Converging farmers' and scientists' perspectives on researchable constraints on organic cocoa production in Ghana: results of a diagnostic study

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Abstract

A diagnostic study was conducted to identify the major constraints on organic cocoa production at Brong-Densuso and surrounding communities in the Suhum-Kraboa-Coaltar District, Eastern Region, Ghana. The study followed a technographic study that highlighted cocoa as a public crop requiring broad techno-social innovations. In the technographic study, problems identified included low yields, persistent pest management constraints and a low adoption rate of technologies developed by the Cocoa Research Institute of Ghana. The diagnostic study adopted a Participatory Learning and Action Research approach to set up and implement fieldwork with relevant stakeholders leading to problem identification, prioritization, and collective design of an action plan (research agenda). Cocoa farmers within the study area are conscious of the environmental problems associated with the use of inorganic pesticides and the high cost of using them. Hence, they produce cocoa without applying any pesticides. Quite recently, however, their association with an organic marketing company led to a search for non-chemical pest and disease control measures and for ways to certify their cocoa beans as organic. A misconception as to what species of cocoa pests constitute 'capsids' was settled between farmers and scientists using a cage experiment on capsid damage. The farmers became convinced that the Cocoa Mosquito (*Helopeltis* spp.) (Hemiptera: Miridae), which they had previously considered an important pest, was a capsid species that caused little or no damage to the beans inside the pods. After this clarification, damage caused by the Brown Capsid (*Sahlbergella singularis*; Hemiptera: Miridae) and the Black Capsid (*Distantiella theobroma*; Hemiptera: Miridae) emerged as the most serious production constraint, followed by Black Pod disease (caused by *Phytophtora palmivora)*. The malfunctioning of tenure agreements and the mistrust between landlords, who are mainly absentee farmers, and their caretaker cocoa farmers pose a serious threat to pest management innovations, especially where pruning to control Black Pod disease and uprooting trees infected with Swollen Shoot disease are concerned. The key stakeholders involved in the study agreed on three innovative (organic) capsid control methods for further research: the use of sex pheromone traps, crude aqueous neem (*Azadirachta indica*) seed extracts, and the use of ant (*Oecophylla longinoda*) colonies as biological control agents, the latter being proposed by farmers. The paper reflects on the diagnostic study as a continuous process in response to a continually changing context even beyond the end of the diagnostic research phase.

Additional keywords: participatory research, cocoa pests and diseases

Introduction

Agricultural research agendas are often drawn up and implemented without systematic participation of and consultation with farmers. Agriculture in tropical regions usually is complex and risk-prone. It uses few external inputs and has multiple purposes (Reijntjes *et al*., 1992). It therefore requires site-specific solutions and active involvement of farmers. Conventional agricultural research based on 'linear ways of thinking' has largely failed to provide the desired technologies and innovations that meet the needs of resource-poor farmers (Richards, 1985; Chambers & Jiggins, 1987a; Röling 1988; Van Huis & Meerman, 1997). Formal research institutions are becoming increasingly concerned about the very low adoption rates of the technologies they have developed. For example, surveys revealed that only 3.5–7% of the farmers adopted pest and disease control technologies developed by the Cocoa Research Institute of Ghana (CRIG) (Donkor *et al*., 1991, Henderson *et al*., 1994; Padi *et al*., 2000).

This concern often translates into a misconceived question: How do we make farmers adopt our research recommendations? The low adoption may be due to the linear processes and top-down approaches used in their development and dissemination in the first place (Matteson *et al*., 1994; Röling, 1996). Conventional practice assumes that researchers are the custodians of knowledge and the source of technical innovations, that extension is a delivery mechanism and that farmers are the 'ultimate users' (Bruin & Meerman, 2001). The ineffectiveness of conventional agricultural research, especially for highly diverse, rainfall dependent and risk-prone agriculture, has led to a search for Participatory Technology Development methods (e.g. Jiggins & De Zeeuw, 1992). Such methods are especially important in situations where farmers do not have countervailing power over agricultural politics, over research and other institutions, including donors (Röling & Jiggins, 1998).

The diagnostic study presented below fits squarely into the Participatory Technology Development tradition. It is an attempt to experiment with a research phase that deliberately sets out to make 'pre-analytic choices' (Giampietro, 2003) in a way that gives farmers an optimal chance to influence the outcome. A diagnostic study seeks to establish effective collaboration among stakeholders, especially farmers, but also others such as extension workers, scientists, marketing groups, and policy makers, to identify production constraints and to design action research to overcome them. The method involves collective problem description and mobilization of local resources towards an interactive design of research to produce technologies and forms of organization 'that work and are acceptable' to farmers and hence can become part of farmers' innovation strategies (Röling, 2002).

In order to allow the reader to assess the extent to which farmers and other stakeholders were given a fair chance to affect the pre-analytic choices, it is relevant to explain the 'baggage' with which the principal researcher entered the study.

At the beginning, when he joined the Convergence of Sciences (CoS) project, he intended to work on cashew. However, this was not allowed by CoS management. CoS scientists from the three participating countries (Ghana, Benin and the Netherlands) had met and decided on the crops and eco-regions that CoS was to work on, and cashew was not one of the crops selected. These decisions had been made before any farmer was consulted. Hence, his initial interest in Integrated Pest Management (IPM) in cashew shifted to IPM in cocoa. In this regard, two pre-analytic choices were made: cocoa and IPM. These choices seem not unreasonable, however.

The diagnostic study draws part of its objectives from an earlier study referred to as technographic study suggested by Richards (2001). The technographic study was to identify broad socio-technical innovation needs and key actors within an industry (at the macro-level). Cocoa had been identified as a public crop that required introduction of innovations to enhance and sustain Ghana's major cash crop industry (Abekoe *et al.*, 2002). The technographic study on cocoa highlighted some broad techno-social constraints including low yields, persistent pest management problems, collapse of farmers' organizations, weak extension support and low adoption of proposed technologies (Abekoe *et al.*, 2001). Literature reviewed suggested that low yields in cocoa are associated with capsid damage causing between 25 and 30% crop losses (Anon., 1951). A more recent study indicated that the cost of capsid control using inorganic pesticides is too high for resource-poor farmers, and that farmers, consumers and the general public are increasingly aware of their negative effects on human health and the environment (Padi, 1997). This threatens the sustainability of cocoa production, an important cash crop and foreign exchange earner in Ghana. The questions then are: Is there an opportunity to pursue ecologically friendly methods of capsid control? and Will that lead to sustainable pest management in organic cocoa production?

The concept of organic cocoa is fairly new in Ghana even though some aspects of organic practices have been used by cocoa farmers for decades. They practise 'organic by default' for two main reasons: some do not use inorganic pesticides because they cannot afford to use them and others because they consider them poisonous and hazardous to human health. 'Organic by default' is simply the way cocoa farmers produced cocoa before the introduction of inorganic fertilizers and pesticides. So the potential for producing organic cocoa exists but there is a need to organize and build the capacity of interested farmers and provide them with the necessary research and extension support to increase yield for sustainable production. Owing to the fact that organic cocoa is fairly new, the structures and networks to support its development are equally weak or non-existent. As a result, there are only two areas in Ghana where some experiments with organic cocoa production have been carried out. These areas are the Kakum forest reserve in the Central Region, and Brong-Densuso reported on in this article. The re-introduction of the Cocoa Diseases and Pest Control programme (mass spraying) by the Ghanaian Government in 2001 has adversely affected the Kakum organic initiative and cocoa beans from that area can no longer be classified as organic. Hence, the only place in Ghana with the potential for producing and marketing organic cocoa now is Brong-Densuso. But had it not been for the cocoa farmers' outcry we witnessed and that alerted CRIG, which in turn involved other relevant institutions to intervene, the only organic cocoa production initiative left would have been effectively destroyed.

Organic cocoa farming at Brong-Densuso could be said to have started long ago because over 95% of the farmers have not sprayed their cocoa for about 20 years. Yet, it was not until one of the cocoa farmers travelled overseas and returned with the idea of adopting scientific organic practice in order to benefit from a mark-up, that they decided to embark on 'organic' cocoa production. Consequently, about 80% of the community's farmers embraced the idea of organic farming and formed the Traditional Organic Farmers Association (TOFA). The association established links with the International Federation of Organic Agriculture Movements and became member of the movement. In 1997, TOFA established links with the Organic Commodity Products (OCP) company. Currently, the organic cocoa production at Brong-Densuso intends to work towards a broader understanding of the cocoa ecosystem and use its components wisely in respect of the laws of nature. Specifically, farmers want to be assisted with using natural and environmentally friendly methods to control pests and diseases, particularly capsids.

The diagnostic study was, therefore, to establish whether capsid damage in cocoa was indeed perceived as a serious production constraint by cocoa farmers, and whether it was worthwhile devoting four years of research to that problem. It was also to find out who constitute the relevant stakeholders and what are their perceived problems, views, interests and goals, as well as who would be willing to participate in a further study to address farmer-felt needs. The diagnostic study aimed to co-design with all stakeholders an action-research agenda to develop IPM approaches to tackle the capsid problem.

Materials and methods

Overall approach

The diagnostic study began with an extensive literature review. For its fieldwork, the study used qualitative methods adopting Participatory Learning and Action Research (PLAR) methods described in a resource guide that draws heavily on the application of Participatory Rural Appraisal (PRA) tools and techniques (Defoer *et al.*, 2000). PLAR aims to assist farmers through learning tools to identify, infer and analyse what they perceive as problems and suggests ways that make the best use of local resources to address them. The study with farmers was conducted using the following major steps: (1) *introduction*, which primarily looked at setting up and implementing the study; (2) *participatory problem identification and prioritization*, with emphasis on making the problems and processes more practical through the use of maps and diagrams drawn by farmers; and (3) *re-examining and sorting out conceptual differences* through further dialogue and discovery learning experiments involving the farmers' Local Agricultural Research Committee (LARC), CRIG scientists, extension workers and the PhD research team. The final step, (4) *action-planning*, included the election of farmers by the community to conduct further research with other stakeholders. During the entire process, the senior author continued to reflect on the changing government policy, marketing opportunities and other contextual issues.

The study area

The Bron-Densuso study area was chosen based on farmers', scientists', extension officers' and researchers' opinions after preliminary visits because of the following characteristics:

1. Brong-Densuso is the central location of an estimated 600 ha area where cocoa farmers are committed to the production of organic cocoa but are experiencing some production problems.
2. Its cocoa farmers are committed to learn, share knowledge and experience to address their production constraints.
3. The presence of a cocoa farmers association and a private organic marketing company.
4. The proximity to the CRIG research station allowing easy interaction with scientists.

After preliminary interaction with the relevant stakeholders it was realized that the area offered a unique opportunity for carrying out interactive research leading to local innovations that can be shared by all partners. The presence of an organic company, OCP from the USA, and the organic farmers association TOFA seemed to offer an ideal space for innovation and partnership between a strong market development company and relatively organized farmers with whom the research team could establish a contractual partnership.

The study area covers the township of Brong-Densuso and its surrounding communities including hamlets in cocoa farms. Brong-Densuso is a small twin town with Akwadum on the trunk road that connects Suhum, the district capital of the Suhum-Kraboa-Coaltar District, and Koforidua, the capital of the Eastern Region. The Eastern Region falls within the semi-equatorial forest zone and experiences a major (March to June) and a minor (September to October) rainy season. The temperature varies between 24 and 29 °C, and the annual rainfall between 1270 and 1650 mm (Abekoe *et al.*, 2002). Brong-Densuso is the central point for Brong No.1, Brong No. 2, Obuotumpan and Nkatenkwan villages and hamlets. The estimated population of all four communities was 1880 people from various ethnic groups who are mainly farmers. The main ethnic groups included Akans, Ewes and Ga-Adangbes. The Krobos, who are part of the Ga-Adangbe ethnic group, constituted the majority tribe in the area. The various ethnic groups – who are migrants – have purchased cocoa lands in the study area from the Akyems (the indigenous landowners) and have now become the *de facto* owners. The present generation of cocoa farmers has inherited the land either from their parents or their grandparents. Family members who have not benefited from direct inheritance, in some cases have been given the right to use the land but cannot own it.

Farm owners (cocoa landlords) who engage the services of caretakers mainly adopt the *abusa* system acccording to which the yield is shared in a 2:1 ratio: two-thirds go to the farm owner and one third goes to the caretaker. The concrete arrangement varies per situation and depends on the relationships between the two parties. In other cases, landlords and caretakers share the yield equally (the *abunu* system). This system is usually adopted for caretakers who are close family relatives or migrant farmers who had helped to establish new cocoa farms. There is still another category of farmers who have their own cocoa farms, but have arranged to take care of neighbouring farms for people referred to as 'absentee landlords'. They share the yield in different proportions. Few farmers have documented agreements to abide by; but the arrangements are mostly based on trust with family members or neighbours as witnesses.

Specific Participatory Learning and Action Research tools used

The methodological tools of Participatory Learning and Action Research (PLAR) are steps to guide the study aimed at participatory identification of constraints and collective planning to resolve them. The specific PLAR tools used were as follows:

The introductory community meeting

The diagnostic study started with a meeting to inform all cocoa farmers in the Brong-Densuso and surrounding farming communities about the objectives of the study and to ask for their participation in drawing up a plan of action. On the day of the meeting, the senior author introduced himself as a research student in the presence of an extension worker, CRIG researchers, OCP staff, a produce-buying company (PBC) officer and members of TOFA. The message was to conduct research on cocoa with them, with emphasis on learning from each other. After the formalities, the meeting took the form of an open forum discussion on the general concerns in farming and life in the community. Following a brainstorming session on general farming problems, we agreed to meet each Thursday (a non-farming day) to collectively diagnose the causes of the problems the farmers had enumerated or perceived to be affecting cocoa production. At the end, 22 (15 males and 7 females) out of the 57 cocoa farmers present volunteered to participate in the diagnostic phase of the research. The 22 farmers became the consultation group that represented the community in subsequent meetings for open discussions, jointly facilitated by the researcher, the farmers and an extension worker from the Ministry of Food and Agriculture (MoFA). The number of farmers at meetings varied from week to week due to absentees.

A community territory map

In a subsequent meeting, farmers were given a flip-chart sheet to draw a map of their community showing territorial boundaries, neighbouring villages and important resources for discussion by all stakeholders. The process of drawing the map, surprisingly, went beyond the initial goal and generated discussions on land ownership and on apparent disagreements between cocoa land caretakers and landlords in relation to certain agricultural management practices.

A community organizations chart

The volunteering farmers were encouraged to list and indicate on paper the various organizations they interact with, using Venn diagrams to classify them into external or internal organizations and also indicate the degree of interaction in each case (Defoer *et al.*, 2000). The diagram was to assist the research team, farmers and community members, in identifying and visualizing the major agricultural organizations to which community members belong or interrelate with. It was also to show linkages between the organizations and their respective functions. Some information gathered from the map was triangulated with the organization diagram and vice-versa (see stakeholder analysis for details).

Farm visits with key informants

The research team accompanied three to five farmers to their fields on four different occasions to see the practical things they do, experience how they conduct their farm activities and listen to the reasons for the things they do. The farm visits were to provide an opportunity to observe, learn and discuss farm management practices including how the farmers handle cocoa pest and disease problems in the field.

Identification of major pest and disease constraints

Ranking and scoring was used as a methodological tool to prioritize pest and disease problems in order to find out whether capsid damage was the major technical problem affecting cocoa production. Initial meetings held with farmers did not confirm the expectation. It was only after a disagreement between farmers and scientists about what constituted 'a capsid' had been resolved and pest and disease problems had been re-prioritized, that capsids came out as the major technical constraint. Details of how the priority setting took place are presented in the section on results and discussion under the subheadings 'production constraints' and 'negotiating insect knowledge between farmers and scientists'.

Discovery learning and negotiation exercises through cage experiments

In the first round, Black Pod disease came out as the highest-priority problem. The Cocoa Mosquito (*Helopeltis* sp.) (H) was second, while the capsids *Distantiella theobroma* (DT) and *Sahlbergella singularis* (SS) ranked fourth in importance. Farmers considered the Cocoa Mosquito as a major pest because it leaves unsightly lesions on the skin of cocoa pods and causes 'clamped beans'. However, clamped beans are known to be caused by the African Shield Bug (*Bathycoelia thalassina*) (BT). Meanwhile, according to scientists, the capsid species DT and SS cause real economic damage by attacking young shoots and small and medium-sized pods, but this damage is less visible to farmers. To 'negotiate' this issue, the following experiment was designed with farmers.

Farmers collected the insect species H, SS and BT from their farms, including adults and nymphs. At the time of the experiment DT was not available. A cage experiment was subsequently conducted under farmers' conditions using a completely randomized design with six treatments and three replications. The treatments included H adults, BT nymphs and adults, SS 2nd instar, SS 4th instar and SS adults. A treatment consisted of four insect specimens per cage. Plastic containers with a nylon-mesh lid to allow for effective ventilation were used as cages. In each cage the insects were offered cocoa pods, young cocoa shoots (both soft and hard) and fruits of *Desplatsia dewevrei* (an alternative host plant for *Sahlbergella singularis*) of about the same size or surface area as the cocoa pods. The set-up was monitored four times during 96 hours, involving farmers and scientists. Data on feeding lesions of the various groups of insects were recorded. After the experiment, the pods were opened and the 'beans' (seeds) observed for possible damage (clamped beans, etc.). The number of lesions on the shoots and pods was counted and compared to identify the relative feeding preferences of the insects and the damage they caused.

Concluding community meeting

The purpose of the concluding meeting was to report on the major issues that had emerged in order to find ways to address them. It was an opportunity for the rest of the community to express their concerns and reactions. Following this exercise, community members belonging to different social groups such as farmers, opinion leaders and TOFA members, were divided into two smaller groups in a way that ensured that each subgroup represented all the categories identified. They discussed, debated and came out with their methods for pest and disease control, stating what is known and practised and what is known but not practised. The same subgroups followed the same procedure to come out with their criteria for appropriate pest management strategies. From the list of criteria, scientists from CRIG, the extension worker and other stakeholders also made their suggestions until all finally agreed on three methods to be tested against capsids. The senior author facilitated this process.

The agreed research agenda was appraised to assess its economic viability with all stakeholders sharing information on the prospective benefits of organic cocoa production. The community members were asked to elect not more than seven highly committed farmers from the 22 who had volunteered from among the initial 57 at the first meeting, to represent the community in the subsequent research and learning processes to be undertaken. Although they were asked to take into account gender balance, the seven farmers elected included six males and only one female. Hereafter they will be referred to as the Local Agricultural Research Committee (LARC), which became the link between the community and the research team as described by Braun *et al.* (2000).

After the election of the LARC members it became evident that the farmers had used the following election criteria, not in any order of importance:

1. Voluntary spirit as judged by the community.
2. Appreciable knowledge about cocoa.
3. Previous experience with agricultural research, development, or extension.
4. Readiness to make time for communal activities.

5. General behaviour of the chosen farmers; in terms of attitude to work ('not lazy').
6. Self-help spirit and devotion to the community's goals.
7. Generally, primary school level education.
8. The ability to report back to the community on what has been done within a fixed period of time.
9. Active and not shy to express themselves in public (for females in particular).
10. Patience, honesty and humility.

Other tools or methods employed

1. Extensive use of PRA tools such as ranking and scoring, seasonal calendar, semi-structured interviews, problem-tree techniques and triangulation of data from secondary sources.
2. Intensive literature search and desktop analysis of data collected in the field.
3. Sharing the outcome of the study in a seminar with the key institutions CRIG and MoFA, and with CoS project members to incorporate suggestions as necessary.
4. Stakeholder analysis.
5. Facilitation by the senior author of the prevention of mass spraying of the organic farms including the plots set aside for the experiment.
6. Translation into the local language of written reports from the study to community members for their comments. LARC has asked for a final copy for its records.

Results and discussion

The major stakeholders

The major stakeholders in organic cocoa production identified during the diagnostic study are:

The Traditional Organic Farmers Association

The Traditional Organic Farmers Association (TOFA) is the umbrella association that represents the aspirations of cocoa farmers who are interested in producing cocoa for premium prices by using organic and safe methods of farming. It was established to help educate its members to achieve their collective aim of not using synthetic pesticides but its organization still appears to be quite weak. There are about 10 farmers who have been trained to act as a neem-seed extract spraying gang that works with instructions from TOFA, OCP and CRIG.

The Organic Commodity Products company

Organic Commodity Products (OCP) is an American organic cocoa marketing company. Being interested in organic cocoa OCP established contact with TOFA and had an agreement with the Ghana Cocoa Board (COCOBOD) through CRIG to fund CRIG's small-scale and countrywide large-scale trials on the use of neem-seed extract to control capsids, to improve soil fertility in organic cocoa production, and finally buy the cocoa beans for a premium price from farmers once organic certification would be successfully completed. OCP was paying for the cost of organic certification. In the absence of effective extension support, the company employed field staff who provided support to organic farmers.

The Ghana Cocoa Board

The Ghana Cocoa Board (COCOBOD) was established in 1947. It is governed by a board of directors appointed by the government and is mandated to monitor and regulate the operations of the cocoa, coffee and sheanut industries. COCOBOD regulates the marketing and export of cocoa and its products but had no project to produce organic cocoa until OCP sought its permission to fund organic research and certify the beans for export. Therefore, OCP expected COCOBOD to grant exclusive rights to the company for at least five years after the organic certification of Ghanaian cocoa had been obtained so as to enable the company to obtain sufficient returns on its investment into neem research that began in 1998 and was supposed to end in 2003.

The licensed buying companies

There are three main buying companies in the community but, as part of the agreement with OCP, plans were far advanced for OCP to purchase the organic cocoa through the COCOBOD. One of COCOBOD's subsidiaries, the Produce Buying Company (PBC), received specific instructions to separate the organic cocoa beans when certified so that OCP could export them.

The Cocoa Research Institute of Ghana

The Cocoa Research Institute of Ghana (CRIG) is a subsidiary of COCOBOD charged with the responsibility for research on cocoa. CRIG initiated cage, laboratory and field trials with neem in 1998. The first year of a field verification trial was in 2001. With funding from OCP, CRIG also trained spraying gangs and provided them with spraying equipment and other inputs required for the application of aqueous neem-seed extract (ANSE).

The Ministry of Food and Agriculture

Traditionally it was not the Ministry of Food and Agriculture (MoFA) but the Cocoa Services Division – also a subsidiary of COCOBOD – that was in charge of cocoa extension. Under pressure from a structural adjustment programme, MoFA has now been given this responsibility. The effect of this recent change can be seen in the field. The number of farmers per extension worker was already very large and has now been further increased while their work has been complicated by having to take on cocoa as additional crop. Meanwhile, OCP made a special arrangement with two extension workers, in addition to its own field staff, to provide extension support to the organic farmers. Individual interests of all stakeholders were in sink with their collective objective of producing organic cocoa for the export market. Although their efforts, to some extent, were already complementary, all stakeholders in different ways welcomed the CoS approach of working together with farmers to identify priorities for further research.

The different categories of cocoa farmers

Within the local context, we identified four different categories of cocoa farmers, each with females and males except for casual labourers who all were males. Figure 1 presents a pie chart with the percentages of the different categories in the 'farmer' population. Two major farmer groups are the landlords and the caretakers, who represented 43 and 28%, respectively. The other ones are landlords/caretakers, i.e., farmers taking care of their own cocoa farms and, in addition, playing the role of caretakers for absentee landlords, and casual labourers who represent a relatively small number of people hired on a daily basis.

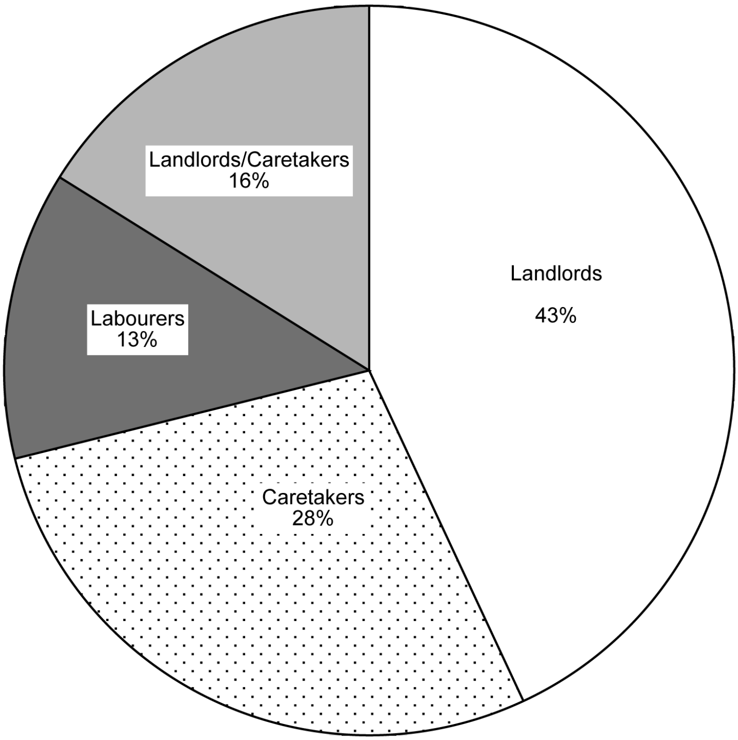

Figure 1. Estimated distribution of the different categories of cocoa farmers (n = 830).

The impact of cocoa production on farmers' income

The population of the study area consists of farmers and the economy is basically an agrarian economy where about 90% of the inhabitants are cocoa farmers who also grow food crops for subsistence. However, the information collected shows that they sometimes sell food crops to meet minor domestic expenses. For example, they may sell some cassava to be able to buy dried fish for evening meals. Wealth ranking by 10 farmers who used 100 stones to represent 100% of the people from Brong-Densuso and its surrounding communities revealed that the majority see themselves as low-income farmers but will not accept the classification 'poor' (Table 1). According to them poverty is about all the negative things such as misery, deprivation, lack of education and no access to health care. As they put it, "If we continue to call ourselves poor, then there is no hope, but we have hope to overcome". A rich person or *osikani* was defined as someone who not only possesses his/her own house and a vehicle (either commercial or private, or both), but also contributes to the development of the community. For example, the only farmer scored as *osikani* was a man who had provided a set of furniture for a church in the community. Community members in the self-help category (*mmodenbofo*), who constitute about 70% of the population, work hard to meet their basic ends with few available resources (land and their own labour). On the other hand, the lazy people or *anihafo* are those who do not have any profession and are not 'real farmers' but spend most of their time 'arguing while playing at draughts under a big tree'.

Table 1. Distribution of societal (or wealth) status in the study area as scored by farmers.

Societal status	English translation	%
Osikani	Rich	< 1
Mmodenbofo	Self help	69
Anihafo	Lazy people	30

In another exercise, 18 farmers (males and females) were given 60 stones to score the six major crops they had earlier mentioned for their importance as the main source of income. The results from the scoring and ranking confirmed that cocoa is their main source of income (Table 2). Farmers explained that income from cocoa enables them to build new houses or repair existing ones. At the personal level, some of them are able to save enough money from cocoa to pay the dowry needed to be able to marry a woman. To cross-check the relevance of cocoa as their major cash crop, the same 18 farmers used 120 stones to show the distribution of their income across the year (Figure 2). The cocoa cropping calendar starts in November when the major harvest takes place, and ends in October the following year. Farmers explained that November is the month when their income is highest because it coincides with the peak cocoa harvest. The cumulative effects of acute shortage of basic foodstuff such as cassava, and plantain, and unusual expenses in December at Christmas are felt in January, leaving a sharp decline of cash at hand. In January, income from cocoa is less than in the two previous months.

Table 2. The six most important crops ranked according to their contribution to cash income.

1. Cocoa	4. Plantain
2. Cassava	5. Orange
3. Maize	6. Oilpalm

From Table 2 and Figure 2 it can be seen that cocoa clearly is the major source of monetary income. Farmers claimed they obtain about 80% of their annual cash revenue from this crop. Consequently, they welcomed a research focus on cocoa.

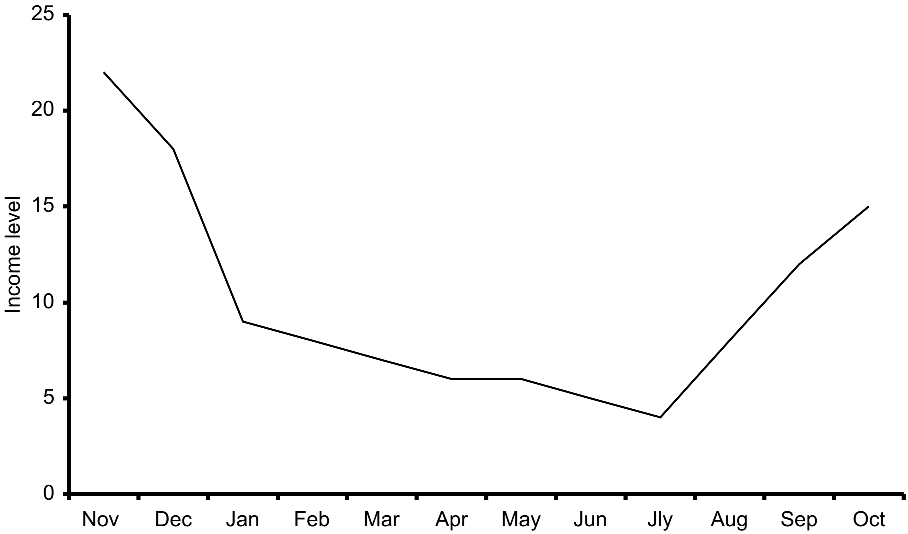

Figure 2. Monthly income levels of cocoa farmers at Brong-Densuso, Ghana.

Cocoa production levels

In another prioritizing exercise, farmers identified decreasing production as the core problem and cause of poverty. To triangulate farmers' claims, production data were collected from the local officer of the PBC, which purchases about 80% of cocoa produced at the Brong-Densuso.

Figure 3 shows wide fluctuations in production, which was a cause for concern. What is more, for the second half of the 1990s, farmers' views on declining production levels in cocoa were to a great extent confirmed by the production data gathered. The quantity of cocoa beans purchased declined from 210 MT in 1997/1998 to 106 MT in the 1999/2000 season. However, the first years of the new millennium seem to show improvement. The increase may be due to favourable cocoa prices offered by government and by an expected premium price for organic cocoa

Production constraints

Table 3 shows how 19 farmers identified and ranked their production constraints by using 20 stones per farmer. Ten out of the 16 items in Table 3 are related to pest and disease problems. The farmers attributed their low yields to Black Pod disease caused by *Phytophthora palmivora*, which was seen as the most serious production constraint,

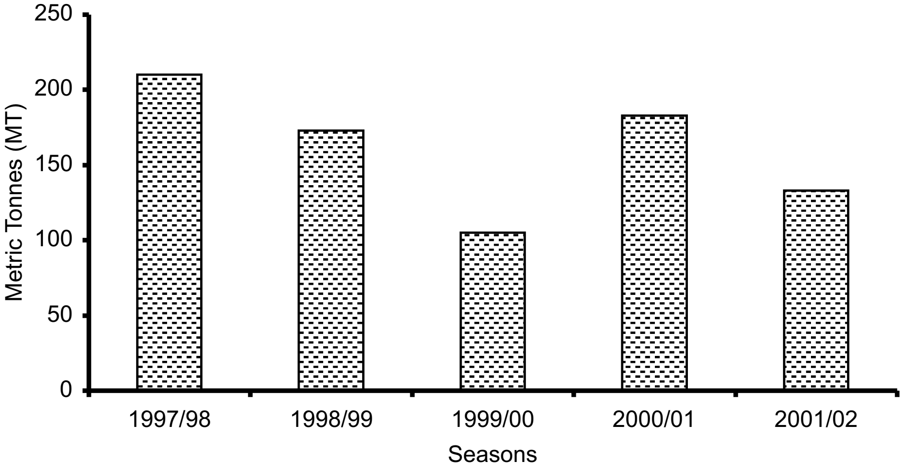

Figure 3. Amounts of cocoa beans purchased from Brong-Densuso, Ghana, during five consecutive seasons.

followed by *Helopeltis* spp. (Cocoa Mosquito). Parasitic mistletoes, capsids, financial problems in the pre-harvest season and 'malfunctioning of tenure agreement' ranked among the highest production constraints. The relatively high score of the financial problems in the pre-harvest period validates the data on monthly income levels (Figure 2). Malfunctioning of tenure agreement was the fifth constraint together with the general disagreements between landlords and caretakers that affected crop management.

As already indicated in the methodology section, the high ranking farmers gave to

Table 3. Cocoa production constraints in order of importance, identified and ranked by 19 farmers in the study area (1st round). Local and scientific names in parentheses.

1.	Black Pod (anonom)
2.	Cocoa Mosquito (*Helopeltis* spp.)
3.	Mistletoe (nkranpan)
4.	Capsids (akate) & financial problems prior to harvesting
5.	Malfunctioning of tenure agreement
6.	Stem borers (osah)
7.	Weeds & parasitic climbing plants
8.	Destructive ants on roots of shade plantain
9.	Termites (nfote) & over-aged trees
10.	Wilting of cocoa on sandy soils along the rivers
11.	Swollen Shoot (kookoo sasabro)
12.	Shade management (removal of unwanted chupons, overgrown branches, thinning or filling in)
13.	Destruction of cocoa by falling trees

the Cocoa Mosquito provided an interesting example of scientist-farmer interaction. Farmers gave the high ranking because the Cocoa Mosquito is often seen in appreciable numbers and causes highly visible black lesions on the cocoa pods. For scientists, the Cocoa Mosquito belongs to the same insect family as the two other capsids. However, the damage it causes is relatively harmless, whereas the damage caused by the two other capsid species is economically very important indeed. These species, which are difficult to spot because they hide under the peduncles and pods and in crevices on stems and branches, are *Distantiella theobroma* (DT) and *Sahlbergella singularis* (SS). Although they also feed on pods, these two capsids are more important because their feeding on tender shoots forms lesions that can become infected by fungi such as *Calonectria rigiduscula,* which causes dieback of the cocoa tree (Entwistle, 1972). Scientists explained these points to the farmers, which strengthened farmers' conviction that pests and diseases constitute their major problem. According to the farmers, six out of every ten pods are lost to pests and diseases.

After sorting out the misconception on *Helopeltis* damage, farmers re-ranked their production constraints (Table 4). In this second ranking exercise, capsids ranked first, followed by Black Pod disease. Although the assembled farmers felt that capsids should be the focus of the research, they agreed that also Black Pod disease control should be given some attention.

Table 4. Cocoa pests and diseases of economic importance as ranked by 19 farmers in the study area (2nd round).

Pest/disease	Local name	Pest/disease	Local name
1. Capsids	Akate	4. Termites	Nfote
2. Black Pod	Anonom	5. Mistletoes	Nkranpan
3. Swollen Shoot	Kookoo sasabro		

Negotiating insect knowledge between farmers and scientists

Joint ecological studies in cocoa plantations involving LARC farmers and scientists, identified the following 'shortcomings' in the knowledge of farmers as perceived by the scientists:

1. Most farmers were not able to identify the capsid species *S. singularis* and *D. theobroma*, but all of them recognized the Cocoa Mosquito (*Helopeltis* spp.).
2. The farmers were not aware that capsid lesions on pods, if left untreated, become necrotic and could look like Black Pod infections;
3. The farmers believed that *Helopeltis* spp. damage cocoa pods and are the cause of clamped beans (*apo-a-apo*). In reality they are caused by the shield bug *Bathycoelia thalassina*, feeding on the pods, leaving the beans empty and dehydrated.

On the other hand, farmers made the following observations, which were confirmed by scientists:

1. All farmers associated the visible lesions on cocoa pods with *Helopeltis* spp.

2. One farmer claimed that SS capsids feed on the tender shoots, sucking sap from the plant and that this effect is most devastating in young cocoa plants.
3. Farmers observed that the Cocoa Mosquito (*Helopeltis* spp.) physically looks like a malaria mosquito (the vector of malaria) and that this species is very different from the two capsid species that form the major pests.

CRIG scientists were impressed by the farmers' knowledge on cocoa ecology. To bridge the 'gaps' they perceived between their knowledge and that of the farmers, they made a presentation showing the species and the damage they cause. They also shared some information on the biology and behaviour of capsids. The scientists explained that *Helopeltis* lesions on cocoa pods only have serious consequences when the pods are still as small as fully-grown okra (*Abelmoscus esculentus)* fruits, but that they do not lead to damage to the beans when the pods are mature.

Although the earlier misconceptions about the role of *Helopeltis* spp. appeared to have been cleared following the explanations from CRIG scientists and the ecological studies in the plantations, it was considered appropriate to conduct a cage experiment for discovery learning to further clarify the situation. We have explained the experimental set-up in the methodology section. Here we describe some of the concrete outcomes. The cage experiment focused on allowing farmers to discover 'what eats what and causes what'?

The farmers convinced themselves that although the cocoa pods in the cage with *Helopeltis* spp. showed a lot of lesions, when the pods were opened the beans were not affected in any way. They also observed that apart from the cocoa pods, *Helopeltis* spp. did not feed on any of the other plant materials, indicating that in the absence of cocoa pods, *Helopeltis* spp. do not cause any harm to the tree. The SS adults fed on all the plant materials in the cage. Farmers were shocked to learn that the five developmental stages (1st to 5th instars) as well as the adults of SS feed on both hard and soft tissues and on the productive parts of the cocoa plant, including the pods. The scientists explained that the DT capsids, which were not included in the cage experiment, also pass through five instar stages causing similar damage (as the SS) to cocoa, but prefer soft shoots to hard ones.

The adults of *Sahlbergella singularis* fed on all the materials in the cages. Farmers realized that the likelihood that this species can survive in the absence of cocoa pods makes them quite dangerous. In all treatments, however, farmers observed that, although some pods and the young shoots had turned black and mouldy, the beans showed no damage when the pods were opened. Yet, the scientists argued that the lesions on tree and pods, particularly on shoots, could become infected and cause dieback, which consequently may kill the cocoa tree.

Farmers concluded from their own observation and discussions that *S. singularis* causes much more damage than *Helopeltis* spp. They also observed that, although all the *B. thalassina* used in the cage experiment were still alive after 96 hours, no lesions were observed on any of the feeding materials. On the other hand, in all cages with *B. thalassina* drops of water occurred on the plant materials. Scientists explained that the mouthpiece of *B. thalassina* is much longer than that of the other insects and can penetrate deep into the pods to suck sap from the cocoa beans, leaving them dry and later clamped. The drops of water in the cage were the result of this feeding behaviour.

It was therefore concluded that *B. thalassina* was associated with clamped beans in cocoa pods. This learning experience settled the misconception between scientist and farmers about which capsid species constitutes the most important pest reducing cocoa production.

Cause-effect relationships of the socio-technical constraints identified

To identify and verify the major causes of low cocoa yields and their relationships for possible areas of research intervention, a problem tree technique was used. Malfunctioning of tenure agreements leads to inadequate crop management practices that in turn lead to excessive weed growth becoming the cause of low yields. The farmers explained that high humidity and lack of proper shade management promote the incidence of Black Pod disease. For Swollen Shoot disease the only control measure is to uproot the affected tree, a measure landlords do not easily accept. On the other hand, caretakers complain that most of the landlords do not comply with their part of the tenure agreement and neither do they visit the farm even when they live in the community, and so they do not seem to appreciate the problems of crop management. Most absentee landlords only visit their farm during harvesting to collect the proceeds but do not invest in inputs to improve the farms. Further probing confirmed that only 39% of the landlords are local residents and that about 25% of all farmers are absentees. Some landlords in turn blame caretakers for stealing cocoa beans before declaring the production.

The exercise revealed that some of the land tenure arrangements are not functioning properly, and this is partly the cause of inadequate maintenance of cocoa plantations and mistrust between some cocoa landlords and their caretakers. This mistrust may have some relation with the low adoption of technologies developed by CRIG since the category of farmers to whom information about the technologies is disseminated may not be the implementers, and if they are they may not be the owners, who make the final decisions. However, the caretakers and the landlords have some disagreement with timber contractors collaborating with some district authorities about felling large shade trees and in this process destroying cocoa trees. This endangers the biodiversity that farmers crave to maintain for organic certification. The shade trees may belong to the cocoa farmers but the District Forestry Officers and the District Assembly, in consultation with the traditional council, give permission to fell them. Meanwhile, both caretakers and landlords admit that their disagreements and mutual mistrust negatively affect crop management practices including pest and disease management. The two groups also share the common view that the cocoa trees do not only constitute an important asset in family wealth (*agyapadee*), but they also make farmers eligible for the acquisition of government scholarships for their children. Cocoa trees can further be used as collateral to obtain loans from banks. All these benefits lead some farmers to consider the number of trees or hectares of cocoa they own as important, if not more important than the yield itself. The social value of cocoa trees is reflected in land tenure arrangements and their role in crop management practices. So capsid control is the only important production-enhancing measure for which the malfunctioning tenure arrangements provide a window of opportunity.

Farmers' pest and disease management practices

After the subgroup discussions at the concluding meeting, farmers showed the pest and disease control measures they practise and the ones they ignore (Table 5). It was noted that apart from *Oecophylla longinoda* that had been proposed as a biological control agent, all measures mentioned – according to the farmers – were in fact CRIG recommendations. So the very limited adoption of CRIG recommendations that we mentioned earlier is obviously not caused by lack of awareness. As we can see from the second and third columns in Table 5, farmers have good reasons not to follow the recommended practices. Hence, even farmers within easy reach of CRIG have adopted a management system that is very low in cost, both in terms of money and labour, but

Table 5. Cocoa pest and disease management practices known to and actually practised by farmers, and reasons for the discrepancy.

Pest/disease	Control measures		Measures not practised and reason why not
	Known to farmers	Actually practised and why	
Capsids	Spraying of synthetic insectices Spraying neem extract Control by *Oecophylla* ants (predators) present on cocoa trees	Farmers benefited from the spraying of neem in 2001 and 2002 Some farmers believe *Oecophylla* ants control capsids but no conscious efforts made yet	No synthetic insecticides for over 20 years due to cost, hazards and interest in organic production for premium price
Black Pod	Crop management practices: weeding, pruning, removal of infected pods (all meant to reduce excessive humidity and spread of disease)	Very few do management practices frequently	Management practices are not done because of labour and financial constraints, and caretaker versus landlord conflicts
Swollen Shoot	Cutting down or uprooting trees for use as firewood	None	Landlords do not want to cut cocoa trees Mealy bugs not controlled because farmers are ignorant of their role as vectors
Mistletoes	Removal of mistletoes	Done by very few farmers	Mistletoes not removed because of labour constraints

provides them with some needed cash with minimal effort. Consequently, national yields are very low and reduce Ghana's status as a cocoa exporter. There is no doubt that the very low prices paid to cocoa farmers have stimulated this strategy. In the past 20 years, farmers only received about 40% of the world market price. The current PhD study is undertaken at a time when the Ghana government has realized that it is killing the 'goose that lays the golden eggs'. As a result it has strategically increased producer prices from 56% in 1998/1999 to 68% of the fob (free on board) price in the 2002/2003 cocoa season (Anon., 1999). For instance, in June 2002 the price of a bag of cocoa beans (64 kg) was increased from $ 34 (¢ 274,000) to $ 48 (¢ 387,500), which was about a 41% increase. By October of the same year, it was further increased to $ 66 (¢ 531,250). Given also the proposed premium prices of 120% to 140% paid for organic cocoa, the experiments with organic cocoa start at a moment when technical innovation again makes sense. Previously, the adoption of even the most appropriate technologies would hardly have been worthwhile. We shall come back to this issue later in the paper.

Towards collective decisions about the research agenda

All stakeholders were brought together in front of a cocoa shed in a special meeting to discuss the next research phase. Apart from all categories of male and female farmers, the stakeholders included community leaders, extension workers, CRIG scientists and an OCP representative. The community leaders consisted of the Caretaker-Chief and some opinion leaders, who at the same time are advisors to the Chief. Special effort was made to include landlords, who have the last say when it comes to choose the agricultural practices on their farmlands. Unlike in most places, landlords in the study area do not pay any form of royalty to any Chief because they have purchased their land from the then Chief of the Akyem-Abuakwa traditional council. This makes the position of landlords very crucial.

The high awareness of CRIG pest and disease management technologies and farmers' reasons for *not* adopting them (Table 5) makes the identification of farmers' criteria for choosing or accepting pest management strategies an important item of the diagnostic study. These criteria were identified in two sub-groups, which produced the following consolidated list:

1. The method should be effective against capsids and other important pests.
2. It should help increase yields.
3. It should be cost-effective.
4. Availability of simple operating equipment in processing the product (e.g. a maize-mill to grind neem seeds).
5. Availability of biological insecticides in the community (e.g. neem trees producing seeds).
6. The method should not be harmful to human life and the ecosystem (e.g. it should not destroy snails that are eaten as a source of protein and that form a delicacy for some of the ethnic groups).
7. The technology should not affect the taboos or cultural beliefs within the community.

8. The waste products of pesticides should be useful (e.g. neem chaff controls some termites).
9. The technology should have other uses, such as medicinal (e.g. neem cures malaria).
10. The product should break down rapidly into harmless compounds. So food crops grown under cocoa should be safe to harvest and eat soon after pesticide application (this is because the farmers practise mixed cropping, even in the cocoa plantations).
11. The method should conform to organic certification standards.

It was observed that because farmers had worked with CRIG, OCP and TOFA on research about botanical pesticides such as neem, it became their point of reference for formulating the criteria.

Discussion among stakeholders about appropriate strategies to address capsids, taking into account the history of farming practices in the area and the arguments brought forward, showed that they were interested in organic pest management. Consequently, the farmers suggested that our study would continue to investigate the use of ANSE. Since the community was engaged in on-going joint trials with CRIG and OCP, the research team initially protested that such a focus would mean a duplication of effort. Yet, the farmers, TOFA, OCP and CRIG argued that ANSE be included because the farmers were divided over whether it could effectively control capsids as alleged by the scientists. Therefore, the PhD study in which farmers would be represented by LARC farmers was an opportunity for an independent cross-check whether ANSE really controls capsids. Another control method to be investigated – the use of a biological control agent (the predatory ant *Oecophylla longinoda*) – was suggested by a female farmer and supported by the rest. Although few farmers argued that *O. longinoda* can effectively control capsids, their concern was that the ants are extremely aggressive so that their use should be further investigated. Although two CRIG scientists insisted that we discard the use of *O. longinoda* because some work had been done in the 1960s without much success, the majority decided that we look into the potential of these ants. In addition, CRIG researchers proposed the use of sex pheromone traps for capsid control.

Conclusions and implications for further research

1. The diagnostic study has confirmed that pest management innovations emerging from the technographic study on cocoa deserve more research attention.
2. Specifically, capsid damage was prioritized as most serious technical production constraint followed by Black Pod disease. Key actors have suggested three innovative (organic) methods to be interactively developed to manage capsid damage.
3. Farmers were initially ignorant of the fact that *S. singularis*, *D. theobroma* and *Helopeltis* spp. are all capsid species. However, they realized through self-discovery learning processes that, although *Helopeltis* spp. are easily spotted in the field causing a lot of visible lesions on cocoa pods, *S. singularis* and *D. theobroma* cause real damage to cocoa production.
4. The study identified an interface between land tenure and pest management

constraints: existing malfunctioning of tenure agreements between landlords and caretaker cocoa farmers, as a social problem, poses a serious threat to effective pest management in cocoa.

5. The study has also provided a better understanding of the livelihood of cocoa farmers and created a platform for learning opportunities among key stakeholders towards the development of more effective pest management methods to address the production constraints identified.
6. In Ghana there is potential for organic cocoa production. So there is a need for creating appropriate conditions such as favourable market opportunities to support interested farmers.

The diagnostic study did not end with the concluding community meeting. The policy context of the cocoa industry changed considerably from 2001 onwards, particularly after the diagnostic study had been completed. Two contextual issues stand out: (1) the change in government policy, and (2) the events around OCP.

Since independence in 1957, the government has always managed the cocoa industry and in fact creamed it off as one of the few sources of hard currency and revenue. In the period 1982–2001, under the World Bank's structural adjustment initiative, the government did not provide or subsidize agricultural inputs. The present government considers this as one of the main causes of low productivity. It is against this background that its present policy of intensifying cocoa production was designed, including the re-introduction of a cocoa disease and pest control programme (mass spraying). As mentioned earlier, other important new policies include raising the farmers' share of the fob price. This price increase alone creates a completely new context for cocoa farming.

The second major contextual change was the withdrawal and collapse of OCP. One of the company's concerns, apart from financial problems, was the fact that they and COCOBOD had a fragile agreement. Whereas COCOBOD argues that OCP has been given exclusive rights for five years to buy organic cocoa from within Brong-Densuso once the local cocoa has been certified, OCP maintains that it has funded research on organic cocoa in four regions for four years with the understanding that COCOBOD would allow the company to buy cocoa from all those areas to justify their investments.

In all, it became clear after the diagnostic study that OCP had withdrawn. The official reason given was that the company has run into financial problems, which was true: the company was liquidated. The withdrawal and collapse of OCP means that the policy environment is no longer very conducive to organic cocoa and that the ideal opportunity has been lost. As described earlier, during the diagnostic study OCP, CRIG, MoFA and ToFA had all worked in harmony in their complementary roles as stakeholders. But few months after the completion of the diagnostic study, news formally got to farmers that OCP had withdrawn from the deal they had with TOFA and CRIG. The LARC farmers deeply regretted this.

During one of the meetings one of the LARC farmers got up and said that their attitude or commitment is low this time because, as he put it: "We still have a problem". They listed the following:

1. "The withdrawal of OCP as the organic marketing company has demoralized farmers interested in producing organic cocoa because the promised premium prices,

the input support (neem seeds and other resources) as well as extension support will not be forthcoming."

2. "We find it very difficult to come together and learn about organic pest management when government is spraying other cocoa farms free of charge. For this reason, farmers from other places as well as new entrants from neighbouring villages not yet involved in TOFA's programme would be less willing to adopt organic farming and not have adequate quantities of organic cocoa beans to attract new marketing contracts."

Similarly, for the above reason, the LARC meeting did not focus on implementing the research agenda agreed upon. Instead the farmers raised issues that questioned the basis for moving ahead with organic cocoa production. What were we to do? Should we as facilitators ignore farmers' concerns and go ahead with the implementation of the research agenda when they claimed "We still have a problem"? In response to the problem situation, our primary strategy was to identify the situations desired by farmers, set these as goals, and collectively search for ways of achieving them. The LARC farmers enumerated the following as the major ingredients for the situation they perceived as desirable:

1. Organic cocoa production and premium prices to be restored to reduce poverty.
2. Formalize protection from synthetic pesticides to ensure a safe environment and organic cocoa.
3. Indiscriminate felling of forest trees on the cocoa farms should be stopped.
4. TOFA's capacity to facilitate concerted action should be strengthened.

Finally, we called for an emergency meeting of all stakeholders who had participated in developing the action plans, which included the Chief, Assemblyman, CRIG, MoFA, COCOBOD and the rest of the community farmers, where we all agreed on both the problems and the proposed way forward. As a result, COCOBOD through CRIG assumed full responsibility to play the role of OCP, and promised the farmers to continue the certification process and to purchase the cocoa at a premium price. Consequently, COCOBOD through CRIG has set aside a budget to support the only organic cocoa production initiative in Ghana.

Reflections on the diagnostic study

Diagnostic studies are not so much a research phase as a continuous process

The diagnostic study did not end with the concluding community meeting, and perhaps it will continue as long as the context keeps changing, requiring regular adaptation through dialogue. These contextual changes have to be discussed among the stakeholders including LARC and the larger community before entering the next research phase. The local platform established by the diagnostic study facilitates such discussions when necessary. The variability of the context seems mainly to be caused by institutional unpredictability. Farmers are keenly aware that their opportunities are determined by the context.

Farmers' perceptions are not necessarily 'indigenous'

The influence of the neem experiment on farmers' perceptions of what is desirable shows that their views are highly influenced by all kinds of sources. It is likely that farmers, upon-hearing the devastating effects of Black Pod disease in other parts of the country, and upon seeing its effects on pods, gave priority to Black Pod disease as the most crucial problem. Theoretical explanations and a discovery learning experiment *made visible* the impact of the capsids.

A realistic research agenda is not just based on eliciting farmers' views

Farmers may not have the complete knowledge. What is important is that the scientists' views have a space for entering into the process of co-producing the research agenda as well, through a negotiation process that maintains farmer ownership over that research agenda. So the purpose of the diagnostic study was not to 'test the hypothesis' that capsids are a major problem. It was to mobilize the collective intention to tackle a shared problem with stakeholders having agreed on complementary roles in designing answers to the problem.

These learning experiences buttress the view that farmers' and scientists' perspectives may be influenced by existing knowledge, which can often be biased and/or limited. Hence the need for participatory and interactive approaches to converge ideas from both scientists and farmers in addressing agricultural production constraints.

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