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Farmer Field School (FFS) in Coconut

Participatory biomanagement of Rhinoceros Beetle

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Farmer Field School (FFS) in Coconut

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CONTENTS

ABBREVIATIONS

AESA	-	Agro Eco System Analysis
APCC	-	Asia Pacific Coconut Community
B	-	Breadth
CFC	-	Common Fund for Commodities
CPCRI	-	Central Plantation Crop Research Institute
DFID	-	Department of International Development
EC	-	Emulsifiable Concentrate
FAO	-	Food and Agriculture Organization
FFS	-	Farmers Field School
FYM	-	Farm Yard Manure
GMF	-	Green Muscardine Fungus
ICAR	-	Indian Council of Agriculture Research
IPM	-	Integrated Pest Management
L	-	Length
NGO	-	Non Governmental Organization
OrNV	-	Oryctes Nudi Virus
PRA	-	Participatory Rural Appraisal
PVC	-	Poly Vinyl Chloride
RB	-	Rhinoceros Beetle

Farmer Field School (FFS) in Coconut- Participatory biomanagement of Rhinoceros Beetle

Coconut (*Cocos nucifera Linn.*), is a versatile crop supporting livelihood of more than 10 million farm families, directly and indirectly. The coconut farmer faces several challenges like pest and disease incidence, low productivity, inadequate level of knowledge and adoption of scientific recommendations, climate change and absence of policies and plans for rejuvenating the crop. Besides challenges like fluctuating price of the produce, resource use, labour shortage, escalating price of inputs *etc*., are also noteworthy. In these cases it could be seen that knowledge plays an important role in overcoming majority of these factors. Hence Farmer Field School (FFS) was chosen as the most appropriate extension strategy for improving the knowledge of the coconut farmers in integrated biomanagement of rhinoceros beetle, which is a major pest of coconut.

Rhinoceros beetle (*Oryctes rhinoceros* Linn.) is a major pest of coconut, widely prevalent in the coconut growing countries of the world. The pest incidence causes 10 per cent reduction in the yield of coconut palms. Data collected during field survey (2008-09) in 1000 ha area covering 2000 palms showed that 70 per cent of the coconut homestead in Alappuzha district are having rhinoceros beetle infestation. Average pest incidence was found to be 22.7 per cent in adult and juvenile palms and 48.3 per cent in coconut seedlings. Ten percent yield increase is expected in palms by adopting integrated biocontrol technologies, apart from increasing the health and vigor of 48 per cent pest affected seedlings in the area. Rhinoceros beetle infest all the growing stages of coconut, *i.e.*, nursery stage, seedlings planted in main field, juvenile palms and adult bearing palms. Farmer Field Schools (FFS) aim at empowering coconut farmers in various scientific aspects of coconut cultivation and achieve productivity and profitability through growing healthy crop.

- Growing healthy coconut palm – scientific management practices, integrated nutrition, management of pests/ diseases and soil and moisture conservation measures.
- Acquiring knowledge and skills in identification of the pests and its life stages, symptoms of pest incidence in different growth stages of palm, different mode of pest attack.
- Skills in monitoring of pest incidence and evaluation of pest reduction (status) due to adoption of management practices for appropriate and effective choice of practices / technologies in field situations.
- Prophylactic measures + sanitation : Adoption of recommended prophylactic measures like axil filling, identification of breeding sites of rhinoceros beetle in the locality and adoption of appropriate measures to ward off immature stages of the pest
- Becoming proficient in the management of rhinoceros beetle at individual level as well as at community levels.

Farmer Field Schools

The term farmer field school (FFS) comes from the Indonesian expression *Sekolah Lapangan* (Central Java – 1989) meaning field school. The features are that it is non-formal, experiential, group extension process, farmers as learners, participatory and provides education in the crop cycles or specific topics based on curriculum.

FFS – farmer participants

Ten to fifteen farmers were selected in each FFS from two grama panchayaths, Devikulangara and Kandalloor. Emphasis was given for including women farmers, small and marginal farmers, farmer leaders, representatives of coconut farmers' organizations, and extension workers, so that the spread and utilization, of knowledge gained will be sustained. Farmers meetings were conducted in the localities and based on the objectives, knowledge tests were organized as benchmark for the programme. Voluntary and sincere participation of the farmers were expected in all sessions.

Pre FFS data documentation

Schedule was prepared and pre-tested for documenting the socio economic and knowledge profile of the participant farmers by personally interviewing them and observations noted through actual field visits to their gardens. The age, education status, farming experience, total land holding, crops cultivated in coconut gardens, total number of coconut palms (juveniles and bearing), livestock status, social participation, extension participation, extension contact, information sources used for getting information on coconut cultivation aspects, trainings attended in coconut cultivation, use pattern of pesticides, preference of biological control of coconut pests, nutrient management and use of inputs, knowledge on coconut cultivation practices and general constraints faced in adoption of recommended practices were recorded.

Initiation of the FFS activities

The farmer field schools were initiated in both the panchayaths with the following features.

- The FFS programme was scheduled based on curriculum. The curriculum was prepared as per the recommendations of the 'Workshop on curriculum development for farmer field schools of CFC/DFID/APCC/FAO project' during 3-5 February, 2005, Kochi, Kerala, India. (with slight modifications to suit the local situations)
- The facilitators explained the types of training activities that impart learning environment, knowledge on coconut cultivation to farm level processing, sharing of experiences and working together and interacting for improving the impact of field level applications.
- Place, time and schedule of classes fixed through consensus.
- First meeting had the participation and involvement of peoples' representatives, coconut farmers organizations, self help group members, extension officials, scientists and the FFS participants.
- Field visits and agro eco system analysis (AESA), group dynamic exercises on special topics like solutions for problems faced by farmers in their farming, experience sharing, practical exercises were conducted.
- Learn the 5 W and one H, *i.e.*, What, When, Why, Which, Where and How? The 'Why' of any topic is crucial for learning and through FFS, farmers could analyze the 'Why' for each step and empower themselves for appropriate decision making in technology choices and utilization

Knowledge documentation: Refined ballot box exercise

Each FFS has a pre and post ballot box test. In Kerala State considering the high literacy rate and in

consultation with the farmers the ballot box exercise was suitably refined and used. The facilitators explained the procedure and the ballot box process done in actual fields of farmers. Plastic containers were prepared with the questions written in local language (Malayalam) on the lid. The FFS farmers were asked to choose the correct answers according to them and put the ballot with options written, into the container. The correct and incorrect answers were then tabulated and presented to the farmers. The correct answers were discussed with the farmers after completion of the ballot box exercise. The questions used for pre and post sessions were same and the knowledge gain was recorded and data analyzed.

Preparations for FFS sessions

Several materials are required for organizing FFS sessions. It may vary with the topic of FFS and the farmers' information needs. It warrants good planning and situation analysis for putting the information and knowledge across the learners. Some of the very commonly needed items are - flip charts, poster papers, drawing pins, plywood sheets, writing boards, small plastic bags, containers, questions written and pasted in lids, notebooks, scissors, knife, pens, pencils, IPM kits, form for recording data, bottles, cotton, chairs, specimens, materials for method demonstrations like preparation of spray solutions, precautionary measures while using plant protection equipments, how to apply *Metarhizium* in rhinoceros beetle breeding pits *etc.*

Agro Eco System Analysis (AESA)

Agro ecosystem analysis is an important component and learning, analyzing method in Farmer Field Schools (FFS), for enabling coconut farmers to take appropriate and best decisions for managing the pests.

Agro ecosystem analysis leads to learning through increased partnership and sharing, obtaining skills in pest identification, symptoms, life cycle identification, improving decision making abilities of the farmer in deciding technology options / time of adoption / frequency and effectiveness of utilized technologies. Ecosystem of the crop is very important in deciding the technologies to be adopted, how when and where as well as its analysis application. Hence analysis of agro ecosystem assumes an important step in FFS.

Steps to be followed in Agro ecosystem analysis for FFS

Observe - To know changes in the crop, the agro ecosystem, field situation *etc*.

Learn - To understand the problems affecting coconut palm of various growth stages. The pest biology, natural enemies present in the system, nature of changes and input or technologies adopted.

Decide - To take best action (best choices for problem solving) for solving the problem in an eco-friendly and sustainable manner.

Act - To implement the decision taken for managing the problem in more appropriate manner.

The format for the AESA by the FFS farmers is provided below. The subgroups will collect the data in the sheet based on field visit, inspection of coconut palms, discussion among the participants and will be presenting the details for drawing conclusions.

ICAR-CPCRI, Regional Station, Krishnapuram, Kayamkulam
FFS- Agro Eco System Analysis

1. Name of FFS **2. Group No.** **3. Area of plot** **4. Topic of FFS**		**Date & Time of observation**
General Information 1. Coconut Varieties 2. Age of palms Young Juvenile Adult 3. Spacing of palms 4. Fertilizer application Organic Chemical fertilizers 5. Climate 6. Crop/cropping methods 7. Soil type 8. Irrigation-Yes/No	**Parameters for observation** 1. Number of leaves 2. Number of leaves attacked by Rhinoceros beetle (RB) 3.Type of leaves infested (spindle/outer) 4. Breeding sites 5.Stages of Rhinoceros beetle (RB) seen in breeding sites	1.Management practices 2.Management schedule
Pest of coconut Name the pests (symptoms and frequency) observed	**Cropping pattern** (Single/multiple/mixed)	**Natural enemies of pests observed**
Observations 1. Soil moisture 2. Diseases of coconut 3. Pests 4. Health status of palms 5. Nutrient Deficiency symptoms 6. Weeds		**Recommendations** What are the package of practices to be followed?

The facilitators will be guiding and supporting them with relevant information and tips.

Principles of AESA relevant to coconut

Grow a healthy crop of coconut

ICAR- CPCRI evolved package of practices for growing coconut for achieving maximum productivity and profitability. A healthy crop usually will be free of any pest and disease incidence. In root (wilt) disease affected coconut growing tracts, it is of utmost importance to learn and grow coconut adopting the crop health management strategies. The fine tuned *adhoc* management practices recommended by ICAR – CPCRI are as follows:

Phytosanitation

Farm and palm hygiene are two critical factors that could reduce the pathogenic inoculums in a coconut garden. While farm cleanliness suppresses build up of pathogen, palm sanitation improves the health status of palm. Eradication and complete destruction of root (wilt) symptomatic-diseased palms in mildly-affected areas as well as emerging disease zones is a practical solution to reduce the field inoculums. All disease advanced and uneconomic palms yielding less than 10 nuts/ year is recommended to be removed for optimum resource utilization and efficiency.

Selection of mother palms

Superior, high-yielding and disease-free palms could produce high quality progenies in coconut. Being a perennial crop, selection of an inferior genotype could substantially reduce the production level in palms which could be practically diagnosed only at a later bearing stage. Hence, a good selection is warranted. High yielding and disease-free palms showing typical characters of plant viz., reproductive and fruit characters are to be selected. The age of dwarf parental palms should be 20 years and above and in the case of palms of known parentage, the age can be 10 years and above. In gardens planted with large number of dwarfs, mother palm selection should be restricted to 10-20% of high yielding and regular bearing palms.

Bio-priming of seedlings

Bio-priming of seedlings with bio-inoculants such as *Pseudomonas fluorescens* imparts tolerance to disease as well as promotes better seedling growth and imparts tolerance to disease in the field. Application of talc-based preparation of *P. fluorescens* @ 50 g (10^8 cfu/g) per seedling during four, seven and ten months after sowing in nursery is recommended. At the time of planting in the main field, coconut seedlings are to be dipped in 100 g (10^8 cfu/g) of talc-based preparation of *P. fluorescens* in slurry-mode.

Selection of seedlings

A good seedling emerges early from the seed nut (5 months after sowing) and grows robustly with higher collar girth (10-12 cm). Splitting of leaflets will be much faster in such seedlings assuming faster growth. Such vigorous seedlings are to be selected for early and uniform bearing in the main field.

Liming of soils

Widespread deficiency of Ca and Mg and enhanced acidity in Kerala soils was reported in Kerala State Planning Board study. Hence application of dolomite @ 1 kg / palm / year is recommended towards ameliorating Ca and Mg deficiency and also for increasing soil *p*H. When application of lime is resorted to, it should be supplemented with magnesium sulphate on soil-test basis.

Application of organic manures

A good organic base in soil is very important for enhanced availability of nutrients as well as for the

improvement of physical, chemical and biological properties of soil and also buffers the soil for maintaining neutral soil *p*H. Application of 25 kg farm yard manure or 10 kg of vermicompost enriched with *Trichoderma harzianum* @ 100 g would ensure protection from the stem bleeding disease which is prevalent in the RWD affected gardens in coastal areas.

In situ biomass recycling

Basin management of palms by raising green manure crops such as *Peuraria phaseoloides* (Peuraria) / *Vigna unguiculata* (Cowpea) @ 50 g in palm basins during April–May and September–October and incorporating the biomass at flower initiation stage not only fixes atmospheric nitrogen but also enhances the C:N ratio for better palm growth. It was also found to reduce the intensity of root (wilt) disease and increase nut yield substantially through better availability of other nutrients with improved soil aeration. Growing *Gliricidia* plants along the border and periodical pruning and incorporation in palm basins is also advised for improving organic matter content.

Application of fertilizers

Soil-test based application of fertilizers in two splits during the monsoon period is recommended. General recommendation of nutrients for the root (wilt) disease affected areas are 500 g N, 300 g P_2O_5, 1250 g, K_2O and 250g $MgSO_4$/palm /year.

Application of dolomite should be ensured prior to the application of fertilizers so as to avoid competitive interaction among primary, secondary and micronutrients. Ensure adequate moisture status during nutrient application. Juvenile palms should be provided with 1/10, 1/3, 2/3 dose of NPK during the first three years of planting in the main field.

Judicious application of micronutrients based on soil analysis and in adult palms application of borax @ 120-240 g in four split doses based on the intensity of deficiency symptom is recommended.

Soil and water conservation measures

Soil moisture conservation measures such as mulching / husk burial should be undertaken during November to May. During summer months, palms are to be irrigated with water @ 250 l/palm/week to mitigate moisture stress as water is very critical for palm growth. Drip irrigation methods also could be adopted to save water and increasing efficiency @ 30-35 l/day/palm using 4 drips per palm in laterite soils, and 6 drips in sandy soils. Avoid water logging and provide proper drainage wherever necessary so as to ensure soil aeration and root growth.

Cropping / farming system approach

Cropping system approach could be adopted by raising intercrops in rotation / adopt mixed cropping /mixed farming with recycling of organic matter for reaping sustainable income. Restructuring of canopy of other perennial tree crops to provide maximum light for the coconut palms is recommended.

Management of leaf rot disease

Leaf rot management is crucial in the health improvement of root (wilt) disease affected palm, as >99% of leaf rot affected palms exhibit symptoms of root (wilt) disease.

Cut and remove leaf rot affected portions (only spindle and two top most fully opened leaves) to reduce the pathogen level. Apply Hexaconazole (Contaf 5 EC) @ 2ml in 300ml water by dispensing around the base of spindle leaf or apply talc-based preparation of *P. fluorescens /Bacillus subtilis* or a consortia of the two bio-agents @ 50 g in 500 ml water/palm. Any one of the above treatments may also be adopted as prophylactic measure during April- May and October- November in RWD endemic regions.

Bio-intensive management of rhinoceros beetle

Adult beetles bore into terminal spindle region of adult palms and bole region of seedlings causing retarded growth and mortality in juvenile palms. It could be managed effectively through adoption of area wide farmer-participatory integrated approaches. Incorporation of *Clerodendron infortunatum* and / or *Metarhizium anisopliae* @ $5x10^{11}$ spores/m^3 into breeding sites is an effective farmer friendly strategy. Proper inspection of growing spindle leaves and mechanical hooking of adult beetles from infested palms has to be resorted in fresh infestation.

Prophylactic leaf axil filling repels and ward off pest. Farmer can select any one of the options for leaf axil filling in juvenile palm as a prophylactic measure (i) oil cakes *viz.*, marotti, neem, pongamia (250 g) with equal volume of river sand (ii) naphthalene balls (12 g) (iii) 50 g chloridust mixed with 2 kg sand for 8 palms or (iv) placement of two perforated polythene sachets containing chlorantraniliprole (3 g) on top most leaf axils. Release of adult beetles inoculated with *Oryctes rhinoceros* nudivirus (OrNV) @ 10-15 beetles / ha. Installation of PVC pheromone traps with oryctalure embedded on nanoporous matrix @ 1 trap /5 ha. Avoid placement of traps in gardens with juvenile palms.

Integrated management of red palm weevil

Red palm weevil is the most destructive and fatal enemy of coconut palm.

An integrated management strategy including phyto sanitation and timely management of pre-disposing factors such as damage by rhinoceros beetle and leaf rot disease is recommended. Avoid injury to palms and complete destruction of red palm weevil infested palms. Cut petioles leaving 1.2 m from trunk of palm. Curative treatment of infested palms with imidacloprid (1 ml / litre) or spinosad (5 ml / litre). Installation of pheromone traps with ferrugineol embedded on nanoporous matrix @ 1 trap / ha. Timely servicing of food baits once in 6 days and avoid placing traps in gardens with juvenile palms or palms intercropped with tall intercrops (banana).

What are the observations to be undertaken by FFS farmers?

1. Monitoring coconut gardens
   - Category of palms; age wise - seedlings (nursery), juvenile, young and adult palms
   - Pests (rhinoceros beetle, red palm weevil, coreid bug, eriophyid mite, mealy bugs, scale insects, rat etc.)/diseases (root (wilt), leaf rot, stem bleeding, boron deficiency symptoms) incidence
2. Observe for natural enemies of coconut pests in coconut garden- Birds (Indian tree pie, crow, owl, hen, duck, myna *etc*.), ants, rat snake, spiders *etc*,.
3. Action points while taking observation
   - Number of total leaves and rhinoceros beetle infested leaves (with characteristic 'V' shaped cuts, drooping of spindle)
   - Red palm weevil infestation- early/advanced (spindle wilting, oozing of brown liquid, splitting of petiole base, presence of cocoons, holes on the stem)
   - Number of nuts damaged by rats (circular holes just below perianth)
   - Severity of eriophyid mite infestation
   - Number of bunches/palms infested by coreid bug (crinkled and malformed nuts, shed buttons with brown lesions inside perainth cover)
   - Number and types of breeding sites of rhinoceros beetle (cow dung pit, decaying coconut log, coconut stumps, compost pit, dried and decaying coconut leaf heaps.

Learning to observe and diagnose field problems is a pre requisite skill of coconut farmers in sustainable coconut cultivation. The FFS participants were sub divided into groups and visited the coconut gardens for direct observation and documentation.

Farmer Field School (FFS) Curriculum

The outline of the curriculum for FFS on coconut rhinoceros beetle was finalized based on discussions with multi stakeholders, experts and participating farmers based on their level of knowledge, adoption and field needs. The curriculum is provided as follows:

Table. 1. FFS curriculum for biomanagement of rhinoceros beetle of coconut

Time table & topics	Activities and lesson plan	Objectives to be achieved	Results expected
Session 1 • Meeting the coconut farmers. • Developing relations and getting consensus of participation from the peoples representatives, extension officials, farmers of the panchayath area Date:	• Selection of participants • Networking with farmers organizations, NGOs, farmers societies, Extension departments, local panchayath • Identification of field sites • Consultation and dialogue for FFS Curriculum preparation	• Facilitate participatory approach • Education programme on coconut rhinoceros beetle and management • Need analysis, constraint documentation – coconut farmers	• Support from local institutions • Willingness of FFS farmers to attend all the sessions • FFS located in the field and premises of the participants residential area
Session 2 • Need analysis and knowledge documentation of the participants • Strengthening relationship with coconut farmers group	• Field visits • Ballot box preparation for knowledge documentation • Group dynamics • Special topics • Coconut basin management with cowpea • How to identify diseases of coconut	• Preparation of AESA • Learning how to sample in field situations • Field problems – discussion for solving problems • Points to be noted while incorporating cowpea plants • Management of leaf rot disease	• Farmers ask questions on what they observe • Identification of major problems in their field • Farmers to notice the relative advantage of basin management cowpea • Learn how experiments are conducted

Time table & topics	Activities and lesson plan	Objectives to be achieved	Results expected
Session 3 • Community participation and involvement in FFS activities	• Field visit and observation analysis • Group exercises • Special topics Topics on various pests of coconut, symptoms of attack, identification of pests • Nutrient management of coconut seedlings	• Collect data on pests, beneficial insects, observe the details of symptoms in coconut palms of various growth stages • Initiating insect zoo • Study life cycle of rhinoceros beetle – insect zoo method • Collection of grubs from rhinoceros beetle breeding sites in the locality	• Farmers ask questions • Analyse them selves on AESA data • Develop interest in group learning • Learn group dynamics • Participants develop curiosity and interest in learning the development of rhinoceros beetle eggs- larvae- pupa-adult
Session 4	• Field visits and study • Farmers doing experiments –comparing changes in well managed and poor managed plots and note the impact • AESA of the FFS locations • FFS farmers set up Rhinoceros beetle pheromone traps • Special topics • Insect Zoo- familiarizing with different instars of Rhinoceros beetle larvae • Treatment of RB breeding sites with *Metarhizium*	• Practice and understand data collection and documentation • Understand need for proper management of palms for better yield and health • How to set the trap and the servicing of traps • Prepare AESA • Learning and practicing treatment of breeding sites of RB and why it should be done	• Carry out data collection and analyzing • Monitor the incidence of coconut pests and damage • AESA for field situation analysis and linking with pest/disease incidence • Farmers learn need and importance of working together • Collect beetles, learn about bio control
Session 5	• Field visits and study • Farmers doing experiments – comparing changes in well managed and poor managed plots and note the impact • AESA of the FFS locations • Special topics • Insect Zoo- familiarizing with different instars of Rhinoceros beetle larvae • Treatment of RB breeding sites with *Metarhizium* – infection mode in larvae	• Monitoring of traps • Survey of pest incidence in field situations • AESA preparation • Understanding damage symptoms of rhinoceros beetle in seedlings, Juveniles and adult palms, • Learning difference in impact of RB incidence in different growth stages	• AESA for field situation analysis and linking with pest/disease incidence • Farmers learn need and importance of working together • Collect beetles, learn about bio control Learn how to monitor traps • Learning modalities of pests survey and damage • Learning what happens when larvae infected

Time table & topics	Activities and lesson plan	Objectives to be achieved	Results expected
Session 6	• Field visits and study • Farmers doing experiments – comparing changes in well managed and poor managed plots and note the impact • AESA of the FFS locations • Farmers collect data on development of coconut seedlings • Special topics • Identification and chemical treatment for Red Palm weevil • Soil sampling method • *Clerodendron* incorporation in breeding sites for RB management	• Practice procedures for observation recording, comparative analysis • Learning to monitor traps of RB • Surveillance for pest incidence, damage recording • Learn to do the AESA and drawing conclusions • Identification of Red palm weevil incidence and management practices • Learning methodology for soil sampling and the need for integrated need based nutrient application	• AESA for field situation analysis and linking with pest/disease incidence • Farmers learn need and importance of working together • Collect beetles, learn about bio control • Learning modalities of pests survey and damage of major pest – Rhinoceros beetle • Learn importance of soil and management in crop health • Learn use of locally available plant sources for RB management
Session 7	• Field visits and study • Farmers doing experiments– comparing changes in well managed and poor managed plots and note the impact • AESA of the FFS locations • Learn how to measure the growth of seedlings • Special topics Insect zoo identification of male and female beetles • Compare plots with good and poor management and difference inpest/disease incidences • Identifying Boron deficient palms and management	• Practice and understand procedure for data collection and analysis • To find out whether adoption scientific management practices influence crop health • Monitoring of pheromone traps and record the observations/perceptions • Learn to identify male and female RB beetles • Learn to identify nutrient deficiency symptoms	• Farmers collect data and present their analysis • Able to monitor and take decisions on pest management • Discuss AESA and draw conclusions • Farmers learn how to work together and advantages • Report pest biology of RB • Learn impact of B deficiency in yield reduction and how to manage.

Time table & topics	Activities and lesson plan	Objectives to be achieved	Results expected
Session 8	• Field visits and study AESA of the FFS locations • Learn how to measure the growth of seedlings • Compare plots with good and poor management and difference in pest/disease incidences • Special topics. • Insect zoo- identification of male and female beetles • Identification of various stages and severity of leaf rot disease and treatment aspects • Field level multiplication of *Trichoderma harzianum* and effectiveness in bio control of stem bleeding disease	• Practice and understand procedure for data collection and analysis • To find out whether adoption scientific management practices influence crop health • Monitoring of pheromone traps and record the observations/ perceptions • Learn to identify leaf rot disease, stem bleeding symptoms and impact in plant growth • Learn to multiply *Trichoderma* at farm level using FYM, neem cake and organics	• Able to monitor and take decisions on pest management • Discuss AESA and draw conclusions • Farmers learn how to work together and advantages • Report pest biology of RB • Farmers learn how to multiply bio agents in farm level and use in the field
Session 9	• Field visits and study AESA of the FFS locations • Learn how to measure the growth of seedlings • Compare plots with good and poor management and difference in pest/disease incidences • Special topics • Insect zoo- identification of life stages and duration of RB life cycle • Importance of mulching and role in soil and moisture conservation • Integrated nutrient management of coconut	• Practice and understand procedure for data collection and analysis • To find out whether adoption scientific management practices influence crop health • Monitoring of pheromone traps and record the observations/ perceptions • Learning the duration of RB life cycle and relating with management options • To understand the importance of balanced/ integrated nutrition for health and productivity of coconut palms • Mulching procedures for resource management	• Able to monitor and take decisions on pest management • Discuss AESA and draw conclusions • Farmers learn how to work together and advantages • Report pest biology of RB • Farmers learn how to apply and integrate organic and inorganic fertilizers • Farmers learn to practice mulching coconut basins as simple low cost method for moisture conservation

Time table & topics	Activities and lesson plan	Objectives to be achieved	Results expected
Session 10	• Field visits and study • AESA of the FFS locations • Learn how to measure the growth of seedlings • Compare plots with good and poor management and difference in pest/disease incidences • Special topics • Insect zoo- Pest biology • Collect red palm weevil, eriophyd mite infested nuts, coried bug infested nuts- compare • Bait preparation and placement for rats- identification of rat damage • Coconut livelihood options- coconut products	• Understand procedure for data collection and analysis • To find out whether adoption scientific management practices influence crop health • Monitoring of pheromone traps and record the observations/ perceptions • Learning and documenting the pest biology of RB life cycle • To understand specific symptoms of pest damage for adoption of correct management practices • To learn skills in product diversification	• Able to monitor and take decisions on pest management • Discuss AESA and draw conclusions • Farmers learn how to work together and advantages • Report pest biology of RB • Farmers learn how to identify symptoms and damage of different pests • Farmers learn to prepare coconut products and importance of entrepreneurship for better income from farming
Session 11	• Field visit and study • Special topics • Complete insect zoo – learning and observations • Preparation for field day	• Collect final data from field • Report effect of management in pest/ disease incidence • Monitoring traps and impact • To prepare AESA • Plan and prepare for field day	• Farmers carry out data collection and analyses • Farmers report on efficacy of pest / disease management • Farmers report on pheromone trap for RB • Farmers directly involved in field day organization indicating the group learning and need for each other in implanting activities
Session 12	• Organize and participate in FFS field day	• To showcase skills, knowledge and perceptions of FFS participants	• Successful field day with participation of relevant stakeholders • Giving certificate and honoring FFS

**Adapted from FFS curriculum developed in Singh. S.P and Romulo N. Arancon Jr. (2007) CFC/DFID/APCC/FAO Project on Coconut Integrated Pest Management, Asian and Pacific Coconut Community, APCC-IPM Publication No.3.*

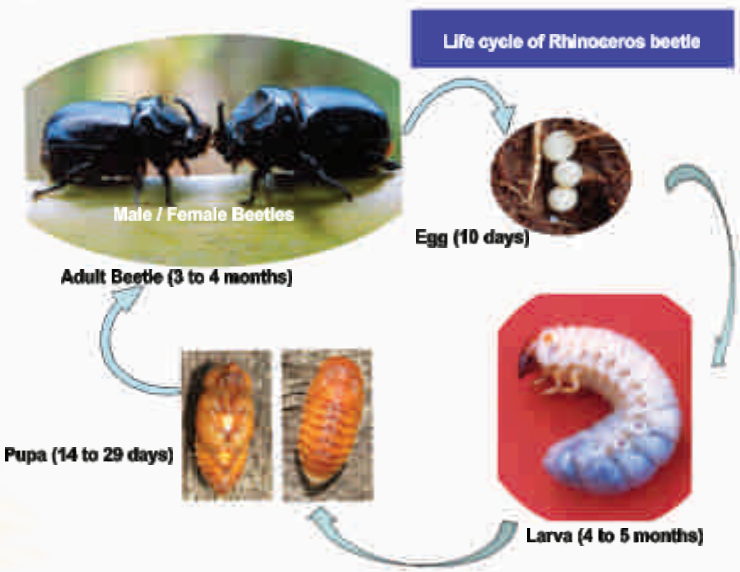
** Innovations in curriculum needed depending upon topics, locations, farmers and farm profile etc.*

**Avoid seasonal pests. Major pests present widely give learners basic skills in FFS. Identify them in consultation with farmers*

**For coconut FFS, it can be bi or tri weekly and later stages monthly*

Insect zoo - Rhinoceros beetle

The activity of developing an insect zoo is an important experiential learning which is part of the FFS curriculum. This will enable the participant farmers to understand the life cycles and importance of understanding the pest development in taking decisions of management options, time, frequency and reasons for the same. The FFS participants also learn about the natural enemies and the dynamics of pests, natural enemies and natural factors through direct observations. The zoo can be made to learn about the pest development stages in any suitable containers or locations in the field of farmers as per the availability and convenience. The facilitator of the FFS explains the concept, how to build it up and how to learn. If the group is more than 20 they can be divided into subgroups for in depth learning and participation. They study life cycles of the pest and duration of each stage, host plant interactions, the egg laying locations of rhinoceros beetle, the action of *Metarhizium* fungus on grubs and adults of rhinoceros beetle, how to identify the affected grubs *etc*. Thus insect zoo activities help the participants for studying the details of rhinoceros beetle and action of *Metarhizium* in managing the beetle population.



Eggs

- Seen in breeding sites of beetle (decaying organic debris)
- Period: 10 days
- Round shape
- Size: 3x2mm
- Colour: creamy white
- Enlarge size slightly during growth by absorbing water
- Not feeding

Larva

- Seen in breeding sites
- Three instars of same morphology but size increases after each moult
- Small larva: 2cm(L)x 3 mm (B)
- Middle size: 5cm(L)x 5mm (B)
- Full grown: 6-7cm(L)x 1-1.7cm (B)
- Shape dorso-ventrally curved "C'shaped"
- Colour: white with brown/black head
- Three pairs of legs
- Spiracle openings on sides of body
- Small setae on last abdominal segment
- Mandibles are very sharp
- Mouth parts: biting and chewing
- Food filled abdomen visible through skin
- Healthy larva active and move fast
- Feed on decaying matter like cowdung, decaying coconut logs, compost *etc*.
- Period: 4-5 months

Pupa

- After completing larval growth it pupates in a cocoon in the breeding ground itself by making a round cover with cowdung
- Colour: brown
- Non feeding
- Moves the tail part when touched, if alive
- Complete metamorphosis to adult inside the cocoon
- Pupal period: 14-29 days. After pupal period it emerges out as adult by splitting the external skin

Adult:

- Color: Black
- Size: 35-50mm in length,14-21mm breadth
- Male rhinoceros beetle has long horns in their head region similar to the rhino horns
- Male beetles are larger in size than female beetles
- ? Females have short brown hairs in their posterior end
- ? Six legs
- ? Lay up to 108 eggs
- ? Mostly active during night
- Longevity: 3-4 months
- Adult mostly emerges during June –September
- Feeds on coconut petioles, spathe and unopened spindle

Ballot Box - Knowledge questions (Answers given in Annexure II)

1. Common name of rhinoceros beetle grub? (In Malayalam)
2. When do we mulch coconut basin?
3. How much quantity of cowpea is sown in a coconut basin?
4. Which are the common organic fertilizers used in coconut farming?
5. Which are the chemical fertilizers required for coconut?
6. How much quantity of organic fertilizer required for a coconut palm/ year?
7. How much quantity of chemical fertilizer is required for coconut palm/ year?
8. How much water is given per palm through drip irrigation?
9. Colour of adult rhinoceros beetle ?
10. How to identify attack of rhinoceros beetle?

11. What is Metarhizium?
12. Which is the appropriate time for application of Metarhizium in cow dung pit?
13. What are the preventive measures for rhinoceros beetle attack?
14. What are the chemical pesticides used for leaf axil filling?
15. Which pest infestation leads to spindle breakage and drooping?
16. Bio agent used for controlling rhinoceros beetle other than Metarhizium?
17. How do you identify Metarhizium infected grub?
18. What is the name of this programme being conducted by ICAR- CPCRI?
19. Which are the life stages of rhinoceros beetle?
20. Rhinoceros beetle infestation on coconut palms is heavy during which period of the year?
21. Which month high incidence of rhinoceros beetle occures ?
22. Which stage of rhinoceros beetle attack coconut palms?
23. Why do we use Metarhizium in cow dung pits rather than leaf axil?
24. In which stage of coconut growth stage, rhinoceros beetle attack can be fatal?
25. Which is more effective in rhinoceros beetle management- indivudal or community approach?
26. Which pest is fatal to coconut palms?
27. Traditional method for rhinoceros beetle management?
28. Weed plant used for management of rhinoceros beetle?
29. Breeding site of rhinoceros beetle other than FYM pits?
30. Natural enemies of rhinoceros beetle?
31. How do you differentiate between male and female rhinoceros beetle?
32. How long it will take rhinoceros beetle to complete the life cycle?
33. Frequency of placement of naphthalene balls placement in coconut leaf axil?
34. Which oil cakes can be used for leaf axil filling of coconut for repelling rhinoceros beetle?

Table 2. Management of Rhinoceros beetle of coconut – FFS lessons

Biointensive Practices/ recommendation	Details of adoption	Adaptations/ refinement suggested by the FFS participants	Farmers perceptions
Green Muscardine Fungus (GMF)	100g rice based packets of GMF for $1m^3$ area	Moisture content of base material to be ensured. Not effective in summer hot months	Very effective if adopted on community basis. In FFS focus should be given for including livestock farmers
Incorporation of the weed plant *Clerodendron infortunatum* in FYM pits	Incorporate whole plant in FYM/ compost pits where RB breeds	Frequency can be increased rather than single application	No cost, effective simple, available, easy, any time.
Prophylactic leaf axil filling	Two sachets of chlorantraniliprole 6g/palm, Naphthalene	Polythene sachet effective during rainy season	Cost wise not economical, Frequency more,

	balls- 12g/palm, Neem cake – 250g		labour charge. Could be adopted in seedlings in main field and juveniles
Use of RB pheromone traps	1 trap per 5 hectares	Effective for adult catch	Not actually reflected in reduction of RB incidence
Cowpea basin management	100g seeds sown /basin	Sowing 2-3 times per year and incorporating in soil	Easy, simple, cost effective, doable by farmer, reflects in yield
Red Palm Weevil – Chemical treatment	1 ml imidachloprid /litre of water	Effective if symptoms identified in early stages	Climber availability in time is constraint.
Leaf rot disease treatment	Apply 2 ml contaf in 300 ml water after removing the affected portions	Effective and easy	Climber availability in time is constraint.
Trichoderma harzianum– field level multiplication and application	1kg in 90 kg cowdung/ compost + 10 kg neemcake. Apply 5 kg/ palm in basins after growth of fungus	Group interventions to be adopted	Effective , environment friendly, doable by farmers
Mulching coconut basins	With available organic residues	Recycling of coconut fronds	Traditional practice, needs adoption
Integrated nutrient management for coconut	Soil test based liming material/ nutrient supply	Not regularly adopted due to fluctuating price of coconut. Apply organics regularly	Organic manures would be better choice for coconut cultivation.
Identification and Boron deficiency management	Symptom based application of 120g borax per palm	Soil test based community adoption reduces cost	Effectively managing deficiency of B

Farmer Field Schools (FFS) – impact of the educational programme

A. Pre treatment data collection through PRA and survey

Collected pre-data on rhinoceros beetle (RB) and other pests/ disease incidence and associated factors from FFS locations. Farmer profile, knowledge and adoption data were also documented .The average area under coconut among the farmers surveyed was 52.8 per cent and 54.5% of farmers were having holding size of <40 cents. None of the farmers adopted any plant protection in the crown of the palms due to severe shortage of climbers and lack of proper knowledge, except for leaf axil filling adopted by 42 per cent of the farmers for seedlings planted in main field and pre bearing palms. Around one third of the farmers did not attend any extension programmes nor any farm publications/ radio/TV farm programmes. 55 per cent of the households surveyed had potential breeding sites of rhinoceros beetle including vermi-compost units or FYM pits

Table 3. Farmer profile - FFS participants (n=120)

Particulars	Categories (%)			
Age of farmer	< 40yrs (18.1)	41-60 yrs (50.06)	60yrs (31.9)	
Education level	Upper Primary (20.4)	High school (38.75)	PDC/ITI (18.1)	Graduate (22.7)
Land holding size	< 40 cents (54.5)	41- 80 cents (22.73)	81-120 cents (13.6)	>120 cents (6.82)
Total palms	< 25 (45.2)	26-50 (20.5)	51-100 (25)	>100 (9.3)

Around 50 per cent of the farmers were found to be in the age category of 41-60 years and the youths among the farming community were below 20 per cent indicating the reduced involvement of them in farming. All the farmers were educated and having coconut cultivation in small and marginal holding size. The data on land holding size and total number of palms in each farmers plot warrants for group approach and innovative participatory education programmes.

Table 4. Farm profile – FFS locations/ participants (n=120)

Particulars	Category	%
Intercropping	No intercrops Intercropped gardens	29.50 70.50
Adoption of general management	Poor Average Good	4.50 75.00 20.50
Extension contact	Low Medium High	61.10 23.40 15.50

Intercrops of various density and combinations are found in 70 per cent of the coconut based homesteads of the FFS farmers. The adoption of recommended management practices indicated medium level by three fourth of the participants which could be correlated with the low level of extension contact among 61 per cent. The low level of extension contact also point towards the need for concerted and focused extension approaches among coconut farming community.

Eighty one per cent of adult palms, 82 per cent of juvenile palms and 38 per cent of young palms in the area showed rhinoceros beetle incidence. Pre bearing young palms (3-10 years) showed maximum leaf damage (20.84%) compared to bearing palms (18.21%) and seedlings (<3 years) planted in the field (10.85%).

Pre-treatment data collection was done from the project areas *viz.*, Krishnapuram panchayth, Devikulangara panchayath, Kandalloor panchayath and Kayamkulam Municipality area. In each panchayath 15 locations were randomly selected for recording the pre-project data. In each location data was collected from 250 coconut palms, thus a total of 2000 palms. Average leaf damage due to the pest incidence, in the project area ranged from 29.27 to 33. 17 per cent.

B.Farmer Field School (FFS) on rhinoceros beetle management

The FFS programme was inaugurated at Kandalloor panchayath on 22-12-2012. A compact disc on rhinoceros beetle was released on the occasion. In addition, Green muscardine fungus, *Metarhizium anisopliae* and plant growth promoting rhizobacteria, *Pseudomonas fluorescens* were distributed to farmers

A farm level exhibition giving emphasis on pest/diseases of coconut was also arranged in the venue. 103 farmers participated in the interactive discussions. Nine FFS groups were formed in Kandalloor. Details of FFS units at Kandalloor are furnished in Annexure I. Detailed base line data collection was initiated along with FFS session. All the breeding sites were treated with GMF under participatory effort with stakeholders.

The FFS programme was launched at Devikulangara on 7/02/2013 with participation of 62 farmers in the function.

3,504 RB breeding sites were treated with GMF in Krishnapuram Panchayath on 08/07/2013 with co-operation of farmers club and Krishibhavan. The meeting was attended by 41 farmers. Details on use of *Metarhizium* were imparted to the participants and fungal culture packets were distributed for application in all the wards of Krishnapuram.

The foremost impact of the FFS among participants was the improvement in the knowledge of the participants. The analysis of the improvement of knowledge was furnished the table in gender aggregated manner. The participation and empowerment of women farmers were noticeable in the farmer field schools.

Table 5. Knowledge and adoption of farmers on rhinoceros beetle management before interventions

> 30 % of knowledge and adoption before the project	
1.	Identification-Adult beetles of rhinoceros beetles
2.	Breeding sites of RB
3.	Symptoms of RB attack on adult palms/ juvenile palms (leaf damage)
4.	Leaf axil filling salt/ash/sand mixture
< 30 % of knowledge and adoption before the project	
1.	Time of highest attack of RB
2.	Chemicals for leaf axil filling
3.	Awareness of GMF / OrNV
4.	Rhinoceros beetle attack leads to reduction in yield of coconut
5.	Rhinoceros beetle damage symptom on seedlings
6.	Placement of pheromone traps
7.	Use of *Clerodendron infortunatum* for rhinoceros management

The knowledge and adoption of traditional practices were more prevalent among the coconut farmers. Whereas knowledge items like time of highest pest damage, chemicals used for leaf axil filling, bio

management technologies, pheromone traps *etc.*, recorded below 30 per cent among the farmers before the FFS. Hence more emphasis was given for the improvement in these knowledge items in the FFS sessions.

Table 6. Mean knowledge index of FFS and Non FFS farmers of project area (n=60)

	Knowledge index on Rhinoceros Beetle & Integrated management		Knowledge index on other coconut pests/diseases & management	
Category	**Men**	**Women**	**Men**	**Women**
Farmer Field School(FFS) participants	51.92	52.29	55.58	45.15
Non Farmer Field School Participants	28.73	36.88	29.33	32.74

- The average knowledge index of the FFS farmers on rhinoceros beetle and its management practices were 52.10. The knowledge index of women farmers was 52.29 and men farmers 51.92, indicating similar learning ability of both genders from the FFS sessions.
- The average knowledge index of the non - FFS farmers on rhinoceros beetle and its management practices was 34.79. The knowledge index for women and men farmers were 36.88, 28.73 respectively, indicating similar knowledge level on the topics among both genders of the Non- FFS farmers.
- The data indicated that FFS farmers are more knowledgeable than non FFS farmers on various aspects of Rhinoceros beetle and its management practices.
- The classification of farmers into high/medium and low level of knowledge was found to be almost similar among the FFS and Non FFS farmers. But when compared to the average score of FFS farmers the non- FFS farmers were found to be in the lower knowledge level.

Table 7. Categorization of FFS &Non FFS farmers based on their knowledge level on integrated management of Rhinoceros beetle (n=60)

% of Correct responses	FFS Farmers (%)		Non FFS Farmers (%)	
	Men	Women	Men	Women
0-25	20.58	20.58	44.12	44.13
26-50	14.71	14.71	38.23	17.64
51-75	41.18	44.12	14.71	32.35
76-100	23.53	20.59	2.94	5.88
	100.00	100.00	100.00	100.00
Average knowledge Scores	**51.04**	**52.35**	**28.72**	**36.88**

The relative higher knowledge level of FFS farmers was very evident from the data given in table 7. 35.29 percent of FFS farmers were in the category of less than 50 percent correct responses to the

knowledge items; where as 72.06 per cent of non- FFS farmers come under this category, clearly indicating impact of FFS in reducing the knowledge gap. This point was further reiterated with the fact that 64.71 per cent of FFS farmers answered more than 50 per cent of knowledge items correctly compared to 27.94 percent of non- FFS farmers. Since knowledge is a pre requisit for technology adoption, FFS is an appropriate extension intervention for improving knowledge of farmers.

Table 8. Knowledge scores on rhinoceros beetle and management –FFS and non–FFS farmers (n=60)

Sl.No.	Knowledge statements	FFS (Men)	FFS (Women)	Non-FFS (Men)	Non-FFS (Women)
1.	Common name of Rhinoceros beetle grubs?	33	19	34	19
2.	When do we mulch coconut basin?	44	20	25	12
3.	How much quantity of cowpea is sown in coconut basin?	32	17	14	7
4.	Which are the common organic fertilizers used in coconut farming?	54	25	49	23
5.	Which are the chemical fertilizers required for coconut?	36	19	17	10
6.	How much quantity of organic fertilizer is required for coconut palm /year?	44	21	35	18
7.	How much quantity of chemical fertilizer is required for coconut palm /year ?	20	11	18	6
8.	Irrigation schedule for coconut	26	11	24	7
9.	Colour of rhinoceros beetle?	45	21	37	17
10.	How do you identify attack of rhinoceros beetle?	46	22	32	16
11.	What is *Metarhizium*?	30	20	1	2
12.	Which is the appropriate time for application of *Metarhizium* in cow dung pit?	21	10	3	2
13.	What are the preventive measures for rhinoceros beetle attack?	33	19	18	15
14.	What are the chemical pesticides used for leaf axil filling?	9	12	4	2
15.	Which pest infestation leads to Spindle breakage and drooping?	35	14	22	13
16.	Bio agent used for controlling rhinoceros beetle other than *Metarhizium?*	18	11	1	3
17.	How do you identify *Metarhizium* infected grubs?	31	20	0	0
18.	What is the name of this programme being conducted by ICAR - CPCRI?	23	17	0	1
19.	Which are the life stages of rhinoceros beetle?	33	21	0	0

Sl.No.	Knowledge statements	FFS (Men)	FFS (Women)	Non-FFS (Men)	Non-FFS (Women)
20.	Rhinoceros beetle infestation on coconut palms is heavy during which period of the year?	12	5	5	2
21.	Which month high incidence rhinoceros infestation?	36	20	20	13
22.	Which stage of Rhinoceros beetle attack coconut palm?	47	22	43	18
23.	Damage causing growth stage of rhinoceros beetle	45	21	28	17
24.	Why do we use Metarhizium in cow dung pits rather than in leaf axils?	30	17	3	1
25.	Will adoption by individual farmers be effective for RB management?	33	18	10	1
26.	Which pest is fatal to coconut palm?	35	11	18	10
27.	Traditional method for rhinoceros beetle management?	43	16	23	14
28.	Weed plant used for control of rhinoceros beetle?	20	15	4	5
29.	Breeding sites of rhinoceros beetle other than cow dung pits?	34	17	17	12
30.	Natural enemies of rhinoceros beetle?	36	15	16	14
31.	How do you differentiate between male and female rhinoceros beetle?	8	2	3	3
32.	How long it will take to complete the life cycle of rhinoceros beetle?	10	4	1	2
33.	Intervals for naphthalene ball application in coconut leaf axils	6	4	1	0
34.	Oilcakes used for repelling rhinoceros beetles?	40	19	21	16

Thirty four knowledge items were identified for measuring the knowledge level of FS and non – FFS farmers regarding the various aspects of rhinoceros beetle management. The knowledge items for which low scores recorded by the FFS farmers were given emphasis and curriculum modified further for FFS sessions.

The knowledge items which recorded lower scores by the FFS farmers were the chemical pesticides used for leaf axil filling, life stages of rhinoceros beetle, correct identification *Metarhizium* infected grubs, name of the programme, differentiating between male and female rhinoceros beetle, life cycle of rhinoceros beetle, Interval for naphthalene ball application in coconut leaf axils. Curriculum was modified and the FFS farmers after attending the sessions recorded high level of knowledge in the specific knowledge items.

The foremost impact of the FFS among participants was the improvement in the knowledge of the

participants. The analysis of the improvement of knowledge was furnished the table in gender aggregated manner. The participation and empowerment of women farmers were noticeable in the farmer field schools.

Impact in pest reduction due to FFS and field interventions

The data on reduction of the rhinoceros beetle infestation of the intervention areas from 2012 to 2015, indicated 76 to 85 per cent reduction indicating the efficiency of the area-wide community adoption of technologies for management of rhinoceros beetle as well the knowledge improvement which results in the sustainability of the technology adoption. The technology could also improve the average yield of the palms due to the reduction in pest damage by 10-13 per cent.

Farmer field schools for perennial crops like coconut requires refinement in terms of curriculum, duration and review. It could be established that the FFS sessions are effective in improving the knowledge ad interest among participant farmers to significant levels. The gender aggregated data indicated the learning ability depends on the experience and FFS play a role in involvement of women farmers in decision making regarding the technology adoption in their homesteads. The FFS methodology needs to be adopted in other areas of coconut cultivation like cropping/ farming systems, nutrient management, integrated crop health management, soil and water conservation, post harvest management and value addition wherein the knowledge empowerment will lead to further learning and sustainability of the technology utilization.

Annexure I

LOCATION: KANDALLOOR GRAMA PANCHAYATH

Name and Address of farmers

FFS GROUP I: (WARD 1)

1. Santhosh, Vijayabhavanam
2. Remanan, Lekshmi Bhavanam
3. Vijayan, Chaithanya
4. Rajappan, Anaswara
5. Binulal, Lalnivas
6. Ramachandran, Karesherril
7. Rajendran, Akshara
8. Uthaman, Krishna bhavanam
9. Radhakrishnan, Amal bhavanam
10. Vishwamohan, Sadhupuram
11. Ponnapan, Prem Nivas
12. Leelamma, Gangadara bhavanam
13. Rajendran, Rajesh bhavanam
14. Chellappan, Binu bhavanam
15. Radhakrishnan, Rahul Nivas
16. Sudanandan,Sudhabhavanam

FFS GROUP II: (WARD 3)

1. Shankara Pillai, Alekalathil
2. Gopikrishnan, Alekalathil
3. Saraswathy, Saraswathy Bhavanam
4. Sanal purushothaman, Sunil Bhavanam
5. Jayakrishnan, Revathy
6. Shantha .U.K.pillai, Vrindavanam
7. Muraleedharan Nair, Muralibhavanam
8. Gopinathan Pillai,Alekalathil thekkathil
9. Sreedharan Nair,Sreelasyam
10. Ayyappan Nair,Veliyathu, Kalathilkandathil
11. Muraleedharan,Vilayathukizhakkathil
12. Damodaran, Puthumana
13. Krishnapillai, Chennala
14. Ramachandran Nair,Vazhavilayil

FFS GROUP III: (WARD 5)

1. Govinda Pillai, Kuttimadathil
2. Ramanan, Shobhalayam
3. Thankamma, Susmitha Bhavanam
4. Vasu, Poykkara Padeettathil
5. Kamalakumari, Poykkara thekkathil
6. Viswambaran, Sanil Bhavanam
7. Rukmini Nair, Ushas
8. Indira Bhaskaran, Kodanayyathu
9. Vijayan, Pulimoottil
10. Ajikumar, Punnamoottil
11. Padmanabha Panikkar, Krishnabhavanam
12. Omana, OB Bhavanam
13. Abdulsalam, Kavinte Vadakkathil
14. K.Sadasivan, Athira
15. Prabhakaran, Chithirayil
16. Letha,Chaprayil Vadakkathil

FFS GROUP IV: (WARD 6)

1. Ramakrishna Pillai, Aswathy
2. Bharathan, Puthenkandathil, Puthiyavila
3. Kuttan, Sandhyabhavanam, Puthiyavila
4. Sankarankutty, Kurumpolil, Puthiyavila
5. Madhuri, Kurumpolil, Puthiyavila
6. Kuttan, Kurumpolil, Puthiyavila
7. Shivaprasad, Bhaskaravilla, Puthiyavila
8. Sarala, Jyothis, Puthiyavila
9. Mahadevan Nair, Puthiyavila
10. Gopinathan Nair, Gokulam, Puthiyavila
11. Sivaraman, Shobhanivas, Puthiyavila
12. Sasidharan, Kolathu, Puthiyavila
13. Radhakrishnan, Vrindavanam
14. Mahadevan Pillai, Thykkattusseril

15. B.Biju, Poykkara Bijunivas, Puthiyavila
16. Retnamma, Kolathu, Puthiyavila

FFS GROUP V: (WARD 7)

1. Sivan Unnithan, Mezhuvanamadathil
2. Shivasankaran Chettiyar, Shiva bhavanam
3. Kamalamma pillai, Madathil padeettathil
4. Harikumar, Kamalabhavanam
5. Radakrishnapillai, R.K.Nivas
6. Rajendran Achari, Sadupuram
7. Sreeletha, Lekshmi bhavanam
8. Sreepal, Mezhuvanatharayil
9. Ayyappanpillai, Mezhuvanamadathil
10. Sasidharan,Vaishakam
11. Rajendran, Harisree Nivas
12. Reghunath, Sadhupuram
13. Ashok Kumar, Ajeesh bhavanam
14. R.Sasidharan Nair, Sreevilasam

FFS GROUP VI: (WARD10)

1. Chandramani, Sarass
2. Viswamohanan, Mannathu thekkathil
3. Retnamma, Rejibhavanam
4. Prabhakaran, Pukayilathondu
5. Bhaskaran, Poomangalathu
6. Maniyamma, Kadavathra Thekkathil
7. Uthaman, Kadavathrayil
8. Rajamma, Puthenkandathil
9. Anandan, Edakandathil
10. Sathyabhama, Kdasseril Kandathil

FFS GROUP VII: (WARD11)

1. Jaysingh, J.J.Nivas
2. Pushpa, Kottusseril thekkathil
3. Chandrasenan, C.R.Nivas
4. Vijayan, Nadesseril
5. Rajan, Nadesseril
6. Maniraj, Kadesseril
7. Surendran, Vandanam
8. Jinarajan, Shiju Bhavanam
9. Sindhu, Pathakarisseril
10. Vidyadharan, Pulikkattusseril
11. Viswamohanan,Vyshakh
12. Krishnan Nair, Sreerangu
13. Karthikeyan, Karavallil Padeettathil
14. Divakaran, Sreenilayam
15. Sathyan,Sujith bhavanam

FFS GROUP VIII: (WARD12)

1. Ananda Chandran, Thanal
2. Rohini, Dwaraka Bhavan
3. Suja, Shanthiyil
4. Lekhmanan, Breshnev Bhavan
5. Prahladan, Pulayanthara Kizhakkathil
6. Banarjee Babu,Valayikkalathu
7. Shivanandan, Seema Bhavanam
8. Chandrahasan, Puthan Parampil
9. Rajamma, Madathil
10. Ajayakumar, Retna Nivas
11. Radha,Vrindavanam
12. Radakrishnan, Ampadiyil

FFS GROUP IX: (WARD14

1. Vijayan, Geetha Bhavanam
2. Gopakumar,Vasantha Bhavan
3. Chau.En.Lai, Thamburu
4. Bhargavan, Sumangalathu
5. Anilkumar, Kaduvangal
6. Surendran, Peedikachirayil
7. Purushan, Anusmrithi
8. Thajudeen, Onampallil
9. Haridasan, Harimandiram
10. Thampuran, Bhargavi nilayam
11. Panchami, Kochupulimoottil)

Annexure-II

Answers to Knowledge questions (Ballot box)

1. *Kundalapuzhu* (Malayalam)
2. Summer months
3. 100 g
4. Farm yard manure, compost, neem cake,green manures
5. NPK(Urea, Mussorie phosphate, Muriate of Potash) , Magnesium sulphate, micro nutrients
6. 25 kg/ palm /year
7. NPK (500:300:1000g/palm/year) Urea (1.1kg) Mussorie phosphate (1.5 Kg), Muriate of Potash (1.7Kg), $MgSo_4$ (500 g)/palm/year
8. 32 litres palm/day-drip irrigation
9. Black
10. V shaped cuts on leaves, spindle drooping, holes on unopened spindle
11. Green muscardine fungus (*Metarhizium anisopliae*) causes disease in rhinoceros beetle and grubs
12. When there is enough moisture (except hot summer *viz.*, March-May)
13. Leaf axil filling, phytosanitation
14. Chlorantraniliprole (ferterra)/chloridust
15. Rhinoceros beetle
16. *Oryctes rhinoceros* Nudi virus
17. Dead, mummified with green spores on body
18. Farmer field school
19. Adult beetle, egg, larva, pupa
20. Rainy season
21. July-September
22. Adult beetle
23. *Metarhizium* infects grubs, moisture for fungal growth can be assured Because RB breed in cowdung pits.
24. Seedlings and juvenile palms
25. Community based area - wide approach will be effective, economical &eco friendly
26. Red palm weevil
27. Leaf axil filling with salt, ash and sand, removing beetle from infestation site with beetle hook
28. *Clerodendron infortunatum*
29. Decaying logs, compost pit, coir pith heaps.
30. Hen, ants, mongoose, rat, crow, owl, *etc.*
31. Male beetles have long horn than female, female have tuft of hairs in the last abdominal segment
32. 8-10 months
33. 45 -60 days
34. Neem cake, marotti cake, pongamia cake

FFS Sessions...








Farmer Field School (FFS) in Coconut

FFS Sessions...

Farmer Field School (FFS) in Coconut

Participatory biomanagement of Rhinoceros Beetle

'V' shaped cuts - Symptom of Rhinoceros beetle infestation

Spindle damage by Rhinoceros beetle

Clerodendron for incorporation in FYM/ compost pits

Metarhizium infected grub

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