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Knowledge Improvement and Social Benefits among STCP Farmer Field School Participants in Cameroon

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ABSTRACT

Gaps in the farmer field school literature and mixed results do not allow for conclusions to be reached about the efficacy of the approach, especially in Africa where there are few mature farmer field school (FFS) programs. A case study of farmers who attended cocoa integrated crop and pest management (ICPM) farmer field schools operated by the Sustainable Tree Crops Program (STCP) in Cameroon and non-participating farmers provides empirical evidence on three issues: the effectiveness of FFS training, the potential contribution of farmer-to-farmer diffusion to the scaling up process and social impact. Cameroonian data show positive results that confirm the power of discovery learning. FFS provided farmers with new skills and knowledge on cocoa ICPM and FFS graduates demonstrated superior knowledge on cocoa ICPM generally compared to non-FFS farmers. However, the tendency of FFS participants to retain and diffuse new skills and practices more than concepts and principles suggests the need to review aspects of the training. Forty nine FFS graduates spontaneously provided hands-on informal training to 193 other farmers on key ICPM practices, demonstrating the tremendous potential contribution of farmer-to-farmer diffusion to scaling up farmer training. The case study shows that FFS can be a starting point for farmer empowerment, but suggests that social and technical outcomes can only be sustained if the appropriate local and national level institutions, support systems and policy framework in relation to agricultural extension and research are developed. The paper also highlights methodological issues related to measuring the social impacts of FFS.

Key words: Farmer field schools, Diffusion, Social impact, Cocoa, Integrated crop and pest management, Cameroon, Africa

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I. Introduction

The challenge facing agricultural extension in the 21st century is how to develop sustainable approaches that go beyond extending technical knowledge to producers, to playing a leading role in helping small-scale farmers organize themselves for production, marketing and advocacy in ways that promote farmer empowerment. The farmer field school (FFS) approach, which promotes group learning based on principles of adult education, is seen as one approach that can meet these goals. Developed in Asia in 1980s, FFS have been implemented worldwide on numerous crops, other agricultural activities (e.g. livestock) and even social issues. Introduced from Asia in the mid 1990s, there are currently FFS programs in over 27 African countries covering diverse topics such as integrated production and pest management (IPPM) of annual and perennial crops, soil management, livestock production and HIV/AIDS (Braun, Jiggins, Röling,, van den Berg and and Snijders, 2006).

While recent studies show that FFS leads to reduced pesticide use, increased productivity and improved farmer knowledge (van den Berg, 2004), critics have pointed to two key challenges in promoting the approach: the high cost of FFS in terms of time, funds and human resources and the difficulty of scaling up FFS in a financially sustainable way (Davis, 2006; Feder et al., 2003; Quizon et al.,, 2001). Nearly all of the empirical evidence on FFS implementation challenges is taken from Asian countries with long-standing FFS programs. Moreover, there are important gaps in the FFS literature and mixed results which do not allow for conclusions to be reached about the efficacy of the approach.

Better internalization and retention of knowledge, attributed to the discovery learning process, coupled with social benefits of FFS training, are key justifications for the relatively high time, human and cost investments required to implement the approach. A number of studies show the effectiveness of FFS as a training method by comparing knowledge test scores of FFS and non-FFS farmers (Mutandwa and Mpangwa, 2004; ; Godtland *et al.*, 2003; Rola et al., , 2002) One of the few empirical studies comparing the technical knowledge of FFS graduates and farmers trained through conventional methods showed higher knowledge test scores among the former (Godtland *et al.*, 2003). A study conducted in the Philippines suggests that FFS alumni retain knowledge several years after the training (Rolas et al.., 2002).

Rather than promoting "one fits all" recommendations, the aim of FFS is to impart, in addition to new skills and practices, an understanding of ecological principles and concepts so that farmers can experiment with, and adapt management practices to their own specific farm conditions. Accordingly, FFS seek to improve farmers' problem solving abilities by sharpening their observational skills and decision-making ability. Yet, most research on FFS focuses on adoption of practices and technologies and few studies assess the impact of FFS training on farmer experimentation, observational skills and problem solving abilities. Although Simpson and Owens found evidence of experimentation among Malian and Ghanaian FFS graduates, they conclude that their "potential role as knowledge generators, or how they could approach solving different problems, was clearly not well established" (2002:32).

Proponents of the farmer field school approach propose that social benefits and related spin-offs mitigate the relatively high investment costs. Notably, the social benefits of FFS include better communication skills (e.g. confidence in public speaking, negotiation skills) and increased social capital as a means to collective action. The few empirical studies of social impacts of FFS show mixed results. A recent study in Sri Lanka found that few FFS groups survived as viable entities five years or longer after the end of the training (Tripp et al.,, 2005). Mwagi and colleagues (2003) found that Kenyan FFS graduates gained superior leadership skills and became more cohesive as a group compared with non-FFS farmers. Another Kenyan study found that many FFS graduates are regarded as "role models, opinion leaders and leaders in their communities" (Khisa and Heinemann, 2005). In particular, the study notes that women have "become more confident, assertive and are better able to make decisions on behalf of their household" (Khisa and Heinemann, 2005:80).

The FFS literature devotes much attention to the challenges of scaling up. The FAO team that developed the FFS approach recognized farmer led expansion as a key stage in scaling up. It was expected that, alongside schools led by extension agents with state or NGO funding, FFS expansion would also take place through farmer-to-farmer spread of knowledge and techniques and that communities would establish and support schools run by farmer facilitators, thereby reducing the cost of FFS and making the approach more cost-effective and sustainable. The key diffusion-related questions addressed by researchers are: do farmers share what they learn in FFS? What knowledge do they transmit to other farmers and how effective is farmer-to-farmer knowledge diffusion?

Studies on FFS diffusion show mixed results. While most FFS participants are willing to share their experiences with others, the effectiveness of farmer-to-farmer knowledge diffusion depends on what is being shared and how knowledge sharing takes place. Research conducted in West Africa (Simpson and Owens, 2002) and the Philippines (Rola et al.,, 2002) suggests that FFS participants are more likely to share practices and skills and less likely to discuss abstract concepts and principles with other farmers. Studies investigating the effectiveness of farmer-to-farmer diffusion show disappointing results. While 69 percent of FFS graduates in the Philippines shared what they learned with other farmers, mainly through verbal communication, the knowledge of secondary recipients on key technical topics was not significantly better than that of a control group of farmers (Rola *et al.*, 2002). A recent study in Sri Lanka also suggests limited effectiveness of farmer-to-farmer transmission of the key practices learned in FFS (Tripp *et al.*, 2005). While studies in Africa provide evidence of high rates of knowledge transmission by FFS participants (Gockowski *et al.*, 2006; Bunyatta *et al.*, 2005), few assess what was diffused and whether knowledge recipients internalize the knowledge passed on to them. In Ghana and Mali it was observed that some farmers "established close, almost apprentice-ship type, relations with one or two other farmers" (Simpson and Owens; 2002: 32), but the study did not investigate the technical knowledge of secondary recipients.

Studies on the diffusion behavior of FFS participants provide little analysis of whether the way in which farmers share knowledge (e.g. verbally, through apprentice arrangements or by demonstration) affects knowledge retention and differences in diffusion behaviour between farmers and cross-culturally, ignoring the sizeable sociological literature on diffusion behaviour among small-scale agricultural producers (Adamo, 2001; David and Sperling, 1999; Rogers, 1995;Almekinders et al.,1994). For example, the authors of the Sri Lankan FFS study (Tripp *et al.*, 2005) assumed that FFS farmers would automatically share knowledge with their neighbors, although the importance of social status and networks in determining technology diffusion pathways is well documented (Adamo, 2001; David and Sperling, 1999; Almekinder et al., 1994;;). Wintaro's (2004) study based on participant observation provides rare sociological insight by suggesting that status related factors such as age are an important factor influencing the effectiveness of diffusion by FFS graduates.

Better understanding of diffusion behaviour by FFS participants could help FFS program managers to encourage participants to share knowledge and skills in a more systematic manner.

II. Purpose

As enthusiasm over FFS spreads in Africa and a growing number of donors and governments establish FFS programs, it is important to have more empirical evidence from Africa on the effectiveness of FFS and the strengths and weaknesses of the approach. In particular, more studies are needed on the effectiveness of the approach in imparting knowledge and empowering farmers, areas strongly influenced by the socio-cultural context. These discussions must go beyond mere description to provide analyses of factors contributing to farmer learning and diffusion behaviour and to document the impact of FFS on farmer empowerment. This paper contributes to the literature on FFS impact. It draws on a case study of cocoa integrated crop and pest management (ICPM) FFS conducted by the Sustainable Tree Crops Program (STCP) in the central province of Cameroon. STCP, which operates in four other West African cocoa producing countries (Côte d'Ivoire, Ghana, Nigeria and Liberia), is hosted by the International Institute of Tropical Agriculture (IITA). The aim of the paper is to examine what knowledge and skills farmers acquire in FFS, what they transmit to non-participants and the social impacts of this training approach.

The discussion is organized in five parts. Following the section on research methods, section Two describes the FFS methodology adopted by STCP. Section Three discusses what farmers learned in FFS, their uptake of ICPM practices and diffusion of knowledge, while section Four examines the social impacts of FFS. The final section of the paper assesses the implications of the Cameroon case study for the debate on FFS efficacy.

III. Methods

Between 2003 and 2005, the Sustainable Tree Crops Program (STCP) conducted 65 cocoa integrated crop and pest management FFS in the central province of Cameroon. In 2004, the program supported 15 FFS in the forest and savanna zones. Schools were located in five divisions in the forest zone: Nyongo et Kelle, Nyong et So, Lékié, Mefou et Afamba, Haute Sanaga and in one division, Mbam, in the savanna zone. The vast majority of FFS participants were men, reflecting the low number of women cocoa farm owners in Cameroon. The study was conducted between May and June 2005 using multiple methods to investigate farmers' technical knowledge of cocoa management practices, their diffusion behavior and the social impact of FFS. First, non-structured interviews were conducted with selected FFS graduates to investigate knowledge diffusion patterns. Some interviews revolved around diffusion mapping, a participatory method that allows farmers to show where and with whom they shared knowledge and information (Adamo, 2001). These interviews also allowed the researcher to elicit wealth indicators for inclusion in the formal survey questionnaire and to explore socio-cultural factors affecting farmer-to-farmer diffusion.

In June 2005, a formal survey of FFS and non-FFS participants was conducted around 8 FFS in three Divisions (Lékié, Mefou et Afamba and Mbam), selected to represent forest and savanna agro-ecologies. Interviews were conducted with 8 FFS graduates randomly selected from each school, resulting in a sample of 64 FFS participants. For each of the 8 FFS locations, a non-FFS village was selected based on the following criteria: same characteristics as the FFS village in terms of proximity to a road, agro-ecological conditions, ethnicity of the population, absence of an FFS, resident facilitator or participant. Non-FFS villages were typically between 5 and 25 km from FFS villages. In each of these villages, interviews were conducted with eight cocoa farmers, giving a sample of 64 non-FFS (NFFS) farmers. In most, but not all, cases, non-FFS farmers were randomly selected from a sampling frame of farmers with productive cocoa farms. A third sample, consisting of 26 farmers who received knowledge from FFS participants through demonstration (referred to in this paper as 'knowledge recipients'), was interviewed on uptake of ICPM practices and knowledge. This purposive sample was drawn from the list of knowledge recipients provided by 24 FFS participants interviewed in three villages. All knowledge recipients lived in the same village as FFS graduates. In all, 154 cocoa farmers from 16 villages were interviewed in the three categories (Table 1). Most interviews were conducted in French, but where necessary, local languages were used.

Table 1: Number of farmers interviewed by category and location

	Lékié	Mefou et Afamba	Mbam	Total
FFS graduates	16	16	32	64
Non-FFS farmers	16	16	32	64
Knowledge recipients	16	10	-	26
Total	49	42	64	155

The survey instrument for FFS and NFFS farmers covered questions about uptake of practices/knowledge learned in FFS, diffusion of knowledge acquired from FFS to household and non-household members, method of diffusion, social impacts of FFS and a test to assess knowledge related to four broad areas covered in FFS: cocoa physiology, disease and pest management, rational pesticide use and post-harvest operations. Each question in the knowledge test was related to a basic idea, concept or principle conveyed during the FFS. The test was developed in conjunction with FFS facilitators to ensure its fairness. In scoring the test, a numerical score (1-2 points) was assigned to each correct answer and 0 to incorrect answers.

A shorter questionnaire was administered to knowledge recipients covering what knowledge and practices were acquired from FFS participants, adoption rates and the ICPM knowledge test. Respondents were only asked questions from sections of the knowledge test that corresponded to the specific practice or message passed on by an FFS graduate. It was hypothesized that FFS graduates would have higher knowledge scores than non-FFS participants and that the scores of knowledge recipients would be higher than non-FFS participants.

IV. Cocoa production in Cameroon and the need for a discovery learning farmer training approach

Cocoa (*Theobroma cacao)* has been grown in Cameroon since the 1920s and today the country is the sixth largest producer in the world. The crop accounts for 6% of the country's export revenue and provides over 50% of household income among small-scale growers (IITA, 2003: 11). Farmers in the central province, where the study was conducted, grow cocoa on small farms as part of a mixed farming system incorporating food crops (cassava, yam, maize, melon, cocoyam, groundnuts, vegetables), perennials (banana/plantain, coffee, oil palm, mango, avocado, *Dacryodes edulis*, citrus), and in the case of Lékié Division, horticultural crops (tomato, okra, pepper) grown for sale in urban markets. Although cocoa farms in Cameroon are predominantly owned by men, much of the work is done by household labour. There were few socio-economic and demographic differences between FFS participants and non-participants (Table 2), which implies that the FFS participant selection process was relatively unbiased. Participants tended to have significantly smaller cocoa farms and households, fewer years of experience in growing cocoa and living in rural areas and less access to a means of transportation.

Table 2: Characteristics of farmers surveyed

	FFS graduates (N=64)	Non-FFS farmers (N=64)
Age	41.8	50.0
Years lived in village	29.2	37.2^{**}
Household size	7.0	7.7^{*}
Years of formal education	9.0	7.3
Years of experience growing cocoa	12.8	22.9^{**}
Cocoa farm size (ha)	3.2	4.6^{*}
Have an off-farm income sources (%)	45	31
Belongs to a farmer group (%)	100	91
Type of transport owned (%):		
None	83	70
Bicycle, motorbike, car	17	30
Eton ethnicity (%)	25	27
Had previous training on cocoa (%)	44	41

$^{*}P < 0.05$; $^{**}P < 0.01$

The average yield of cocoa in Cameroon is low at 354 kg per hectare due to the age of the trees (up to half of all trees are above 30 years old), poor farm management and two major biotic constraints: black pod disease caused by *Pytophthora megakarya* and mirids, an insect pest that feeds on young shoots and pods. To reduce losses from black pod disease and mirids, farmers spray their trees an average of 6.3 and 2.6 times per season with fungicides and pesticides, respectively (IITA, 2003). From the mid 1970s, SODECAO, the government agency responsible for cocoa improvement, trained farmers on farm management practices such as planting method, pruning, phytosanitary harvesting and spraying, mainly through demonstrations. It also subsidized the cost of pesticides used to control black pod disease and mirids. Due to declining state and donor support to SODECAO, these training sessions and active cocoa extension were phased out in the mid 1990s.

Despite the decline of state supported cocoa extension, about a third of Cameroonian cocoa farmers surveyed nationwide identified extension agents as their main source of technical information on cocoa, radio being the next most important source (IITA, 2003). Although there was no significant difference in the proportion of FFS and non-FFS farmers that had received technical training on cocoa from SODECAO and other rural service providers (farmer organizations, NGOs, input suppliers) (Table 2), FFS graduates had attended a significantly higher number of training events compared to non-participants. Cocoa extension activities focused on blanket technical messages without much emphasis on understanding interactions within the cocoa agro-ecology and factors contributing to diseases and pests. For example, while demonstrations may be an effective method for teaching farmers skills and practices such as pruning cocoa trees, this approach is less appropriate for conveying knowledge about diseases and pests (e.g. how shade contributes to the spread of black pod disease). Similarly, teaching farmers to spray fungicide on a calendar basis and mass spraying campaigns undertaken by government agents (Sonwa *et al.*, 2004) do not encourage farmers to make observations on disease levels and to make their own decisions about when to spray. The result was, as one farmer put it succinctly "We never learned to think for ourselves". To address these weaknesses in past extension approaches, STCP adopted farmer field schools as a method for training farmers on cocoa integrated crop and pest management.

Because the FFS approach is flexible and has been adapted to various situations and purposes, it is important to describe the specific FFS approach adopted by STCP. The objectives of cocoa ICPM FFS are to increase farmers' yields and reduce pesticide use by encouraging good farm sanitation (pruning, shade management, weeding), rational pesticide use for black pod and mirid management and improve farmers' knowledge of diseases and pests, crop physiology, and post-harvest operations. Schools of 20-30 participants meet fortnightly for an average of 16 four-hour sessions, over a period of 10 months (March to December) to carry out discovery learning exercises and field activities guided by a trained facilitator. Farmers trained by the project, but with no previous FFS experience, facilitated the FFS, most having at least 11 years of formal education.

To encourage experimentation, observation and decision-making, the FFS farm (belonging to one of the participants) is divided into two adjacent plots: the ICPM plot, where new practices are implemented, and the farmer practice plot, where participants carry out their normal practices. Learning occurs through three types of activities. Discovery learning exercises, allow farmers to develop an understanding of concepts and principles related to the topic as well as skills or practices, while field activities focus solely on teaching skills or practices. Through conducting agro-ecosystem analysis (AESA), FFS participants learn how to make close observations on farm conditions and to analyze the interactions between the cocoa trees and other biotic and abiotic factors coexisting in the field. Compared with IPM FFS on annual crops, which focus on pest dynamics, the STCP cocoa ICPM FFS curriculum concentrates more on cultural practices (e.g. pruning, shade management, phytosanitary harvesting and disease management). This emphasis, observed in FFS on other perennial crops (Williamson, 2002), is attributed to the paucity of scientific knowledge about some of the major pests and diseases of cocoa in West Africa, limited IPM options for cocoa, and in some cases (e.g. cocoa pod borer in Indonesia), interactions that are too complex for farmers to understand within a relatively short time span. The group learning process, and specifically group dynamic exercises, are designed to increase farmers' communication skills, self-confidence and encourage team building.

V. Farmer learning and application of ICPM practices

When asked what they learned in FFS, the majority of farmers mentioned practices related to black pod management, spraying and post-harvest operations (Table 3), the main ICPM messages conveyed through the training. A third of FFS alumni considered pruning cocoa trees as the most important topic learned in FFS. FFS graduates were less likely to mention learning about topics related to rational pesticide use (spraying based on observation, choosing the correct sprayer nozzle, correct use and maintenance of sprayers, protection during spraying and pesticide selectivity). With the exception of the concept of natural enemies and the impact of humidity on black pod disease, FFS graduates rarely mentioned agro-ecological concepts and principles covered in the discovery learning exercises, but focused more on management practices and techniques. Although 44 percent of graduates had received previous training related to cocoa, FFS provided new knowledge on a number of topics including shade management, black pod disease management, pesticide application and the concept of natural enemies (Table 3). The emphasis in discovery learning exercises on understanding concepts and principles related to the learning topic through observation and hands-on learning, is probably the main reason why farmers considered much of what they learned in FFS to be new.

Table 3: Technical topics learned in FFS as recalled by participants

	% who mentioned the topic was covered in FFS	% who acquired new knowledge on the topic
Pruning cocoa trees	95	44
Shade management	83	58
Phyto-sanitary harvesting	91	40
Managing black pod	58	54
Impact of humidity on black pod	41	73
Identifying natural enemies and pests	63	78
Quantity of pesticides to use and proper mixing of chemicals	64	63
Spraying method	72	63
Not spraying fungicide on a calendar basis	39	88
Protection while spraying	44	75
Harvesting method	63	50
Pod breaking method	70	49
Fermentation	80	41
Drying	67	33

Most FFS alumni applied ICPM practices on their farms in 2004, although the study did not verify these reports. Compared with non-FFS participants, they were significantly more likely to prune their cocoa trees, manage shade from other trees, carry out phyto-sanitary harvesting more frequently and spray fungicide correctly (Table 4). As the study was conducted in June, it did not investigate post-harvest practices. These findings suggest that key areas of knowledge identified by farmers as acquired from FFS resulted in changes in management practices. Partial budget analysis from a 2005 study of Cameroonian farmers who attended STCP-supported cocoa FFS showed that ICPM practices lowered overall costs of production by 11%, implying that even if cocoa yields were unchanged, farmers would still be better off financially (Nyemeck and Gockowski, 2006).

Table 4: Implementation of key cocoa ICPM practices in 2004 (percent)

	FFS graduates (N=64)	Non-FFS farmers (N=64)
Pruned cocoa trees	98	57
Frequency of phyto-sanitary harvesting:*		
Regularly	89	59
Not regularly	10	13
Never	2	29
Managed shade of other trees*	86	70
Spray fungicide to moisten pods without run-off*	75	22

*P < 0.05 level for difference between groups based on *t*-test.

VI. Diffusion of knowledge acquired in FFS

Eighty six percent of FFS alumni shared some aspect of what they learned with other farmers. Informal training focused on pruning cocoa trees, shade management, spraying technique, phyto-sanitary harvesting and fermentation method (Table 5), the same topics mentioned by the sample of 26 knowledge recipients (Table 6). FFS graduates shared knowledge with an average of 3.9 other farmers. The Cameroonian diffusion rates are higher than those recorded by a 2004 study in Ghana which showed that 86 percent of STCP FFS alumni shared information with, on average, 2 other farmers (Gockowski *et al.*, 2005). Knowledge sharing was effective in sparking interest in FFS among knowledge recipients as evident by the willingness of 19 of the 26 farmers to pay an average of CFA 14,700 (U.S. $28) to attend a field school.

Table 5: Diffusion of knowledge and practices acquired from farmer field schools

Knowledge/practice	% of FFS participants who trained others (n=49)	No. of farmers informally trained by FFS participants
Pruning cocoa trees	84	155
Shade management	43	76
Spraying technique	43	95
Phyto-sanitary harvesting	35	84
Drying	18	30
Quantity of pesticides to use and proper mixing of chemicals	14	18
Grafting	14	40
Identification of insects	12	30
Harvesting	10	27

Note: Percent does not add up to 100 as most FFS participants shared knowledge on multiple topics

Table 6: Cocoa ICPM knowledge and practices learned and applied by knowledge recipients (N=26) (number of respondents)

	Learned	Applied
Pruning cocoa	25	22
Shade management	17	15
Phyto-sanitary harvesting	17	14
Fermentation method	14	12
Quantity of pesticides to use and proper mixing of chemicals	11	9
Harvesting method	9	8
Spraying method	9	8
Not spraying fungicide on a calendar basis	9	8

Since knowledge retention and behavioral change is most likely to occur on the basis of what we see and do, the way information and knowledge was shared is important. While the majority of farmers (84%) verbally shared their field school experience with others, forty nine FFS graduates (77 percent of those surveyed) informally trained a total of 193 farmers through demonstration and verbal instruction on the beneficiary's own farm (76%). A smaller number of FFS alumni provided informal training on their own farm (11%), while 10% assisted knowledge recipients to carry out ICPM practices on the whole farm. In one instance, three farmers requested an FFS graduate to enter into a sharecropping arrangement (locally known as *bolengo*) so that he could apply ICPM practices to their farms. Although the study did not compare learning and uptake of ICPM practices by the method of communication (i.e. verbal instruction alone vs hands-on training), the high uptake of ICPM practices by knowledge recipients in addition to evidence from the extension literature suggests that interpersonal communications and hands-on training as a means of farmer-to-farmer diffusion has a stronger positive effect on learning and adoption rates (Rogers, 1995; Bentley *et al.*, 2003).

FFS participants informally trained relatives (42%), friends/neighbors (30%) and fellow members of farmer groups (27%). Significantly, diffusion occurred predominantly on request (76%) from residents of the same village (84%), but in 16% of cases, knowledge sharing took place outside of the FFS participant's village. Strong demand for knowledge sharing was prompted by visible results (e.g. more pods, less black pod) on the farms of FFS participants. Reasons given by the 14% of farmers who did not share knowledge in any manner were that all their friends were FFS participants and lack of interest on the part of other farmers. One farmer summed up the psycho-social aspect of diffusion by observing: "It is not easy to share knowledge. People thought that I was crazy when I started to prune. It will take time for information to be shared".

As household labour, particularly by women and children in weeding, carrying water for spraying, harvesting and post-harvest operations, is important in cocoa production in Cameroon, intra-household knowledge diffusion has significant implications for FFS impact. Documenting intra-household knowledge diffusion allows us to test the commonly held assumption that agricultural trainees, usually men, pass on new knowledge to other household members. Seventy three percent of FFS graduates shared some aspect of what they learned with a total of 121 household members, 64% of whom were females. FFS graduates shared knowledge with their wives (39%), children (33%), other relatives (25%) and non-related household members (3%). Those that did not pass on knowledge had no other household member involved in cocoa production activities. Participants shared over 17 knowledge points and practices with household members, the most common being phyto-sanitary harvesting (16%), spraying method (14%), pod breaking method (14%) and pruning cocoa trees (12%). Notably, FFS participants were more likely to share management practices rather than knowledge, and with the exception of pod breaking, these were the same practices shared with non-household members.

VII. Farmer knowledge of cocoa ICPM

Test questions were grouped into four subject areas: tree physiology, disease and pest management, rational pesticide use and post-harvest operations, with the first two subject areas focusing more strongly on concepts and principles, while the last two were more skills related. On average, FFS graduates had significantly higher test scores than non-FFS farmers in all subject areas (Table 7), an indication that field schools are providing technical knowledge and information that other farmers do not have access to. However, their test scores on tree physiology and rational pesticide use were below average. While knowledge recipients had lower test scores compared with FFS participants in all subject areas, their scores were higher than those of non-FFS farmers in three of the four areas, significantly so for rational pesticide use and post-harvest practices (Table 7).

Test scores trends between and among the three groups of farmers provide insights into the effectiveness of FFS and knowledge diffusion. While the highest score for all groups was on post-harvest operations, tree physiology (FFS graduates and knowledge recipients) and disease and pest management (non-FFS farmers) received the lowest scores. This suggests three things. First, Cameroonian cocoa farmers generally have relatively good knowledge of post-harvest operations from previous training, although FFS training significantly improved knowledge in this area. Secondly, topics where the test scores of knowledge recipients and non-FFS farmers were significantly different confirms the findings of other studies that informal knowledge transfer through verbal explanation and demonstration is less effective for abstract concepts related to tree physiology and diseases and pests and is better suited to message related practices and techniques (i.e. post-harvest operations and rational pesticide use). Finally, low test scores among FFS graduates suggest that FFS training is weak in the area of rational pesticide use and tree physiology, the latter being an area requiring understanding of abstract concepts.

Table 7: Knowledge test score (%) among FFS participants, non-participants and knowledge recipients

Subject area	FFS graduates	Non-FFS farmers	Knowledge recipients
Tree physiology	50[a]	40	39 (n=25)
Disease/pest management	59[a]	36	42 (n=13)
Rational pesticide use	52[a]	41	50[b] (n=18)
Post-harvest	66[a]	46	62[b] (n=16)

[a] P < 0.00 level for differences between FFS graduates and non-FFS farmers, based on t test
[b] P < 0.01 level of differences between non-FFS farmers and knowledge recipients, based on t test

What accounts for the relatively low test scores of FFS graduates on certain topics? Timing of the study may be one factor. The study was conducted at an early stage in the development of the FFS program (i.e. the second training cycle), at a time when the FFS curriculum was still undergoing changes, especially in the area of rational pesticide use and facilitator training on certain topics still was incomplete. However, evidence suggesting weaknesses in the FFS participants' comprehension of ICPM concepts and principles is worrying in view of the emphasis in the FFS methodology on conceptual understanding. For example, both FFS graduates and non-participants shared certain misconceptions regarding tree physiology. Many farmers considered pruning as necessary to "rejuvenate" a cocoa tree but were unable to explain how this works (i.e. removal of unproductive branches allows for better energy use). Some, both FFS participants and non-participants, maintained the traditional belief that when a cocoa tree has excessive branches, the "sap" is not enough to nourish all the branches, thereby reducing production (*cf.* Bidzanga, 2005). A number of farmers in both groups misunderstood the relationship between light and mirid infestation (thinking that more light means less mirids whereas the opposite is true) and were not aware of the effect of humidity on moss formation. Relatively few FFS participants understood the concept of pesticide specificity and a quarter of those interviewed sprayed fungicide to the point of run-off (Table 4). Weaknesses in the comprehension of FFS participants raises general questions about the effectiveness of FFS in improving farmers' understanding of abstract concepts and principles, and more specific questions about the quality of training in the Cameroon case. A related issue, about which the FFS literature is relatively silent, is method and frequency of evaluating farmer learning and what approaches work best for monitoring and improving training quality.

VIII. Farmer knowledge of cocoa ICPM

Measuring the social impacts of FFS poses major methodological challenges. Our evidence is drawn from a survey questionnaire which asked farmers to evaluate non-technical benefits and verify their responses by giving specific examples of changes in their behaviour. Cameroonian FFS participants mentioned five areas where they experienced social benefits (Table 8). Some FFS participants divided a portion of their cocoa farms into experimental and farmer practice plots so as to compare results after applying ICPM practices. This suggests farmers' interest in adapting ICPM practices to their own farm conditions. Doing agro-ecosystem analysis in FFS led many farmers to base their farm management decisions on observation rather than habit or recommendations, a behavior that they applied to cocoa and other crops. One farmer commented: "Before I used to lose a lot of chemicals [when I sprayed on a calendar basis]. Now, I make observations [on the pods] before deciding whether to spray against black pod disease".

Table 8: Farmers' perception of social benefits from FFS

Benefit/change	Percent
Able to arrive at group consensus	63
Make observations before making farm management decisions	59
More confident public speaker	47
Better at working in a group	41
Experiment more with cocoa and other crops	31

While only a few farmers conducted "experiments" on cocoa (e.g. comparing planting methods, using a new type of fungicide), most experiments were done on other crops; an indication of how FFS improved farmers' problem solving abilities. Some farmers tried pruning other tree crops such as bananas and oil palm, and one even attempted to graft orange trees. Other "experiments" include spraying pesticides on pepper, maize and tomato. Drawing on his new knowledge of natural enemies, one farmer successfully reduced caterpillar populations by introducing red ants into his tomato garden. A more detailed, qualitative study is needed to confirm farmers' perception of increased experimentation and to ascertain whether FFS graduates experiment differently and more frequently than non-participants. The value of strengthening farmers' abilities to solve problems and experiment more systematically can be best optimized by organizing selected FFS graduates into research groups linked formally or informally with national research institutes so that research results can be validated and disseminated more widely through FFS and other channels. Research efforts by FFS graduates and cocoa researchers in Ghana and Nigeria, with support from STCP, is one of the few examples from Africa of how FFS can provide a platform for technology development (*per. comm.* I. Okuku, STCP Nigeria).

FFS alumni reported improved social skills such as punctuality, being able to speak more confidently in public, listen to others without interrupting and respecting the opinions of others. The case where a FFS graduate publicly challenged an extension agent on the safety and specificity of a new brand of insecticide provides anecdotal evidence of farmers' increased self-confidence. As one farmer succinctly noted "Before the FFS I was timid; I could not address people in a group. Now I am confident. I can openly talk with anyone without being afraid". The FFS experience made some farmers more enthusiastic about cocoa farming. Some said that before the training, they went to their cocoa farms to pass time, but now they looked forward to going to their farms to make observations and work. As one farmer confessed "Before the FFS, I used to neglect my work on the cocoa farm. Now I take it more seriously".

The survey provided evidence of stronger social capital among FFS graduates, at least in the short term. Six months after the schools closed, 67% of FFS graduates surveyed continued to meet regularly with other participants without follow-up by an FFS facilitator. Post-FFS groups had an average of six members, but some groups had up to 21 members. Group formation was no doubt facilitated by pre-existing relationships: 89% knew one or more participants prior to the FFS as relatives (72%), friends (67%) or fellow group member (27%). Most groups worked on members' farms on a rotational basis, carrying out ICPM practices, an uncommon practice in some locations before the FFS. Notably, group support and validation appeared to be important to developing and maintaining the confidence for carrying out ICPM practices such as pruning cocoa trees and using pesticides rationally as well as for supporting group action. Five participants belonged to groups that worked for pay on other farmers' cocoa farms. The most common service provided by FFS work groups was pruning cocoa trees. The following quotation provides details on how farmer work groups operate:

> "I am a member of a nine-member work group created in May 2005. The idea of forming the group came from the FFS participants themselves but the facilitator helped us to get organized. The goal of the group is to encourage sharing of ideas after the FFS and to encourage each other to use good production methods. We would like our group to become a new GIC (local interest group) that will encourage its members to grow organic cocoa and to sell for a higher price because the GIC I belong to now does not help us to grow cocoa. Right now, the group consists of only FFS graduates but we would like to open up membership to other people. We work on each other's farms twice a week (Wednesdays and Tuesdays). We are also available to work on non-members' farms for pay".

Three participants had formed a local interest group (GIC), while one had established a savings group (*tontine*) with other FFS graduates. As distances between villages where FFS participants live could hinder post-FFS group formation (28 of the 64 participants surveyed lived an average of 5 km from the FFS site), clustering of FFS sites is recommended to promote collective action, innovation and farmer-to-farmer diffusion (Witt, Waibel and Pemsl, nd).

IX. Conclusions

The present case study provides empirical evidence on three issues where there are gaps in the farmer field school literature: the effectiveness of FFS training, the potential contribution of farmer-to-farmer diffusion to the scaling up process and social impact. Cameroonian data show positive results that confirm the effectiveness of discovery learning. FFS provided farmers with new skills and knowledge on cocoa ICPM, especially pruning of cocoa trees, shade management, phyto-sanitary harvesting, spraying methods and fermentation. FFS graduates demonstrated superior knowledge on cocoa ICPM generally compared to non-FFS farmers, and most applied skills and knowledge acquired from the training to their own farms. However, the study raises two cautionary points regarding farmer learning in FFS. The tendency of Cameroonian FFS participants to retain and diffuse new skills and practices more than concepts and principles raises the question whether elements of FFS related to ecological concepts (e.g. agro-ecosystem analysis) and discovery learning protocols that focus on principles need to be modified, deemphasized or dropped. Doing so would shorten the FFS training cycle and reduce training costs without necessarily compromising farmer learning about cocoa ICPM. Similar studies in STCP project areas in Ghana, Nigeria and Côte d'Ivoire will help to confirm whether weaknesses in farmer knowledge are specific to the Cameroonian case or reflect weaknesses in STCP training tools, facilitation or the FFS methodology more generally. Secondly, while Cameroonian FFS graduates had higher test scores than non-participants, below average scores in the area of tree physiology and rational pesticide use suggest the need to assess the effectiveness of FFS training. FFS managers should regularly assess how trainers are trained on abstract conceptual topics and evaluate facilitators on an annual basis. Because of the high cost of formal evaluation studies and the time lag in getting results from such studies, "quick and dirty" methods for monitoring training quality are needed, especially when large numbers of FFS are being implemented. Scores from the end of training "ballot box" test, an integral part of FFS, could be used more rigorously to evaluate farmer learning and provide quick feedback to program managers and facilitators on training effectiveness.

Besides anecdotal evidence from Mali and Ghana, there is little evidence of FFS graduates' involvement in informal training of other farmers (as distinct from verbal sharing of information) such as highlighted by the present study. STCP FFS staff in other West African countries have also observed apprenticeship like arrangements between FFS graduates and other farmers. What accounts for this behaviour and how can it be supported and encouraged? A number of contributing factors can be proposed including strong traditions of sharing and support found in many African cultures, the existence of multiple strata of social networks and groups into which FFS participants are linked and the confidence developed by FFS graduates through the experiential learning process. More cross cultural sociological studies are needed on farmer-to-farmer diffusion processes of agricultural knowledge and practices to fully understand this phenomenon. Learning from spontaneous farmer-to-farmer diffusion and making it more systematic so as to maximize scaling up, can take many forms including requesting each FFS participant to identify and work with a number of "apprentices", providing "apprentices" with technical support (extension materials and follow-up field visits by FFS facilitators) and encouraging learning through community dialogue initiated by FFS graduates. Some of these approaches are being implemented and monitored by STCP in five West African countries as part of efforts to scale up cocoa ICPM FFS and assess the effectiveness of these approaches.

Much is expected of FFS, but some expectations implied in the literature in relation to social and political impacts may be unrealistic and show a misunderstanding of FFS objectives. Why should we expect FFS farmers to organize themselves around IPM many years after the training without further support (*cf.* Tripp *et al.*, 2005; Wintaro, 2002)? Shouldn't farmers' willingness to organize themselves around non-IPM issues be ample evidence of stronger social capital? Similarly, why expect FFS graduates to be well versed in experimentation when the approach was never intended to provide training in this area (*cf* .Tripp, 2005)? The Cameroonian case study suggests that FFS can be a starting point for social change by improving farmers' ability to make observations and decisions, apply new knowledge to solving other problems, communicate better, have increased self-confidence and form groups to support cocoa production activities as well as other livelihood initiatives. But it would be unrealistic to expect these outcomes to be sustainable without developing the appropriate local and national level institutions, support systems and policy frameworks. A key challenge in Africa is linking FFS groups to rural development initiatives that promote farmer empowerment and developing local institutions for sustaining the momentum created by FFS with the objective of creating an FFS-derived sustainable development movement, similar to the community IPM movement in parts of Asia.

Finally, the study raises up issues related to methodologies and approaches for assessing the impact of FFS. Formal surveys alone cannot provide the kind of in-depth analyses required to understand diffusion pathways, farmer experimentation and empowerment more broadly. Qualitative studies using diffusion and social network mapping, focus groups and participant observation, among other methods, are needed to complement formal surveys. More cross-cultural comparative studies would allow us to determine the importance of cultural factors in determining impact, particularly diffusion behaviour. The timing of knowledge, diffusion and social impact studies is an important issue and should be determined by the specific objectives of the study. Longitudinal studies would be useful for documenting long-term change in behaviour and knowledge. These observations echo calls in the literature for developing a conceptual framework for monitoring and evaluating FFS that considers the interests of both FFS program administers and farmers and documents social, economic and political impacts (van den Berg, 2004).

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