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Paper for International FFS Workshop,
21-25 October 2002, Yogyakarta, Indonesia

FFS for Estate Crops: Ecological, Organizational and Methodological Constraints for carrying out FFS training in Cashew, Cocoa, Coffee, Pepper and Tea

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Abstract:
Farmer Field Schools have been developed in Indonesia for Cashew, Cocoa, Coffee, Pepper and Tea. This adaptation to perennial tree crops has required adaptation of methods of Agro-Ecosystem Analysis and inclusion of several physical and cultural practices within the FFS. Chief among ecological differences is the lack of any ecological crash like a rice harvest. Other differences must be taken into account. A matrix cross-referencing crop problems and needed practices is offered. The main constraints to implementing these methods are of two sorts; organizational, and ecological. Organizational constraints include limitations resulting from the nature of the institutions managing the training. Problems of scaling up must prioritize training quality, without which the effort to do wide-scale FFS training will fail. Ecological constraints are numerous, and for our crops include the lack of robust natural enemies for two pests, Cocoa Podborer and Coffee Berry Borer. Regarding evaluation of training, a basic database has been developed which allows for tracking of learning through FFS leading to improvement of both field techniques and the training exercises. A sample interview instrument is offered.

Acronyms:

AARD	Agency for Agricultural Research and Development
AESA	Agro-ecosystem Analysis
BCA	Biological Control Agent
CBB	Coffee Berry Borer *Hypothenemus hampei* (Coleoptera)
CPB	Cocoa Podborer, *Conopomorpha cramerella* (Lepidoptera)
DGE	Directorate General of Estates, within the Department of Agriculture, Indonesia
FFS	Farmer Field School
GOI	Government of Indonesia
IPM	Integrated Pest Management
IPM-SEC	Integrated Pest Management Smallholder Estate Crops

Introduction. In 1997 the IPM-SEC project first officially began activities and in 1998 training of facilitators was begun in five provinces. The IPM-SEC project, funded by the Asian Development Bank and the GOI, was originally designed to extend IPM farmer training to estate crops. The FFS model of training, originally developed by the FAO assisted Indonesian IPM Rice Programme, and later extended to many other countries, was the model of training adopted.

We have elsewhere described the new version of IPM as "Ecological IPM" in contrast to previous versions which we have labeled "Economic Threshold IPM" (Mangan & Mangan, 1998). This distinction holds here. The IPM-SEC project was developed to apply these same Ecological IPM methods to estate crops which had so successfully been applied to rice and other crops. In one sense the project was an experiment to see if these methods would work.

To assure that there was a research component which responded to the needs for more information, AARD was included in the project. The original hope was that, as the project proceeded, new questions about IPM in estate crops could be answered by research.[1]

Presently, the IPM-SEC project deals with six crops, five of them tree crops. These are: cashew, cocoa, coffee, pepper and tea. The one non-tree crop commodity is cotton. Since much is already known about Ecological IPM in cotton, and since it is an annual crop which undergoes a total harvest (including destruction of the plant itself), it will be left out of this discussion.

Comments on evaluating FFS programs are based on the experience of one of us (Margaret) who designed the evaluation of FFS training with the USDA funded SUCCESS project in Sulawesi, designed to control CPB in cocoa.

The following discussion is largely based on the experiences of adapting Ecological IPM to estate crops.

Does Ecological IPM work on Tree Crops?

The distinction between "Ecological IPM" and "Economic Threshold IPM" is a useful distinction based on emphasis in the approach to IPM. Very briefly, the following table shows some significant differences.

[1] This was a good idea on the surface; unfortunately, AARD has not proven responsive to requests for research and has provided little of any usefulness regarding new field techniques, ecosystem studies, or even new methods to apply BCAs.

Table 1: Distinction between Economic Threshold IPM and Ecological IPM

	Economic Threshold IPM	***Ecological IPM***
observation and field monitoring method	"scouting" of pests for a fixed sample of branches on a fixed number of trees	observation of all elements in ecosystem for a selected number of trees, called "Agro-ecosystem Analysis"
object of observation	pests alone. (Some effort might be made to take note of beneficials, but these do not enter into decision-making.)	presence and interaction of all elements in ecosystem: pests, beneficial insects and spiders, disease, nutrition, crop waste.
chief tool of analysis	formula for determining economic loss due to pest damage.	Agro-ecosystem Analysis, used to assess the relative safety/danger to the tree crop caused by all pests and disease, also noting levels of beneficial insects/spiders and nutrition needs of the crop.
decision method	spray insecticides when you cross the threshold of number of pests to be tolerated.	observe again within less than a week to check on the effects of beneficials in controlling pests.
main advantage	because it is based on a simple formula, it is easy to teach compared to Ecological IPM.	significant reduction in pesticide use over Economic Threshold IPM; far more sustainable with more significant economic and environmental benefits.
main disadvantage	still results in about twice as much pesticide use as is really needed.	must be taught to farmers in multiple sessions throughout the crop season.

We showed that in rice, Farmer Field School (FFS) training in Ecological IPM resulted in significant reductions of pesticide over a different IPM training model in Economic Threshold IPM (Mangan and Mangan, 1998). Here we are dealing with FFS approaches to Ecological IPM in tree crops in Indonesia. Does Ecological IPM also work on Cashew, Cocoa, Coffee, Pepper and Tea? What are the differences between these crops and rice? And how does the FFS approach have to be adapted to accommodate estate crop IPM? There are two significant aspects to this problem; the perennial agro-ecosystem, and the nature of the pests we have to deal with.

The perennial agro-ecosystem. The first aspect that is different about the estate crops treated here is that they are perennials. Each of our crops has a minimum 10 year period of growth; average tree age before complete renewal varies a great deal both from crop to crop and even farmer to farmer, but might be something like 20 years[2].

[2] Coffee and Cocoa can reach 30 years, and Tea even older.

Whereas the rice ecosystem undergoes destruction and hence catastrophic change during harvest, the perennial ecosystem remains fundamentally unaltered, particularly in the case of continuously harvested crops like Cocoa, which produces fruit throughout the year, and Cashew, which has three flushes per year. Tea grows leaves continuously throughout the year. Of the five perennial estate crops we deal with, only one—coffee—can be said to have a significant period during which no flowering and fruiting takes place. This means that any pests are presented with two conditions which do not characterize an annual crop like rice or cotton; a continuous food supply and a dependable habitat.

As a consequence, certain mechanical practices, like plow down after a clear harvest which results in drastic reduction of a pest through destruction of its food and habitat--as with yellow stemborer in China or pink bollworm in cotton--are not possible with perennials and cannot be used for crop pest control. The "natural" condition is therefore one in which the pest is always present in the cropping system; there is no time of initial entry into the system.

Elusive and difficult pests. A second aspect of estate crop IPM is the nature of some of the pests. Two pests are particularly difficult to deal with because they spend all of their larval life inside the very fruit which we wish to harvest, and are invulnerable to both natural enemies and biological and even chemical pesticides during that time. The two most difficult pests of perennials in the IPM Smallholder Estate Crops project are the Cocoa Podborer and the Coffee Berry Borer.

The Cocoa Podborer, CPB (*Conopomorpha cramerella*), is an elusive, nocturnal moth about 1.5 cm long. It lays eggs singly on the cocoa pod. The small egg is difficult to find for both natural enemies and farmers. Immediately upon hatching, the tiny larva bores into the cocoa pod to remain there until ready to pupate. All the while it is feeding inside, it is safe from natural enemies as well as biological insecticides (Bt) and other biocontrol agents like nematodes. Only in the pupal stage, after emerging from the cocoa pod, is it vulnerable to a parasitoid wasp like *Goryphus mesoxanthus*, or to predation by weaver ants and other predators.

The Coffee Berry Borer, CBB (*Hypothenemus hampei*), is a tiny (1.5 mm) bark beetle which spends its entire larval life inside the coffee berry. Males mate inside but never emerge. Only mated females emerge to fly to a new berry and bore into the tip, to lay eggs and start the cycle elsewhere. Only during their flight to new berries, usually in the afternoon, are the adult female Berry Borers vulnerable to predators. True, there is an occasionally released parasitoid wasp in Indonesia, *Cephalonomia stephanoderus*, which enters the hole in the coffee berry and parasitizes the larvae of this beetle, but releases have not resulted in establishment in the coffee ecosystem.

An annual crop pest which is in the same category is the cotton Pink Bollworm (*Pectinophora gossypiella*) which likewise attacks the product we wish to harvest, and remains invulnerable to biological and chemical attack during its larval stage spent inside the cotton boll. However, the Pink Bollworm can be controlled by disposing of all sticks and trash after harvest.

Other pests which attack directly the crop we wish to harvest are two sucking Hemipterans, *Helopeltis thievora* and *Helopeltis antonii*. These two species attack Tea leaves, Cocoa pods, and the budding tips of Cashew. They are therefore serious because they attack not just one of our estate crops, but three. However, they do not safely hide inside the fruit we wish

to harvest, and remain vulnerable to spiders and other predators as well as Biological Control Agents (BCA) such as *Beauvaria bassiana*.

One estate crop pest which probably should be downgraded in seriousness is the canarium moth, *Cricula trifenestrata*, which is an occasional defoliator of Cashew. This moth lays its eggs in a neat row along the outer edge of the cashew leaf, where they are easy to see and collect, and where parasitoids can easily find them. On top of that, the canarium moth produces much higher priced silk than the common silk worm (Kalshoven, 1981: 319), and is presently being cultivated for its silk. Outbreaks are rare, and are quickly put down by parasitoids which achieve a very high rate of parasitization on *Cricula* eggs.

There are two reasons for a basic reassessment of our estate crop pests. The first is that a detailed evaluation of the impact of a pest is necessary if we are to figure out mechanical or biological controls to deal with it within its agro-ecology. The second is to overcome the tendency of pest protection bureaus to regard every pest as very significant and destructive—and even to promote insignificant pests to "significant" status when there are no more significant ones causing problems.[3] This tendency to promote pests to more dangerous status, common in older economic threshold models of IPM, interferes with a realistic appraisal of the condition of the ecosystem from week to week. If all pests are regarded to be equally serious, then it is not possible to do a really accurate analysis of the agro-ecosystem.

These considerations lead to a rough and ready scale of estate crop pest difficulty which takes into account environmental factors presented by the perennial nature of the crop. This rating of pest control difficulty and relative importance can be presented in Table 2 below.

[3] Thus when the Cotton Bollworm, *Helicoverpa armigera*, was not yet significant in Xinjiang in the mid eighties, cotton aphids (*Apis gossypii*) were classed as a significant pest. But in Pakistan, where the Pink Bollworm (*Pectinophora gossypiella*), Spiny or Rough Bollworm (*Earias sp.*) and Cotton Bollworm are present, plus Whitefly (*Bemesia tabaci*) and Jassids (*Empoasca devastans*), the lowly aphid, which has a range of natural enemies, barely makes the pest list. Departments of pest protection, it seems, must have their preferred significant pests.

Table 2: Pest Difficulty Matrix for some Perennial Estate Crop Pests

CONTROL DIFFI-CULTY	SAMPLE CROP PEST	TYPE OF DAMAGE	VULNERABILITY TO NATURAL ENEMIES	NATURAL ENEMIES	MECHANICAL/CULTURAL CONTROLS
HIGH	**Cocoa** Podborer (*Conopomorpha cramerella*)	DIRECT: destruction of harvestable cocoa beans throughout the year	LOW: invulnerable to biological control agents, natural enemies, and non-systemic insecticides while inside cocoa pod as larva. Adults, pupae and eggs vulnerable to some Natural Enemies.	NONE during damage cycle: ants, spiders, and some other predators attach pupa and adult; various larval-pupal parasitoids, an egg parasitoid, and nematodes	YES: 1. open canopy pruning 2. sanitation 3. frequent harvesting 4. plastic bags on young fruit
	Coffee Berry Borer (*Hypothenemus hampei*)	DIRECT: destruction of harvestable coffee beans throughout the harvesting season	LOW: vulnerable to introduced, released parasitoid which is unavailable to farmers. Adults vulnerable to some Natural Enemies when outside the berry.	ONE during damage cycle, but this is an introduced, released parasitoid not available to farmers. Adults may be vulnerable to a number of predators when they are ourside beries. *Beauvaria bassiana* can give significant control in humid areas.	YES: 1. regular harvesting 2. sanitation of over-ripe or fallen fruit 3. release of parasitoid (very restricted availability in Indonesia)
MEDIUM-HIGH	**Tea** Leafsucker (*Helopeltis thievora & antonii*)	DIRECT: sucking and destruction of young tea leaves throughout the year	MODERATE TO HIGH: vulnerable to a range of arthropod and vertebrate predators	SEVERAL: spiders, insect predators, egg and nymphal parasitoids, *Beauvaria* swallows and other vertebrates	YES: frequent harvesting (at least once each ten days).
	Pepper berry sucker (*Dasynus piperis*)	DIRECT: sucking and destruction of young pepper corns at each season	MODERATE: vulnerable to a range of arthropod and vertebrate predators	SEVERAL: jumping spiders, insect predators, the parasitoid wasp *Oencyrtus malayensis*, snakes and other vertebrates	NONE

Table 2: Pest Difficulty Matrix (continued)

CONTROL DIFFI-CULTY	SAMPLE CROP PEST	TYPE OF DAMAGE	VULNERABILITY TO NATURAL ENEMIES	NATURAL ENEMIES	MECHANICAL/CULTURAL CONTROLS
MODER-ATE	**Cocoa** podsucker (*Helopeltis theivora & antonii*)	INDIRECT: pierces and sucks outside skin of cocoa pod throughout the year	MODERATE TO HIGH: vulnerable to a range of arthropod and vertebrate predators	SEVERAL: jumping and other hunting spiders, web weaving spiders, Robber flies, insect predators, and egg and nymphal parasitoids, also *Beauvaria*	YES plastic bags on young fruit, same as with Cocoa Podborer
	Coffee Green Scale (*Coccus viridis*)	INDIRECT: sucks sap from coffee branches and leaves; honeydew promotes growth of fungus on leaves.	HIGH: attached by a range of arthropod predators, but guarded for its honeydew by ants	MANY: Coccinellid beetles provide effective control when ants don't chase them away.	NONE
	Cashew shoot-sucker (*Helopeltis theivora & antonii*)	DIRECT: pierces and sucks the fruiting buds of cashew branch tips at each flashing	MODERATE TO HIGH: vulnerable to a range of arthropod and vertebrate predators	SEVERAL: jumping and other hunting spiders, web weaving spiders, Robber flies, insect predators, and egg and nymphal parasitoids, also *Beauvaria.*	YES: Pruning to open canopy may reduce *Helopeltis* infestations.
	Pepper branch borer (*Lophobaris piperis*)	INDIRECT: bores holes into branches of pepper vines thus reducing productive branches	MODERATE: vulnerable to several parasitoids. May be vulnerable to some predators when outside pepper branches.	SEVERAL: *Spathius piperis* is a parasitoid wasp which parasitizes the larva of *Lophobaris*. *Eupelmus curculionis* is another larval parasitoid. Some generalist predators may attack adult.	YES: cut off affected branches with larvae still inside and burn them

Table 2: Pest Difficulty Matrix (continued)

CONTROL DIFFI-CULTY	SAMPLE CROP PEST	TYPE OF DAMAGE	VULNERABILITY TO NATURAL ENEMIES	NATURAL ENEMIES	MECHANICAL/CULTURAL CONTROLS
LOW	**Cashew** white moth cicada (*Lawana* sp; and *Machaerota rostrata*)	DIRECT: pierces and sucks the budding branch tips of cashew in periodic outbreaks	VERY HIGH: vulnerable to a broad range of arthropod predators and parasitoids and to *Synnematium* fungus.	MANY: web weaving and hunting spiders; mantids and other insect predators; Platygastrid egg parasitoid	NONE
	Cashew Canarium moth (*Cricula trifenestrata*)	INDIRECT: eats cashew leaves in occassional, localized outbreaks resulting in complete defoliation.	HIGH: vulnerable to a broad range of arthropod predators and egg parasitoids	MANY: web weaving and hunting spiders; mantids and other insect predators; highly efficient egg and pupal parasitoids	YES: egg masses are easily seen and gathered for possible sale to silk producers; parasitoids resident in eggs can be released into environment
	Coffee Mealybug (*Ferrisia virgata*)	INDIRECT: sucks sap from coffee branches	HIGH	MANY: Coccinellids and other Natural Enemies provide effective control	NONE

Need for more research. More research is needed into ecological aspects of the most important pests mentioned above. Although "long term national research" is supposed to be done in the IPM-SEC project, this has not included research into potential control by parasitoids and predators. Many significant questions about the breeding cycle of significant pests and the natural availability and role of beneficials in tree crop ecosystems remain unanswered. Among these are the following.

Cocoa Podborer (CPB).
CPB probably originates from the island of Sulawesi and migrated into cocoa from some native host plant. We need to know what affect humidity has on biology and reproduction. What effect does sunlight have on biology and reproduction? What are the chief natural enemies? What is its typical daytime habitat? Besides the pupal parasitoid *Goryphus mesoxanthus* (Ooi, 1992), and egg parasitoids *Trichogrammatoidea* (Sulistiawati & Junianto, 1995), what parasitoids attack the CPB? What predators attack the adult moth? How many eggs does one moth lay? What is the original host plant from which it migrated into cocoa? Are there alternative host plants? What are the natural enemies when on the original host plant? What is the altitude limit above which CPB is not found? Why? etc.

Coffee Berry Borer (CBB) .
CBB is an introduced pest which came into Indonesia with coffee at some point. What are the chief predators of the adult female (if any)? Where does the Berry borer remain after all coffee is harvested? Are there alternative host plants besides coffee? What are the effects of Weaver ants (*Oecophylla smaragdina*) on CBB? What is the maximum range of the flight of an adult female? How many eggs does an adult female lay? How long does an adult female live after laying eggs?

Other questions could be asked about the other pests which appear in the Pest Difficulty Matrix above. Much more research should be done in order to increase our understanding of the biology and ecology of especially the more serious pests.[4]

Suitability of Agro-ecosystem Analysis in high trees and vines.
The method of Agro-ecosystem Analysis (AESA) was first developed on rice as a method of observation of the rice ecosystem, and includes observation of pests, natural enemies, and neutrals (detritivores, weed eaters, etc.) which should be taken into account in making a decision.[5] On rice, this observation is carried out by farmers once a week. It involves the random selection of ten spots (hills) throughout a rice field, and observing of all insects and other animals on the entire rice plant from water level to the tip of the flag leaf. Based on the result, the farmer decides what measures to take.

Estate crop IPM requires a range of different crop management approaches. Some of these are mentioned in Table 3, below. Each crop requires its own approach to agro-

[4] At the same time, lack of research cannot prevent us from proceeding with IPM control methods which seem to work. The idea that research must always precede application is a purely mental schema which cannot be used as an excuse not to proceed with trial and error in the field.

[5] The term "scouting" refers to looking for and counting pests in Economic Threshold IPM. AESA is not the same as "scouting"; if we use the term "scouting", then confusion will occur about what makes AESA different. The term "observation" is always used.

ecosystem analysis. In addition, it requires its own frequency of observation. Pepper and coffee usually undergo agro-ecosystem analysis once in two weeks. Cashew, cocoa, pepper and tea require observation weekly.

Some estate crop canopy shapes (not drawn to scale)

coffee
(two level)

cashew
(older tree)

cacao
(pruned to reduce CPB)

But tree canopies can be much more difficult to observe than rice plants. Some cashew trees grow to more than ten meters high. Canopies can be quite extensive. Some coffee canopies are two-tiered, having a lower canopy at 1.5 meters or so, then a higher canopy at 3 to 4 meters. Ladders are required for AESA on Cashew, high Coffee, and Pepper vines. This also entails some risk—during training, one facilitator trainee fell from a tree.

We have used a rough ratio of one tree in every three in which the farmer should ascend the ladder for a more complete canopy observation. but this is only a rule of thumb. Is this ratio adequate? Which parts of the tree are most crucial to observe? Certainly the budding branches in Cashew, the fruits in Coffee and Cocoa must always be included in the observation. In addition, leaf condition must always be observed (e.g., drooping yellowing leaves for nematodes in coffee or vascular streak dieback in Cocoa) and roots have to receive a careful look (e.g. for White Root Fungus in Cashew or nematodes in Coffee). But is there something missing? What else might be important? The methods we now use may not always be delivering a real picture of the ecosystem. This would be a good topic for research if we could get research institutions to look into it.[6]

So far, AESA delivers better information than any scouting method of observation, simply because it gives more information about the ecosystem. But research is needed to improve the methods on tree crops.

[6] While the IPM-SEC project also involved AARD, researchers in that institution have contented themselves with studying the impact of inputs and have produced nothing so far on the adequacy of sampling methods or the crop ecosystems of the five treecrop commodities in general.

Constraints and opportunities in applying ecological IPM methods in Estate Crops.
How well does the principle of conservation of natural enemies work on estate crops? Ecological IPM began with rice whose pests all have a rich array of natural enemies, both aquatic and terrestrial. Moreover, by the start of the FAO IPM Program, a substantial body of research already existed on the role of natural enemies in the control of the chief rice pest, Brown Planthopper. But tree crops are all substantially different. All are grown as perennials. All (except for coffee) bear fruit either year round or in repeated flushings. Tree crops have a perennial ecosystem which does not experience a total crash as with a rice harvest in which there is a complete destruction of the whole field.. All tree crops also lack the aquatic element in the rice ecosystem which provides many beneficials. Moreover, compared to rice very little research on ecosystems of these tree crops has been done in Indonesia. Next to nothing has been published on the natural enemies of the chief pests.

Table 3, which breaks down the issues for pest control by means of various methods acceptable to IPM, is the result of repeated observations of the Estate Crop ecosystems in 13 participating provinces.

Table 3
Some IPM Constraints and Opportunities
for various Estate Crops, by Crop

IPM METHOD:	CASHEW	COCOA	COFFEE	COTTON	PEPPER	TEA
Conservation of Predators and Parasitoids	Excellent control of *Lawana sp., Machaerota rostrata* (both Flatid Homopterans) and *Cricula trifenestrata* by Natural Enemies; good control of *Helopeltis* by weaver ants and spiders and other Natural Enemies	CPB has too few natural enemies*; good potential for control of *Helopeltis* and *Apogonia* with weaver ants; encouraging black ants (*Dolichoderus* spp.) may reduce *Helopeltis* and CPB	CBB has few natural enemies*. *Zeuzera coffea* , a branch borer, has parasitoids and some predators. Weaver ants may provide some protection against CBB, but there are as yet no experimental results on this.	Pink bollworm conceals itself inside the boll and has few natural enemies* which can control it.	Lots of jumping spiders and robber flies; a parasitoid *Spathius piperis* can control the branch boring weevil *Lophobaris*; as a result disease, not pests, is the main problem.	Loopers are parasitized by Tachinid and Ichneumonoid parasitoids, but there is not a very rich range of spiders feeding on *Helopeltis*.
Augmentation of natural populations of predators and parasitoids	Augmentation of *Aphanomerus* sp., an egg parasitoid of *Machaerota rostrata*, may be possible	Some possibility of control of CPB by release of *Trichogramma* spp., and *Goryphus mesoxanthus*, but no functioning insectaries		Promotion of "dirty farming" in which detritus is piled between rows to harbor food such as springtails for natural enemies	Use of green cover crop, *Arachis pintoi*, to provide refuge for beneficials	

Table 3 (continued)

IPM METHOD:	CASHEW	COCOA	COFFEE	COTTON	PEPPER	TEA
"Classical" Biocontrol (introduction of exotic predators and parasitoids to control introduced pests)			Complete seasonal harvest prevents establishment of CBB parasitoid *Cephalonomia stephanoderis,* first introduced in 1989. Ample populations of Coccinelid *Curinus* introduced in 1986 to control jumping lice in lamtoro now limits green and white scale in coffee.	Some potential for release of *Trichogramma* spp., but no functioning insectaries and little government capacity for insectary management	Within Indonesia, the parasitoid *Spathius piperis* may need to be introduced to certain islands like Bangka, where it has not been observed to occur.	
Mechanical/ Cultural methods for pest control	Pruning and cutting back canopy so trees do not touch prevents expansion of *Helopeltis*	Continuous flowering and fruiting means there is no seasonal die-off of CPB. Pruning, Sanitation, bagging pods, frequent harvesting and fertilizer diminish CPB	Simultaneous flowering and fruiting has not resulted in a CBB die-off; little is known about alternative hosts during the fallow period.		Pruning of affected branches can help control the branch borer, *Lophobaris piperis*	Cutting out bushes infected by *Ganoderma pseudoferreum*, trenching around infected area and applying sulfer
Use of pathogens for biological control	*Trichoderma* can control root rot; *Synnematium* can control Flatid pests; *Beauvaria* attacks *Helopeltis*.	*Trichoderma* can control *Phytophthora*; *Beauveria bassiana 725* can be effective against CPB; *Beauvaria* attacks *Helopeltis*.	*Beauvaria bassiana 615* can be effective against CBB	*Bt* and *NPV* can be used against *Helicoverpa armigera* and *Spodoptura spp.*	*Trichoderma* can control *Phytophthora*	*Ganoderma* can be controlled by *Trichoderma; Beauveria* attacks *Helopeltis*.

FFS Training Issues

The two projects on which we have worked are primarily farmer training projects. Here we offer some assessment of factors which influence the quality of farmer training.

Organizational capacity and will. The chief organizational and training issue is always the capacity and determination of the implementing organization. In this regard, the IPM-SEC project in Indonesia is restricted in its performance by the fact that the main implementing organization responsible for this training is the Directorate General of Estates of the Government of Indonesia. As a consequence, project performance is limited by all the problems of an overextended third world bureaucracy, including lack of clear

job descriptions, unclear responsibilities and mandates, ad hoc work assignments, budgetary leakage, and lack of continuity in personnel assigned to work on the project.

It also means that the motivation structure of the government, which is fraught with many defects and drawbacks, interferes with optimal performance. While government personnel are afraid to do the wrong thing, they are seldom rewarded for doing the right thing, and are hence reluctant to take initiative. Nor is evaluation perceived as a means for project improvement, but is rather seen as a way to cast blame. As an example, in Project Year Five a monitoring and evaluation system still has not yet been put in place, largely because of reluctance of government personnel to be accountable and evaluated. Real on-the-ground performance is thus left to the imagination.

At the same time, the donor agency for the IPM-SEC project is the Asian Development Bank (ADB) which itself is characterized by unclear loan agreements, lack of continuity in project management (four Task Managers in three years) and mixed and confused objectives. The ADB wants performance and institutional change and strengthening, but includes high cost budget items which distract the Department of Estates from this central agenda. One of us (James) estimates that a dedicated NGO would probably be able to deliver much higher quality training services to a far greater number of farmers. The same considerations would affect projects in other countries.

The SUCCESS[7] project, on the other hand, is run by ACDI Voca, an NGO, in cooperation with the provincial Department of Estate Crops in Sulawesi. Because it is not directly implemented by the government, that project has been able to circumvent a great many of these bureaucratic obstacles and distractions referred to above, and train farmers much more quickly. In any comparison, the motivation of NGOs seems to be much better than that in government organizations. Commitment level is higher, and so is efficiency.

Facilitator motivation. The most critical single element in the success of FFS is facilitator motivation. Constraints to this motivation are imposed by the will of the implementing organization to support the facilitators in their work (not primarily to impose authority on them), and to handle logistics effectively. Limitations on support to facilitators are directly proportional to decreases in impact of FFS training. The FFS model of training is a robust one with many levels of redundancy. However, weak and diminishing institutional support or seriousness can result in limited impact and performance, and inevitably affects facilitator morale.

This might seem to be stating the obvious. But it is still worth stating because there are individuals in international donor institutions who have carried out questionable evaluations in an attempt to curtail investment in undertaking FFS. It could indeed be the case that shortcomings attributed to the FFS model would indeed instead be attributable to poor institutional support resulting in both late delivery or non-delivery of supplies and lowered motivation.

Facilitator selection. Another critical factor is selection of people with the right technical background to be facilitators. The FAO Rice IPM Program in Indonesia benefited from already having a core of educated pest observers in every significant rice-growing

[7] Sustainable cocoa extension services for smallholders, aimed at controlling CPB through FFS training.

subdistrict; these pest observers had university education in entomology, and were thus familiar with insects. This gave the rice project a core of facilitators who did not have to be trained in insect and spider identification. However, no such core of trained field observers existed for the Directorate General of Estates. Because there was no corps of trained pest observers, the facilitators in the IPM-SEC project are hired on a contract basis for the duration of the project. This has meant that additional pre-service training has been necessary to assure facilitators can identify insects and spiders—a basic technical skill without which any IPM project will not succeed.[8]

To compensate for this lack of skill at a fundamental level, the IPM-SEC project has developed innovative basic training approaches to training facilitators in methods of insect and spider identification that are aimed at recognizing differences at the order level, and for those orders that contain both beneficials and pests, at the family level. A series of books featuring insects, spiders and diseases, in color, is being published and made available not just to facilitators, but also to farmers.

Monitoring and Evaluation of FFS

Monitoring is designed to check on implementation of an IPM training program—not to penalize. A monitoring function is necessary in any large scale training program in order to make sure training is happening as well as to improve implementation. Preparation and delivery of training materials and providing of training services can always be improved. This is an important function for monitoring.

The most important element in such a monitoring system, once more, is attitude. The monitoring system must be seen as the friend and supporter of more effective logistics and better delivery of training services, not an investigative enforcer. If trainers and support training personnel come to regard the monitoring function as threatening to their job security or career advancement, then it will not succeed.

Participation of trainers and support persons in design of the monitoring system, as well as encouragement of accurate and penalty-free reporting to monitors, can help to achieve this. While it is generally recognized that monitoring must be external to training delivery in order to assure objectivity, there is also a substantial risk that monitoring personnel not directly involved in training may not understand what is most important to observe, record or report.

The function of evaluation. Evaluation here means research into the impact and effects of training. Evaluation is needed in order to revise or fine-tune the training program itself, and to improve training activities and learning levels, learner participation and involvement, and training effectiveness. Evaluation is also needed in order to measure social impact; there is never a technical problem in agriculture extension that is not first and foremost a social problem. Evaluation should also track environmental impact of the training. A database must be set up for tracking farmer responses to FFS training.

The best data should be gathered before training, after training, and a year later, for the same farmers. This approach gives longitudinal data which are far more robust than from

[8] You cannot conserve beneficial insects and spiders if you cannot identify them.

a simultaneous comparison of trained with untrained farmers. However, such data gathering requires a longer term commitment of resources, both human and financial.

Interviewing method. How farmers are interviewed is of critical importance. Asking the right questions in the right way is far more important than sample size. Many studies are worthless despite large sample size because they were not done well and do not gather real information. The following are some important tips to better data collection.

On the type of questions asked

- Include all essential questions and even more which will get supporting information.
- Eliminate all questions which ask the farmer, "are you doing the right thing?" but only ask questions of the type, "what is it that you do? what did you do? what is this?"
- Eliminate all questions which assume the understanding of Agriculture Department jargon or special IPM terminology; use explanatory questions instead.
- Make sure all questions are ones which ask information about what the farmer thinks or does.
- Eliminate all questions which are "test" questions, which test if a farmer knows the meaning of a word or the "correct" name of an insect or spider.
- Make sure questions are structured in such a way that they can be sorted by the computer database (see below) and do not lead to ambiguous answers.
- In formatting the interview instrument, ensure all of any one question is on the same page, because parts of a question that run onto a second page often do not get asked by the interviewer, or else responses to a question occurring on one page do not get recorded by the interviewer on the next page.

On pre-testing the interview instrument

- Once the set of questions has been devised, pre-test the interview instrument with about ten farmers to see if their responses are suitable.
- Revise the interview instrument based on pre-test findings.
- Never avoid pre-testing because you assume that an interview instrument will get the information you are looking for.
- In designing the questionnaire form, make sure adequate space is provided for writing down farmer answers. This is both for the convenience of the interviewer and for the convenience of the person who has to read the answers for entry into a computer.

On the selection and training of interviewers

- Interviewers should know enough about IPM so they can rephrase every interview question if the farmer does not understand it.
- Interviewers are to be made aware through role plays and other training experiences that an interview is NOT a test; that is, each and every answer which a farmer gives is to be regarded as correct.
- Interviewers should know the purpose for every question in the interview instrument.
- Interviewers are to give the farmer adequate time to answer every question, and may not rush the farmer.
- Interviewers must be able to write clearly, so that others can read their writing later.

On the selection of who are to be interviewed

- The sample should include farmers who own and cultivate their own orchards and therefore make decisions about cultivation and crop protection.
- The sample should include women (at least 25%) because women work in every one of these estate crops and make decisions.
- Education level or literacy should not be a criterion because all questions in the interview are to be read and explained by the interviewer.

On carrying out the interviews

- Each farmer is to be interviewed individually in a separate room or alone under a tree.
- No other farmer is to be present during the interview—just the interviewer and the farmer.
- Each farmer should be requested at the end of the interview not to discuss his/her answers with other farmers before they are interviewed, so farmers do not start the rumor that there are "right" answers (i.e., ones which the interviewer accepted).
- Each farmer is to be told that there are no "wrong" answers. For purposes of the interview, all answers are to be regarded as correct.
- Each farmer must have each question read aloud to him/her in order to insure uniformity of treatment regardless of educational background of farmers.
- No farmer may fill in the interview instrument as if it were a questionnaire.
- A question should be rephrased and asked again to make sure the farmer understands it.
- Farmers are to be given as much time as they want to answer questions.

On entering the interview results into a computer database

- Responses to open ended questions should be sorted and "keyed" before computer-entry is started. This will enable computerized data searches to take place later.
- Regarding the keying of open ended questions, one trained interviewer should do all the entry to insure that there are not multiple interpretations of farmer answers.
- The database should be revised based on the kinds of results that come from the interview.

Sample interview instrument to determine impact of cocoa FFS [9]

The following interview instrument (with some modifications) was pre-tested and used in gathering information on cocoa farmers in Indonesia (M.S.Mangan, 2001). This instrument is intended as a sample only; anyone wishing to evaluate an FFS training program should carefully consider all the points mentioned above and design an instrument for purposes of his/her own training program. However, it stands as a good example of how to carefully phrase and sequence interview questions to get at the desired information.

[9] An interview instrument is not the same as a questionnaire. With an interview instrument, all questions are read aloud to each farmer, and the answers are recorded by the interviewer. With a questionnaire, the farmer is free to fill in the questionnaire form him or herself.

SAMPLE FFS INTERVIEW INSTRUMENT (Cocoa oriented)

FFS identification.

1. Date of interview: _____
2. Name of interviewer: _____
3. FFS code _____
4. Province _____
5. District/County _____
6. Subdistrict_____
7. Village _____
8. FFS farmer's name _____
9. Facilitator's name _____

About the Farmer.

10. Farmer's name _____
11. Farmer's age _____ and sex. ☐ Male ☐ Female
12. What is your ethnic group? _____ If from an other island, were you part of a transmigrant program? Yes / No
13. FFS training No._____
    - ☐ graduate, date of graduation:_____
    - ☐ trainee, when started with training? _____
    - ☐ non-trainee, but influenced by training
    - ☐ non-trainee, uninfluenced by training

Family situation:

14. Married Yes / No What does your wife / husband do for work? _____
15. How many people live in your household? _____ people. How many children live at home? _____
16. Have you or anyone in your household had any Farmer Training before? Yes / No

17. (*If "Yes", then . .*) Describe the Farmer Training you have had:
(*Description of Training, and funding organization*) (*Date*)

_____

_____

18. How do you find information about new ways to improve your crop yields?
radio ☐
TV ☐
Estate Crops Field Officer ☐
other farmers ☐
work as labor on a plantation (in Malaysia) ☐
posters/ pamphlets ☐
other ☐ _____

About the Farm.

19. How much area do you farm? _____ ha.
20. What crops do you grow on all your land?

_____

21. What area of land do you have cacao growing on? _____ ha.
22. What is the status of the cocoa land that you farm? ☐ Own ☐ Rent
☐ Sharecrop ☐ Manage ☐ Other

_____

23. What area of land do you have cocoa growing on? How many plots?

Grove	1	2	3	4	5
Distance from home					
Size (ha.)					
No. Trees					
Age					

24. Describe the physical aspects of your cacao grove.
☐ hilly ☐ flat ☐ steeply sloping mountain side ☐ rocky
☐ swampy ☐ prone to flooding ☐ other

_____

About Labour:

25. How many people (family + laborers) work in your cocoa garden/s – how many hours per day do they work in the cocoa garden?

Person (family status/ laborer)	Age/ Sex	Plot	How often?	No. of hours / day?	Type of work?	How much paid

26. Do your children work with you in the cocoa garden? Yes / No

Child	Age/ Sex	Plot	How often/week	No. of hours?	Type of work?

About the cacao trees.

27. What are the names of the types of shade and "other" trees you have in your cacao grove, and how many?

Name of tree in the cacao grove	**Shade/"other"**	**Approximate No. of trees**

28. When did you first grow cacao? _____

29. *If #31 is before 1992, ask. . .* Do you plan to replace your cocoa trees? If so, how?

☐ Replanting? ☐ Side-grafting? ☐Other?

_____

30. Do you have experience with successful side-grafting? _____ What clones did you use? _____ From whom/where did you get these clones? _____

31. Where do you get your information on current cacao prices here?

TV/ radio ☐
Estate Crops Field Officer ☐
other farmers ☐
family ☐
local buyers ☐
other ☐

_____

32. What is your major cacao pest or disease? _____

33. How high did the level of pest infestation (CPB) of your cacao pods get last year during the high harvest? _____ %.

34. How high did the level of pest infestation (CPB) of your cacao pods get last year during the low harvest? _____ %.

About harvesting.

35. How many times and how many kilograms of cacao have you harvested in recent months:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Times												
L /Kg												

36. Which months are the peak harvest months?

_____

37. How do you decide what pods to pick? Pods that are:

__ a) fully yellow only

__ b) partially yellow

__ c) large size, but not yellow

__ d) signs of disease / pest attack

__ e) other

_____

38. Do you ever have difficulty in harvesting your pods frequently and completely?

Yes / No Please explain any difficulty?

_____

39. How many days do you dry the beans? _____

40. Do you ferment your beans? Yes/No If yes: how many days? _____

About marketing

41. To whom do you sell your beans?

☐ local trader comes to your farm

☐ you go to the village buyer

☐ You sell at the market yourself

☐ other

_____

42. How far is the distance to the buyer? _____ Km..

43. What do you pay for transport? _____ /Person _____ /Kg.

44. Do you sell only your own beans? Yes / No Or together with beans from other farmers? Yes / No

About pruning.

45. Do you ever prune your cacao trees? Yes / No

46. (*If "Yes", then . .)* Why do you prune?

_____

47. (*If "No", then...*) Why do you not prune?

_____

48. How many times in one year do you prune your cacao trees?

Maintenance pruning _____ times.

Heavy pruning _____ times

Top pruning _____ times

49. If you prune your trees, how high do you prune? _____ m.
50. What sort of pruning tool do you use? ☐ saw ☐ scissor ☐ parang ☐ pruning shear other _____
51. How do you obtain your pruning tools? _____
52. How did you learn to prune your trees? _____

About cacao grove maintenance.

53. Do you think it is important to sweep up fallen pods, branches and leaves in your cacao grove? Yes / No
54. Why, do you think, might it be important to sweep up fallen pods, branches and leaves in your cacao grove? _____

    _____
55. Do you use a method to clean up the fallen branches and leaves in your cacao groves? Yes / No
56. (*If "No", then...*) Why do you not clean up the fallen branches and leaves in your cacao groves? _____

    _____
57. How do you dispose of fallen branches and leaves?

    ☐ burn ☐ bury them ☐ put in hole ☐ sweep into windrows ☐ put in river ☐ other_____
58. What do you do with the husks of the pods and the fruit waste after opening the pods? _____
59. Is it important to dispose of the husks and fruit waste? Yes / No
60. (*If "Yes", then . . .)* Why do you think it is important to dispose of the husks and fruit waste? _____

    _____
61. When do you dispose of the husks and fruit waste? _____
62. How do you dispose of husks and fruit waste? ☐ burn ☐ bury them ☐ put in hole ☐ sweep into windrows ☐ put in river ☐ other

    _____
63. How many days after harvest do you dispose of husks and fruit waste?

    _____

64. (*If "No" to Question 63, then...*) Why do you not dispose of husks and fruit waste? _____

_____

65. Do you pick the black and dry pods off your trees? Yes / No.
66. What do you do with them? _____

_____

67. Is it useful to remove the black and dry pods off your trees? Yes / No
68. Why might it be useful to remove the black and dry pods off the cacao trees?

_____

_____

About weeding.

69. Do you weed around your cacao trees? Yes / No
70. (*If "No", then...*) Why do you not weed around your cacao trees?

_____

71. What method of weeding do you use? _____
72. Of what use is weeding around your cacao trees?

_____

73. Do you use a herbicide? Which one? _____
74. Do another herbicide? Which one _____
75. How often do you apply herbicide? _____
76. What effect does the herbicide you use have? _____
77. What do you use to measure the amount of herbicide you apply?

_____

78. Do you own a backpack sprayer? Yes / No Size _____

About Fertilizing.

79. What is the current price of fertilizer per Kilogram?

Type	Urea	KCl	TSP	Other
Rupiah/Kg				

80. Have you fertilized your cacao trees in the past? Yes / No

If no, why not? _____

If yes, when was the last time? _____

81. What type/s of fertilizer do you use?_____
82. How many times per year do you apply fertilizer to your cacao trees?
    _____ / year
83. Do you fertilize all your trees at once, or only some at a time? ☐ All at once.
    ☐ Some at a time.
84. How do you decide which trees need fertilizing?
    ☐ Time of the season. ☐ Other farmers are doing it.
    ☐ Extension Officer told you to. ☐ Appearance of your trees
    ☐ Other _____
85. How much fertilizer do you use (e.g.; how many kilograms) per tree?
    _____ kg/ tree.
86. How do you apply your fertilizer? _____
87. What do you use to measure the amount of fertilizer you use for each tree?
    _____
88. Do the husks and the fruit waste have any fertilizer value? Yes / No
89. (*If "Yes,…" then)* What? _____
90. Do you know what compost making is? _____

About pests and predators

91. What animals and insects live in your cacao grove? Describe them or draw them if you do not know their names. _____
    _____
92. Are any of these cacao pests? Yes / No
93. Which ones are pests? _____
    _____
    _____
    _____
94. What makes them a pest?
    _____
95. How did you learn this?
    _____

96. Are any of the animals or insects that you have observed in your grove good for your cacao? Yes / No
97. Name, describe or draw those which are beneficial for your cacao.

_____

_____

98. In what ways are they beneficial?

_____

99. Do you think it is of use to learn all about insects and other animals in your cacao grove? Yes / No.
100. Why do you think that? _____

_____

101. What cacao pests or diseases do you have to deal with?

_____

_____

102. Do you know what CPB is? Yes / No
103. Do you know what Red Branchborer (Zeuzera coffea) is? Yes / No
104. Do you know what Helopeltis is? Yes / No
105. How do you know if you have a problem with CPB? What symptoms would you see? _____

_____

106. Compared to last year, do you think this CPB problem is: ☐ same ☐ less ☐ worse
107. Can you name the stages of the life cycle of the CPB? _____,

_____ , _____ , _____

108. Where did you learn this? _____
109. When do you start to take action against CPB in your cacao grove?

_____

_____

_____

110. What action do you take?

_____

_____

_____

111. Are there any natural enemies for CPB? Yes / No
112. (*If "Yes", then . .*) Name as many natural enemies of CPB as you can

_____

113. Does frequent harvesting help to control CPB? Yes / No
114. (*If "Yes", then . .*) Describe how frequent harvesting can help to control CPB

_____

115. Does pruning help to control CPB? Yes / No
116. (*If "Yes", then . .*) Describe how pruning can help to control CPB

_____

_____

_____

117. Can keeping the ground under your cacao trees clean help control CPB?
Yes / No.
118. (If "yes", then..) Why do you say this?

_____

_____

_____

119. Are spiders and ants useful in your cacao grove? Yes / No
120. How are ants and spiders useful or not useful in your cacao grove?

_____

_____

_____

121. When you spray pesticide against CPB or Helopeltis, is it possible the natural enemies of the pest are also killed?

_____

122. What do you think are the most important problems you have now concerning the production of cocoa?

_____

_____

_____

_____

About Pesticides.

123. Do you use pesticides on your cacao trees? Yes / No If no, why not?

_____

124. For what insect/s do you spray pesticides?

_____

125. How do you decide you need to spray your cacao trees?

_____

126. Is it useful to spray pesticides? Yes / No

127. Why? _____

128. Do you like to spray pesticides on your cacao trees? Yes / No

129. Why do you like / not like to spray pesticides on your trees?

_____

130. How many times did you use pesticides on your cacao trees last year?

_____ / month.

131. As a result of attending FFS, are you using more or less pesticide?

_____

132. Which pesticide/s do you use?

_____

133. How much pesticide do you apply?

_____

134. How do you apply your pesticides?

_____

135. Which part of the tree do you spray? _____

135. What do you use to measure the amount of pesticide you apply?

_____

136. When you spray pesticides, do you:

spray the whole grove, ☐

part of a grove, ☐

only the infected trees, ☐

other _____

137. During which season do you spray pesticide:

during low harvest season ☐
during normal harvest ☐
during main harvest ☐
other (explain)

_____

138. Have you ever noticed an increase in CPB some days after spraying? Yes / No
If 'Yes' . . . What did you notice?

_____

139. *If 'Yes'* . . .about how many days after spraying did you notice this increase?
_____ days.

Some questions about FFS

140. What have you learned in this training that is important to you as a cacao farmer? _____

_____

_____

141. What other problems do you have that training might help?

_____

_____

_____

142. Have you told other cacao farmers about what you have learned in this training?
--- Farmers who are NOT involved in the FFS? Yes / No

143. How many farmers have you told? _____

144. Who have you told? ☐ family ☐ neighbors ☐ friends
☐ other _____

145. What did you tell them?

_____

146. Did you show other cacao farmers how to do any of the skills you have learned in this FFS? Yes / No

147. What did you show other farmers?

_____

148. Where did you show them? ☐ FFS ☐ Your cacao grove ☐ Their cacao grove ☐ Elsewhere _____

_____

149. Have you shown literature or pamphlets you received at FFS to other farmers? Yes / No

150. (*If "Yes", then . .)* What did you show, and to whom ?

_____

151. Of the farmers you have told and/or shown information about CPB control: how many are now really adopting these practices?

_____

152. What is the name of one of these farmers?

_____

153. What has happened to your cacao production since you participated in this FFS?

_____

_____

154. What management practices are you now using to deal with pests and disease in your cacao grove?

What are you doing?	**Why are you doing this?**

155. Compared to last year, what effects are your management practices having on the CPB problem? _____

_____

156. Compared to last year, what effects are your management practices having on the Helopeltis problem? _____

_____

157. Compared to last year, what effects are your management practices having on other problems? _____

_____

158. Is it useful for cacao farmers of one village or sub-village to work together?

Yes / No

159. How is it useful? _____

_____

160. Do you think cacao farmers can organize themselves to improve their cacao yield, and income from cocoa? Yes / No

161. (*If "Yes", then . . .)* How? _____

_____

_____

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