineffectiveness of an extension approach (T&V) that has failed to reveal them, re-echoes the inappropriateness of the existing model of the transfer of technology in meeting the needs of ecologically responsive farmers. Röling *et al.* (2004) observed that co-learning in an action research context is irreplaceable with the transfer of technology by extension workers. The latter approach provides little or no space for farmers to interactively learn about pest management decision-making. It rather turns the farmers into passive recipients of handouts and fixed technical prescriptions. They become consumers of technology (Waibel, 1993). Chambers and Jiggins (1987) described the transfer of technology as a model that poorly meets the needs and priorities of small-scale farmers. Hence, the exposed farmers who have experienced both approaches, preferred the LARC approach to the existing extension approach.

Reflection on the use of LARC approach

The LARC concept was applied somewhat differently in this study as compared to Ashby *et al.* (1987). Following analysis of the conditions and context of the study area, discovery learning tools mainly used in FFS were critical to enhance a better understanding of the problem of what are capsids in the first place (Ayenor *et al.*, 2004). However, to make the whole exercise useful to the community, we paid more attention to community learning and action than FFS usually does, by systematically reporting back to the community, thus setting the basis for a community IPM, where TOFA used the information and knowledge acquired in its membership drive and advocacy activities. This adaptation of the LARC was to further enhance learning and action. The LARC experience further validates the suggestion of convergence of platforms such as FFS, LARC and Community IPM (Braun *et al.* 2000), also anticipated by Van de Fliert, *et al.* (2002). They observed that the synergy and complementarities amongst these platforms, if well managed and used properly, could continue to evolve and contribute to the development and sustainability of agriculture in ways that none alone can accomplish.

Conclusions

The basis of the notable differences in knowledge, practices, attitudes and intentions about cocoa capsids management between the exposed and the non-exposed farmers can be attributed to the LARC approach and its attention to the community through series of presentations from which the exposed farmers benefited. Indeed, results indicate that LARC was the major source of information, skills and practices acquired by the exposed farmers, while extension was responsible for the simple messages that the non-exposed farmers received. Hence, the LARC approach has not only shown its ability to diffuse information successfully to the larger community, but has equally demonstrated that it seems capable of transferring complex ideas and principles to other community farmers.

The LARC approach, as applied in this study, seems to have significantly reached and positively influenced other community farmers beyond the direct participants (LARC Farmers) to acquire complex ideas and skills required for ecologically sustainable practices. In this respect it seems more effective than the FFS approach.

The study has shown that the use of the LARC approach has effectively integrated participatory learning and action research with farmer participatory extension in cocoa production. Therefore, the LARC is a farmer educational tool that can supplement extension and enhance its effectiveness.

The use of LARC, FFS and Community IPM as complementary learning tools in this study offers some evidence for scientists to flexibly integrate these learning platforms with attention to community needs. This would open up the participatory space to embrace indirect beneficiary farmers and give more meaning to need-based research grounded in local development objectives and dynamics.

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