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Final report

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1 Acknowledgments

We thank our project partners the University of Sydney, Cocoa and Coconut Institute of PNG and The Centre for Agriculture and Biosciences International (CABI) - Southeast Asia. We thank Paul Gende and John Konam who left during the project to pursue other goals. We also thank the farmer communities who provided their time and assistance during the project and Dr Richard Markham our original ACIAR RPM.

2 Executive summary

This project involved a collaboration between PNG-CCI, CABI-SEA and the University of Sydney to develop the profitability of cocoa production in PNG following the incursion of the cocoa pod borer (CPB) and introduction of improved planting materials. Baseline surveys for farmers identified to participate on the project activities have been completed for all the project sites. Data showed that implementation of extension training led to increased cocoa yields in three of the four Provinces surveyed, indicating that farmer knowledge is not always the main constraint to productivity when other factores such as finiancial incentives and labour availability are limiting.

Twenty (20) cocoa clones were identified, selected and screened for tolerance against CPB at sites in Bougainville, Madang, New Ireland and East New Britain (Objective 1). These trials will continue beyond the end of the project, with infilling of dead cocoa trees, for collection and analysis of yield data, ADSI and crop loss over a longer period. Budwood gardens for the improved cocoa clones were established at each project site to make the improved planting materials accessible to farmers.

We recognized that the movement of cocoa germplasm involves biosecurity risks and prepared best practice guidelines for biosecurity and nursery practice for endorsement by the PNG Cocoa Board. Propagation methods were tested in Buin, South Bougainville and replicated in New Ireland and Madang Province. Nursery budding was shown to be more successful than field budding at each site.

Compost and fertilizer trials were established on Tavilo plantation, East New Britain. The compost facility to accommodate the shredder was completed and a shredder installed (Objective 2). A goat house has been completed to provide a source of animal manure for composting.

Discussions were held with representatives of PPAP, DPI, Department of Commerce, donors, leading farmers, women's group and exporters to identify priorities and investigate key market outlets both for domestic and export markets. Market opportunities and potential crops and products currently traded in both domestic and export markets and showing potential to diversify smallholder farmer income include vegetables (broccoli, zucchini, tomato, carrot, asparagus), livestock (goats, pigs, chickens), rice, cash crops such as coffee, vanilla, black pepper, betel nut and galip nut, seaweeds and fish in this project (Objective 3). Many families depend on sales of fresh produce at local food markets for much of their income, particularly women. Information on farm planning was included in the extension training under Objective 4.

Region specific extension strategies were developed in collaboration with CABI and PNG-CCIL (Objective 4). The impacts of the regional extension strategies, training activities and overall assessment of adoption of IPDM practices by farmers will be evaluated in a survey to be completed and presented as an Addendum to this report. Training on improved integrated pest and disease management (IPDM) was conducted in all four provinces from 2015 through to 2017. The trainings on different aspects of IPDM/CPB control forms a major component of the inputs into the cocoa farms, using the PPAP PNG Cocoa Extension Manual.

Amongst the key activities successfully completed were the baseline surveys on Knowledge, Attitude and Perception (KAP) of the cocoa farmers, Cacao Good Agricultural Practices (GAP) training manual, Training of Master Facilitators (TOMF), Training of Facilitators (TOF) and farmers. Specifically, we managed to conduct one TOMF for 22 master facilitators from 2 (AROB and NIP) out of 4 selected provinces and three TOF sessions for 19 officers, 84 village extension workers (VEW) and 37 lead cocoa farmers at four project sites in 2 out of 4 provinces in 2017. The TOMF Manual prepared for Cocoa Safe Project was used for the training activities. Inputs were provided on GAP, cocoa safety, Integrated Pest & Disease Management (IPDM) and safe post-harvest processing

aspects. A total of 34 training sessions were held with participation of 533 cacao farmers (repeated farmer in some sessions) from all four provinces on demand and need basis.

The project delivered the following outputs: (i) Guidelines for nursery best practice and safe movement of cocoa germplasm; (ii) skilled human resource (master facilitators, facilitators/village extension workers & farmer trained in various aspects of cocoa production); and (iii) Products e.g. publications and extension and communication materials (TOMF training manual, factsheets, etc.) that are used for communicating key messages and creating awareness.

A number of administrative and operational issues affected the PNG partner organisation, PNG-CCIL, and led to the departure of key staff. These changes limited our ability to achieve all of the original project goals. Despite this, the project was used as the foundation for three new large projects (HORT/2014/094, HORT/2014/096 and SMCN/2014/048) that will ultimately see the project goals realised on a bigger scale than envisaged.

3 Background

Cocoa is an important economic crop of Papua New Guinea (PNG) with annual exports valued at over PNGK300 million. About 80% of cocoa is produced by smallholders, with 150,000 households depending on cocoa for their livelihoods. The overall development goal of this project was to maintain and increase market access of cocoa exports from Papua New Guinea by improving practices along the supply chain to improve smallholder farmer livelihoods. This project builds on the earlier projects funded by ACIAR and conducted jointly by The University of Sydney, CAB International (CABI) and PNG Cocoa Coconut Institute Ltd (PNGCCIL) on management of cocoa pod borer (CPB) in PNG through improved risk incursion management capability, integrated pest and disease management (IPDM) and participatory training through Farmer Field School (FFS) approaches.

Development of improved cocoa planting materials for release to farmers in Papua New Guinea is the major objective of the Plant Breeding Sub Program of the Cocoa Board of Papua New Guinea. In the past cocoa production in Papua New Guinea was largely based on open pollinated Trinitario brought into the country at the beginning of the 20th century. With the introduction of the Upper Amazonian germplasm in the 1960s and subsequent improvements through hybridization of selected Upper Amazonian and Trinitario germplasms, the original Trinitario cocoa is being replaced and fast disappearing. Cocoa improvement efforts culminated in the release of the SG1 & SG2 hybrids in the 1980s and the release of the first and second series of hybrid clones in 2003 and 2013 respectively.

Cocoa hybrids can produce well under good growing conditions. However cocoa hybrids show high tree to tree variability for yield. To address the yield variability problem, the Cocoa Board through the cocoa breeding sub program is encouraging and promoting the use of hybrid derived clones to take advantage of the genetic uniformity that exists in clones as compared to the highly variable hybrids. Clones are genetically identical and are therefore expected to be uniform in terms of their performance.

Pest and Disease resistance/tolerance is an important criterion in addition to other genetic traits in the selection of clones for release to farmers. As such the Cocoa breeding sub program places special emphasis on the selection of disease resistant or tolerant cocoa varieties to major pest and diseases of cocoa in Papua New Guinea.

An important challenge to the Cocoa Industry in Papua New Guinea has been the infestation and subsequent spread of Cocoa Pod Borer in the country since its first discovery in 2006. The devastating effects of the pest are very much evident through the decrease in production and quality of cocoa from Provinces once renowned for cocoa as their mainstay. On the other hand CPB has been partly responsible for recent trials to establish cocoa production in a number of Highland Provinces.

This project focused on the development of new management strategies in regions with new CPB infestations in PNG, and adoption and implementation of Good Agricultural Practices (GAP), providing effective pest control while minimising hazards to the user and the environment. Therefore, cocoa farmers were trained to use IPDM approaches in handling CPB and other problems.

The exploitation of good genetic planting materials requires good management. This project recognized that many farmers use their cocoa plantings as a “fortress crop” within their semi-subsistence livelihood strategy that provides cash in times of need. The incentives for investing an estimated two hours of labour daily per hectare to improve cocoa productivity should be investigated and promoted to cocoa farmers if they are to become successful businesses. Pests and diseases such as CPB and Phytophthora thrive on poorly managed cocoa, and efforts to improve cocoa genetics will be futile unless farmers are encouraged to manage their plantings. In this project we developed improved IPDM practices and investigated to diversification of smallholder farmer incomes

to improve the resilience of livelihood strategies. The integrated cocoa/goat farming system we investigated provides an incentive for farmers to implement sanitation, feed waste materials to goats that then produce manure for organic fertilisers, meat and milk to improve family nutrition. These approaches were designed to encourage GAP by providing incentives and improving capacity.

4 Objectives

This project had four objectives:

Objective 1: To evaluate improved planting material

Objective 2: To integrate improved management practices into sustainable and profitable cocoa farming.

Objective 3: To investigate opportunities for smallholders to intensify cocoa production and diversify income.

Objective 4: To develop region specific extension strategies

5 Methodology

Project planning and coordination

- The Project Inception Workshop was organized at CCIL-Tavilo, after field visits to Madang, Bougainville and East New Britain from 1-12 July 2014
- First Annual Meeting was held in Kavieng, New Ireland from 2-6 November, 2015
- Second Annual Meeting was organized in Madang from 19-23 September, 2016
- Third Annual Meeting was held in Tavilo 9-16 September 2017
- The End-of-project Review was held at Tavilo 11-15 June 2018.

Figure 1. First project inception meeting and visit to cacao field.

Objective 1.

In our efforts to develop and select cocoa for Tolerance to Cocoa Pod Borer a preliminary selection of 42 cocoa genotypes was made from various breeding materials. The clones were established in an on-station plot at the Tavilo Research Centre and tested for two years after which a pre-selection of 20 clones was made for further testing in other locations around the country.

There were four (4) sub activities that included the following;

Activity 1.1: Select clones with good CPB tolerance

Cocoa Pod Borer is a devastating cocoa pest and if left uncontrolled or not adequately managed, has the potential to reduce cocoa production by 80-100%. Since the first incursion of Cocoa Pod Borer (CPB) in PNG in 2006 and the subsequent failure to eradicate the pest, it has now spread to almost all cocoa growing regions of the country. Genetic control for CPB tolerance is an important component of the management package

recommended for the control and management of Cocoa Pod Borer. Many physical traits have been used to select for CPB tolerance but unfortunately no one single trait really stands out when selecting for tolerance.

Experiences from Malaysia and Indonesia have shown that there is no complete resistance/tolerance to CPB and even if found, the pest evolves to overcome resistance. Assessment of breeding progeny using an Average Damage Severity Index (ADSI) for each clone based on pod assessments for CPB is currently being used as a preliminary tool in the selection for relative CPB tolerance. With this method, a scale of 0 - 4 is used to score the pods where, 0 =healthy pods with no CPB and 4 =cemented pod with more than 50% un-extractable beans. The ADSI or Disease

The severity Index for each clone was calculated as follows:

ADSI = [(n1 x 0) + (n2 x 1) + (n3 x 2) + (n4 x 3) + n5 x 4)] / N where;

n1 = number of pods in category 0 (Healthy-No infection)

n2 = number of pods in category 1 (Slight-Sign of infection but all beans healthy)

n3 = number of pods in category 2 (Light-20 % un-extractable beans))

n4 = number of pods in category 3 (Moderate-21-50% un-extractable beans)

n5 = number of pods in category 4 (Heavy->50% un-extractable beans)

Using the ADSI methodology, assessments were carried on various cocoa genotypes, using pods harvested every fortnight. The pods were broken, assessed and scored for CPB damage by assessing the damage and grouping them using the scale of 0 – 4 based on the severity of damage. After calculating the ADSI for each clone, 42 were selected for further testing. Field establishment of the clones was done in 2009 and 2010 and preliminary field screening for CPB was done during 2011-2012.

Activity 1.2: Screening for effectiveness against CPB in multiple sites

Under Activity 1.2, twenty (20) clones were selected from the 42 clones described in Activity 1.1 for multi-location testing. A total of six sites were selected from three provinces (Bougainville, New Ireland, Madang) with two sites each per province. All clones were planted in single rows of twenty (20) trees per clone or two rows of ten (10) trees per clone. A randomized planting arrangement for the clones was done in each site. Selected sites for activity 1.2 are given in Table 3.

Table 3. Testing sites for activity 1.2 under the project.

Province	District	Village
Autonomous Region of Bougainville	North Bougainville	1.Malasang 2.Tinputz
New Ireland	Kavieng	1.Luwapul 2.Panameko
Madang	Sumkar	1.Rempi 2.Murnas

Activity 1.3: Test best specific method for propagation.

Papua New Guinea (PNG) cocoa varieties are propagated through seed propagation or vegetative propagation. The first and more common method is from seeds that are obtained from either open pollinated pods or pods produced by hand pollination of selected cocoa genotypes. The second which is fast gaining popularity are those

vegetatively propagated by bud grafting known as clones. Both types of planting materials have to be raised in a nursery as seedlings or grafted plants before planting in the field.

The growth and performance of the planting materials in the field largely depends on how the plants are raised in the nursery. Given an appropriate husbandry practices, planting of well-nursed seedlings and/or clonal plants result in cocoa blocks with well-established and productive trees.

Vegetative propagation of cocoa through the technique of bud grafting is highly recommended to be done in nurseries. Bud grafting of seedlings in the nurseries produce healthy seedlings for later transplanting out into the field and also high success rate of bud patch sprouting because of environment is conducive for development of buds into emerging seedlings.

However, with time and management cost involved in the process of raising seedlings in the nurseries, bud grafting can be directly done in the field. Rootstocks are established in the field and then grafting is conducted.

Hence, Activity 1.3 involved a comparative study for direct field bud grafting compared to nursery budding or grafting of seedlings. This study was planned to be conducted in three provinces (Autonomous Region of Bougainville, New Ireland and Madang Province). However because of the liquidation of the project partner CCIL it was only conducted in Bougainville at Buin. About 200 rootstocks were raised in the nursery and another 200 rootstock were raised in the field for budding in June 2016. An experienced grafter/budder was tasked to do the grafting. Twenty (20) CPB clones were grafted to the rootstocks both in the and the field at Buin DPI station in South Bougainville.

Activity 1.4: Develop nursery best practice for propagation

Cocoa planting materials available to farmers in Papua New Guinea are derived from either seeds (SG2 hybrids) or hybrid clones (HC-1 and HC-2). The two types of planting materials have different management requirements but both need to be properly raised in the nursery before field planting. Good and healthy seedlings (either hybrids or clones) are important to the establishment of good cocoa blocks or cocoa farms. Farmers are encouraged to adopt good and recommended nursery practices to help raise good planting materials in the nursery for their own use of commercial distribution. Details of good nursery practices were adapted from the cocoa manual on The Establishment, Operation and Management of Commercial Cocoa Nurseries in Papua New Guinea produce by PNG-CCIL.

Objective 2
The activities under Objective 2 were conducted by the CCIL Agronomy team.
Activity 2.1 A shredder was purchased and composting facilities established at Tavilo in 2016, although the shredder was not released from PNG Customs until July 2017. A goat house was also built at Tavilo to provide manure for composting, however the delays in sourcing goats meant that we decided to use chicken manure for the field trials. *Setaria decumbens* was planted as fodder for the goats.
Activities 2.2, 2.3 Hybrid clones were planted to evaluate composts and treatments (6 treatments x 3 replicates) applied in January 2017.
Activity 2.4 Results of these trials will be subjected to a cost-benefit evaluation and used to revise IPDM recommendations.
Activity 2.5 (prospecting biocontrol options for CPB) was suspended because of a shortage of staff and low rate of observations of biocontrol agents in the field.
Activity 2.6 Demonstration plots (4 treatments each of 25 trees) implementing IPDM options were established on 10 farms in each of the four target provinces in 2015.
Activity 2.7 These sites were used in extension training (Objective 4), and used to collect data for the cost-benefit analysis of IPDM.

Objective 3
Activity 3.1 Market opportunities were investigated in interviews with buyers in Australia, Singapore and Malaysia. Results were shared with Government officials and growers.
Activity 3.2 Value chain analysis was used to identify weak points and constraints, and to document market requirements.
Activities 3.3, 3.4, 3.5 Farmer interviews were held to identify potential diversification, including food crops, livestock and fish. Training was included under Objective 4.

Objective 4.

CABI's role was to facilitate the design, conduction and implementation of PNGCCIL activities on ground and to ensure the quality of training activities and evaluate the extension strategy and overall assessment of adoption of IPDM practices by farmers.

CABI also actively participated in field visits and project meetings held in Madang, Bougainville and Tavilo July 2014 (Dr A. Sivapragasam and Jeremy Ngim), Kavieng November 2015 (Jeremy Ngim), Madang September 2016 (Jeremy Ngim and Soetikno) and Tavilo September 2017 (Muhammed Faheem and Jeremy Ngim).

- **Activity 4.1. Conduct knowledge, attitude and perception survey**

A pre-project baseline survey for smallholder cocoa farmers was conducted to better understand their socio-economic conditions, knowledge, attitudes and perceptions in different regions of PNG. PNG-CCIL extension officers interviewed 306 farmers in four regions – (i) Bougainville, (ii) Madang, (iii) Kavieng, New Ireland and (iv) East New Britain provinces during the mid-year 2015. The survey was designed to see how are the farmers profile, their knowledge, attitude, and on- and off-farm practices to cope with the CPB and other crop management practices. The study was focused to understand the grower's attitude towards farming as a business, their ability to sustainable farming and derive maximum benefit from their investments to improve their livelihoods. The survey data were analysed and compiled as a Baseline Survey Report (Appendix 2).

- **Activity 4.2 Develop GAP training modules and update existing curricula**

CABI developed a Cacao GAP training manual as one of its objectives jointly with PNG-CCIL and ACIAR experts. This manual was used for the training of the PNG-CCIL staff, extension officers and finally farmers.

For the preparation of the training manual, a curriculum development workshop was organized with ten participants from CABI and PNG-CCIL. The main objective of this manual was to serve as a guide and reference material for all trainings i.e. training of

master facilitators (TOMF), training of facilitators (TOF) and later farmer trainings. The technical material further will be used to develop leaflets, booklets and posters.

The tentative curriculum for the Cocoa GAP Training Manual and its constituent parts were explained for further brainstorming on the selection of topics. CABI developed the Cocoa Safe Training manual under STDF funds which follows the ASEAN GAP principal and format. There was couple of topics which overlaps with the Cocoa GAP manual. Thus it was decided to combine two manuals into one comprehensive cocoa training manual for PNG which covers all aspects of production, harvesting, processing, GAP, food safety and pesticide use. The manual also have recording forms which can be used for farm records and auditing purposes for farmers that might plan for certification in the future. There is a proposal that cocoa farms that exports cocoa beans to EU need to be certified by 2019.

It was identified that some topics needed to be updated and tailored made for PNG cocoa farmers e.g. (i) cocoa pruning and tree formation for clonal buddings in place of seedling material, (ii) fertilizer application/ manuring and/or composting, (iii) weeding and (iv) insect pest and disease management (IPDM), etc. The other topics like (i) Pesticide usage and safety, ii) Pest and disease data sheets, iii) Harvesting & Post-harvesting, processing and

Figure 2. Curricula development workshop for TOMF training manual

transport can be taken from Cocoa Safe Training Manual. The Cocoa Board was contacted to get information on cocoa bean quality grading and to include this in the manual. It was suggested that the produced extension material be endorsed by the PNG Cocoa

- **Activity 4.3. Train extension staff on updated curricula**

The TOMF training manual (Appendix 5) was used as the latest updated curricula material for the training of the extension staff and other facilitators.

- **Activity 4.4. Test and evaluate the effectiveness of the extension strategy**

The proposed extension strategy in this project is farmer participatory training approaches which includes train the village extension workers (VEW) and lead farmers as facilitators who would go back to their villages, adopt the new farm practices they had learned during the training. Later they will establish the Village Resource Centers (VRCs) to meet with others local farmers in the villages to share what they had learned through Farmer Field School (FFS). This FFS approach was conceptualized between the 1970s and 1980s and first implemented in Indonesia in 1989, and then approach has expanded throughout the word.

The evaluation is important to build programs on solid ground, assure the quality standards, measures the results and pinpoint the improvements needed in the extension strategy. Formative evaluation approaches are being used at each step of the extension approaches i.e. TOMF, TOF and farmer training. Simple pre- and post-evaluation test and participants' feedback were collected during each training.

CABI has developed the protocol for the quality assurance of FFS while training farmer to ensure that the project is implemented as planned (Appendix 4). Further we developed the questionnaire for interviewing the farmers and lead farmers/VEWs to evaluate the delivery of information; farmers' understanding, knowledge and perception; access to information by social class, gender, and ethnic groups; intensity of face-to-face contacts; type of participation (volunteering, planning, recruiting, learning, experimenting, evaluating); indicators of commitment (attendance, continuity, frequency) etc.

- **Activity 4.5. Modify and adapt extension strategy**

After getting the findings from the Activity 4.4, we can make some modification in the extension strategy, if needed and then adapt it on wider scale. This activity will be followed Activity 4.4.

- **Activity 4.6. Training of Master Facilitators**

The Training of Master Facilitators (TOMF) was jointly conducted by six master trainers from CABI and PNG Coconut & Cocoa Institute Ltd. (PNG-CCIL) in Arawa, Bougainville from the April 18 – 22, 2017 (Appendix 5).

- **Activity 4.7. Training of Facilitators**

As per the extension strategy, the trained master facilitators will further conduct the training of facilitator (TOF) for the Village Extension Workers (VEW) as Facilitators. These trained VEWs will establish the Village Resource Centers (VRCs) in their villages. CABI and CCIL master trainers will join and backstop the Master Facilitators in in the various provinces when requested.

- **Activity 4.8. Training of farmers**

As per the proposed extension strategy, the VEWs/Facilitators will establish the Village Resource Centers (VRC) in the villages where they run the farmer field schools (FFS) to train the farmers. We were not yet able to undertake this activity of running FFS in both Bougainville and New Ireland provinces by the trained facilitators/VEWs.

The questionnaire developed in Activity 4.4 will be used during these trainings to monitor the quality and standard operation of FFS. CABI will provide training to Master Trainers on these quality assurance criteria and then MT will fill these questionnaires occasionally in FFS.

- **Activity 4.9. Analyses of social and economic factors that promote adoption of IPDM**

In terms of IPDM, the usual indicators include farmer practice before/after, improved efficiency of input use, improved profitability, increased household income, decreased pesticide load on the environment, and less risk of illness or other negative effects of pesticides. The focus of FFSs was, and still is, on learning through discovery, experimentation and group or community actions. FFSs thus have social goals beyond mere changes in pest management techniques that seek to promote the empowerment of farmers by building human and social capital.

The quantitative method i.e. a structured questionnaire administered using the app Commcare will be used to collect and analyze data and evaluate the impact of IPDM adoption among the cocoa farmers.

CABI-SEA will develop complete protocol and required questionnaires/tools, train the CCIL field staff on collection of information and data.

6 Achievements against activities and outputs/milestones

Objective 1: To rapidly evaluate improved planting materials

No.	*Activity*	*Outputs/ milestones*	*Due date of output/ milestone*	*What has been achieved?*	Comments
1.1	Identification of cocoa planting materials (primarily clones) that are most suitable for mitigation of CPB infestation	Planting material with demonstrated CPB tolerance	7/2014-1/2015	20 new clones have been identified and selected from 57 potential CPB tolerant clones from Breeding program. Selections were based on high yielding potential, good level of resistance to Black pod and VSD and planted in New Ireland (Panamecho and Luapul), Madang (Rempi) and Bougainville (Malasang and Tinputz). All clones were planted in 2015 and early 2016.	Details of the s
1.2	Screen for effectiveness against CPB in multiple locations	Site-specific planting materials	1/2015-7/2017	The clones were planted in 2 sites in New IrelandProvince (Panamecho and Luapul), 2 sites in Bougainville (Malasang and Tinputz), and 1 site in Madang Province (Rempi).	Assessment or CPB damage w come into bear
1.3	Test best location-specific methods for vegetative propagation and establishing the planting materials	Efficient propagation techniques developed	1/2016-1/2017	Farmers have been trained on various plant propagation techniques (bud grafting, top grafting). Budwood gardens have also been established and maintained in each project sites.	20 new clones proven to perfo encouraged re release and pr CPB tolerant cl propagated thr maintenance o access for farm Now linked to H
1.4	Develop nursery best practice recommendations	Nursery recommendations for four Provinces	7/2017	Nursery (smallholder) best practice recommendations have been completed and documented.	The document publication.

P=Partner country, A = Australia

Objective 2: To integrate improved management practices into sustainable and profitable cocoa farming

No.	*Activity*	*Outputs/ milestones*	*Due date of output/ milestone*	*What has been achieved?*	*Comments*
2.1	Develop small-scale composting facilities	Composting produces organic fertiliser on farms	1/2015-1/2016	Composting facilities have been established. Construction of the composting shed and composting boxes started on 24th November, 2015 and completed on 1st January 2016. A goat house for manure collection and composting shed have been built. The goat house (manure source) with capacity to house 1 x buck and 2 x does has been completed. Feeding boxes and walkway have been re-adjusted. A shredder has been purchased for shredding cocoa pod husks. Shredder arrived Tavilo on the 28th July 2017.	The compost fa be used for othe Chicken manure the arrival of go A herd of goats Highlands in 20 University of Na Vudal, ENBP. S Bougainville and concept only an into goat husba Delivery was de Customs.
2.2	Establish compost and fertiliser trials	Trials established to optimise organic/inorganic nutrient requirements in each Province (ENBP, NI, Bougainville, Madang)	7/2015-7/2016	As adequate volume of goat manure is needed for composting work, there is an alternative to collect from UNRE goat house or elsewhere while waiting for sufficient goat and manure stocks at CCI. Have resorted to chicken manure as agreed in 2017 Project Review. 2 weeks old cocoa pod husks have been collected and manually crushed; chicken manure collected from UNRE poultry unit. Composting of cocoa pod husks and chicken manure has commenced on 3/11/17 and is continuing with turning every 15 days for 3 months. Matured compost will be ready for use by 16/02/18. Pasture (*Setaria ducembens*) collected from NARI, Kerevat is established (no costs incurred) for goats. Hybrid cocoa clones to infill an existing Agronomy trial has been field planted and extra clones including clone 73-2/2 is needed to complete infilling.	The trial is yet t Bougainville and Field trials and undertaken in S

2.3	Initiate trials to study soil management under intensified cocoa	Trial established in ENBP, with others to follow	1/2016-7/2017	Hybrid cocoa clones to infill an existing Agronomy trial has been field planted and extra clones including clone 73-2/2, needed to complete infilling. Soil management field trial (6 treatments by 3 replicates) has been established and pre-treatment data collection commenced mid-January 2017.	
2.4	Review IPDM practices	Revised IPDM recommendations	1/2015	Awaits field trial results to revise and make recommendations	Data and inform 2.2, 2.3, 2.6 and basis of the revi implemented at confirming the c hours of labour trials from SMCI fertiliser recomm
2.5	Prospect and evaluate complementary CPB biocontrol options	Additional IPDM recommendations	1/2015-1/2016	This activity was suspended in the 2016 Annual Review Meeting in Madang.	This activity was Malaysia, but su CCIL. There wa biological agent was decided in a separate study project.

2.6	Establish multi-location trials implementing IPDM with intensified cocoa management	Four trials established (one in each Province)	1/2015-7/2017	Multi-location trial sites have been established in the 4 provinces (East New Britain, New Ireland, Madang and Bougainville) in late 2015. Treatments for IPDM and intensified cocoa management inputs have been applied. Several rounds trainings of IPDM/GAP cocoa management practices have been conducted in each of the sites to maintain the inputs and treatments. Trainings include: - Sanitation - Cocoa and shade tree pruning. - Weed management (manual and chemical weed control using herbicides) - Fertilizer/Manure application - Frequent and complete harvesting - Application of fungicides - Control of insect vectors - Monthly target pod spraying Farmers encouraged to plant new improved planting material. Data collection is continuing.	There have bee collection, traini dissolving of PN Multilocation IP effectiveness in training. Four le each site, with 2 Data for Madan Ireland, Bougair but yet to be an Linked to Objec
2.7	Establish demonstration plots for farmer training and extension	Demonstration plots established in villages (10 in each Province)	1/2017-5/2018	More than 10 farms have been identified in each project site. The farms have been used for training to demonstrate various cocoa management skills including IPDM and GAP during training sessions.	Village-level de roll-out improve have been estal trainings have b Monitoring will c IPDM demonstr management. In smallholder pros income diversifi 50% of the cost success.

- P=Partner country, A = Australia

Objective 3: To investigate opportunities for smallholders to intensify cocoa production and diversify income

No.	*Activity*	*Outputs/ milestones*	*Due date of output/ milestone*	*What has been achieved?*	Comments
3.1	Market and consumer analysis to determine market opportunities	Market opportunities identified	1/2016	Research undertaken in Australia, Singapore, and Malaysia A range of unsatisfied markets exists	For PNG smallh value opportunit clearly understo with project offic and Papua New meetings on Bo
3.2	Key constraints analysis to determine capacity for diversification of production and marketing	Constraints identified	1/2016	. Licensing restrictions imposed by Cocoa Board: economies of scales in transportation. Constraints are able to be addressed within the project	Constraints limit respond to prem identified to form beans is limited incentives, rathe disease in prope constraints to ex transportation – project. Neverth within the restric liberalised. Both
3.3	Investigate market diversification opportunities and implementation	Market requirements identified	7/2016-7/2017	Farmers are capable of meeting market requirements	Develop approp handling and ma and market requ Events such as the Warwigira p farmer interest. high-end chocol North America.
3.4	Investigate opportunities for production diversification	Potential small animals, intercrops, supplementary crops and cropping cycles identified	7/2016-7/2017	Farmers and communities are willing and capable of diversification while maintaining cocoa productivity	The Reviewer's developing a be and gender issu were not possib about ambitious cocoa farming h (HORT/2014/09 be analysed. Smallholder farr with different foo especially when food crops has a women, who alr surplus food cro designed to incr productivity. Afte a range of veget scientific instrum appropriate soil, were identified a
3.5	Develop capacity of farmers to meet market demands	Guidelines developed for diversification	1/2017-5/2018	Enough farmers are interested to meet market demand and quality	Many farmers w exploring marke grower interest transport challe

Objective 4: To develop region-specific extension strategies

No.	*Activity*	*Outputs/ milestones*	*Due date of output/ milestone*	*What has been achieved?*	Comments
4.1	Conduct knowledge, attitude and perception studies	Surveys completed in four Provinces	1/2015	Baseline surveys have been completed in the 4 provinces. As agreed in the 3rd Annual Review Meeting in 2017 CABI has assisted in the analysis and a report has been submitted.	Farmers knowle an obstacle to p Adoption of inte practices and g practices are ch financial constra Two key finding 1. If farme them ir succes 2. Irrespe succes yield w similar
4.2	Develop GAP training modules and update existing curricula	Revised GAP curriculum	7/2015	Curricula development workshop was successfully conducted in 2016 at Tavilo Research station. Finally CABI successfully developed the Cacao GAP training manual by June 2016 with support from PNGCCIL. Later it was used in the TOMF and extension officers trainings (Activity 4.5 and 4.6) at Arawa, ARO Bougainville in April 2017 and TOF in Bougainville and New Ireland. CABI has its electronic copy for future updating and we also shared it with Paul Gende and Dr Eremas Tade.	It was suggeste components of from the training pamphlets and done yet due to particularly in th

4.3	Train extension staff on updated curricula	Extension staff trained in GAP	1/2016	TOMF training manual in 4.2 is taken as the latest updated curricula material. Using that material 15 extension staffs were trained jointly with the TOMF in Arawa, Bougainville from 18-22 April 2017.	In East New Brit concurrently wit also supported f focus on village partnership with and more centra Review, this mo to build institutio sustainable imp Extension staff i • Cocoa from N • ABG D • TADEF Private • Village
4.4	Test and evaluate effectiveness of the extension strategy	Extension staff implement strategy in four Provinces	1/2016-1/2017	Need to develop and prepare questionnaire for this activity in advance and conducted during 4.7 & 4.8. CABI has developed a questionnaire for the quality assurance of the process to cover 4.7 & 4.8, and also for evaluation of the effectiveness of extension strategy to cover objective 4.4 and 4.5. Training was conducted to train the Master Facilitators on the quality assurance criteria for FFS and focus group discussion (FGD) with farmers to evaluate the effectiveness of the extension strategy in September 2018. We were only able to collect quality assurance data from three FFS and conduct five FGD due to limited time and staff availability.	CABI has plann training for PNG but it was delay
4.5	Modify and adapt extension strategy	Strategy reviewed and modified for local farmers in each Province	1/2017-5/2018	Based on activity 4.4, the concept of VEW, VRC and FFS approaches were fully acknowledged by the farmers and they received many benefits from these trainings. But they also suggested few additional activates along with FFS i.e. develop an online knowledge bank and ICT tools on available advanced information and production techniques for their easy access. Due to delay in activities 4.4 and 4.8, we were not able to modify the extension strategy based on the findings of activity 4.4. Also need to consider request for training material in local language (budget to produce local training material – like posters, leaflets, booklets, etc.)	Although, farme FFS approach b farmer's fields. E we can propose future extension offline informatio We are not able

4.6	Train Master Facilitators	TOMF course conducted. Core of MF trained	7/2015	The training was completed in Arawa from 18th to 22nd April 2017 with additional night sessions to cover all planned topics. A total of 22 master facilitators (MF) participated in the TOMF from three regional hubs in Bougainville (8 from North & Central and 4 from South) and one regional hub in New Ireland Province(2)	Due to certain a participants from selected to parti Extension staff i • Cocoa from N • ABG D • TADEF Private • Village
4.7	Train Facilitators	TOF courses conducted. Cadre of local Facilitators trained	1/2016	These trainings were undertaken by provinces after TOMF Training in Arawa. The master facilitators, J.Tunjio and P. N'nelau were responsible for TOF in AROB and K. Daslogo and J. Joseph were responsible for TOF in NIP. In New Ireland Province, the master facilitator John Joseph conducted two ToF sessions in Kavieng and Namatanai District, while in Bougainville province, the master facilitators, Jerry Tunjio and Bruno Batari conducted three ToF sessions in Tasipo and Bona Districts. They trained 19 officers and 84 VEWs. In Bougainville around 37 farmers also joined the TOF trainings instead of VEWs. CABI and CCIL Master Facilitators to support the master facilitators in AROB and NIP	In TOF session, husbandry, nurs demands of thei cover the whole required to cove IPDM, nutrition processing etc. Once again the activity, and roll REDS
4.8	Train farmers	FFS conducted. Understanding of improved management by FFS-trained farmers enhanced	7/2016-7/2017	The proper and regular FFS approach was not followed during the training of farmers. Many training sessions were conducted on need basis regarding improved IPDM and GAP in each of the project sites (NI, Bougainville, ENB and Madang). A total of more than 34 farmer training sessions were conducted with the attendance of 533 farmers (approx. total 363 farmers) in four provinces. This activity was also combined with activity 2.5, 2.6 and 2.7. The questionnaire developed in activity 4.4 was practiced in only two FFS in ENB to ensure the quality and standard operation of FFS. CABI already provided training to Master Trainers on these quality assurance criteria and so that they can use it while visiting FFS.	FFS approach c certain limitation .

4.9	Analysis of socioeconomic factors that promote adoption of improved management	Data collected and analysis completed	7/2017-5/2018	This was undertaken after completion of activity 4.7 and 4.8 and project completion. CABI has developed the questionnaire in collaboration with CCIL and Prof. David and then trained the CCIL/field teams to collect data. The questionnaire was transformed into electronic farm on Commcare online database and tablets were provided to CCIL field teams for direct data entry into the database while interviewing farmers. Later CABI and CCIL will analyse to find out the adoption of IPDM and its contributing factors.	This activity is c app. Results an Addendum whe As suggested b focus on the live resources, cons perceptions. A r cocoa farming fa Bougainville has on livelihoods, c health that will c These data will cocoa farming fa research, develo .

- P=Partner country, A = Australia

7 Key results and discussion

Objective 1 To evaluate improved planting material

Activity 1.1 Identification of cocoa planting materials that are most suitable for mitigation of CPB.

Table 1: Relationship between ADSI and Crop Losses.

		Mean		
NO.	**Classification Groups**	**ADSI**	**Losses (%)**	**Corre.(r)**
1	Highly Tolerant	0.62 (0.0-0.9)	5.33 (0-16)	0.41*
2	Tolerant	1.18 (1.0-1.4)	16.25 (6-22)	0.51*
3	Moderately Tolerant	1.62 (1.5-1.9)	20.05 (15-33)	0.56*
4	Moderately Susceptible	2.50 (2.0-2.7)	50.05 (30-55)	0.70**
5	Highly Susceptible	3.40 (3.0-4.0)	80.00 (47-100)	0.93**

Table 2: Quality attributes for some of the selected 42 clones.

Clone	Bean Weight (g)	Shell (%)	Kernell Weight (g)	Clone	Bean Weight (g)	Shell (%)	Kernell Weight (g)
18 –86	0.897	14.2	0.769	30–35	0.726	16.6	0.605
9–208	0.814	14.1	0.699	37-13/1	0.808	15.5	0.683
MUTT	0.675	18.1	0.553	24-4-5	1.570	13.4	1.359
A-25-2-9	0.838	14.1	0.720	2-96	0.867	13.0	0.755
24–4/4	1.087	12.5	0.951	S23-19	1.193	12.6	1.043
S23–5	0.745	18.5	0.607	JK1	0.564	17.4	0.466
14-83	0.873	14.9	0.743	B-3	1.074	13.3	0.931
42-2-10	0.980	13.0	0.852	45-3-2	1.115	14.5	0.953
H-79	1.000	11.7	0.883	96-1-15	1.001	16.7	0.834
B – 9	1.012	14.0	0.870	S23–10	0.753	16.7	0.627
48-2–5	0.789	15.2	0.669	73-14/1	0.686	19.9	0.550
7B-III 4	0.813	16.6	0.678	A8-1-14	0.892	13.9	0.768
13–63	0.755	17.3	0.625	MAN-15-2	0.756	16.2	0.634
38-3/11	1.216	13.8	1.048	A18-1-14	0.814	14.4	0.696
12 66	0.601	17.0	0.499	I10	0.961	15.0	0.816
KAKUNU	0.979	15.1	0.831	M-9-4	0.744	15.9	0.626
17-3/1	0.682	18.4	0.556	13-192	0.766	18.6	0.624
P7	0.729	16.4	0.609				

Figure 1.1: ADSI for 42 Clones during 2011 to 2012

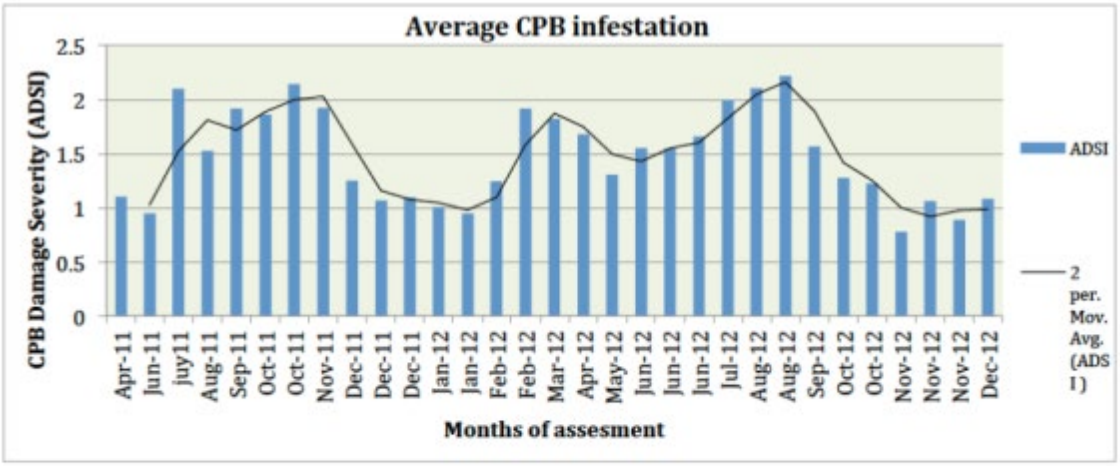
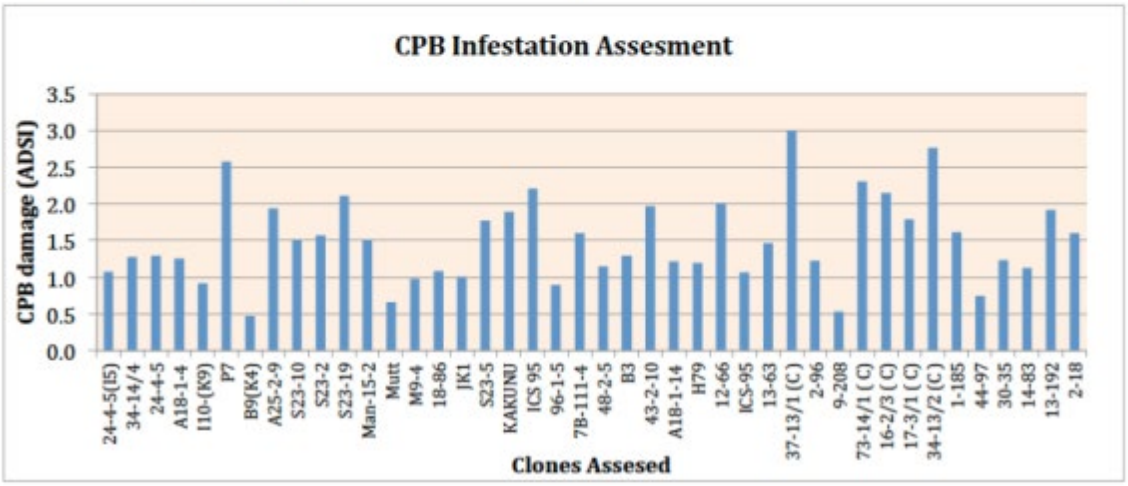


Figure 2: Average ADSI for 42 clones tested during 2011 and 2012.



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5	Highly Susceptible	3.40 (3.0-4.0)	80.00 (47-100)	0.93**

Activity 1.2: Screening for CPB in Multiple Sites

Of the 42 clones tested 8 rated “highly tolerant” (average 5.33% CPB loss), 26 “tolerant” (average 16.25% CPB loss) and 8 “moderately tolerant” (average 20.05% CPB loss). The progeny with lowest CPB loss and acceptable quality attributes were 96-15, 9-208, 18-86, A18-1-14, H79, 2-96 and 14-83. Twenty (20) clones were selected from the 42 clones described in activity 1.1 on the basis of CPB tolerance (Figure 2; “highly tolerant” or “tolerant”), bean size (Table 2) and other agronomic attributes for multi-location testing (Table 4).

A total of six sites were selected from three provinces (Bougainville, New Ireland, Madang) with two sites each per province. All clones were planted in single rows of twenty (20) trees per clone or two rows of ten (10) trees per clone. A randomized planting arrangement for the clones was done in each site. Selected sites for activity 1.2 are given in Table 3.

Table 3. Testing sites for activity 1.2 under the project.

Province	District	Village
Autonomous Region of Bougainville	North Bougainville	1.Malasang 2.Tinputz
New Ireland	Kavieng	1.Luwapul 2.Panameko
Madang	Sumkar	1.Rempi 2.Murnas

The process of establishing the materials in the selected provincial sites commenced at a slow pace due to various reasons. The first two trials to be established were the two trials in Malasang (Bougainville) in September 2015 by top grafting in the field, and Tinputz (Bougainville) in April 2016 using bare rooted clones brought from the Cocoa Research Center at Tavilo. Field establishment for the two trials varied due to the method of propagation. Field grafted materials in Malasang took off slightly faster than the materials in Tinputz established by bare rooted seedlings. Whilst there were dead and missing trees amongst the clones in both trials, flowering and pod production started in early 2017.

For New Ireland, both trials (Panameco & Luapul) were field planted around the same time in July 2016 (Figure 3). The first lot of bare rooted clones for the trials were supplied in April 2016 and raised at the Kopkop nursery in Kavieng. In July 2016 another batch of 400 bare rooted clones were brought from Tavilo and field planted at the two sites together with the clones brought and raised in April 2016.Whilst both trials were field planted around the same time, establishment of the trial at Luapul has been a little slower due water logging in some parts of the plot which need improvement. Both trials in New Ireland had dead and missing plants among the clones but as of August 2017 both trials started coming into flowering and cherelle production. Data will be collected from the two sites following the end of this project with internal funding.

The trials for Madang were established at around the same time as the two trials in New Ireland. One of the trials in Rempi was established using bare rooted clones supplied from Tavilo while the other at Murunas was established by field grafting (Figure 4). The initial establishment of the trials was relatively good in the first few months after field establishment.

A tree census was done on the sites in the three provinces during August 2017 (Figure 5; Table 4). It was also found that a lot of trees were missing amongst the clones in all the sites. Madang had the highest seedling mortality and as such a new site will have to be identified to continue with the trial. The site in Murunas, Madang also had to be

abandoned due to the absence of CB staff in Murunas and other issues beyond our control.

However monitoring ceased following the liquidation of CCIL and the resulting split in R&D work between Cocoa Board and KIK that left staff with a lot of uncertainty and affecting work morale. Cocoa Board staff were asked to vacate premises in the early part of 2018 leaving all cocoa work behind. During a visit to the sites in August 2017 it was established that the trial site at Rempi was decimated by pigs whilst the site in Murunas was up in bushes with many dead and missing trees. Two new sites will be identified and the full six sites re-established using internal funding once the CB-REDS is fully operational.

Figure 3: Young clones established at PANAMECO -New Ireland

Figure 4: Field Planting of Bare rooted seedling in REMPI –Madang

Figure 5: Percentage (%) Mortality of clonal seedlings in the three provinces as of August 2017.

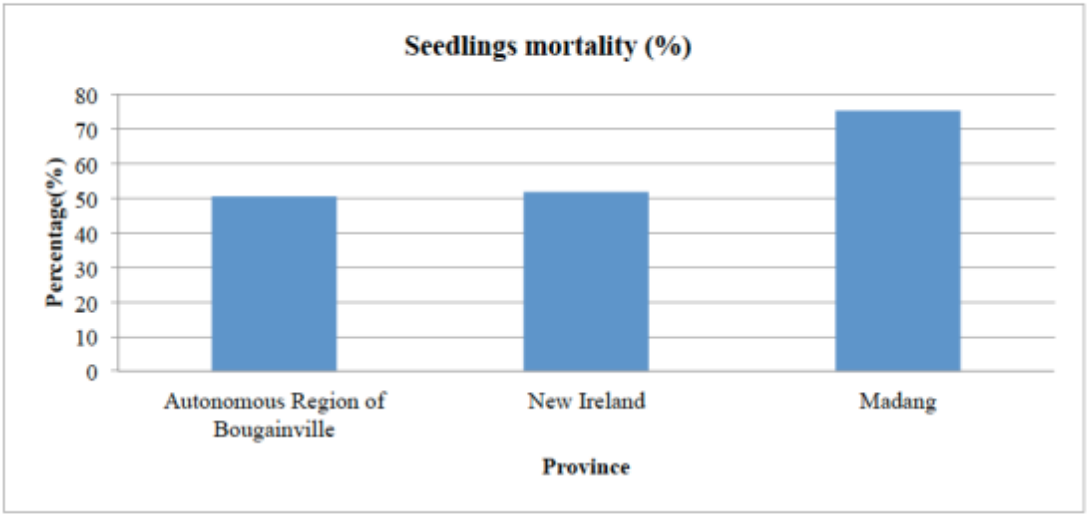


Table 4: Tree census from August 2017 for 5 testing sites.

Clones	Number of missing seedlings					Total missing seedlings
	Autonomous Region of Bougainville		New Ireland		Madang	
	Malasung	Tinputz	Luapul	Panamecho	Rempi	
Kakunu	7	9	16	1	19	52
13-192	13	5	9	15	11	53
96-1-15	7	9	17	5	12	50
M9-4	7	8	10	2	13	40
H79	16	6	18	8	15	63
2-96	9	14	17	5	16	61
A25-2-9	13	14	10	3	12	52
S23-10	19	10	19	2	7	57
Control	0	0	0	0	14	14
A18-1-14	11	12	17	7	16	63
JK 1	13	10	18	6	18	65
14-83	16	14	13	7	20	70
9-208	8	4	16	7	17	52
MAN15-2	8	18	17	3	14	60
18-86	6	18	16	1	16	57
13-63	8	14	19	9	14	64
48-2-8	9	15	13	5	20	62
12-66	9	9	12	3	13	46
S23-5	6	12	10	4	17	49
48-2-5	10	8	16	8	17	59
Total	195	209	283	101	301	1089

Activity 1.3: Test best specific method for propagation.

Papua New Guinea (PNG) cocoa varieties are propagated through seed propagation or vegetative propagation. The first and more common method is from seeds that are obtained from either open pollinated pods or pods produced by hand pollination of selected cocoa genotypes. Vegetative propagation by bud grafting of selected cocoa

clones is fast gaining popularity. Both types of planting materials have to be raised in a nursery as seedlings or grafted plants before planting in the field.

The growth and performance of the planting materials in the field largely depends on how the plants are raised in the nursery. Given an appropriate husbandry practices, planting of well-nursed seedlings and/or clonal plants result in cocoa blocks with well-established and productive trees.

Vegetative propagation of cocoa through bud grafting is highly recommended to be done in nurseries. Bud grafting of seedlings in the nurseries produce healthy seedlings for later transplanting out into the field and also high success rate of bud patch sprouting because of environment is conducive for development of buds into emerging seedlings.

However, with time and management cost involved in the process of raising seedlings in the nurseries, bud grafting can be directly done in the field. Rootstocks are established in the field and then grafting is conducted.

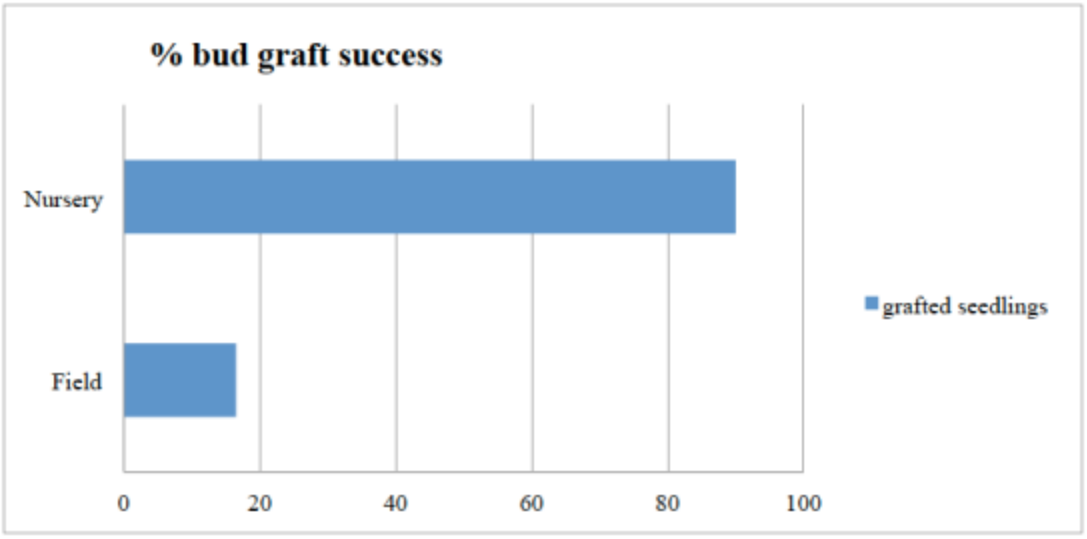
Hence, Activity 1.3 involved a comparative study for direct field bud grafting compared to nursery budding or grafting of seedlings. This study was earmarked to be conducted in three provinces (Autonomous Region of Bougainville, New Ireland and Madang Province). Due to logistical reasons it was only conducted in Bougainville at Buin. About 200 rootstocks were raised in the nursery and another 200 rootstock were raised in the field for budding in June 2016. An experienced grafter/budder was tasked to do the grafting. Twenty (20) CPB clones were grafted to the rootstocks both in the and the field at Buin DPI station in South Bougainville. Table 5 shows result of the clones budded directly in the field and those raised in the nursery.

Table 5. Quantity of successful bud grafted seedlings in the Nursery and Field

Autonomous Region of Bougainville (AROB)		**New Ireland Province**		**Madang Province**	
Nursery	Field	Nursery	Field	Nursery	Field
180/200	33/200	-	-	-	-

In Bougainville bud grafting in the nursery resulted in more successful seedling establishment (90%) than field grafting (16.5%) (Figure 6). More data needs to be collected from the two other provinces, New Ireland and Madang, to make good comparison of bud grafting in the nursery and field.

Figure 6: Percentage (%) successfully grafted seedling from nursery and direct field budding.



Activity 1.4: Develop nursery best practice for propagation.

The following recommendations are aimed at providing farmers with a quick guide for best nursery practice and propagation methods to produce good quality cocoa planting materials. Some of the recommendations have been adopted from the *PNGCCIL Nursery Manual* and are compatible with recommendations of the PPAP for larger nurseries.

1. Site Selection for Cocoa Nursery.

The nursery site must be selected based on the following.

a) Close proximity to a good water source (creek, water well or tank)
b) Level and well drained area with no excessive water during the rainy periods.
c) Good supply of rich topsoil (potting media)
d) Accessible by road at all times.
e) Close proximity to a certified bud wood garden
f) Within easy reach for supervision and good protection from animals and theft.
g) Wind breakers may be required in places where there is continuous wind.

2. Nursery Materials and Other Requirements

A cocoa nursery can be established as a permanent or semi-permanent structure depending on the materials used for construction. It is important to use proper materials for the establishment of nurseries regardless of capacity or intended use of seedlings. Important materials required for construction of a decent nursery include the following:

a) Shade cloth (50 or 75% shading) - for the top part of the nursery.
b) Strong wood, Timber or Metal posts - for Nursery posts.
c) Star pickets and Tie wire - for construction of seedling bays. In the absence of hose a farmer can use wood and split bamboo strips for seedling bays.
d) Clear plastic sheets - may be required for the top and sides of the nursery in areas where there is high VSD pressure.
e) River sand or gravel - should be used to cover the topsoil in the nursery to avoid splashing and muddy surfaces.

f) Small Shed or Shelter – Will be required for grafting during the rain and also for holding seedlings overnight before transferring to main nursery.
g) Seedling bags – Seedlings bags are important for raising seedlings or rootstock in the nursery. There are different sizes of seedling bags but 175mm x 300mm is recommended for cocoa. They can be purchased from any Agriculture store or Hardware stores in Papua New Guinea.
h) Fertilizer/Compost – May be required to mix with soil before filling the seedling bags with soil. Basal fertilizers such as NPK or Urea can be broadcasted onto the soil and mixed before filling.
i) Insecticides- Insecticides will be required to control the buildup of common nursery insects such as leaf hoppers, grey weevils and other leaf feeders. Common insecticides available in PNG are Karate and Anisban.
j) Fungicides – Copper based fungicides such as Copper Nordox will be required to control phytophthora and other fungal diseases on cocoa seedlings.

3. Nursery Construction

A cocoa nursery should be constructed well in order obtain an optimal nursery capacity but at the same time allow sufficient spacing for operational activities.

Nursery sizes will also depend on the purpose whether seedlings will be raised for own use, supply to other members of community or as a business operation. For nursery capacities with more than 15,000 seedlings, posts should be established at 5meters between rows and 3meters within rows.

This should allow for six double rows for seedlings in one bay. The most important thing is to have enough space for movement and to avoid cramping of seedlings. Figure 1, shows different types of nursery that can be constructed. Figure 2, provides a basic outline of the internal nursery layout for a large nursery which should be used as a guide as the size may vary.

Figure 1: Nursery Types

1) Large capacity nursery
2) Small capacity semi-permanent nursery

4) Production of Planting Materials

The Cocoa Board is currently distributing cocoa hybrids and hybrid clones to farmers throughout Papua New Guinea. The production and management requirements of the two types of planting materials may differ in certain aspects. A major difference between the two types of cocoa planting material is that hybrids are propagated by seeds from controlled pollinated pods. Clones on the other hand are propagated by grafting selected trees onto rootstock in the nurseries or in the field. Production of cocoa planting materials

in the nursery should be done using best propagation and management practice to ensure good quality seedling are produced and distributed to farmers for new field plantings or rehabilitation of old cocoa fields.

Cocoa Hybrid Production

Cocoa hybrids are produced by closed hand pollination using selected trees in cocoa seed gardens established by the Cocoa Coconut Institute of PNG. Cocoa hybrids can be sourced from CCIPNG headquarters in Tavilo - East New Britain or CCIPNG provincial centers throughout the country.

All hybrids are produced, and prepared at CB Tavilo Cocoa Research Centre for distribution. The following practices are recommended for proper establishment and management of hybrids in the nursery.

1) Seed preparation
    a) Seeds from mature and ripe pods should be removed from the pod placenta after breaking the pods open.
    b) Place the seeds onto a copra sack, white poly sack or a piece of smooth cloth.
    c) Spread sawdust onto the seeds and rub against the seeds to remove the mucilage on the seeds.
    d) Repeat the process by adding new sawdust until about 90% of the cocoa mucilage is removed from the seeds.
    e) After removal of mucilage treat the seeds with insecticide (28ml/10l) and copper based fungicide (150g/10l). This can be by dipping the seeds in a cocktail mixture for 10-15 minutes.
    f) After treatment remove the seeds and spread over a dry copra sack or smooth cloth and dry for a 1-2 hours.
    g) The seeds should be ready for sowing in the nursery or dispatch after drying

Figure 3: Steps involved in Seed Preparation

Photo source: J.MARFU

1) Seeds mixed with sawdust to be rubbed continuously to remove the mucilage.
2) Clean cocoa seeds with mucilage removed ready for treatment.
3) Placing seeds in a bucket for treatment with fungicide and insecticide.
4) Seeds treated with Copper based fungicide to be dried for distribution

2) Pre-Germination
   a) Before the seeds can be sown in polybags they should be pre-germinated to select viable and healthy seeds.
   b) This should be done by spreading the hybrid seeds onto a wet copra sack or wet cloth and then covering with another wet cloth.
   c) Place them in a cool and dry area and continue to moisten the copra sack or cloth with water for three days.
   d) During this time the seeds should start germinating with the seed radicle (first root) popping out.
3) Sowing Pre-Germinated Seeds
   a) Select only the germinated seeds for sowing into polys bags already lined up in seedling bays in the nursery.
   b) Sowing should be done by placing the radicle (first root) of the cocoa seed about 2cm into polybag soil and covering.
   c) Do not put the seeds too deep into the soil (more than 3cm deep).
   d) Cover the seeds lightly with topsoil to allow full germination to take place.

Figure 4: Pre-Germination and sowing of cocoa seeds in polybags.

Photo source: D.SOGOVARE

1) Pre-germination by spreading cocoa seeds on a wet copra sack for three days.
2) Germinated cocoa seed with the radicle popping out and ready for planting.
3) Sowing germinated seeds in polybags by placing the seed 2cm deep with the radicle pointing
4) Young seedlings (with cotyledon attached) developing after sowing in polybags.

4) Watering of juvenile seedlings.
   a) Immediately after sowing the seeds, the poly bags should be watered. Water the polybags daily.
   b) Avoid putting too much water to avoid dislodging of seedlings and fungal attack through build up of excessive water.
   c) During this time the seed cotyledons should start popping out of the soil.
   d) After this process the seedling start developing into one, two and four months old seedlings.

Propagation of Hybrid Clones

Hybrid clones are produced by grafting bud wood from selected trees onto rootstocks in the nursery or in the field. Currently there are 18 clones recommended by the CB for farmers throughout the country. These clones are established in certified bud wood gardens in CB's provincial centers, Plantations, Large Commercial Nursery sites, LLGs and some Wards throughout the country. Budwood should be obtained from certified budwood gardens for the purpose of establishing new budwood gardens or hybrid clonal production for distribution to farmers. The following practices are recommended for propagation and management of cocoa clones in the nursery.

1) Rootstock Raising
   a) Rootstocks are required to bud-graft (or patch bud) any of the 18 recommended clones by CCIPNG.
   b) Good and big sized beans must be selected for raising as rootstocks.

c) Beans can be collected from either Old Trinitario trees (German cocoa), SG 1&2 hybrids or any of the big clones from the 18 CCI released clones.
d) Preparation of rootstock for planting should be done using the pre-germination techniques described above under hybrids.

2) Clone Propagation

The are several methods of clonal propagation but CCIPNG recommends the bud-grafting method as it is the most common and easy technique for commercial nurseries with very good success rates if done well. Close attention should be given to the following;

a) Rootstock for grafting
   i) Bud grafting can be done on two weeks (juvenile or green budding) or three months old rootstock.
   ii) Grafting onto two weeks old rootstock is quite delicate and requires very experienced hands.
   iii) Grafting onto three months old rootstock is less delicate and has very good strike rates.
   iv) It is recommended to use 3 months old rootstock for grafting but options are open depending on success and strike rate.
b) Bud wood Selection and Supply.
   i) The 18 cocoa clones recommended by CCIPNG should be the ONLY clones used for propagation and distribution to farmers.
   ii) For good strike rates, good, young and healthy bud sticks must be collected from recommended clones.
   iii) Bud sticks collected must be similar in size to the rootstock.
   iv) For green or juvenile budding, small and younger bud sticks should be collected.
   v) In general good and healthy bud sticks should be cut at 5-6 leaf nodes from the growing tip of the branch.
c) Grafting onto Rootstock
   i) All rootstock for budding should be transferred to a small shelter or shade house near the nursery.
   ii) Before budding clean the base of the rootstock with a paper towel to remove access dirt.
   iii) With a budding knife make a half cut near the base of the rootstock with a " T' insertion.
   iv) Peel off the bark from the ' T ' insertion.
   v) Cut out a bud patch from the bud stick of a selected clone and place in the insertion made on the rootstock.
   vi) Cut off the loose bark on the rootstock and firmly tight wrap the bud patch to the rootstock with budding tape. Normal budding tapes can be used for 3 months old rootstock but in the absence of that, NESOFILM and PARAFILM tapes can be used. Both are also recommended with BUDDY tapes for green budding.
   vii) Once all bud grafting is complete leave all grafted seedlings overnight under the shelter. This helps to improve budding success or bud take.

Figure 5: Steps involved with Bud-Grafting (Patch Budding) of Cocoa Clones in the Nursery.

Photos source: J.MARFU

1) Removing Patch Bud from the fan branch of a selected clone by making a rectangular cut with a budding knife.
2) Making a half cut "T" insertion on the rootstock to open up the bark.
3) Inserting the bud patch from the selected clone into the "T" insertion made on the rootstock.
4) Tying or tight wrapping the bud patch to the wood of the rootstock.
5) Removing the budding tape after 10-14 days by making a straight cut on the back of the budded seedling.
6) Young bud sprouting after tape removal.
7) Bud-sprouts for the selected clone developing.
8) Young clonal seedling with top part of the rootstock removed and ready for field planting

17

d) Management of bud grafted seedlings.
   i) All bud-grafted seedlings should be transferred to the nursery and lined or packed into their respective seedling bays.
   ii) Each row should be labelled clearly with the right clone name or number. Budding tapes should be removed from the bud-grafted seedlings 14 days after budding.
   iii) After removing the budding tapes the bud grafts should sprout and start to develop after few days.

iv) Check and remove any new shoots developing above or below the bud sprout.
v) Once the first leaves of the bud sprout turn green or hardened off cut off the top part of the rootstock just above the bud sprout to allow it to develop further.
vi) Continue to remove unwanted shoots above and below the bud sprout.
vii) The clones should be ready for field planting about three months after grafting

5. Management of Nursery Planting Materials.

All cocoa planting materials in the nursery should be managed well in order to have good quality seedlings for field planting or distribution to farmers. Management of the planting materials is an important part of the overall nursery operations.

a) Watering of Seedlings
   i) Watering of the seedlings should be done on a daily basis to ensure good growth development of the seedlings.
   ii) Young cocoa seedlings are sensitive to water logging and is advisable not to over water the young seedlings during the first 2-3 weeks of development.
   iii) Adequate water should be given to maintain sufficient soil moisture. During the wet periods it may not be necessary to water if there is enough soil moisture.
b) Weed Removal
   i) Weed removal in and around the nursery and inside the polybags should be a routine activity.
   ii) This greatly in reducing completion for nutrients for the developing seedlings in the polybags.
   iii) Weeds growing inside the polybags should be removed manually.
   iv) Avoid the use of chemical herbicides inside the nursery.
c) Pest and Disease Control
   i) The most common nursery pests are leaf eaters like grey weevils, aphids, mealy bugs and caterpillars.
   ii) These insects can cause significant damage and stunting of seedlings.
   iii) Regular insect spraying using pyrethroid insecticides like Karate (L-Cyhalothrin) must be applied once or twice a month at the rate of 28ml/10liters of water.
   iv) Additional information on other insecticides can be obtained from CCIPNG or Agriculture suppliers.
   v) Copper based fungicides should also be sprayed once or twice a month to control phytophthora and other fungal disease for young seedlings in the nursery. Fungicides like Copper Nordox can be applied at a rate of 150g/10litres of water. It can also be applied as a cocktail mixture with insecticides.
d) Record Keeping
   i) Record keeping is very important for the nursery operations.
   ii) It is advisable to have two sets of records, one for planting material production and the other for distribution.
   iii) Nursery production records should include Hybrid or Clone Names, Production Dates, Numbers, Census Numbers after 2,3 and 4 months, Final Numbers and Estimated Distribution dates.
   iv) Distribution records should include, Farmer names, Types of hybrids or clones distributed, Date of distribution and location (Village, Ward, LLG).

v) Basic nursery records are important for evaluation of how well the nursery is running and also provides information to authorities for planning and development purposes.
vi) Two examples of important nursery records are given for adoption by farmers. They can be modified to include additional records deemed necessary by farmers.

Table 1: Nursery Operational Record

Month/ Date	Clone Budded	Budder Name	Total Budded	Successful Buddings	Census			
					1month	2months	3months	4months
10/01/16	CCI-B1	L.Beks	200	180	176	170	170	169
12/01/16	CCI-B2	L.Boss	200	187	180	178	172	170

Table 2: Nursery Seedling Distribution Record

Farmer Name	Clones Supplied	Bare Rooted Seedlings	Polybag Seedlings	Village	Ward	LLG/District

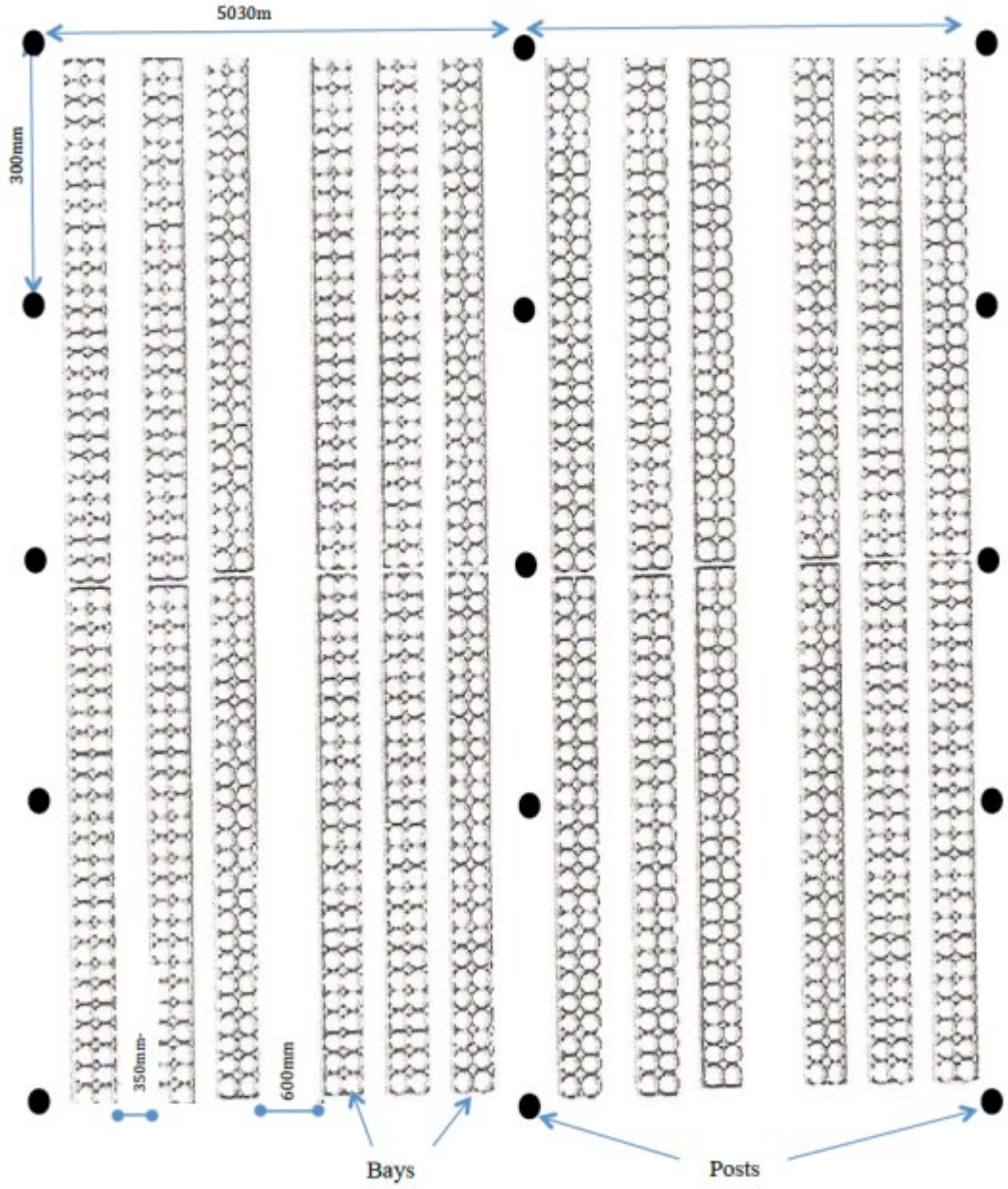
Important Point to Note

Any nursery that is going to be operated as a business will have to satisfy CCIL recommendations for certification. Only certified nurseries will be allowed to operate. Production of seedlings at a smaller scale using the practices and requirements discussed can be allowed for farmers' own use and/or communal sharing within each community.

6. Safe movement of cocoa germplasm.

The first project annual meeting held in Kavieng in November 2015 identified the need to develop quarantine protocols to transfer cocoa planting materials from one location to another, especially to New Ireland and Bougainville where diseases such as VSD are not present. A draft protocol to minimise these risks was prepared (Appendix 1) and submitted to the Cocoa Board for endorsement and publication.

Figure 2: Nursery layout showing seedling rows, bays and nursery posts (To be used as a guide to nursery layout)



Objective 2 To integrate improved management practices into sustainable and profitable cocoa farming.

Initiation of this activity was delayed due to the late delivery of the pod shredder due to a dispute with PNG Customs. Also a shortage of goats meant that we decided to use chicken manure to prepare compost for the pilot trials.

A herd of goats from a scoping visit to the PNG Highlands in 2018 have now been established at the University of Natural Resources and Environment in Vudal, ENBP. Some have already been distributed to Bougainville and the Sepik. This trial is a proof of concept only and rollout will require additional research into goat husbandry, health impacts and economics.

The compost facility has now been established at Tavilo and is being used for other soil nutrition and fertility studies undertaken in SCMN/094/048.

IPDM practices have been reviewed and implemented at field sites and demonstration plots, confirming the cost-effectiveness of investing a daily 2 hours of labour for each hectare of cocoa. Compost trials from SMCN/2014/048 will continue to strengthen fertiliser recommendations.

Attempts to identify potential biological control agents for the CPB moth was based on experiences in Malaysia, but suffered because of staff limitations at CCIL. There was no clear indication of parasitoid and or biological agents activity on eggs, pupae and larvae. It was decided in 2016 that this study be terminated, and a separate study to be undertaken outside of this project.

Village-level demonstration plots were established to roll-out improved management. Demonstration plots have been established and most of the IPDM/GAP trainings have been carried out on those farms. Monitoring will continue to determine the success of IPDM demonstrations in changing smallholder management. In other work (HORT/2014/094) we have found that smallholder prosperity is linked to (i) education level (ii) income diversification and (iii) family health. As labour is 50% of the cost of input, labour productivity is a key to success.

Objective 3 To investigate opportunities for smallholders to intensify cocoa production and diversify income.

Following discussions with stakeholders and feedback from training activities we have identified the following supplementary farming activities to investigate further:

Cocoa
Increasing production to pre crisis level in Bougainville has received the most attention. Rehabilitation of old plantation (with the use of a new clone) rather than new plantations were encouraged and received funding support. However there is less support towards development and improving the marketing aspect of the chain and there is good opportunity to do so. There is also excellent opportunity to explore potentials for niche market. Even with the current production Bougainville can downstream cocoa beans into chocolate bars and or powder for drinks.

Virgin Coconut Oil
An excellent opportunity exist for virgin coconut oil production. There are large coconut plantations and a copra oil producing company, based in Buka can expand its business activities to include this. However VCO is more suited to smallholders. Two lead farmers with coconut plantations expressed interest on VCO production and discussions with a Honiara based VCO producing company has been started with number of smallholders in Bougainville. This can be further developed by exchanges between Honiara and smallholders in Bougainville. In the domestic scene the increasing number of guest houses provide potential markets for VCO made soap and cosmetic products.

Coffee
Both the low and high land coffees (Robusta and Arabica) grows well in Bougainville. Farmers along the ridge of Paguna grows coffee but still in small volume. MONPI coffee in the mainland PNG expressed interest to buy coffee from Bougainville once production is achieved. Supporting the crop at the processing level and by direct market linkage should encourage increased production and opportunity for smallholders to aggregate and export coffee. There is good potential for processed coffee in the domestic market particularly for more than dozen guest houses in Buka and Arawa. Niche markets for coffee and boutique chocolate bar (and drink) makers in Australia and New Zealand can be explored for their interest as well.

Vanilla
With right spacing vanilla can be integrated with cocoa and a large number of old vanilla farms can be found in Bougainville. These were remnants of the “green bar” period when price of vanilla was high and before the collapse of the industry because of low price and cancellation of the export market (because some farmers in mainland PNG add foreign materials to increase weight and these were found by the market during processing).
It was noted that all vanilla exported out were labelled PNG products (not Bougainville) therefore there is good opportunity to re-start the industry and also post 2018 referendum export can be labelled Bougainville vanilla. There is demand for vanilla essence in the local market particularly among the eateries, local caterers and can be integrated with cosmetic products from virgin coconut oil (VCO).

Betel Nuts
Regardless of the health related issues betel nut is the most important source of cash income for many rural households because of high demand in Bougainville and Moresby (regardless of the ban in Moresby city). Betel nuts can integrated with cocoa however it doesn’t provide much of the required shades and is considered to be a host for certain type of beetles that can feed on the young cocoa pods.

Peppers (black and white)

There is expressed interest from the domestic and export market for processed peppers. Trial work conducted showed that condition in Bougainville suits pepper and samples provided to the domestic market (Buka central market and food service businesses) showed strong demand but there is very small production. A market in USA was also said to be keen to buying dried peppers.

High Value vegetables
Demand in the local market for broccoli, king size tomato, zucchini and carrots and asparagus is interestingly high, particular among the small guest house/low cost tourism sector. Nearly all the guest houses in Bougainville cater for breakfast, lunch and dinner and effort is made to cover local, Asian and European menus. Some guest homes in Arawa include full meals (breakfast, lunch and dinner) in their rates. Conditions up the highlands suits these vegetables well. The increasing number of visitors and training workshops (in Buka and Arawa) contribute to the growth of catering business. Re-opening of the mine will add to the opportunity for high value vegetables. There is however a need to improve on the supply chain of seeds for these vegetables.

Rice farming (swamp rice)
An opportunity for substituting import of rice exists and trials (on dryland variety) conducted by a lead farmer (James) showed the condition for growing rice does exist although shortage of labor was seen as an issue. A swamp area close to Arawa also offer an opportunity for swamp rice.

Sea Weed
Number of pilot projects on seaweed production this proved conditions in the outer islands and some coastal areas of Bougainville best suited for production of sea weeds. Export of 213MT was done in 2013 and at a price of K1.50/kg the gross value for the export was about K319,500. Sea weed is now trialed in nine (9) areas of Bougainville including the atoll islands and coastal areas along the main Bougainville. Result to date has been very encouraging and the Department of Commerce (responsible for the pilot project) is planning to turn over these projects to the private sector.

Small scale Tuna fishing
Department of Commerce identify tuna fishing as one of its many priorities that it want to have developed. The department is currently in discussion with a potential investor for small scale tuna fishing, looking at tuna cannery in Lae and Noro, Solomon Islands. There is also a growing domestic market for tuna and this include by fish and chips businesses. Potential markets include US and the EU. The sea around Bougainville is rich with tuna. Another investor also expressed to the department of Commerce an interest in reef fish.

Pam Boat fishing
Pam Boat fishing was started by a regional member of the current AB Government. This was started last year in the Northern Region of Bougainville and is providing employment and income to that area. Fish caught are sold at the local market. There is good opportunity to expand activity to include growing and selling of bait fish to the bigger fishing boats.

Reef Fish
An investor from Malaysia has expressed interest for the coral fraught snappers/reef fish. The Investor has established 2 cool room (of 40 footers) in Kieta and is currently talking to local fishermen/women on the selected reef fish. The Investor is targeting markets in Asia, US and Europe.

Sawn Timber
Bougainville has a moratorium on logging but domestic and export market opportunities exist for sawn timbers, in particular hardwood such as vitex. The growing construction and

renovations of buildings around Buka, Arawa, Buin and number of government stations across Bougainville is driving the current demand. There is growing demand for tropical hardwoods in Australia and New Zealand markets. Provision of movable sawmills (such as the Lucas mills brand) will help to develop this subsector.

Livestock (cattle, goat and poultry)
Bougainville does not have any major cattle, goat and or poultry farms. A small cattle farm was recently started along the road to Arawa. There are few goats raised for milking near Tinputz (Michael Pearson) but only for household use. A semi-commercial poultry farm started in Siwai by a local trader who use his trading shops as his market outlets. The demand for meat, milk and eggs is growing in the domestic market with milk of particular demand among the guest houses. Interestingly the demand for duck meat in the domestic market is also on the rise.

Other crops and products with potential
There are market opportunities for other crops including *taro*, *sweet potato*, *oil palm*, *galip nuts* and small scale (*artisanal) mining*. ABG will need technical support around the regulation of artisanal mining to allow landowners participate in this area but at the same time allow the government to collect revenue from this subsector. Sweet potato is one of the most traded crop in the domestic market. Downstream processing of selected variety of sweet potato into chips also present an opportunity for farmers.

Objective 4: Develop Region Specific Extension Strategies

The Centre for Agriculture and Biosciences International (CABI) is a partner in this project having specific engagement in fulfilling Objective 4 “Develop region specific extension strategies” in collaboration with the PNG-CCIL. The objective 4 includes the following key activities i.e.

4.1 Conduct knowledge, attitude and perception survey

4.2 Development of GAP training modules and update existing training curricula

4.3 Train extension staff on updated curricula

4.4 Test and evaluate the effectiveness of the extension strategy

4.5 Modify and adapt extension strategy

4.6 Training of Master Facilitators

4.7 Training of Facilitators

4.8 Training of farmers

4.9 Analyses of social and economic factors that promote adoption of IPDM

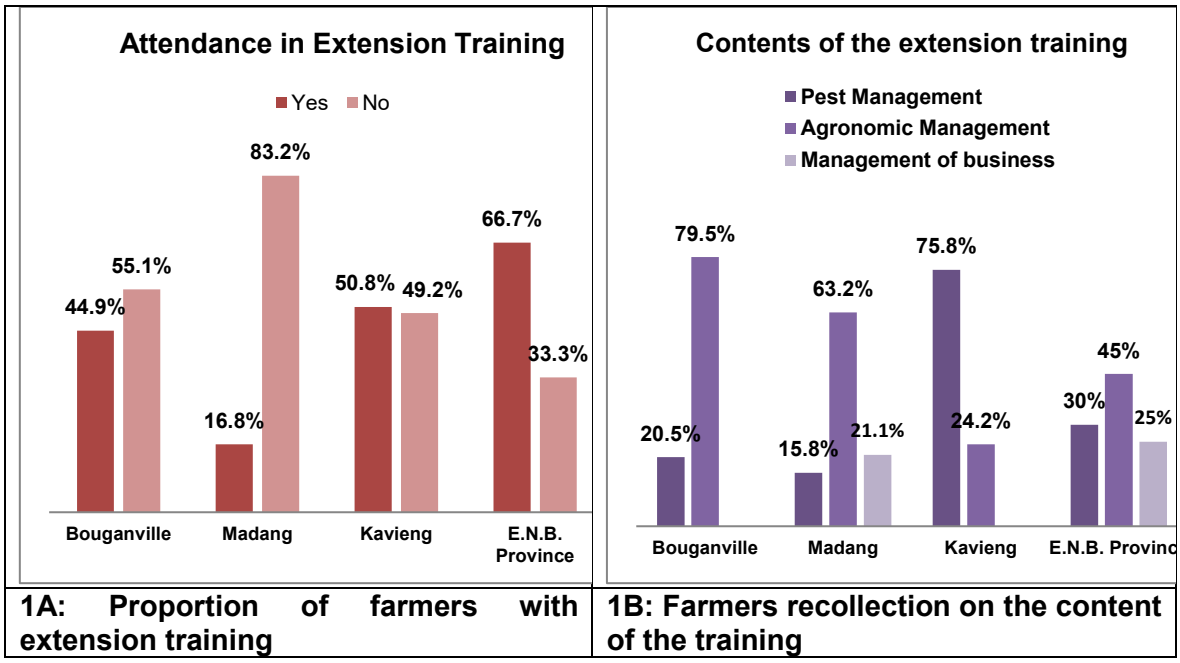
Objective 4.1: Conduct knowledge, attitude and perception survey

The project team developed the pre-project baseline survey questionnaire for smallholder cocoa farmers to understand better their socio-economic conditions, knowledge, attitudes and perceptions. The PNG-CCIL’s extension officers interviewed 306 farmers in four regions – (i) ARO Bougainville, (ii) Madang, (iii) Kavieng, New Ireland and (iv) East New Britain provinces during the mid-year 2015. The survey was designed to see how are the farmers profile, their knowledge, attitude, and on- and off-farm practices to cope with the CPB and other pests’ management. The study was focused to understand the grower’s attitude towards farming as a business, their ability to sustainable farming and derive maximum benefit from their investments to improve their livelihoods. Later CABI experts analysed the survey data and compiled the results as Baseline Report.

The detailed findings of the baseline study can be found in Appendix 2. Some key findings from the study are –

- Average 38% of the farmers were observed to have attended an extension training previously. The extension training contents i.e. pest management, agronomic practices and business management were discussed but it varied to a large extent between the provinces (Figure 4.1 A &B). Farmers therefore require frequent extension trainings which are complemented by follow-ups and hand-on practices.
- If farmers adapt to the trainings and implement them in on-farm practices; it enhances their success rate for better yield at evey site except Madang (Figure 4.2); and
- Irrespective of the gender differences, the success rate of trained farmers to get better yield when they adapt pest management is similar.
- The cocoa pod borer (CPB) dispersal is present in all four studied locations but its infestation is high in Madang (36-52%) and then Kavieng (18-42%) but low in ENB Province (12%) and Bougainville (6-15%).

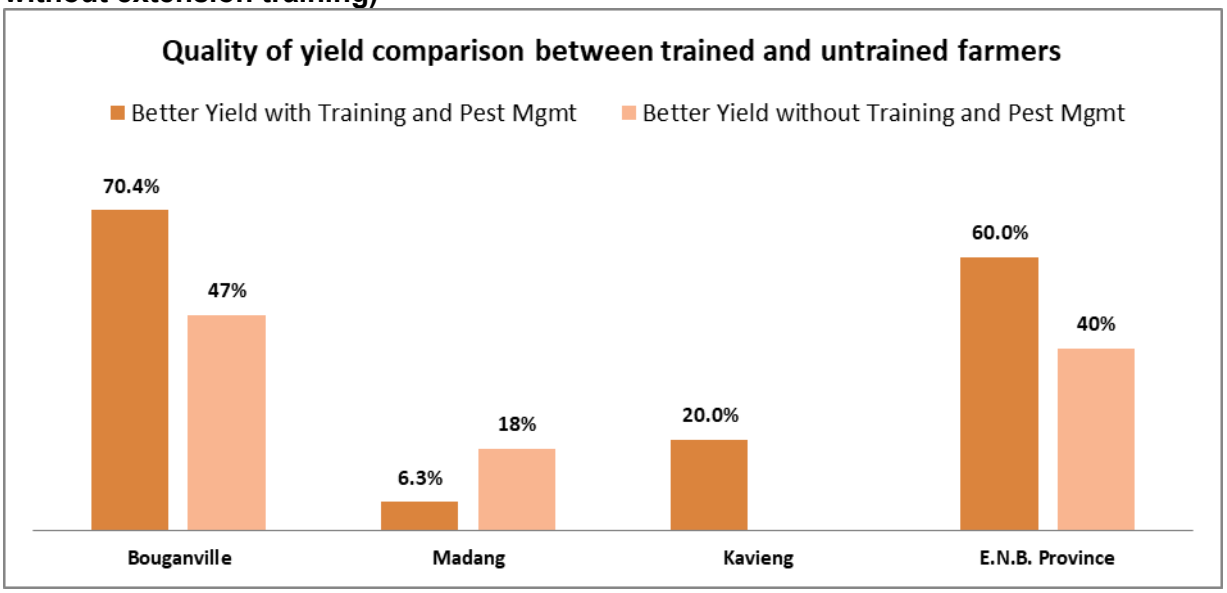
Figure 4.1: Previous Extension Trainings attended by the farmers and feedback provided by them



1A: Proportion of farmers with extension training

1B: Farmers recollection on the content of the training

Figure 4.2. Quality of yield with Pest management between farmers (with and without extension training)



This baseline information will help to validate our efforts in farmers training in relevance to change in their knowledge, attitude and practices while post project assessment.

Figure 4.3. Baseline information collection from farmers

Objective 4.2. Development of GAP training modules and update existing training curricula

A Cacao GAP training manual was ceveloped in June 2016 and used in the TOMF and extension officer trainings (Activity 4.5 and 4.6) at Arawa, ARO Bougainville in April 2017 and TOF in Bougainville and New Ireland. CABI has its electronic copy for future updating and we also shared it with Paul Gende and Dr Eremas Tade. The contents of the manual are attached as Appendix 3.

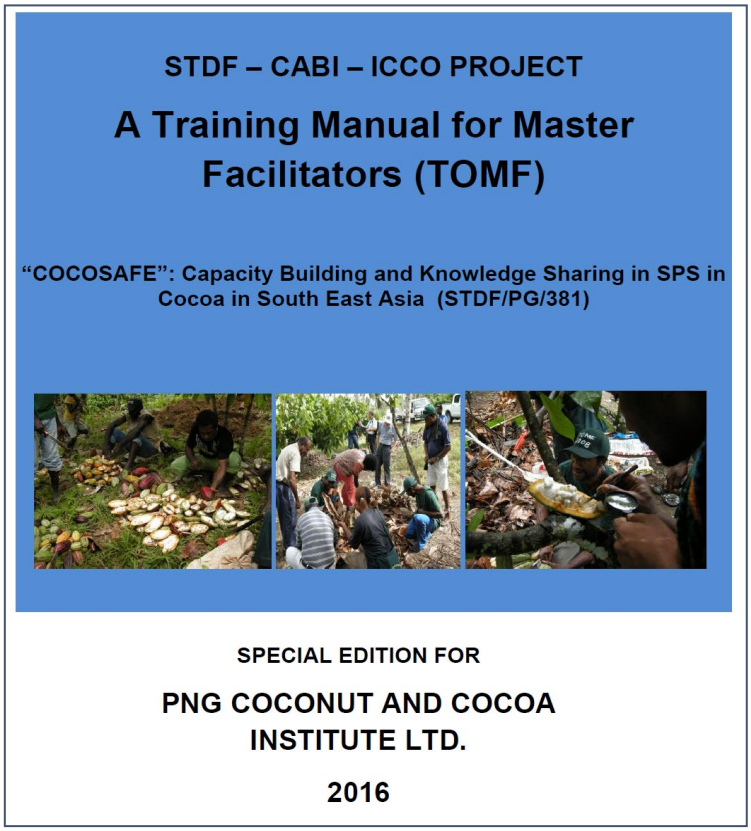


Figure 4.4. Title page of the training manual

Objective 4.3. Train extension staff on updated curricula

The TOMF training manual was used as the latest updated curricula material for the training of the extension staff and other facilitators. A total of 15 extension staff (7 from provincial CCIL, 6 from DPI and 2 from ACIAR) from ARO Bougainville and New Ireland provinces were jointly trained in the TOMF in Arawa, AROB from April 18 – 22, 2017 (see more details in Activity 4.6)

Objective 4.4. Test and evaluate the effectiveness of the extension strategy

The proposed extension strategy in this project is farmer participatory training approach i.e. farmer field school (FFS). This FFS approach was conceptualized between the 1970s and 1980s and first implemented in Indonesia in 1989, and then approach has expanded throughout the world. CABI has developed a questionnaire for the quality assurance of the FFS and designed a Focus Group Discussions (FGD) template to conduct with FFS farmers for evaluation of the effectiveness of extension strategy.

CABI had planned to conduct a training on FFS quality assurance and FGD for PNG-CCIL master facilitators to collect this information in early 2018 so that trained facilitators collect this information while the implementation of activities 4.7 and 4.8. Due to the liquidation of CCIL this was delayed until 10-13 September 2018.

Figure 4.5:. FFS quality assurance training

All participants visited one FFS and divided into group to do quality assurance practice in the FFS (Figure 6).

Figure 4.6. Glimpse of different FFS activities and quality assurance by training participants

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>FFS session</td><td>Discussion on AESA recommendations</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Presentation of AESA findings</td><td>Group photos of FFS and training participants</td></tr>
</table>

Later we were only able to collect quality assurance data from three FFS and conduct five FGD due to limited time and staff availability. Some of the findings of these studies are as followed:

FFS Quality Assurance

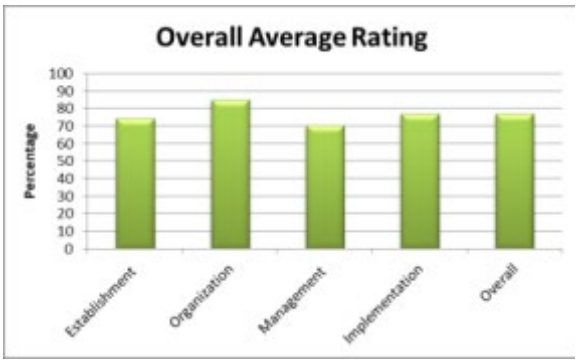
The approach to Quality assurance is to stress the involvement of stakeholder groups with the aim of building of self-capacity to address the problems of the farmers with

participatory approaches. The quality indicators of the protocol are divided into four major categories viz. establishment, management, organization and implementation. The protocol of FFS quality assurance is given as Appendix 4.

The overall ranking of three visited FFS was 73% (good), 90% (excellent) and 69% (good). In overall average, these FFS were good in establishment (74%), management (70%), organisation (85%) and implementation (77%) (Figure 4.7a). Under FFS establishment, the FFS site selection, membership and plot condition was good except the plot selection because they have only one IPM plot and did not have farmer/control plot for comparison of results of IPM practices (Figure 4.4.7b). It was discussed with FFS farmer and they agreed to allot any neighbouring farmer plot as control plot, where farmer is implementing its traditional cultivation practices. They will do AESA in both IPM and Farmer plots. Under FFS group organisation, one FFS did not have proper farmer group formation, while rest all of the activities were good (Figure 4.7c). Under FFS management, these FFS were good in material provision, attendance, and time management, but they did not arrange any FFS exchange visits, which is an important activity to understand and learn from other FFS activities (Figure 4.7d). As per discussion, they were not informed before about this activity and secondly there were also some limitations of travel budget. Under FFS implementation, they were good in facilitation skills, using participatory approaches, conducting eco-system analysis, team building exercise and special topic, but satisfactory in planning new findings and setting up insect zoo exercises (Figure 4.7e). It was advised to conclude the AESA findings very briefly and assign a person to implement the decision.

Figure 4.7. Results of FFS quality assurance.

a



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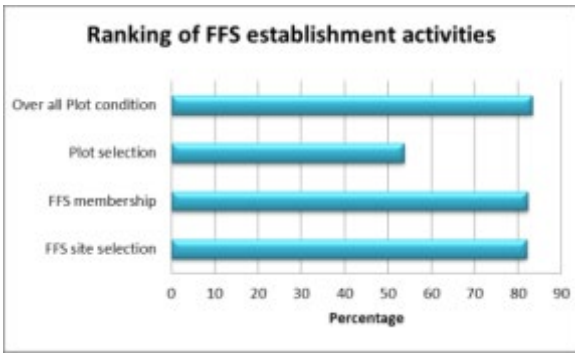

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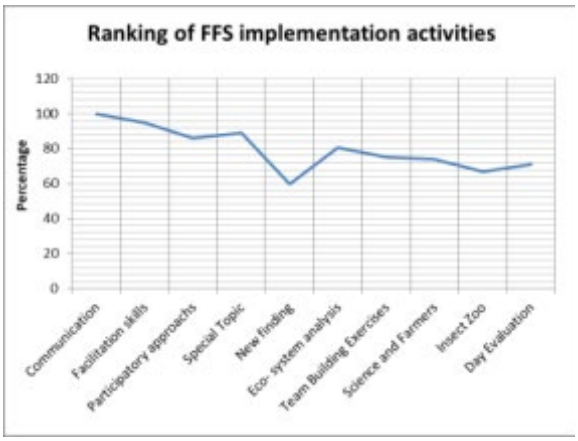


Focus Group Discussions

Focus Group Discussion tool for farmers were also designed for collecting qualitative primary data regarding FFS extension approach being implemented in the project. The guiding questions around the FFS extension approach were listed in the tool but facilitators were advised not to restrict their discussions around those questions only. The tool was conducted with a mixed group of male and female farmers (all FFS users).

The FGDs were only carried out in five locations in ENB but not in other provinces due uncertain conditions. A total of 128 farmers (96 males, 32 females) attended these FGDs with age ranges from 25 – 57 years. Cocoa is the main crop in their area. These farmers are also growing coconut, vegetables, galip nuts and banana other than cocoa. Most of the farmers (92%) were joined and member of FFS. These people are quite busy during the whole day in farming, community and household activities, and they have some free time in the afternoon and they spent their time with neighbouring farmers, community members and family members.

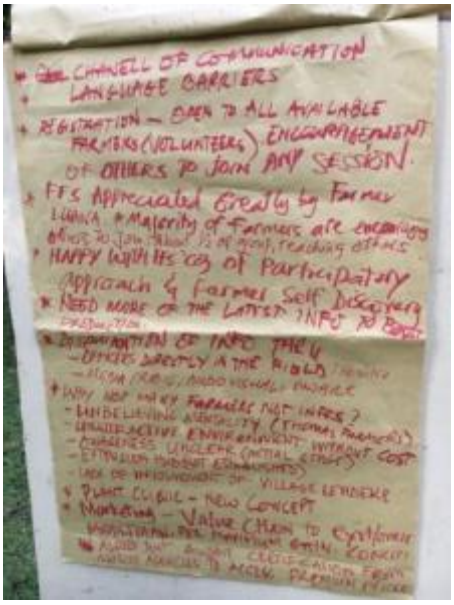


Figure 4.8. Focus group discussions

They indicated that the main advisory services were received through FFS, FFS facilitators and lead farmers in their areas. Some farmers also used suggestions from extension agents working in the Productive Partnership in Agriculture Projects (PPAP) and from Outspam-Olam Pty Ltd. All farmers were very satisfied with the knowledge and skills learned through FFS as it helps them to protect their cocoa from pests and diseases, cultivate new and productive clones, and learn techniques for orchard managements in participatory ways. One of the farmer said “AESA is like a refreshing avenues for the past FFS session in applying on the field”. The attendance of farmers in FFS ranged from 70 – 95%. All farmers are confident to implement the recommendations provided through FFS and satisfied with the results in terms of productivity and profitability i.e. in 2013, the yield of wet beans was 30 kg per ha but in 2018, it raised to 330 kg per ha which results in increased revenue.

Now farmers are also able to monitor the pests and diseases on their farms i.e. in 2013, CPB infestation was 90% but in 2018, its infestation was 10%. On the usefulness of FFS, the famers indicated that they trust the FFS as an important and reliable source of information. They said that they would come to the FFS for pest and disease management advice as less dependent on the agro-dealers. They see the FFS and the advice dispensed as useful sources of information and as a learning and reference tool. Some of the farmers, who attending FFS from last 5 years can independently implement the IPDM package on their own farms with little support from FFS facilitators. Other farmers still required some support from the facilitators, especially in orchard management and P&D management. Farmers also informed that they are also inviting other neighbouring farmers to join the FFS, so that they can also adopt good practices.

All farmers and facilitators agreed that they required new and updated knowledge on cocoa production and IPDM practices from national and international institutes. They demanded more knowledge on the post-harvest techniques, processing of cocoa and marketing of products. They want direct linkages with main traders and exporters, to minimise the middle-man roles.

Farmers also suggested using some new extension approaches for better serving more number of farmers. The use of different ICT tools i.e. mobile apps and online knowledge bank are very important and easily accessible sources of information, which can also easily be updated. The information on mobile app once downloaded, can also be used

offline. Most of the farmers responded that they or their children had the smart phones in their home and can use this app. They also suggested uploading more photos, video and voice recordings on the app instead of text. They also agreed to have the Plant Clinics in their areas where trained facilitators/extension officers can be Plant Doctors and provide advisory services to farmers. These suggestions can be considered in the future advisory and extension program.

- **Activity 4.5. Modify and adapt extension strategy**

Based on the findings of Activity 4.4, the FFS is an intensive training approach implementing ecologically sensible production approaches, in particular, integrated pest management. The FFS sites are easily accessible to member farmers but sometimes farmer attendance is not appropriate. The information provided in FFS is reliable and accepted by farmers. Facilitators suggested receiving refresher trainings for updating their knowledge. Further some new approaches i.e. ICT tools, online knowledge hub, plant clinics etc. were suggested to address in future program.

- **Activity 4.6. Training of Master Facilitators**

Trainings on various aspects of improved integrated pest and diseases management have commenced on various project sites at different times. Trainings were done based on the need by the farmers on different project sites. All trainings were conducted on cocoa farms where the problems and need exists.

In Madang Province trainings on GAP and cocoa rehabilitation began in September 2015 in Tangu Area, Bogia District. In January 2016 trainings were initiated in Baroidig and Rempi Area, Sumkar District. Several rounds of trainings on block and tree rehabilitation, pruning, and improved ipdm have been completed. Four rounds of trainings conducted for Rempi and Baroidig emphasizing block rehabilitation, pruning and fertilizer (organic) application.

In New Ireland, trainings on GAP and improved IPDM components have been conducted on the project sites on different times on Luapul, Panameko and Umbukul. First rounds of trainings on block sanitation and tree rehabilitation and ipdm have been carried out by provincial extension officers John Joseph and Daslogo Kula (PNG-CCIL Provincial Extension Officers) in the project sites mentioned above. The second round of training was carried out together with Anton Kamuso (Plant Pathology) and Rodney Minana (Entomology). The training coincided with baseline data collection. The third round of training was implemented from 7-14th June 2016. The training was focused on organic fertilizer formulation called BOKASHI and its application and the formulation of 4 plant biopesticide formulation as part of improved IPDM packages. Both trainings based on locally available raw materials.

In Bougainville the first round of training visit also coincides with baseline data collection. Training included basic block sanitation and rehabilitations. Mr. Paul Nelau, Steven Tsikoa and PSSP Joe Tomo continued with field visits and training in Buka and Tinputz Area. Mr. Jerry Tunjio and Bruno Batari continued with trainings and field visits in project sites in Central. Mr. Justin Namake continued with trainings in Bana, South Bougainville.

A second training visit to Bougainville by Paul Gende and Anton Kamuso carried out from 11th – 27th June 2016. Training focused on pruning, pest and disease control, and cocoa rehabilitation. Several farmers who had poultry and pigs were encouraged and advised to develop their own manure as source of fertilizer for their cocoa farms.

Ramale in East New Britain had 2 normal farm visits by project officers and 13 training sessions on block sanitation and linning, cocoa rehabilitation, pruning, pest and disease control including biopesticide formulation and application, and fertilizer application. Special topics on trainings on the farm included cocoa cropping cycle, CPB life cycle, disease cycle and different types of pruning. Those trainings were conducted based on the need

identified during the baseline survey and several meetings with the farmers during the normal farm visits.

The Training of Master Facilitators (TOMF) was completed in 5 days with additional night sessions to cover all planned topics. A total of 22 master facilitators (MF) participated in the TOMF from three regional hubs in Bougainville (8 from North & Central and 4 from South) and one regional hub in New Ireland Province(2). Due to administrative and financial reasons related to the liquidation of CCIL, participants from only two out of four provinces were selected to participate in the TOMF. The detail of these MF is given in below table:-

Location	**Lead Farmers**	**DPI**	**CCIL**	**ACIAR**	**Total**
North Bougainville	4	2	2		**8**
Central Bougainville	1	3	3	1	**8**
South Bougainville	1	1	1	1	**4**
New Ireland Province	1		1		**2**
Total	**7**	**6**	**7**	**2**	**22**

The TOMF training manual was used as training reference material. This was a participatory training to encourage participants and farmers to adopt and implement innovative and sustainable crop and pest management strategies. This training comprised of some presentations, discussion sessions and field activities to encourage the participants to explore and discover for themselves.

The CABI master trainer covered different topics i.e. good agricultural practices (GAP) for crop protection, safe use and handling of chemicals, operation of spray machines, workers safety using PPE, safe post-harvest processing aspects. PNG-CCIL master trainers focused on soil and nutrition management, composting, crop husbandry (pruning, grafting, trenching etc.), integrated pest & disease management (IPDM), and post-harvest handling. The training program is attached as Appendix 5. The overall training evaluation results showed 90% falls under satisfactory to excellent and about 44% commented about short training time. The detailed training feedback is given in Appendix 6.

Figure 4.3. TOMF Arawa: (A) Participants of the TOMF in Arawa;

- **Activity 4.7. Training of Facilitators**

In New Ireland Province, the master facilitator John Joseph conducted two ToF sessions in Kavieng and Namatanai District, while in Bougainville province, the master facilitators, Jerry Tunjio and Bruno Batari conducted three ToF sessions in Tasipo and Bona Districts. The details of ToF sessions and trained facilitators are given in below table:

Province / Site	**No of ToF Sessions**	**Topics covered**	**Facilitator trained**	**Trainer**
New Ireland -Kavieng District	01	1. Establishing a new cocoa block. 2.Nursery Establishment & Management 3. Budwood Garden Establishment & Management 4.Cocoa Block Rejuvenation/ CPB Management	06 Officers 47 VEWs	John Joseph
New Ireland -Namatanai District	01		07 Officers 37 VEWs	
Bougainville – Bona District	02	IPDM	4 officers 24 farmers	Jerry Tunjio and Bruno Batari
Bougainville – Tasipo District	01	Crop husbandry (budding, grafting, etc.) IPDM	2 officers 13 farmers	
TOTAL	**05**		**19 officers 84 VEWs 37 farmers**	**03**

More TOF sessions will be conducted to cover the remaining topics on GAP for IPDM, nutrition management, postharvest and cocoa processing etc.

- **Activity 4.8. Training of farmers**

Although we did not start FFS our PNG-CCIL teams carried out a number of famer trainings on improved integrated pest and disease management (IPDM). These IPDM trainings have already been initiated in all 4 provinces in the 2nd half of 2015 and continuing onto 2017 based on the need by the farmers. The trainings on different aspects of IPDM/CPB control forms a major component of the inputs into the cocoa farms.

A total of more than 34 training sessions were conducted with the participation of 533 farmers (chance of repeat farmers in different sessions) in all four provinces i.e. Bougainville, New Ireland, Madang and East New Britain. The summary of these trainings are given in Appendix 7.

- **Activity 4.9. Analyses of social and economic factors that promote adoption of IPDM**

It is very important to study the impact of all the activities and efforts made in this project in context of adoption of innovative and sustainable ways of IPDM in Cacao. The questionnaire on the IPDM technology adoption and impact assessment of project activities were developed and adapted for Commcare. PNG-CB staff are currently completing this survey in all four locations and from the same farmers who were interviewed during baseline study. A separate report will be prepared on the results of this study.

PROBLEMS AND OPPORTUNITIES

Some of the planned activities were delayed and some were not possible due to the liquidation of the partner organization i.e. PNG-CCIL. The subsequent failure of the PNG Cocoa Board to replace CCIL as a Research, Development and Extension section has thrown our plans into disarray.

The potential exists for a reformed CB to eventually take ownership of the project outcomes to scale up these activities in other cocoa grown areas in the country.

FUTURE PLANS

Despite challenging circumstances, we were still able to successfully complete more than 60% of our planned activities. Most of the training activities were conducted in two out of four provinces, which can be referred as pilot case study. The findings in terms of adoption of IPDM practices, increased quality yield and farmers' income and better crop management can easily be replicated in other provinces. In one of the previous study, farmers reported the substantial increase in cocoa yield and income after implementing IPDM and postharvest management practices.

Keeping in view the importance of these trainings on the farmer's livelihood, we are still very hopeful and enthusiastic to complete the incomplete and on-going project activities. The details of the proposed activities are as followed:

- Complete the remaining ToF sessions for VEWs / facilitators in at least one –two provinces
- Start and complete the farmer field schools (FFS) for farmer trainings at VRCs
- Conduct a training for mater trainers on the quality assurance of FFS trainings and overall evaluation of extension approach

- Develop protocol for post assessment of IPDM adoption by the farmers
- Develop good case studies and success stories from the project interventions
- Using smart phone can serve many purposes; access to extension materials like pamphlets, factsheets, videos showing short steps to carry out specific task e.g.; grafting, chemical application, safety, processing etc. (optional)
- Using tablets and smart phones for data/information collection for Activities 4.3 and 4.9.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The major project activities were achieved, with 60-80% completion rate. The indicators of outcomes were not clear according to the design, however most of the activities achieved good quality. Thi is good given the severe capacity issues in implementation due to the liquidation of the in-country project partner PNG-CCIL in 2017.

The appropriateness of scientific rigour was adequate and could easily go to good or high quality depending on the testing of clones. The planting material was appropriate however; the 20 new clones will be tested after bearing in 2018-onwards. The relevance of trial sites to assess cocoa pod borer tolerant clones is highly relevant and aligns to the Cocoa Board initiative to increase cocoa production through high yielding cocoa plants.

8.2 Capacity impacts – now and in 5 years

The achievement of the objectives is rated good quality and could have easily moved to High quality when all outputs are achieved. Farmers must be equipped with knowledge and skills on how to manage cocoa and improve yield, as well as incentives and the capacity to implement knowledge so that they have a better income from their cocoa. This was done by selecting a limited number of farmers per training to collect information on the farms. The project has trained up to 25-30 farmers per Province resulting in 306 farmers out of which were 34 women farmers. The institutional change also impacted on the PNG-CCIL field staff who remain after the liquidation to implement the project objectives activities within the timeframe.

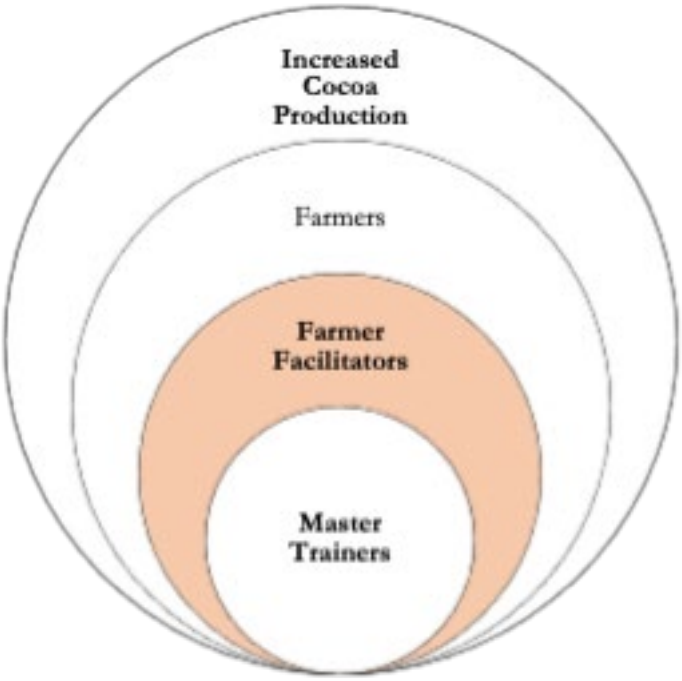


Figure 8.1 Conceptual **l**inks underlying the FFS approach

Sustainability: The use of technology offered under the pest and disease management of cocoa pod borer is rated adequate quality. The FFO approach has the potential to work however it has sustainability concerns where the gender consideration is low, institutional capacity is weak and master facilitators are not committed. The approach of FFO might benefit from linking "*family farms*" tools to integrate gender consciousness to farmers, most of who might be poor and culturally place heavy burden on women to provide the labour to cocoa farms.

This ACIAR project has a number of partners such as University of Sydney and CABI, and these partners could work together with whatever structure succeeds PNGCCIL to improved outcomes into the future. Since 2017, 22 master trainers were trained from all provinces and among them 2 were women. The relationship among a cadre of Master Trainers to Farmer Facilitators shown in Figure 8.1 recognises the challenge in the Farmer Facilitators delivering many trainings to farmers and whether they are expected to also provide follow-up monitoring and training.

Combined with relevant knowledge and commitment, the Cocoa Board is better positioned regardless of the institutional changes to ensure the outcomes are fully achieved. The project is improving planting material not only to control Cocoa Pod Borer but to improve yield in cocoa farms so that farmers could earn better income. The project also established and maintained several bud wood gardens to help farmers have access to high quality planting material in the localities. Planting materials have already been distributed to other farmers through the various nurseries established by some of the project farmers. Budwoods are also taken and distributed to farmers who can bud for themselves.

The attitude, skills and knowledge study undertaken requires a review to look at the attitude of the project beneficiaries and address training packages. This may perhaps consider aspects of training in book keeping and financial literacy, farmer health and gender for a comprehensive resource material, written in simple English and Tok Pisin. The content of the curriculum used in the training of Master Trainers and Farmer Faciliatators particularly is important to ensure farmers are fully practising integrated pest and disease management in relation to cocoa cropping. The challenge is in the Farmer Facilitators delivering many trainings to farmers and whether they are expected to also provide follow-up monitoring and training. According to Koniel Batil – a Master Trainer trainer with Outspan under PPAP World Bank, he trained up to 50 Farmer Facilitators by now so there should be approximtely 1,500 farmers in East New Britain Province trained on intergated pest and disease management of hybrid cocoa cropings. PPAP on a larger scale is reaching out to 7 cooperatives (Tavua, Kbng, Rabavai, Napapar, Rabuana and Wantom) where 500 farmers consisting of 115 females and 285 males are supported with 600 seedlings and tools. There are already over 300,000 cocoa trees planted therefore there is expectation of increase in cocoa production. Paul Gende – the former ACIAR project leader indicated that each farmer field school is expected to have more than 20 farmers attended by women, men and youths.

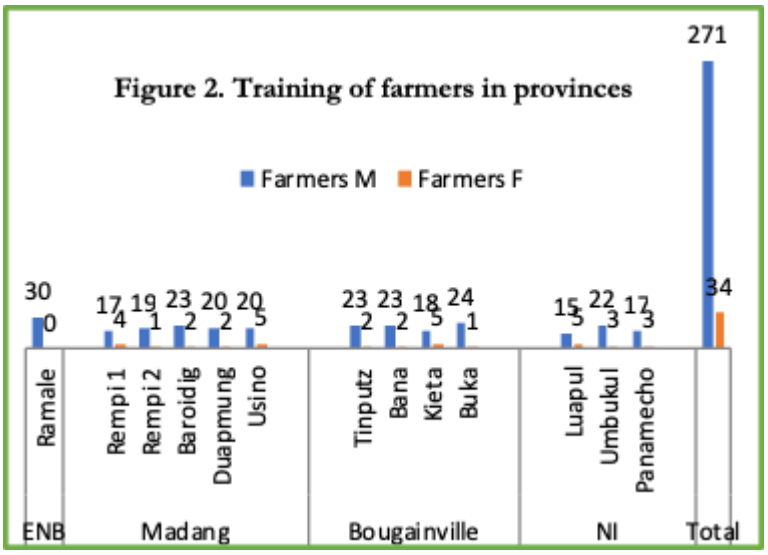
Figure 8.2 (above) Koniel Batil, Master Facilitator based at Papapar continues to facilitate training of farmer facilitators for PPAP World Bank project. (below) A drawing as part of the learning module under farmer facilitator training. This picture was drawn by an illiterate farmer in Tok Pisin. Papapar private nursery, East New Britain (13 June 2018)

8.3 Community impacts – now and in 5 years

This phase of the ACIAR project focused on the trainings on improved IPDM, development of organic fertilizer and application. This new technology attracted interested smallholders in all the provinces. There was support from the ward counsellors and community leaders. A total of 306 farmers trained among them 34 women farmers in East New Britain, New Ireland, Bougainville and Madang provinces. The trainings were on productivity improvement in which all the community members are invited to attend from men, women, and youths.

The Farmer Field of School is a potential approach that if properly packaged in simple ways, can be used by village people with basic knowledge of English and Tok Pisin. This project approach makes it easier for many farmers to be equipped with knowledge and skills on how to manage cocoa and improve yield so that they have a better income from their cocoa. It was obvious that farmers have acquired new knowledge such as cocoa pruning, sanitation, manual weeding and grafting. Most training participants were interested in the development and application of organic fertilizer.

The topics that were indicated of interest to most women were grafting and sanitation while a businessman in Bougainville sought training for budwood garden establishment, nursery establishment, pest and disease management, pruning and methods of block rehabilitation. This review did not provide sufficient information and time to look into broader impacts of the project such as economic, social and environment in the community. The reviewers recommend an impact assessment to inform the project on risk management of potential effects and to improvise on the benefits directly related to the project. However preliminary observations made are explained below.



Empowerment of women and girls: Women and girls were encouraged to participate in site trial trainings as part of the community involvement however that remained less than adequate. **Figure 8.2** shows that only 34 women participated across the Provinces in all the trial sites compared to 271 male farmers. This project did not specifically address gender and would have benefited from a '*family farm'* approach.

Interesting were the outstanding achievements by two women farmers from Arawa farmer trainings. The PPAP World Bank Project has found that 90% of women are involved in seedling budding and pruning. According to the PNG-CCIL project consultant who conducted the trial site training, two (2) women rehabilitated their farms and established a nursery. Both women demonstrated skills in integrated pest and disease management such as pruning, sanitation, and nursery establishment.

The knowledge, attitudes and perception study did not focus on women's specific values in adopting knowledge and skills learned however it indicated that "irrespective of the gender differences, the success rate of trained farmers to get better yield when they adapt pest management is similar". Speaking to the farmers, Master Facilitator and PNG-CCIL staff the new cocoa clones and hybrids are easier for women and youth to manage due to their reduced vigour.

8.3.1 Economic impacts

The project continued to identify market opportunities and constraints to help smallholders to intensify cocoa production and diversity incomes. A formal survey was undertaken in March 2017 of around 20 chocolate markers and chocolatiers in Australia. The results were passed on to the Papua New Guinea industry in a series of newsletters and trainings in Bougainville and East Sepik. A training to develop the capacity of farmers to export was undertaken in south Bougainville.

However, the review team found that Agmark is one suppler in most parts of cocoa growing provinces but has limited engagement with ACIAR project although the CABI socio-economic survey revealed that 69% of cocoa growers from all the provinces sold wet beans mainly to agents (like Agmark, CCI-Kavieng, Outspan, and local buyers with Fermenter. A detailed value chain analysis of each of the supplementary income generating options such as; cocoa, virgin coconut oil, coffee, vanilla, betel-nuts, mustards, pepper (black and white, high valued vegetables, rice farming (swamp rice), seaweed, small-scale tuna farming, reef fish, portable sawn timber, livestock (cattle, goat, poultry) and others is necessary to understand economic market.

8.3.2 Social impacts

Health, education, infrastructure, available land, politics, farmer interests and gender were some variables for socio-economic understandings in order to improve living standards of cocoa farmers lives in the remote parts of the Provinces. The review team visited Ramale village in East New Britain province that is remote and lacks aid-post facilities. Access to the main road can be difficult especially if needing a transport to move cocoa bags. House status were observed to be of permanent, impoverished and traditional. The literacy levels are not known in this project site, however the common form of communication was in Tok Pisin. Despite considerable logistical issues, the project established a fermentation facility worth K40, 000 which was observed as one factor in creating interest in the village to plant cocoa trees. This village received 3 trainings and several site visits and meetings from PNGCCI staff resulting in bud wood gardens, distribution of 18 clones and 20 trees planted per clone due to land shortage.

Figure 8.3 (L) ACIAR funded fermenter showing cocoa beans in drying in the drying process and the ACIAR review team looking at the dried cocoa beans. (R) clones planted with 18 clones distributed for field budding. Ramale Village, East New Britain Province (13 June 2018)

8.3.3 Environmental impacts

The ACIAR project encourages bio-pesticide use as a last resort to manage pest and disease infestation. The review team observed no environmental concerns during the field visit, however the fermenter provided by ACIAR to Ramale village uses firewood to heat up the fermenter and posses risk of cutting trees down to keep the fermenter hot. From the compost and ferilizer trial uses chicken manure which produces strong smell and could be a health problem for those not used with strong stringy smell of the chicken manure. Chicken manure is high in potassium which is good for cocoa tree healthy growth and flowering. However, it is labour intensive and requires up to 4 days of turning and moving before applying in the field.

8.4 Communication and dissemination activities

We have passed our findings to the CB REDS team for dissemination to growers. This includes recommendations for the safe movement of cocoa germplasm and nursery establishment guidelines. We have had no response.

9 Conclusions and recommendations

9.1 Conclusions

The project had a promising start that aimed to engage and unify a fractured CCIL by aligning closely with the CCIL strategic plan. The placement of CCIL under administration soon after the project commenced in June 2015, and subsequent liquidation in 2017 created uncertainty and significant disruptions to our workplan. Unreliable internet connectivity and reception affected communications between project partners.

The failure of the Cocoa Board to efficiently manage the liquidation of CCIL and to fund a functioning replacement body or staff led to the severe disruption of the project. The PNG Project Leader's position and the positions of many project staff were abolished. Key project staff found they were no longer employed by CCIL and no longer had access to office or research facilities. The Project Review was conducted by engaging Paul Gende as a Project Consultant to the University of Sydney, with limited support or involvement from the CB. CB staff failed to provide any response to commnmets provided by the Review team.

It is a testament to the commitment of project staff that they remained in contact with the Australian Project Leader during this on-going uncertainty, without salary or support from the CB. It is difficult to see what could have been done to continue the project at the expected rate of progress under these circumstances."

Neither ACIAR nor the Cocoa Board could provide guidance on how to continue to progress the project, and funds transfers were deferred after advice of the ACIAR Country Manager.

The project has demonstrated the resilience of the ACIAR development model under extremely testing conditions. Working and helping to build in-country institutional capacity is fundamental to the success of this model and must be pursued regardless of the challenges that can be encountered.

Including a diversity of institutional approaches within projects adds resilience. The willingness of CABI to take on the analysis of socioeconomic data when it was not part of their original responsibilities deserves mention.

Despite these constraints this project laid the foundations for HORT/2014/094, HORT/2014/096 and SMCN/2014/048. Many project activities have been incorporated and expanded in these projects.

9.2 Recommendations

We would draw attention to Review Recommendation 2 (Develop simple and realistic Project Proposals) and Recommendation 8 (A smaller number of better quality experiments) as possible mechanisms to improve the effectiveness of project design. Indeed, a careful examination of past ACIAR projects may help to confirm whether or not these two project design issues show any correlation with project effectiveness.

The commitment of the project personnel has 'kept the ship afloat'. Many of those present throughout the review process have not been paid since February and yet were still willing to make a positive contribution. The methods used by project staff to safe-guard project funds were outstanding and should be applied in future projects.

ACIAR must consider whether to continue collaboration with the research arm of PNGCB (REDS) because of its disengagement with the project following the liquidation of CCIL. A national commodity research agency is seen as the most cost-effective method to improve the livelihood of approximately 2 million low-resource farmers in one of our closest and

most important neighbours. There are significant opportunities for research to improve the conditions of farmers and to boost production of an important export earner for PNG. However research activities need careful economic assessment before they are initiated, because there is limited capacity for new technologies that require increased inputs at the production end of the supply chain. Research proposals need to demonstrate how their outputs would fit in the PNG cocoa farming system.

10 References

10.1 References cited in report

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10.2 List of publications produced by project

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11 Appendixes

11.1 Appendix 1: Quarantine procedures for within country movement of cocoa planting materials

Quarantine procedures for within-country movement of cocoa planting materials

The demand for new planting materials requires the shipping of cocoa seedlings and budwood across the country. There is a risk that pests and diseases, including VSD, CPB and *Phytophthora*, could inadvertently spread with planting materials to areas currently free of these problems. In particular, New Ireland, Bougainville and Karimui remain free of VSD.

The following guidelines have been drafted to minimise this risk and provide for the safe movement of cocoa planting materials within PNG.

1. **Transfer of bare-rooted cocoa seedlings**
   - 1.1. Rootstocks must be grown in a clean nursery or quarantine shed free of VSD and other pest and diseases.
   - 1.2. Collect bud wood from blocks that are free from VSD. Budded seedlings are kept for 2 months for observation for VSD symptoms (swollen lenticels, yellow or necrotic leaves, leaf shedding with characteristic 3 necrotic vascular traces on the leaf scar and shoot tip death). Any seedling with suspected symptoms must be destroyed by burning. Do not treat seedlings with fungicide, as this may mask disease symptoms.
   - 1.3. Remove the seedling from the poly bag, wash the roots free of soil and pack in moist sawdust. Check that seedlings are free of VSD symptoms (see 1.2), and have a Phytosanitary inspection certificate issued by NAQIA attached to the package.
   - 1.4. At the destination, inspect the seedlings and plant healthy seedlings in fresh soil in poly bags, then transfer to a temporary Quarantine house.
   - 1.5. The Quarantine house must:
     - 1.5.1. Be enclosed all sides with clear plastic and must have shade cloth above (on top)
     - 1.5.2. Be located away at least 200 m from existing cocoa
     - 1.5.3. Be near a clean water source for hand watering
     - 1.5.4. Have a cemented or gravel base to prevent water ponding
     - 1.5.5. Have restricted access with (quaternary ammonium) disinfectant foot washes at the entrance.
   - 1.6. Workers must wear enclosed footware upon entry. No eating, smoking or buai chewing in or around the Quarantine house.
   - 1.7. Water plants mid-morning to prevent moisture buildup.
   - 1.8. Observe the seedlings every week for VSD and other symptoms for 4 months, and destroy any suspect seedlings, before planting healthy seedlings in the field
   - 1.9. Quarantine house must be cleaned between shipments
2. **Transfer of cocoa clones by Budwood**

2.1. Budwood must be collected from healthy clones that are free of VSD or other pests and diseases

2.2. Budwood pieces must be dipped in fresh 10% bleach for 2 minutes, rinsed in clean water and then wrapped in wet hessian bag before shipping.

2.3. Receiving organisation must prepare a clean quarantine house, enclosed all sides with clear plastic and have shade cloth above (on top) (as described in 1.5).

2.4. Water rootstock seedlings before and after budding in mid-morning to prevent moisture buildup

2.5. Observe the budded seedlings every week for VSD and other symptoms for 4 months, and destroy any suspect seedlings, before planting healthy budded seedlings in the field

2.6. Quarantine house must be cleaned between shipments

November 2015

11.2 Appendix 2 Knowledge, Attitude and Practice of Cocoa Farmers in Papua New Guinea: A Baseline Assessment

Introduction

Cocoa is an important economic crop of Papua New Guinea (PNG). About 80% of cocoa is produced by smallholders, with 150,000 households depending on cocoa for their livelihoods. The overall development goal of this project is to maintain and increase market access of cocoa exports from Papua New Guinea by improving practices along the supply chain to meet international standards of food safety. This project is to build on the success of the earlier project carried out in 2008 to 2012, funded by ACIAR and conducted jointly by CAB International (CABI) and PNG Cocoa Coconut Institute Ltd (PNGCCIL) on management of cocoa pod borer (CPB) in PNG through improved risk incursion management capability, integrated pest and disease management (IPDM) and participatory training through Farmer Field School (FFS) approach. The focus will be on the utility of new strategies in regions with new CPB infestations in PNG and Good Agricultural Practices (GAP) must be well adopted and maintained at a high level of awareness, thereby will reduce the use of chemicals, thus, reduce hazard to the user and the environment. Therefore, the cocoa farmer must know the IPDM methods in handling CPB and other problems. However, a base line survey was done to see how are the farmers profile, their knowledge, attitude, and on- and off-farm practices to cope with the CPB and other pests' management. This baseline information will validate our efforts in farmers training in relevance to change in their knowledge, attitude and practices while post project assessment.

Methodology

The baseline study was conducted among 306 farmers in four regions – (i) Bougainville, (ii) Madang, (iii) Kavieng, New Ireland and (iv) East New Britain (E.N.B) Province. The following table (Table 1) shows the distribution of the farmers according to the four regions. The table also shows the number of the farmers sampled in each of the following districts which comprised of farmers from different villages. While selecting the farmers for the baseline exploration a stratified random sampling was followed, the stratification used being that of the four regions of the country and the districts within the regions.

Table 1: Representation of the farmers from the four different regions

Region	Number of farmers selected	Percentage	Districts covered (sample size)
Bougainville	98	32%	**4** – Tinptz (25), Kieta (23), Bana (25), Buka (25)
Madang	113	37%	**5** – Rempi 1 (21), Rempi 2 (20), Baroidig (25), Duapmung (22), Usino (25)
Kavieng	65	21%	**3** – Luapul (20), Umbakul (25), Panamecho (20)
E.N.B Province	30	10%	**1** – Ramale (30)
Total	**306**		

The baseline study primarily involved collection of primary data on knowledge attitude and practices of the cocoa farmers using a semi-structured questionnaire. The focus of the study is to evaluate whether extension training provided to the cocoa growing farmers are effective in enhancing adoption rate of new techniques[1] and whether adaption helps the farmers achieve better yield. To meet this end during the primary survey care was taken to include both farmers who had received the extension training as well as those farmers who are yet to receive extension training.

Findings

(i) Farmer profiles

The major representation of the farmers in the sample based on the gender profile was from the male counterparts. Most of the farmers mentioned that their plantation includes hybrid varieties and clones (around 67%), while in contrast 22% mentioned that they primarily have local varieties within their blocks. About 50-60% of the farmers sampled were found to rear livestock along with maintaining cocoa plantation, with an exception being the farmers in the Kavieng region where only 35% of the farmers were found to have livestock. Livestock rearing involves poultry and pig which is a common feature across the regions and more than 90% farmers who revealed that they have livestock mentioned about poultry and pig rearing.

Intercropping within the block is observed to be quite high among the farmers (around 81%). Most of the farmers either plant coconut or banana or both along with the cocoa. The proportion of farmers having both banana and coconut within the cocoa blocks varied between 26% to 36% in Bouganville and Madang respectively. In Bouganville 40% of the farmers revealed that they planted coconut along with cocoa while the remaining farmers (34%) had banana plantation in their blocks. Similarly, 33% farmers in Mandang mentioned that coconut was the only crop along with cocoa and 31% remaining farmers had banana along with cocoa. The scenario in Kavieng and E.N.B. Province is quite different as compared to Bouganville and Madang with respect to intercropping. In Kavieng and E.N.B. Province, most of the farmers either have coconut or banana along with cocoa. In Kavieng, about 60% of the farmers practiced coconut intercropping while in E.N.B. Province about 73% of the farmers had banana plantation within the cocoa blocks.

Figure 4: Profile of the farmers in the four regions

[1] *The specific focus is towards the extension training of mitigating a devastating pest i.e. Cocoa Pod Borer (CPB) which often inflicts losses of 80-90% if not properly managed.*

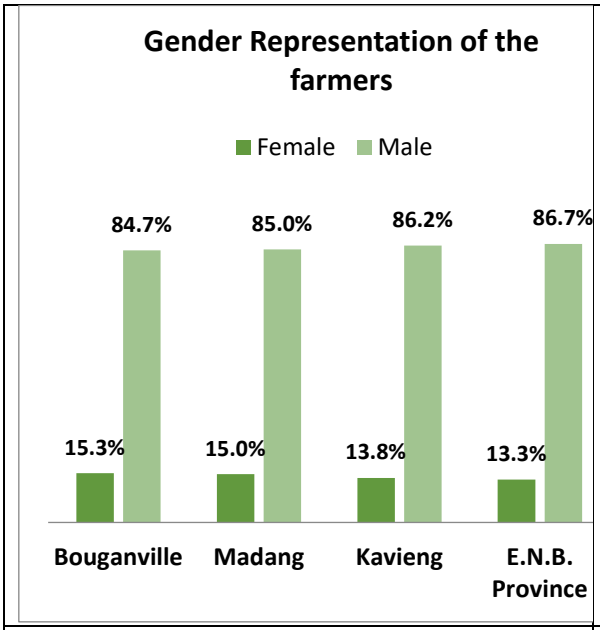

Fig. 1A: Gender profile of the farmers

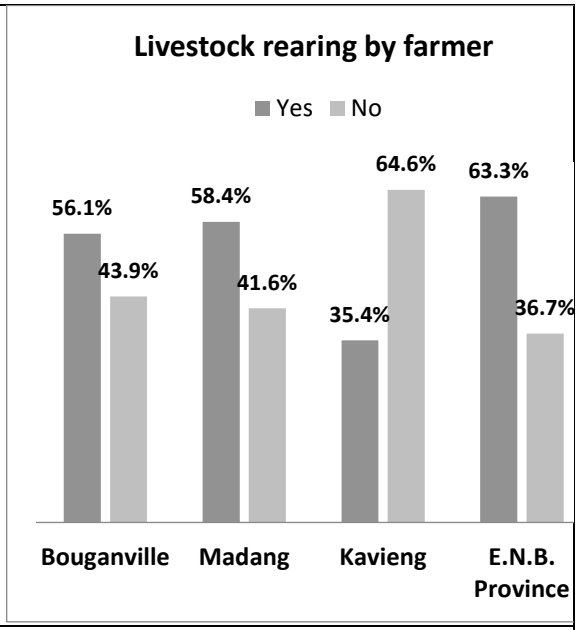

Fig. 1B: Farmers engaged in livestock rearing along with cocoa plantation

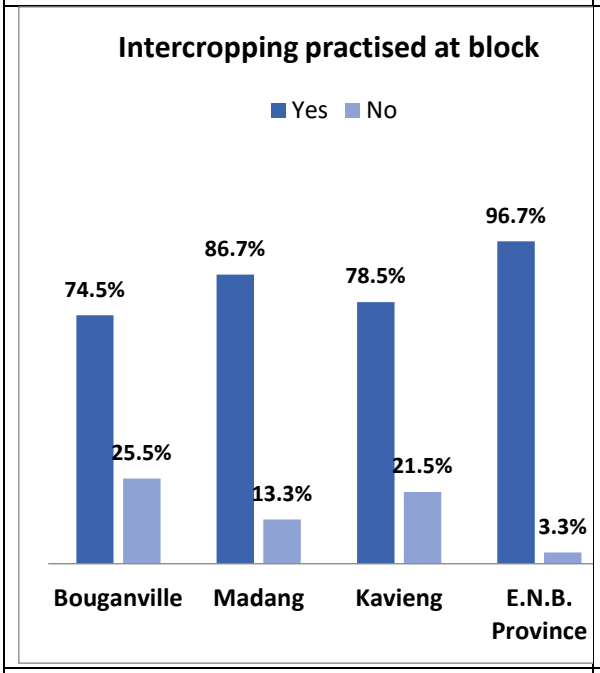

Fig. 1C: Intercropping practiced by farmers along with cocoa

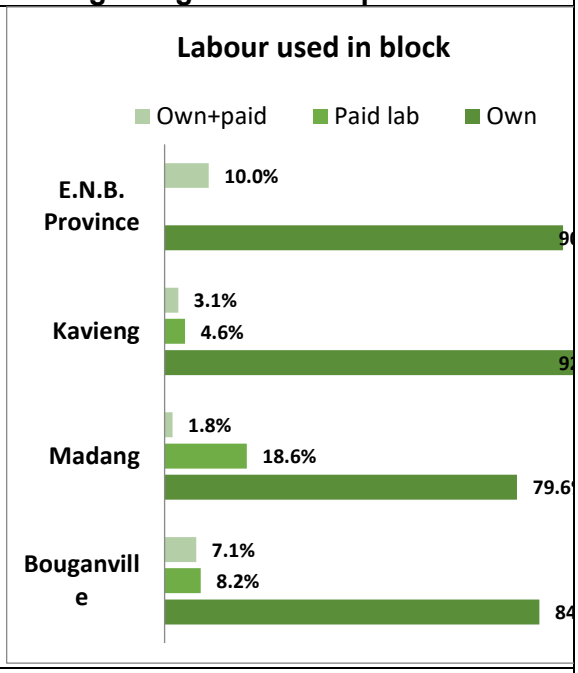

Fig. 1D: Labour used in the block by the farmers

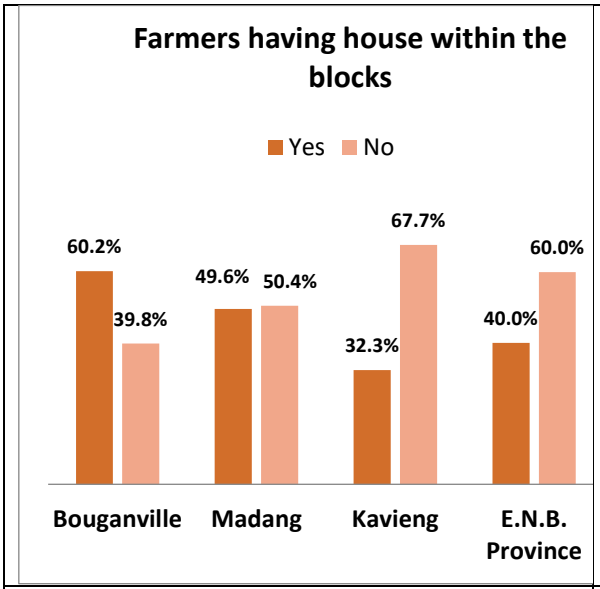

Fig. 1E: Houses of the farmers situated within the blocks

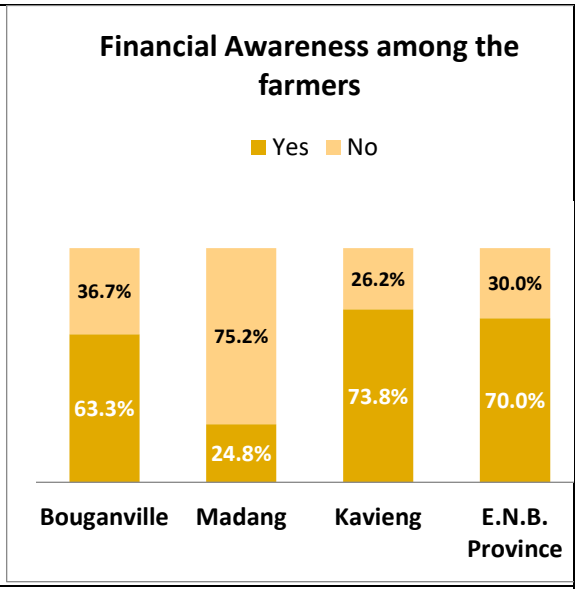

Fig. 1F: Financial awareness among the farmers

Usually the farmers are dependent on family labour comprising of either themselves or members in the family to execute activities like pruning, weeding, harvesting within their blocks. The exception being about 18% farmers (more than the proportion) in Madang dependent on paid labourers in their blocks. The distribution of the farmers staying within their blocks is high in Bouganville and is reported to be lower in Kavieng (32%) and E.N.B. Province (40%). Most of these farmers who live within their blocks use family labour (about 88%) or use both paid labour along with the family labour (5% of them).

The financial awareness of the farmers was reported following the recollection of the banking details by the farmers. Therefore, a farmer was considered to be aware about his finances when the farmers could reveal whether they held a bank account along with the name of the bank where bank account was held. It was observed that farmers in Kavieng and E.N.B. Province were more about their banking details, closely followed by Bounganville (about 63%). In Madang, only 25% farmers mentioned that they had a banking account following which some of them could not mention the bank where they operated the account.

(ii) Farmer knowledge

About 38% of the farmers were observed to have attended an extension training previously. It can be seen from Fig 2A, that the representation of the farmers who had previously received trainings is comparatively more in E.N.B. Province. In contrast only 16% of the farmers represent the group of those attending the training programs. It can also be observed that the group of farmers who had received an extension training previously can be categorized based on the content of the training program the farmer could recollect at the time of the survey. The content discussed (which the farmers could cite) during these extensions varied between the districts to a large extent and a clear consensus is hard to arrive upon.

Trained farmers in Madang and E.N.B. Province (about 21% and 25% respectively) could recollect about business and financial strategies being outlined in the extension training. However, with regards to pest management and agronomic practices, the distribution of the farmers in these districts is dissimilar. While more farmers in Madang could relate back to agronomic trainings, comparatively more farmers in E.N.B. Province could retrace pest management. In analogy while most of the farmers in Kavieng mentioned that pest control was the main extension training that they had received, farmers in Bouganville reported oppositely.

Figure 5: Previous Extension Trainings attended by the farmers and feedback provided by them

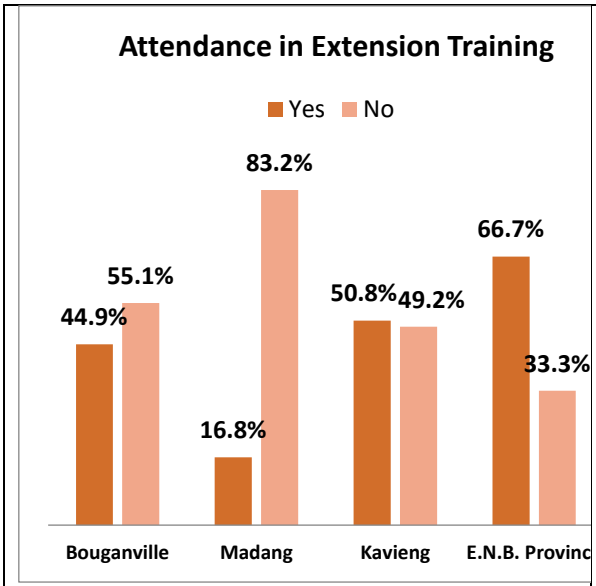

Fig. 2A: Proportion of farmers with extension training

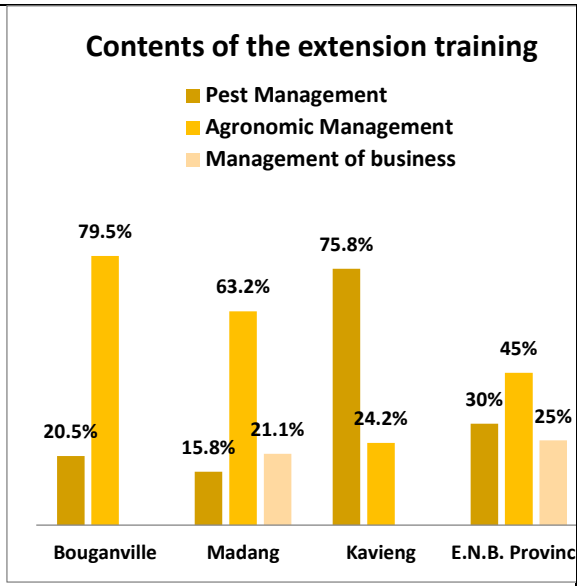

Fig. 2B: Farmers recollection on the content of the training

Regarding the perceptions on the utility of the trainings and the contents that were useful for the farmers, the farmers shared a heterogeneous view. More than 30% farmers in Boungaville, Kavieng and E.N.B Province were satisfied with the skill sets being provided through the extension training. These skill sets included agronomic practices (like nursery management, cocoa husbandry, pruning, etc.) and pest and disease management. Similarly, the farmers in Kavieng and E.N.B Province mentioned about the general management of cocoa business strategies (like book keeping) which were helpful for them. In contrast, only 16% of the farmers in Madang were able to recollect about the contents of the training programs. Farmers in Madang and Bouganville therefore require frequent extension trainings which are complemented by follow-ups on hand-on practices.

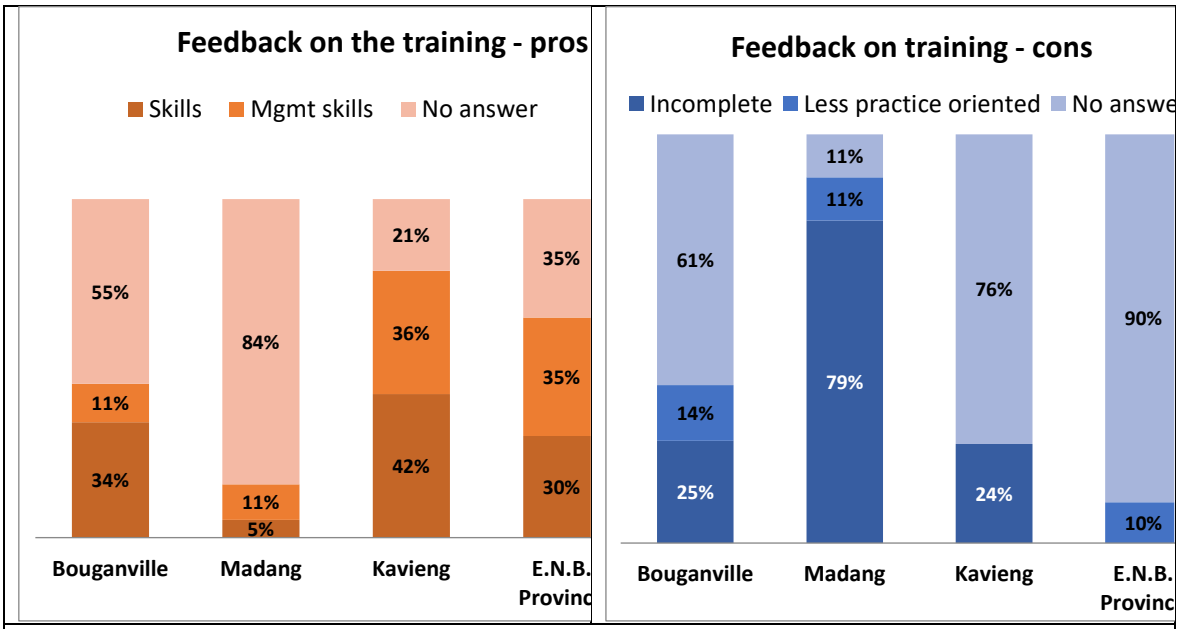

Fig. 2C: Perceptions on the positive and negative aspects of the previous extension trainings

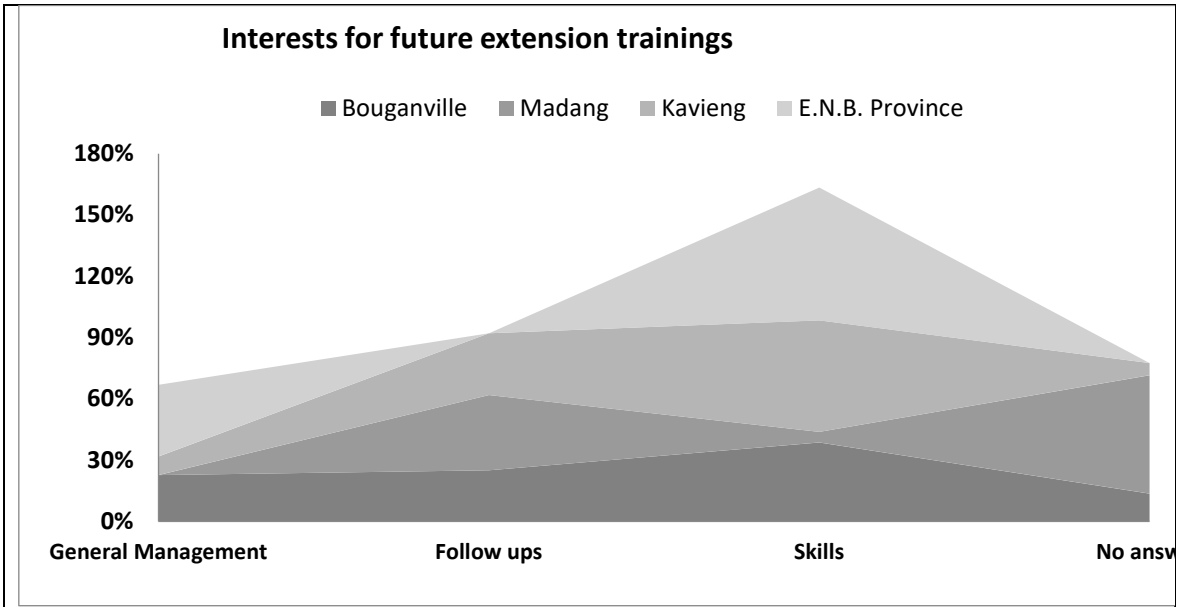

Fig. 2D: Perceptions of the farmers on needs of future extension trainings

(iii) Farmer practices

This section discusses about the practices by the farmers both on-farm and off-farm. The off-farm practices of the farmers are studied with respect to their practices related to selling the type of cocoa beans and the buyers the farmers fetch to sell their beans. In contrast the on-farm practices hinge on two factors – (i) the farmers' own assessment about the block management activities and (ii) use of tools in the farm; where both of these factors are evaluated in the perspective of pest control.

The primary data pooled across the regions reveals that it is a general trend of the farmers to sell wet beans. Within the four regions, farmers in Kavieng and Madang sell wet beans (about 93% and 84% of the farmers respectively), while proportion of the farmers selling wet beans in Bouganville and E.N.B. Province were comparatively lower (about 45-46%). By the same token, the proportion of the farmers in these two regions selling the dry beans and both dry and wet beans are similar.

Figure 6: Selling of cocoa beans

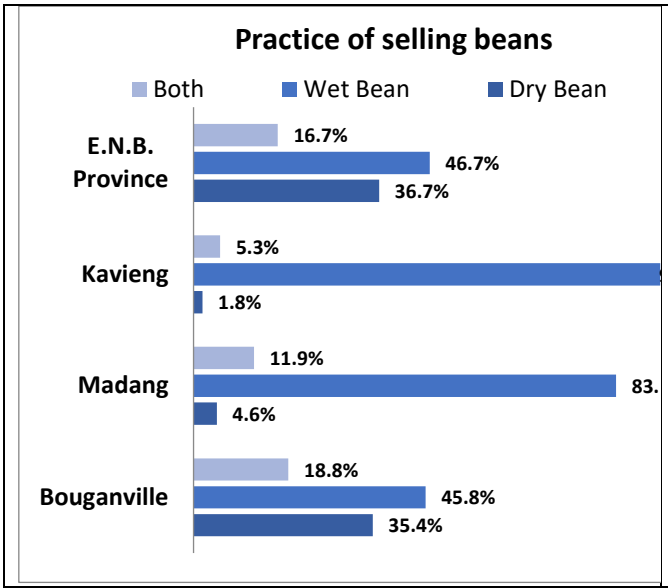

Fig. 3A: Practice of selling cocoa beans across the regions

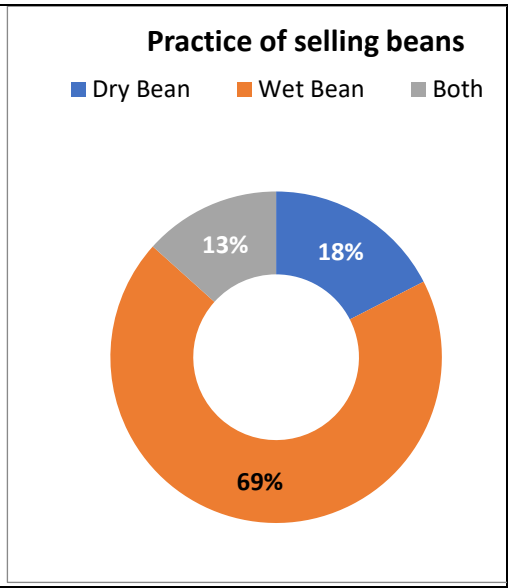

Fig. 3B: Practice of selling the cocoa beans (aggregate data) for the 4 regions

The wet beans are mainly sold to the wet bean buyers and agents (like Agmark, CCI-Kavieng, Outspan, local buyers with Fermenter in case wet beans are being sold). The primary data shows that across the regions farmers sell their wet/dry beans mostly to the agencies, exception being 18% farmers in Bouganville selling their beans to exporters. Although about 53% of the farmers in Madang have their own fermentry, they often depend on the local fermenters selling their wet beans to them.

Figure 7: Buyers of the cocoa beans

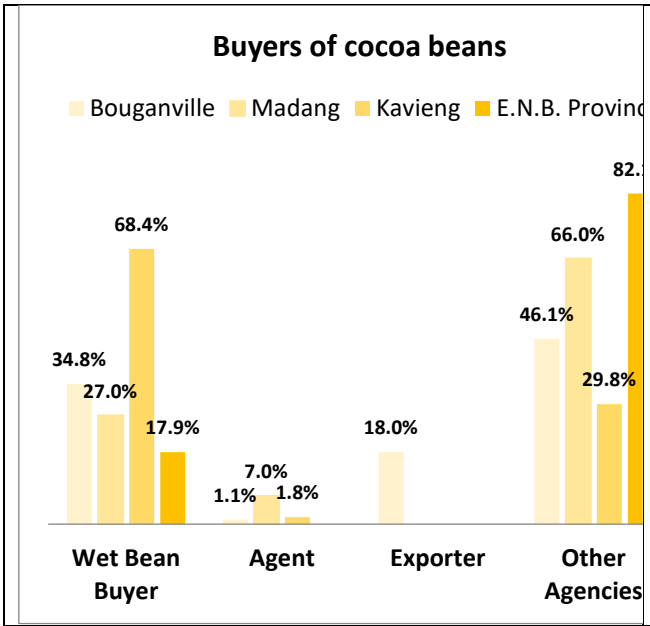

Fig. 4A: Buyers of the cocoa beans in the 4 regions

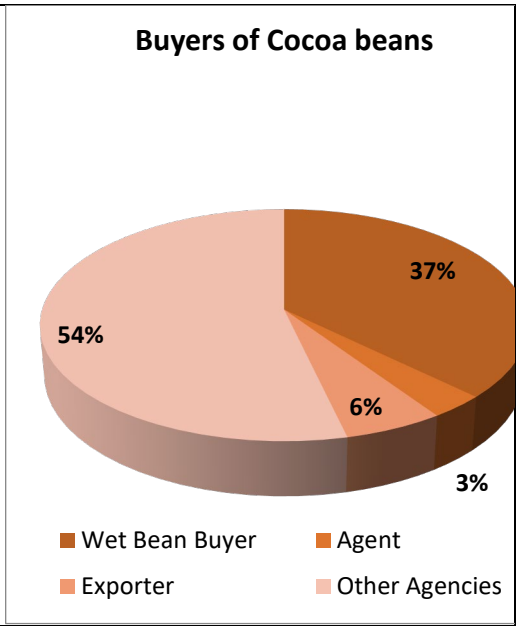

Fig. 4B: Buyers of the cocoa beans (aggregate data)

The farmers in all the four regions were probed about the conditions of their tools used for farm practices. It can be observed that Bush knife is one common tool widely used by the farmers across the regions. In Bouganville, it is found that around 40% of the farmers maintain their farm tools in an operational condition followed by E.N.B. Province where 20-30% of the farmers were found to have tools in operational conditions. The farmers in Kavieng and Madang represented a similar condition 10-20% of the farmers revealed that their tools were in operation condition. Majority of these farmers (more than 85%) do not possess a complete set of tools for farm practices. It is yet another avenue which needs attention when extension trainings are forwarded.

In terms of tools specific to CPB management (like pole prunner, pruning saw, knapsack sprayers and bow saw), the findings are similar. It has already been mentioned that farmers had recommended extension trainings which can provide them new skill sets and this is one such area which needs careful deliberation. The trainings focusing on CPB management has to elicit the utility of tools, use and maintenance, and should also provide hands-on to the farmers. Along with extension training proper follow-ups are also necessary to guide the farmers in these regions.

Figure 8: Condition of tools

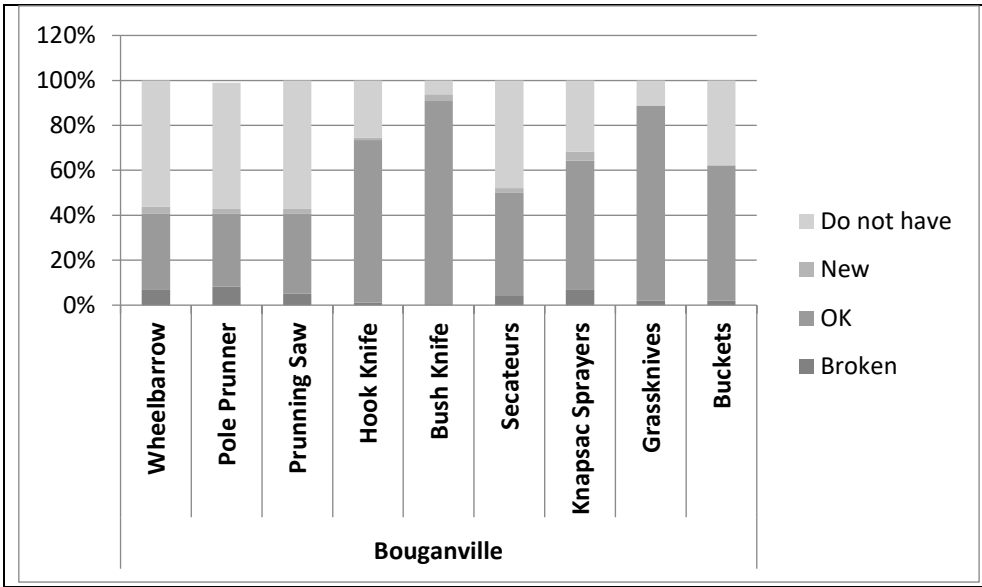

Fig. 5A: Condition of the tools in Bouganville

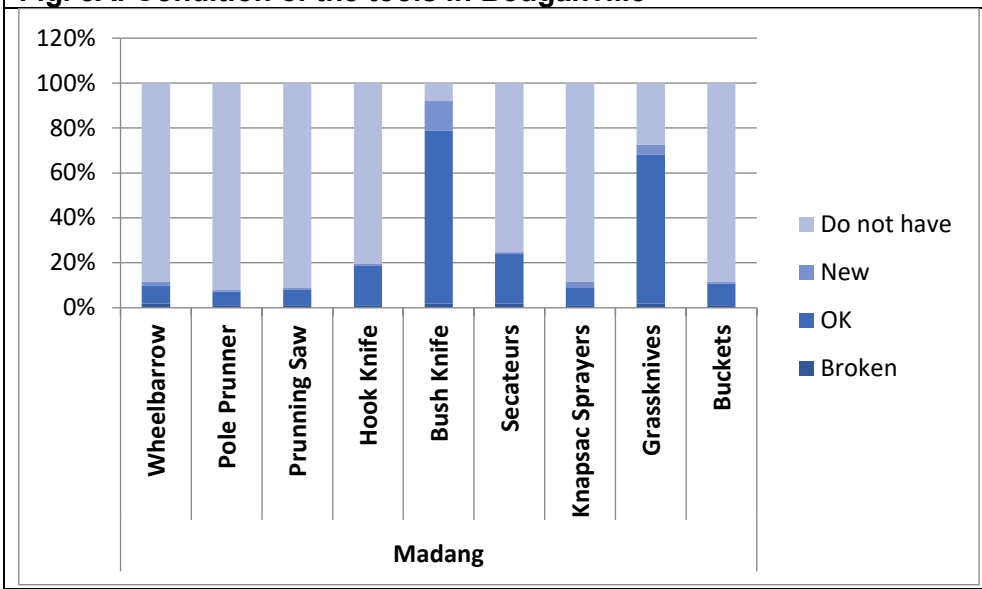

Fig. 5B: Condition of the tools in Madang

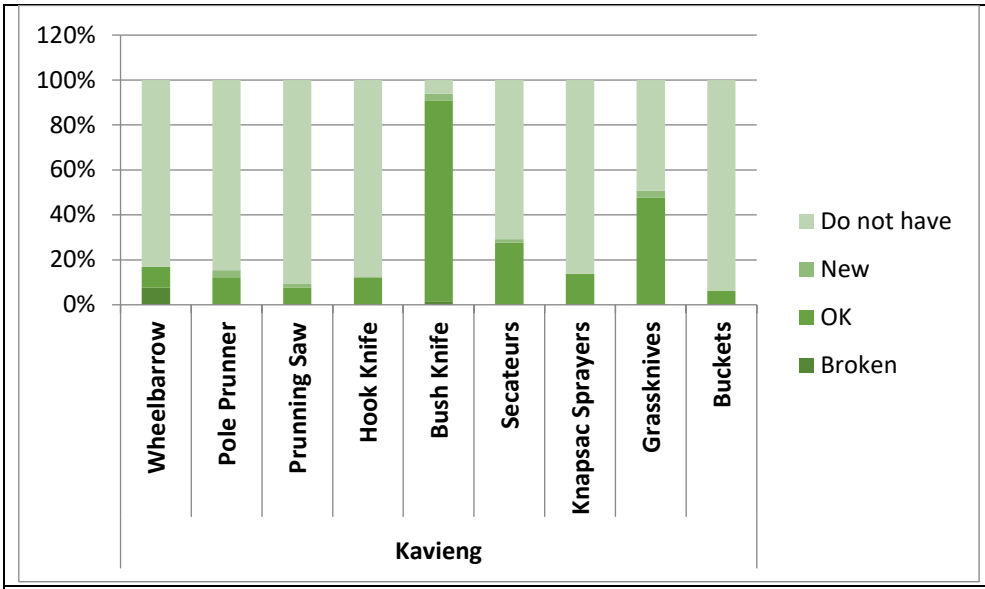

Fig. 5C: Condition of the tools in Kavieng

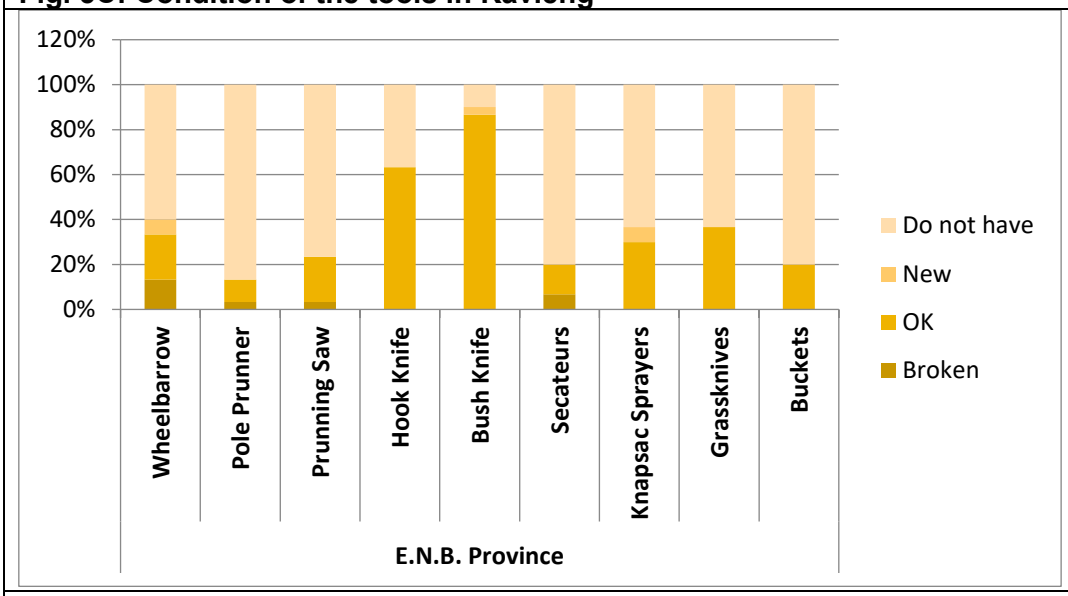

Fig. 5D: Condition of the tools in E.N.B Province

To evaluate the practices of the farmer about their own block management, the farmer was asked about their block conditions regarding weed control, pruning, shade control, sanitation, pest control and nutritional status. The farmers were asked to rank the parameters on a 5-point scale based on whether the existing condition in the block is very poor to very good.

Figure 9: Farmers knowledge about the Block conditions across the districts

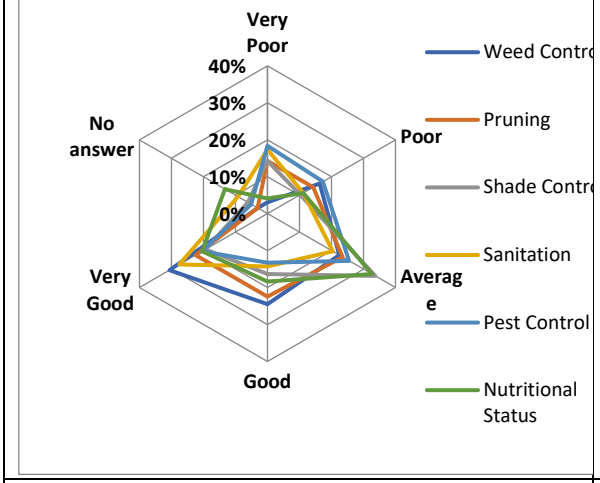

Fig. 6A: On farm practices in Bouganville

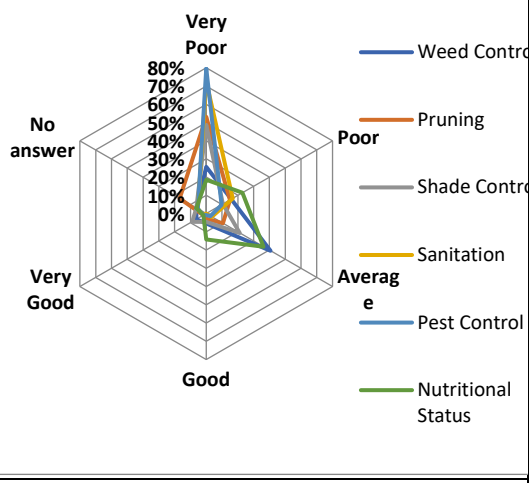

Fig. 6B: On farm practices in Madang

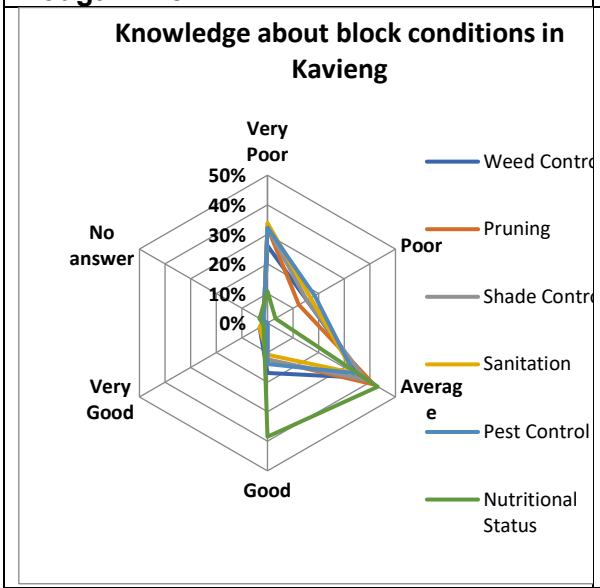

Fig. 6C: On farm practices in Kavieng

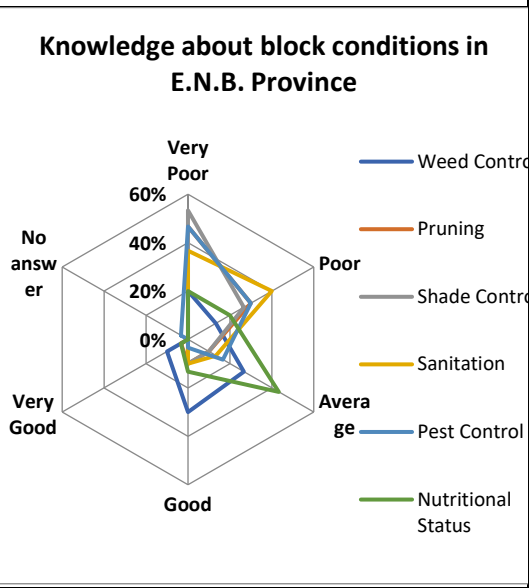

Fig. 6D: On farm practices in E.N.B. Province

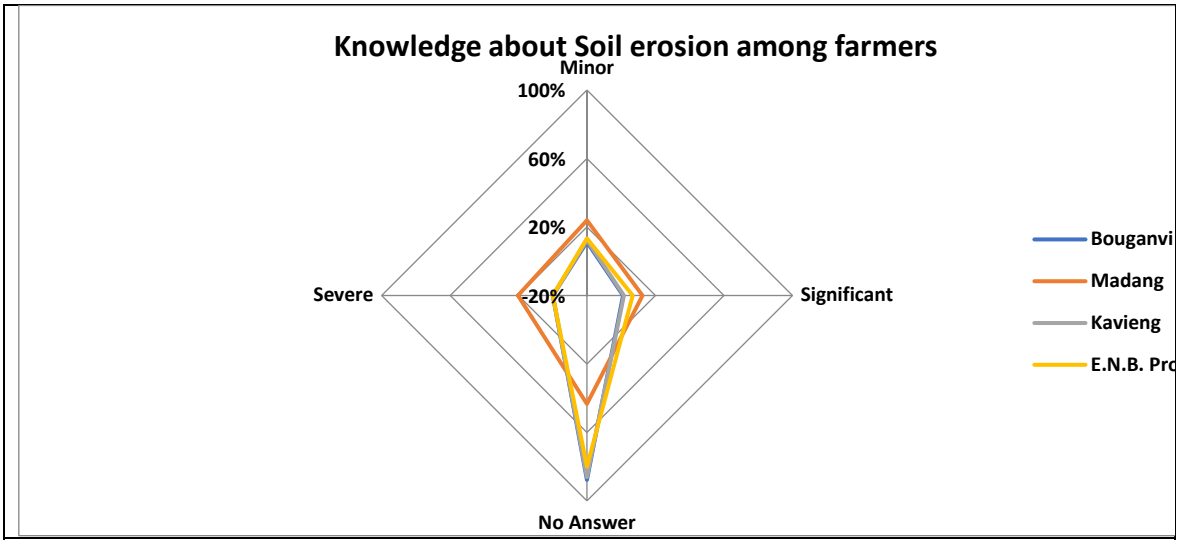

Fig. 6E: On farm practices in the 4 regions

Most of the farmers (about 56%) in Bouganville mentioned that weed control was practiced and their blocks properly maintained, while 44% of the farmers mentioned that pruning was also done. However, the farmers were not very sure about pest control (61% farmers), shade control (58% farmers) and nutritional status (48% farmers). In these parameters it is observed that the farmers reported very poor to average conditions in their blocks. Analysis of the data reveals that farmers in other districts ranked lower to Bouganville in terms of block management practices. In Madang and E.N.B.Province, 75-80% of the farmers do not take care of pest control and neither are they sure about the sanitary measures in their blocks. The situation regarding parameters like shade control and pruning are similar where about 60-70% of the farmers are unaware. Similarly, in Kavieng, excepting nutritional status of the block, 45-50% of the farmers have poor management practices. The primary data also indicates a lower level of awareness among the farmers across the districts with regards to soil condition in their blocks. The awareness of the farmers regarding farm practices need to be enhanced in these districts to open up opportunities for these farmers. Extension trainings need to be further designed based on skill management where farmers can be taught about assessing block conditions and practice measures to mitigate such issues.

As had been mentioned earlier, since the primary focus of the baseline was to understand the farmers' practices on pest control, the farmers were further probed on their pest control techniques. It had already been indicated before farmers across the districts are not proficient with the pest control at the block. This is re-iterated when asked about the pest management techniques practiced at the farm level. While majority of the farmers in Bouganville, Kavieng and E.N.B.Province mentioned that farm level pest management interventions and low, the data for Madang is quite misleading where only 17% farmers indicated their lack of pest management practices[2]. The analysis of the primary data shows that pest management techniques differ across the districts. In Bouganville, farmers depend mainly on Central Pod Breaking (CPB) while farmers in Kavieng in addition also practice weekly harvesting along with CPB. In contrast the farmers in E.N.B. Province use insecticides to control pest in their blocks.

[2] *Since the analysis of data shows some inconsistent findings with respect to the pest control parameter for Madang, the data findings from the district for pest control is not discussed further.*

Figure 10: Pest Management Practices in the districts

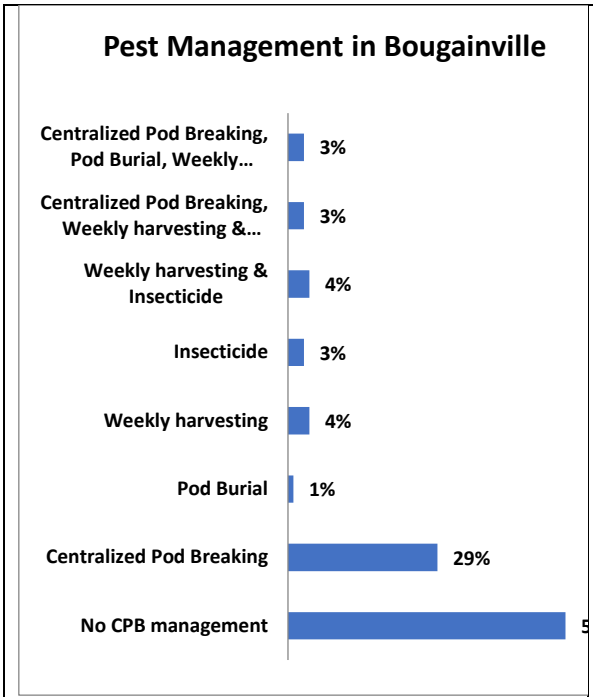

Fig. 7A: Pest management practices in Bouganville

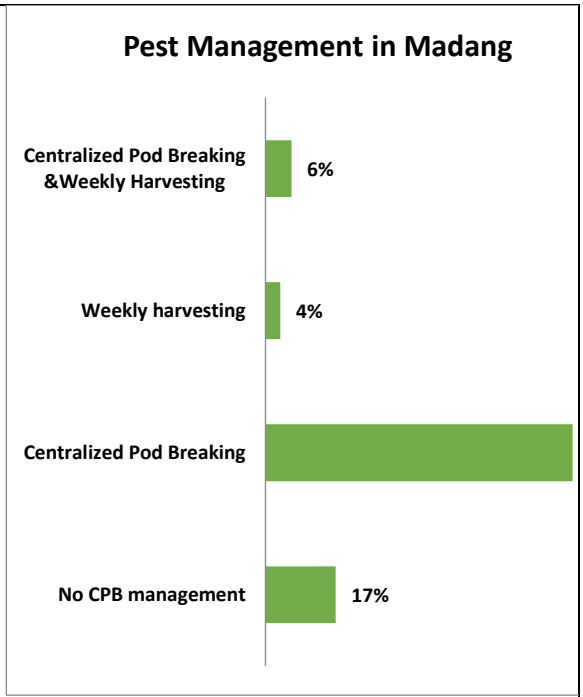

Fig. 7B: Pest management practices in Madang

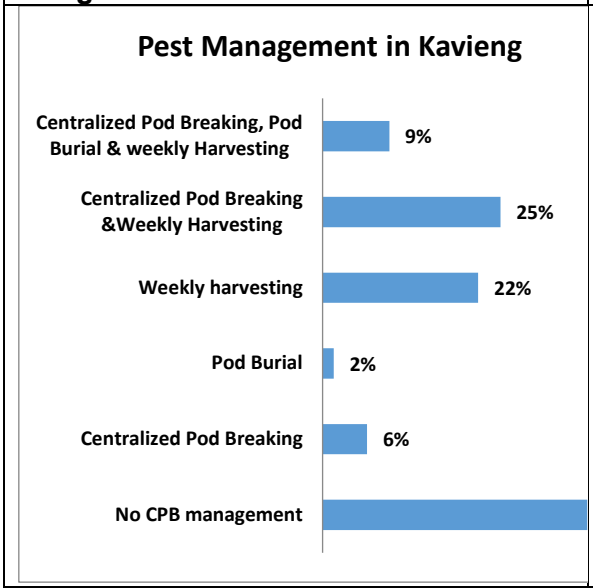

Fig. 7C: Pest management practices in Kavieng

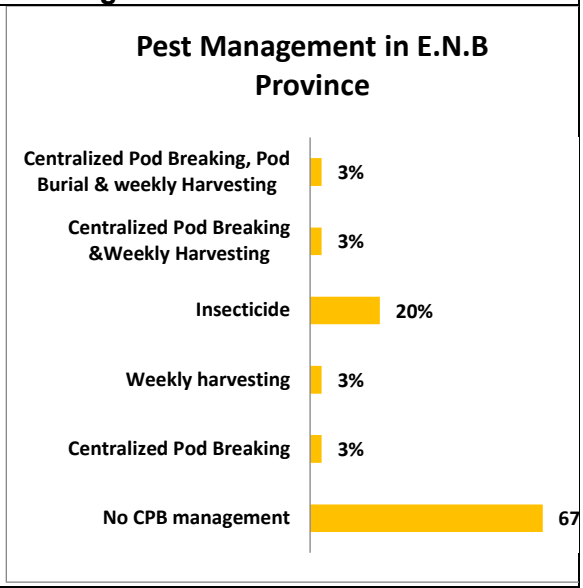

Fig. 7D: Pest management practices in E.N.B. Province

(iv) Farmer attitudes

The primary focus of the baseline study was to understand the attitude of the farmers with regards to extension trainings. Basically this boils down to the evaluation of the farmers taking care to understand the new skills and techniques and also adaption of those techniques elaborated during the training. Of the total farmers surveyed, around 38% of the farmers had received previous extension trainings within the last 5 years. Within this group however, about 87% of the farmers were observed to be entirely aware about the previous trainings attended by them. These farmers could mention the date and the content of the training program precisely. While the awareness about the training program previously attended was lower in Madang, Kavieng and E.N.B. Province (3-5%), the proportion of the farmers in Bouganville who could not recollect the training details were comparatively higher (27%).

As mentioned before, the focus of the baseline study is to evaluate the adoption rate of the farmers when new techniques are introduced to them. Across the four regions, it is observed that the probability of adapting to the techniques elaborated in the trainings is 0.58. The probability of adaption to new methods is found to be comparatively higher among the farmers in Madang (0.84) and lowest in E.N.B. Province (0.25). After having assessed the awareness and adaption of the farmers towards new techniques and processes, it is important to adjudge whether they are executing these processes in a well-defined manner for better yield.

The analysis of the primary data with respect to farmers receiving training facilities and executing pest management to get better yield vis-à-vis with farmers with no extension programs, but have executed pest management to get better yield indicate following findings:

- Proportionately more untrained farmers in E.N.B. Province had been utilizing pest management techniques than the trained farmers (Fig 8A). However, the analysis of the number of farmers getting better yield conditioned to the fact that they used pest management techniques shows that the success rate of the trained farmers are more compared to that of those farmers who are untrained,
- In Bouganville, proportion of trained farmers who adapt to pest management is higher. At the same time, the success rate of these farmers to obtain a better yield is also higher compared to those who have not been trained,
- In Madang and Kaveing, it can be seen that the relative proportions of farmers (whether they are trained or untrained) and adapting pest management are similar. However, the success rates of getting better yield vary. Farmers in Kavieng who had received extension trainings are found to be more efficient than the untrained farmers. In contrast, the success rate of the trained farmers in Madang is comparatively lower which is a cause of concern.

Figure 11: Practice of Pest management with and without extension trainings

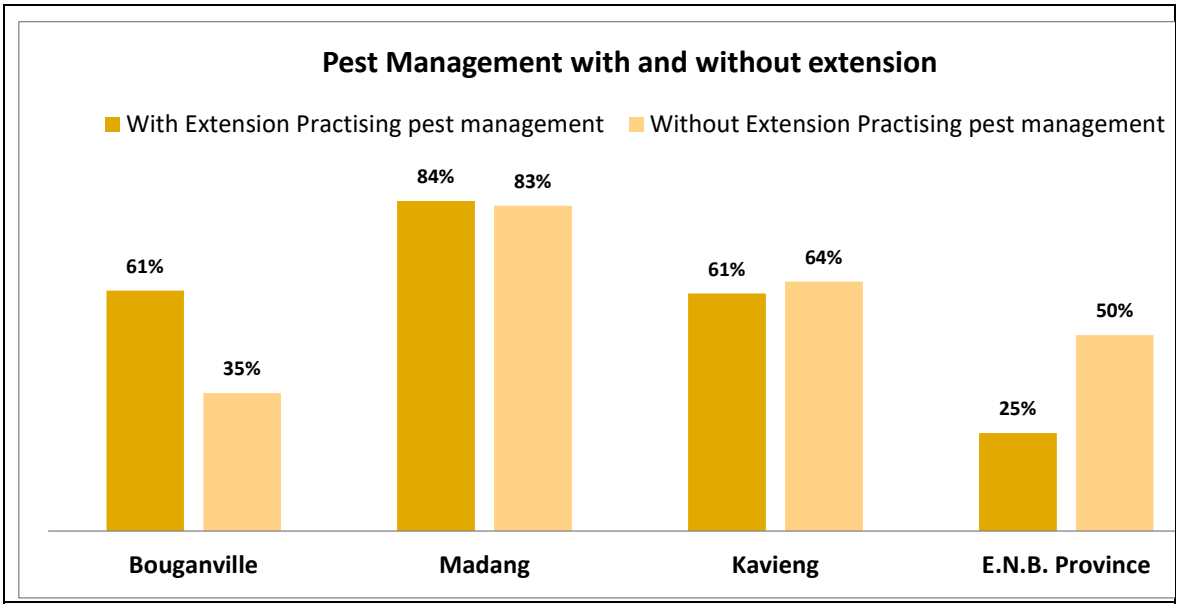

Fig. 8A: Pest management with and without extension

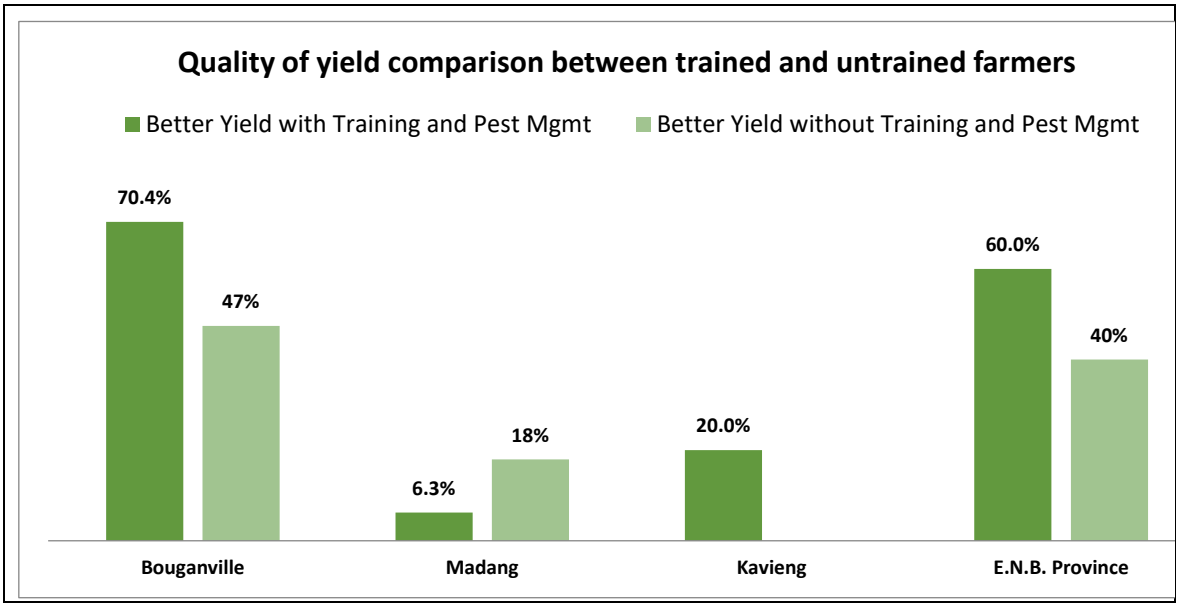

Fig. 8B: Quality of yield with Pest management between farmers (with and without extension)

The examination of the data and the above findings leads to a primary finding that ***if farmers adapt to the trainings and implement them in on-farm practices; it enhances their success rate for better yield.*** This hypothesis has been further tested statistically with the help of the primary data. The statistical analysis done through the help of a proportional z-test shows that null hypothesis - that the two groups of farmers (with extension training and without extension training) are different in their success rate towards better yield with CPB management can be rejected at 95% confidence level (Table 2). The following table shows that 27 out of 68 farmers (who had participated in previous trainings) had got a better yield, while out of the 123 farmers (who had no training and yet took up pest management), only 25 of them reported a better yield. The probability of success is enhanced by the fact whether training interventions are in place or not. The success rate for a trained farmer implementing pest management and getting better yield is 0.4 is comparatively higher than an untrained farmer (the probability of the success being 0.2 in this case). The primary data also indicates that a relatively higher proportion of farmers (about 70-80% in both groups) with and without extension implement the same technique (central pod breaking and weekly harvesting). However, since the success rates vary, it implies that the implementation of the technique needs to be refurbished for the farmers without training.

Table 2: Description of the z-test on the two groups of farmers

	Number of farmers	
	With extension trainings	Without extension trainings
CPB management with high yield	27	25
Total farmers	68	123
Value of α	0.05	
z-score	2.8813	
p-value	0.001	

The other important finding from the data succeeding a statistical analysis of the data based on the gender perspective is that ***irrespective of the gender differences, the success rate of trained farmers to get better yield when they adapt pest management is similar***. The statistical analysis done through the help of a proportional z-test indicate acceptance of null hypothesis that the success rate of better yield with CPB

management for two groups of farmers (male and female farmers with extension training) are not different at 95% confidence level (Table 3).

Table 3: Test to analyze gender based difference between the farmers

	Number of farmers	
	Male Farmers	Female farmers
CPB management with high yield	24	3
Total farmers	105	11
Value of α	0.05	
z-score	-0.3297	
p-value	0.6292	

The above table indicates that if male and female farmers are trained through extensions, the probability of success for better yield (conditioned on the fact that they adapt to the techniques and implement them on farm) is equally likely.

(v) CPB Infestation

The cocoa pod borer (CPB) is a devastating pest of cocoa, often inflicting losses of 80-90% I fnot properly managed. It was firstly reported in the Kerevat area of East New Britain Province in 2006 and has since found its way into the all the major cocoa growing regions of the country. The baseline data showed its dispersal in all four studied locations but its infestation is high in Madang (36-52%) and then Kavieng (18-42%) but low in ENB Province (12%) and Bougainville (6-15%).

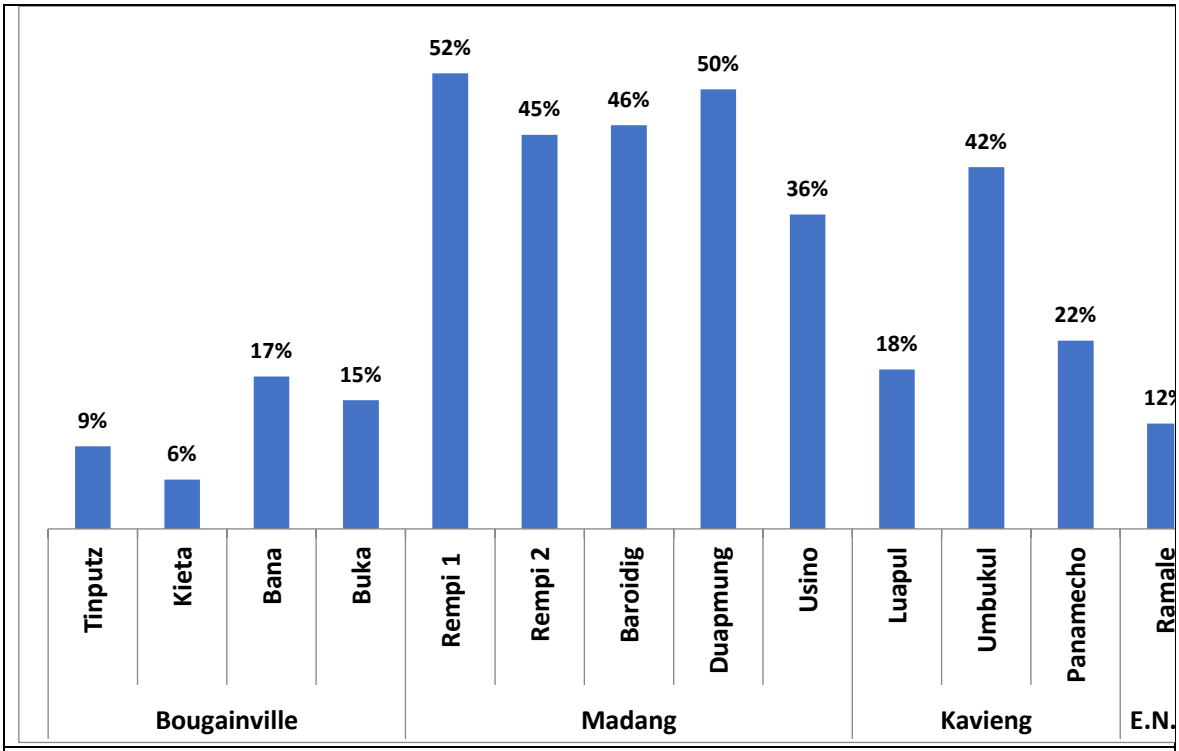

Fig.9. Proportion of plants infested by Cocoa Pod Borers across different regions

Recommendations

As the farmer field schools (FFS) approach will be implemented to train the farmers on IPDM practices, so we have to ensure the quality of contents, processes, and enhancing

the learning and capacity building through the ToT and FFS approach. The overall objective is to capacity building of facilitators and farmers to be able to ensure good quality learning processes for introduction and implementation of Good Agricultural Practices (GAP). The project supervisors and master trainers should be trained on the quality assurances principles and protocols for backstopping and conduct post-FFS meetings with the facilitators and farmers, where required.

The farmer training through Impact evaluation of training the farmers towards Integrated Pest Management (particularly Cocoa Pod Borer) involves understanding of the present situation as well as post-training situation. This is primarily to cull out the perceptional changes a farmer undergoes after the trainings are conducted. For example, the baseline data indicates that there is a fair chance of a farmer enhancing their yield and income once they are trained and they adapt/implement the techniques for on-farm management. In continuum to such an analysis, a post-assessment is required to validate whether there had been substantial increase in the farm yield and income. Such an analysis also leads to the assessment of up-scaling of the training programme once found to be successful for the farmers receiving such exposure.

Addition of some missing variables for the post-assessment –

1. Yearly costs incurred on the block – pertaining to use of insecticides, pesticides, labour
2. Yearly revenue from the block – this should include the current year as well a recall of the previous year. Any changes in the gross margin which the farmer can report.
3. Socio-economic characteristics of the farmers need to be updated – Age of the farmer, education profile (number of years), gender profile, number of trainings attended (on IPM). The baseline data for the farmers trained and surveyed during the baseline need to be updated.
4. Income profile of the household from different sources
5. Feedback about the trainings, utility derived from the trainings, whether adapted on-farm and whether the farmers could perceive improvements in the yield.

11.3 Appendix 3 TOMF Training Manual

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11.4 Appendix 4 FFS Quality Assurance Protocol

FFS Quality Assurance activities under GAP- IPM

Name of the FFS: _____ **Date**: _____ Tehsil:

Name of the Facilitators: _____ District:

A Establishment of FFS

A.1 Site Selection

	Indicators	Marks		Criteria			
		Total	FFS				
A.1.1	Was it a major target crop area?	5		1st major crop Excellent 5	2nd major crop Good 3	3rd major crop Satisfactory. 3	Minor crop Poor 1
A.1.2	Yield of the crop in the area?	3		High 1	Medium 2	Low 3	
Over all scoring for site selection		8		Remarks:			

A.2 Membership

A.2.1	Were all participants practicing farmers?	8		90% Excelent 8	75% Good 6
A.2.2	Were all practicing farmers decision makers as well?	7		90% Excellent 7	75% Good 3
Overall scoring Membership		15		Remarks:	

A.3 Selection of IPM/FP Trial plots

A.3.1	What were the criteria for the orchard / plot selection?	4		Brain storming 4	Somebody offered the plot 2	Selected by the facilitator himself 1
A.3.2	Was written agreement with the orchard/plot owner carried out?	8		Yes 8		No 1
Over all scoring for IPM/FP Trial orchard/crop selection		12		Remarks:		

A.4 Overall Orchard / Crop Condition

A.4.1	Was general condition of the crop/orchard in BAP and FP plots satisfactory?	4		Good 4	Satisfactory 2
A.4.2	Were decisions made last weak justifiable?	2		Yes 2	No 0
A.4.3	Were decisions made last weak implemented?	2		Yes 2	No 0
Over all scoring of general condition of the crop		8		Remarks:	

B Organization of FFS

B.1 Proper Group Fromation

B.1.1	Was proper group formation carried out?	4		based on some prescribed method Excellent 4	based on previous relationship or cast based Poor. 0
B.1.2	Were farmers able to explain the methodology/process of group formation and philosophy behind it? (based on interview)	2		80-90% 2	50-60% 1
B.1.3	Were different honorary positions such as chairman, secretary and treasure etc identified?	2		Yes 2	No 0
Over all scoring of Proper Group Fromation		8		Remarks:	

B.2 Group Coherency					
B.2.1	Sharing of ideas with in the group and with other groups (To involve all the members in all the activities, Extend help to everyone, Healthy competition, Sharing of resources)	**10**		Yes 10	No 0
Over all scoring of Group Coherency		**10**		Remarks:	
B.3 Division of responcibilities					
B.3.1	Division of responsibility with in group members and between groups	**2**		Yes 2	No 0
B.3.2	Division of responsibilities was carried out with consensus	**2**		Yes 2	No 0
B.3.3	Implementation of the responsibilities	**4**		Yes 4	No 0
Over all scoring of Division of responcibilities		**8**		Remarks:	
B.4 Familirity with FFS concept					
B.4.1	**Were participating farmers familiar with the concept of the program?** (Relevance with project objectives e.g. decision making, self reliance/empowerment, problem solving, increase profit margin & community development)	**10**		More than 90% 10	60-70% 5
Over all scoring of Familirity with FFS concept		**10**		Remarks:	
B.5 Farmer's Interest					
B.5.1	Active participation in the activities with enthusiasm (Discussion ,Q & A)	3		Yes 3	No 0
B.5.2	Mood meters	5		Yes 5	No 0
Over all scoring of Farmer's Interest		**8**		Remarks:	
B.6 Farmer's Organization					
B.6.1	Was farmer organization already existed?	**2**		Yes 2	No 0
B.6.2	If Yes, Were farmers aware of and satisfied with organization?	**4**		75% 4	50% 2
B.6.3	If not, was dialogue for farmer's organization initiated?	**2**		By facilitators 2	By FFS member 2
Over all scoring of farmer Organization		**8**		Remarks:	
B.7 Community Development					
B.7.1	**Was farmers able to relate the basic activities of FFS with the activities for the development of the community?** **Working in groups:** To share resources **Observations**: for problem identification **Calculation:** Determine the intensity of the problem **Analyses**: To develop relationship between two or more factors. **Presentation**: To share the results **Discussion:** To pole ideas and to solve conflicts **Science and Farmers**: To initiate studies to solve the problems **Team Building Exercises:** To develop trust and develop habit of working in groups.	**8**		90% 8	75% 7	60% 5	45% 3
Overall scoring of the Community Development		**10**		Remarks:	

C.	FFS Management						
C.1	**Time management**						
C.1.1	Were farmers arrived on time and activity initiated on fixed time?	**3**		Excellent (90%) 3		Satisfactory (70%) 1	
C.1.2	Was time being observed keenly while conducting activities ?	**3**		Excellent 75% activities completed on time 3		Good 60% activities completed on time 1	Poor 50% activities completed on time 0
Over all scoring for time management		**6**		Remarks:			
C.2	**Availability of materials**						
C.2.1	Was all the material relevant with the daily activities available with each participants/group?	**6**		Excellent 100% 6	Good 80% 5	Satisfactory (60-70%) 4	Poor 50% 3
C.2.2	If some material was not available, was innovation made using indigenous material?	**2**		Yes 2		No 0	
C.2.3	Was farmers using material as intended?	**3**		Yes 3		No 0	
Over all scoring for material		**11**		Remarks:			
C.3	**Arrangements for exchange visits between FFS** (Minimum sample size = 5 farmers/FFS)						
C.3.1	Was exchange visit plan prepared and discussed with the farmers?	**2**		Yes 2		No 0	
C.3.2	Was visit objectives clear to the farmers?	**2**		Yes 2		No 0	
C.3.3	Was visit program/schedule prepared in consultation with the FFS to be visited?	**1**		Yes 1		No 0	
C.3.4	Was the exercise "What was learnt" conducted after the visit? and sheets available?	**4**		Yes 4		No 0	
Overall scoring for exchange visit		**9**		Remarks:			
C.4	**Logistic arrangements**						
C.4.1	Was site for holding FFS session selected by the participating farmers? and comfortable?	**2**		Yes 2		No 0	
C.4.2	Were arrangements for seating, for hanging sheets made?	**2**		Yes 2		No 0	
C.4.3	Was proper arrangement for refreshment/water made?	**2**		Yes 2		No 0	
Overall scoring for logistic arrangements		**6**		Remarks:			
C.5	**Attendance of farmers**						
C.5.1	No. of farmers present in the beginning of FFS activities (Registered)	**4**		23 & above 4	16 & above 3	10 & above 2	Less than 10 1
C.5.2	No. of same farmers during field activities (AESA)	**4**		23 & above 4	16 & above 3	10 & above 2	Less than 10 1
C.5.3	No. of same farmers present at the end of the FFS session	**4**		23 & above 4	16 & above 3	10 & above 2	Less than 10 1
Overall scoring for farmer attendance:		**12**		Remarks:			
C.6	**FFS planning**						
C.6.1	Was the daily schedule prepared by the participating farmers facilitated by facilitator? and displayed?	**2**		Yes 2		No 0	
C.6.2	Was the detail of activities and methods explained to the farmers before the start of FFS?	**2**		Yes 2		No 0	
C.6.3	Were the farmers doing activities following standard methods?	**5**		Excellent 90% 5	Good 75% 4	Satisfactory 50% 3	Poor 40% 1
C.6.4	Was proper record keeping being done? i. Crop data, ii. Pest data, iii. Expenditure Data	**6**		All three 6	Only two 4	Only one 2	
Over all score for FFS planning		**15**		Remarks:			

D. Implementation of FFS activities

D.1 Communication

D.1.1	Did two ways communication process exist between farmers & facilitator?	3		Yes 3		No 0	
D.1.2	Were the farmers passive or active recipients evident from their level of participation in discussion?	3		Active 3		Passive 0	
Over all scoring for communication		6		Remarks:			

D.2 Facilitation skills

D.2.1	Was facilitator able to lead the discussion to special topic or trial development?	2		Yes 2		No 0	
D.2.2	Was facilitator able to facilitate in identifying the key learning points from the presentations?	2		Yes 2		No 0	
D.2.3	Was facilitator able to facilitate the farmers in developing relationship between different factors/components of the AESA?	2		Yes 2		No 0	
D.2.4	Was facilitator imposing or posing questions?	2		Imposing 0		Posing 2	
D.2.5	Was facilitator applying different/relevant facilitation skills according to the situation?	2		Yes 2		No 0	
D.2.6	Was facilitators help in identifying and understanding of key learning points by the FFS members during the discussion	2		Yes 2		No 0	
D.2.7	Were following qualities existing in the facilitator? i Patience, ii. Relaxed, iii. Flexible	3		All three 3	Only two 2	Only one 1	
D.2.8	Was the facilitator frequently allowed the farmers to ask Q and to share ideas?	2		Yes 2		No 0	
D.2.9	Was the facilitator able to understand the feelings of farmers and changed the level/focus of activities?	2		Yes 2		No 0	
Over all scoring for Facilitation skills		19		Remarks:			

D.3 Participatory Approach

D.3.1	Were the farmers understood the concept of participatory approach?	2		Yes 2		No 0	
D.3.2	Was each Q followed by another Q?	2		Yes 2		No 0	
D.3.3	Was every member of the group encouraged to participate in the activities?	2		Yes 2		No 0	
D.3.4	Was discussion made leading to decision?	2		Yes 2		No 0	
Over all scoring of participatory approach		8		Remarks:			

D.4 Special Topics

D.4.1	Was the topic come out of discussion during previous FFS session?	2		Yes 2		No 0	
D.4.2	Was time of special topic relevant to the crop stage/situation?	2		Yes 2		No 0	
D.4.3	Was non-formal participatory method was used for special topic?	2		Yes 2		No 0	
D.4.4	Were the farmer's understood/satisfied with the special topic?	4		Excellent 80-90% 4	Good 70-80% 3	Satisfactory 50-70% 2	Poor 30-40% 1
Overall scoring for special topic		10		Remarks:			

D.5 New Finding/Interesting Observation of the day

D.5.1	Did concept of new finding exist in the farmers?	3		75% 3	50% 2	30% 1	20% 0
D.5.2	Were farmer's actively involved/making efforts to find new things?	3		Yes 3		No 0	
D.5.3	Was list of previous new findings prepared and available?	1		Yes 1		No 0	
D.5.4	Was facilitator encouraging farmers or groups for new finding?	1		Yes 1		No 0	
D.5.5	How many new findings made?	3		3 or more 3	2 2	1 1	0 0
Overall scoring for new finding		11		Remarks:			

D.6	**Agro-Ecosystem Analyses (AESA)**						
D.6.1	Were farmers properly briefed before the field activities?	**2**		Yes 2		No 0	
D.6.2	Was the objective (s) of AESA clear to the farmers?	**3**		90% 3	75% 2	60% 1	45% 0
D.6.3	Were all the farmers actively busy in the field?	**2**		Yes 2		No 0	
D.6.4	Was facilitator able to facilitate the observations process by asking leading questions to different groups in the field?	**2**		Yes 2		No 0	
D.6.5	Were observations depicting the real situation (mirror image) of the field?	**2**		Yes 2		No 0	
D.6.6	Were specimens collected from the field for analyzing their relationship?	**2**		Yes 2		No 0	
D.6.7	Were farmers able to differentiate between disease and insect pests?	**4**		0.9	0.75	0.6	0.45
				4	3	2	1
D.6.8	Were farmers able to develop relationship between insects and diseases?	**4**		0.9	0.75	0.6	0.45
				4	3	2	1
D.6.9	Was drawing made from live specimens?	**2**		Yes 2		No 0	
D.6.10	Were all the members of the group involved in date tabulation and sheet preparation?	**2**		All groups	Three groups	Two groups	One group
				2	1	1	0
D.6.11	Were farmers able to recognize different stages of insects?	**2**		0.9	0.75	0.5	0.35
				2	2	1	1
D.6.12	Were all the groups able to make presentation and make decision based on the observations/ relationship of different factors?	**2**		All groups	4 groups	3 groups	2 groups
				2	2	1	0
D.6.13	Was farmer imposing or posing Q?	**2**		Imposing 0		Posing 2	
D.6.14	Was facilitator able to facilitate in identifying the key learning points from the presentations?	**2**		Yes 2		No 0	
D.6.15	Was facilitator able to facilitate the farmers in developing relationship between different factors?	**2**		Yes 2		No 0	
D.6.16	Was facilitator imposing or posing questions?	**2**		Imposing 0		Posing 2	
D.6.17	Was previous week chart available and consulted for decision making?	**2**		Yes 2		No 0	
D.6.18	Was any exercise conducted to improve the observation power?	**2**		Yes 2		No 0	
D.6.19	Implementation of decisions in IPM plot	**4**		By FFS member 4		By plot owner 2	
Overall scoring for AESA		**45**		Remarks:			
D.7	**Team building exercises**						
D.7.1	Was exercise relevant with the existing problem?	**2**		Yes 2		No 0	
D.7.2	Was the exercise properly explained to the farmers?	**2**		Yes 2		No 0	
D.7.3	Were all the participants actively involved in the exercise?	**2**		Yes 2		No 0	
D.7.4	Was facilitator facilitated the farmers in identifying the key learning points and the lesson they learnt from the exercise?	**2**		Yes 2		No 0	
Over all scoring for team building exercises		**8**		Remarks:			
D.8	**Science & Farmers**						
D.8.1	Was the concept of science & farmers made clear to the farmers?	**2**		Yes 2		No 0	
D.8.2	What methodology used to identify the issues?	**4**		Lecture 1	Briefing 2	Discussion 3	Facilitation 4
D.8.3	Was the experiment topic selected by the farmers?	**2**		Yes 2		No 0	
D.8.4	Was the experiment being conducted in the field and by the farmers?	**2**		Yes 2		No 0	
D.8.5	Were farmers involved in the analyses of the results and know the methodology	**4**		80-90%	60-70%	50%	30-40%
				4	3	2	1
D.8.6	Were farmers able to state the objectives, layout and sampling methodology of experimentation?	**4**		80-90%	60-70%	50%	30-40%
				4	3	2	1

D.8.7	Was there any apparent change in the level of confidence of the farmers?	**4**		80-90%	60-70%	50%	30-40%
				4	3	2	1
D.8.8	Did FFS members establish trials on their own land?	**4**		80-90%	60-70%	50%	30-40%
				4	3	2	1
D.8.9	Was facilitator able to lead the discussion during AESA result presentation towards trial development?	**2**		Yes 2		No 0	
D.8.10	Number of trials/exercises developed during the previous AESA?	**4**		More than 3		More than 1	
				4		1	
Overall scoring for Science & Farmers		**32**		Remarks:			
D.9 Insect Zoo							
D.9.1	Were objectives of discovery based learning clear to all the farmers?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.2	What was farmer's concept about insect zoo? 1. Pest/beneficial interaction 2. Pest/plant interaction 3. Beneficial/plant interaction 4. Study of biology of pest/beneficial	**10**		Only 1 0	First 2 3	First 3 6	All 10
D.9.3	Were farmers able to identify correctly at least three important beneficial?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.4	Were farmers familiar with the exact function / interaction of at least three beneficial with their pests?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.5	Were farmers able to recognize correctly different immature stages of important sucking pests?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.6	Were farmers familiar with the life cycle of most of the important beneficial?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.7	Were farmers able to draw correctly picture of at least three beneficial?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.8	Were farmers able to explain the methodology of studying pest-beneficial interaction?	**3**		80-90% 3	60-70% 2	50% 1	30-40% 0
D.9.9	Were farmers able to use the results of insect zoo while suggesting plant protection recommendations?	**5**		All groups 5	4 groups 4	3 groups 3	2 groups 2
D.9.10	Were farmer's groups able to keep the insect zoo in their houses after the completion of FFS session and share the results during next session?	**5**		All groups 5	4 groups 4	3 groups 3	2 groups 2
Overall scoring for discovery based learning (insect zoo)		**41**		Remarks:			
D.10 Evaluation of activities of the day							
D.10.1	Did evaluation chart (what was good, what was not good, things need improvement & how to improve them) prepared?	**4**		Yes 4		No 0	
D.10.2	Was last week evaluation chart available for comparison?	**2**		Yes 2		No 0	
D.10.3	Were the suggestions given under "how to improve" implemented?	**2**		Yes 2		No 0	
Over all scoring for evaluation of daily activities		**8**		Remarks:			

11.5 Appendix 5 TOMF PROGRAM ARAWA 18th – 22nd April 2017 BOUGAINVILLE

Time	Activities	Lead Facilitator / Trainer	Reference
	Day 1: Tuesday 18th April 2017 **DAY SESSIONS**	**MOC: Paul Gende/ Jerry Tunjio**	
8:00-8:05	Opening Prayer		
8:05-8:25	Introduction of participants		
8:25-8:45	ACIAR Project Manager Opening remarks	Dr John Konam	
8:45:9:10	Introducing the Basic Concepts behind TOMF Participants to be group into 4 groups	Jeremy Ngim	**1.1 to 1.6**
9:10:9:40	Program outline Cocoa safe and GAP	Paul Gende / Jeremy Ngim	**2.0**
9:40-10:00	Coffee/Buai Break		
10:00-10:40	**Practical** (ON COCOA FARM) Each group to select one topic:- Discovery Learning Exercise: Module 1 FFS Ex1: Cocoa cropping calendar FFS Ex2: Cocoa Ecosystem FFS Ex3: Cocoa Food Web FFS Ex4: Ballot box test or AESA. Group to present results on Day 5.	Jeremy Ngim Anton Kamuso Anton Varvaliu Paul Gende Rodney Minana	**5.1 & 5.2**
10:40-11:30	**Practical** (ON COCOA FARM) Organic and inorganic fertilizer application Composting/trenching	Anton Kamuso	**3.2.1 to 3.2.3 and 5.3 Ex 3,4 & 5**
11:30-12:00	**Practical** - Organic fertilizer development and application (Bokashi)	Rodney Minana	
12:00-1:00	LUNCH BREAK		
1:00-4:00	**CROP NUTRITION** **Theory - Soil Management**	Anton Varvaliu	**3.2**

	NIGHT SESSIONS		
7:00-8:00	**Theory** 1.Grafting Techniques (side, top, field budding, etc) 2.Prunning techniques (formation, structural, sanitation, etc) 3. Shade management	Anton Kamuso Anton Varvaliu	**3.1.3** **3.1.4**
	Day 2: Wednesday 19th April 2017 DAY SESSIONS	Moderator: Dr John Konam	
7.30	**Group 1 report on Day 1 activities : 5-10 mins**		
8:00-12:00	**Practical** (ON COCOA FARM) Grafting techniques	Anton Kamuso	
12:00-1:00	LUNCH BREAK		
1:00-4:00	**Practical** (ON COCOA FARM) Pruning techniques + shade tree management (Formation, structural, sanitation, etc)	Anton Varvaliu	**5.3** **Module3 Ex1 & Ex2**
	NIGHT SESSION		
7:00-8:00	**Theory - P&D Management** 1.Pests and Disease Management (IPDM/CPB/BP/VSD, ETC.) 2. Pesticide Application & Safety	Paul Gende Jeremy Ngim	**3.3 and 6.0 & 7.0** **3.3.3to 3.3.7and 3.4**
	Day 3: Thursday 20th April 2017 DAY SESSIONS	Moderator: Anton Varvaliu	
7.30	**Group 2 report on Day 2 activities: 5 -10 mins**		
8:00-10:00	**Practical** (ON COCOA FARM) Insecticide application technology RPU – Ex 6 Spray dye exercise	Jeremy Ngim	**5.5** **Module 5**
10:00-12:00	**Practical** (ON COCOA FARM) Cocoa Farm Rehab through IPDM/GAP	Anton Kamuso/ Rodney Minana	**5.4** **Module 4**
12:00-1:00	LUNCH BREAK		

1:00-4:00	**Practical** - Cocoa Farm Rehab through IPDM/GAP	AntonKamuso / Rodney Minana	**5.4 Module 4**
	NIGHT SESSION		
7:00-8:00	**Theory : Post-Harvest and Cocoa Processing** (Harvest, fermentation, drying, sorting, storage, transportation, etc)	Kenny Francis/	**3.6 & 5.6 Module 6**
	Day 4: Friday 21st April 2017 DAY SESSION		
7.30	**Group 3 report on Day 3 activities : 5-10 mins**		
8:00-12:00	**Practical** (ON COCOA FARM) Harvest, Fermentation, Drying	Kenny Francis	**5.6 Module 6**
12:00-1:00	LUNCH BREAK		
1:00-4:00	**Practical** (ON COCOA FARM) Harvest, Fermentation, Drying	Kenny Francis	**5.6 Module 6**
	Day 5: Saturday 22nd April 2017 DAY SESSION		
7.30	**Group 4 report on Day 4 activities : 5 -10 mins**		
8:00-11:00	**Theory:** Basic Book Keeping, Livelihood, Farm Record Keeping	Anton Varvaliu	**Part4 Appendix 2**
12:00-1:00	LUNCH		
1:00 – 2:30	Presentation by Group on FFS Ex 1,2,3,4 and/or AESA from Day 1.	Groups 1,2,3 &4	
2:30	CLOSING Closing remarks	JEREMY NGIM (CABI) DR JOHN KONAM (ACIAR)	

11.6 Appendix 6 TOMF Training Evaluation

	Q1.Subject & Admin matters	Poor	Inadequate	Satisfactory	Good	Excellent
		%				
1	Clear learning objectives		5	11	50	28
2	Facilitation skills		5		44	44
3	Information well explained			22	28	50
4	Level of group involvement		5	22	33	28
5	Quality of learning manual		5	5	11	78
6	Achievement of objective		5	11	67	17
7	Facilitator keeping attention			5	39	56
8	Use of practical examples		5	22	28	44
9	Relevance to work situation#			5	56	28
10	Overall quality of training		5		33	56
11	Effectiveness of trainer			5	33	61
12	Length of training	5	39	28	22	5
13	Overall assessment of training		5	11	50	33
	Mean	0.4	6.4	11.5	38	41
	% Satisfactory, good and excellent			90%		

Note: Response from 18 (82%) participants out of 22.

11.7 Appendix 7 SUMMARY OF TRAINING FOR FARMERS

Date	Province	Topic	Sessions	No. of farmers	Trainers
Sept 2015	Madang – Tangu area & Bogia District	GAP – cocoa rehabilitation	1	>50 farmers	Yak Namaliu Kalangpain Samai Theo Lama
19-25 Oct 2015	Kavieng New Ireland Luapul, Panameko and Umbukul	GAP and IPDM – pruning, P&D control, spray application & safety	1 round	<40 farmers	John Joseph Daslogo Kula (PNGCCIL Provincial Extension Officers)
Jan 2016	Madang – Baroidig and Rempi Area, Sumkar District	GAP – block & tree rehabilitation, pruning, Improved IPDM, organic fertilizer production & application	4 rounds	>50 farmers	Yak Namaliu Kalangpain Samai Theo Lama
10/10/16 – 25/10/16	New Ireland Luapul, Panameko and Umbukul	GAP and IPDM	2 round	40 farmers at Luapul, 40 at Panameko, and >40 at Umbukul	Anton Kamuso (Plant Pathology) and Rodney Minana (Entomology)
7-14th June 2016	New Ireland Luapul, Panameko and Umbukul	1. IPDM – organic fert, formulation called EM-BOKASHI & its application. 2.Formulation of Biopesticide extraction from 4 plants – application & safe use	3 round	40 at Luapul, 40 at Panameko, 50 at Umbukul	Rodney Minana Matiran Micheal
16th Nov 2016 – May 2017	Bougainville -Buka and Tinputz Area	basic block sanitation and rehabilitations	4 sessions	11 farmer at Ieta (Buka) 22 farmers at Malasang (Buka)	Paul Nelau, Steven Tsikoa and PSSP Joe Tomo

2016	Central Bougainville	GAP IPDM, pruning and rehabilitation, CPB control	2 sessions		Jerry Tunjio and Bruno Batari
2016	South Bougainville - Bana	GAP and IPDM, Cocoa rehabilitation, nursery establishments	2 sessions	>30 farmers	Justin Namake
11th – 27th June 2016	Bougainville	pruning, pest and disease control, and cocoa rehabilitation. develop their own manure from pigs & poultry as source of fertilizer	2 round	>20 farmers in the in Buka and Tinpuz >30 farmers in Tasipo and Bana	Paul Gende and Anton Kamuso
2016 and 2017	Ramale in East New Britain	block sanitation, cocoa rehabilitation, pruning, pest and disease control including biopesticide formulation and application, and fertilizer application. cocoa cropping cycle, CPB life cycle, disease cycle and different types of pruning.	13 training sessions	>20-30 farmers attended each session	Rodney Minana Matiran Micheal
Total			34 sessions or more	533 farmers (could be repeat farmers)	