Integrated Pest and Nutrition Management Plan of KERA

11th October, 2023

Contents

Table

1. INTRODUCTION

The project interventions on improved irrigation, promotion of crop cluster development based on market assessment, intercropping and replantation of plantation crop (Coffee, Cardamom, Rubber and Coconut) may lead to agricultural intensification and associated use of agro-chemicals such as pesticides and fertilizers. Although climate resilient practices are proposed to be promoted under this KERA project, there are possibility of increase in application of fertilizer and pesticide to increase productivity. Adoption of good agriculture practice (GAP) and packages of practice (PoP) proposed under this project should consider Integrated Pest and Nutrition Management (IPNM) as an environmental improvement measures. Therefore, the ESMF of the project includes a strategy to introduce Integrated Pest and Nutrient Management (IPNM) to the farmers in the project area. The project will support IPNM as the key strategy to enable farmers to combat pests, diseases and nutrient deficiencies. Effective implementation of IPNM practices will reduce the risk of water pollution through leaching of chemicals from farmlands to water sources, both surface and sub-surface.

2. OBJECTIVE OF IPNM

IPNM seeks to promote and support safe, effective and environmentally sound pest and nutrient management. This IPNM plan specifically designed for KERA project will help raising awareness level of farmers on recommended doses of fertilizer and pesticide application. This will ultimately meet the project objective of promoting Good Agriculture Practice and Package of Practice.

The specific objectives relating to pest management are the following:

- Minimize crop loss, augment farm production with scientific application of synthetic pesticides;
- Reduce environmental pollution caused due to the application of synthetic pesticides;
- Introduction and adoption of biological and cultural methods for managing pests below the Economic Threshold Level (ETL);
- Reduction in health hazards arising due to chemical pesticides during storing, handling and application;
- Minimizing pesticide residues through the application of appropriate doses;
- Promotion of bio pesticides will reduce the application of synthetic fertilizer, meet the overall goal of Organic Farming.
- Raising awareness level on WHO banned pesticide and its associated health hazard

The specific objectives relating to nutrient management are the following:

- Improving and sustaining soil fertility and land productivity;
- Reducing environmental degradation due to overuse of synthetic fertilizers;
- Addressing nutrient deficiencies identified through systematic soil testing;
- Introduction and adoption of organic methods for meeting plant nutrition needs.

3. BASELINE ASSESSMENT

3.1 AGRICULTURAL CROPS

Agricultural crops in the state are broadly classified as food crops and non-food crops. The total area under cultivation of food grains during 2021-22 was 197653.15 Ha. During 2021-22 the area of food grains decreased by 4.82 % as against the year 2020-21. Cropping intensity has fallen down from 136.97% in the 2001-02 to 126.23% in the year 2020-21. Net sown area has fallen down from 21.88 lakh ha. in 2002-03 to 20.35 lakh ha. in 2020-21. Coconut occupies highest portion (37.78%) of net sown area followed by Rubber (29.02) and Paddy (10.08%). Among other principal crops of the state, Coffee occupies 4.22% and

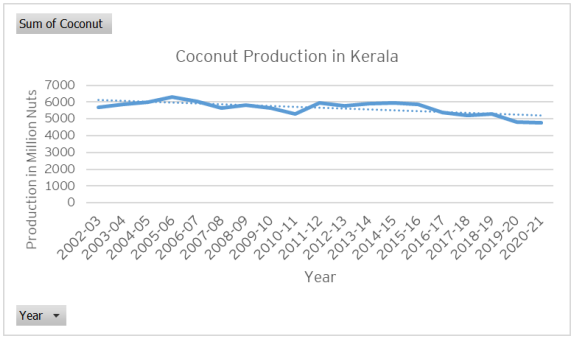
Cardamom 1.92% share of net sown area in the year 2020-21.[1] To increase the production and productivity, KERA project has planned to rejuvenate Coffee, Cardamom, Rubber and Coconut cultivation by means of replantation, Crop Cluster Development based on diagnostic study.

Paddy

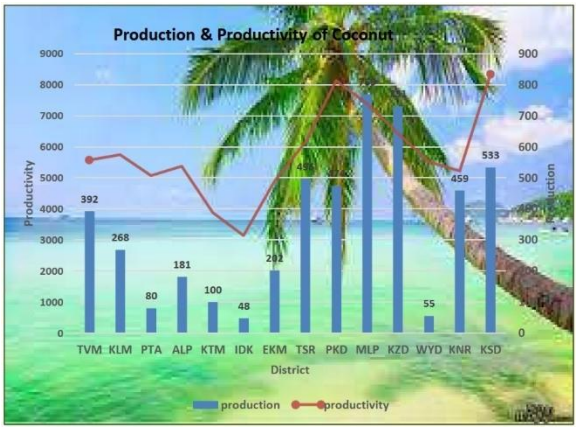
This is the most important food crop grown in Kerala. Paddy is cultivated in three seasons in all the districts of Kerala except Wayanad district[2]. The area of paddy cultivation decreased by 77.66 % during the year 2021-22 as compared to that of year 1975-76. Presently, it occupies 10.08 percent of the net sown area of the state. However, the area under rice has been falling at an alarming rate ever since the 1980s. From 8.82 lakh hectare in 1974-75, the paddy area has come down to 2.05 lakh hectare in 2020-21. The production has also concomitantly declined from 13.76 lakh MT in 1972-73 (peak of production) to 6.33 lakh MT in 2020-21. There has only been a marginal increase in the productivity of rice in the past four decades. In the recent months, the State government has taken a number of steps for the promotion of paddy cultivation.

Coconut

Coconut is a perennial crop, generally grown all over the State. Production of coconut is concentrated specifically in Malappuram district followed by Kozhikkode. The lowest production is in Idukki district. Area, production and productivity of coconut show a decreasing trend.



Considering the area under cultivation of crops, coconut occupies 1st place among them. Area under coconut cultivation was 6.93 lakhs Ha during 1975-76 and 7.2 lakh hectares during 1985-86. The area under coconut cultivation reached highest during 2000-01 i.e., 9.26 lakhs Ha. and it was 7.68 lakhs ha. in the year 2020-21. Thereafter, a decreasing tendency is seen in the area under the cultivation of coconut in Kerala. During 2020-21, coconut cultivation increased by 1.06 % compared to previous year 2019-20 and 15.11% area decreased from 2001-02. Kozhikode district stands 1st in the cultivation of coconut with an area of 113833.58 Ha and it represents 14.86 % of the total area. Malappuram and Kannur districts stand at 2nd and 3rd positions with areas 13.56% and 11.46 % respectively[3]. Coconut nucleus seed gardens in 60ha. area and sustainable coconut cultivation in 200 cluster are proposed under KERA project to increase production and productivity. Practice of intercropping is also planned to be adopted with coconut cultivation.



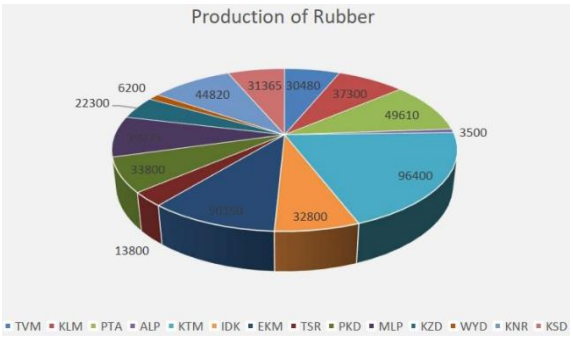
[1] Source: Agricultural Statistics 2021-22, Department of Economics & Statistics, Thiruvananthapuram, May 2023

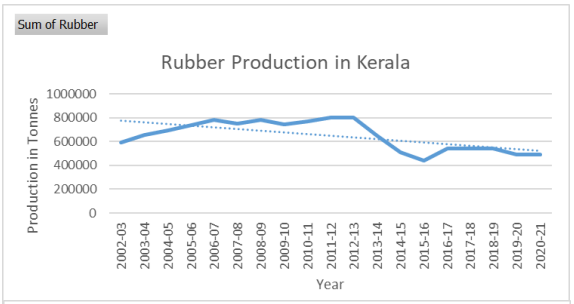
[2] Source: International Journal of Research in Humanities, Arts and Literature (IMPACT: IJRHAL), ISSN (P): 2347–4564; ISSN (E): 2321–8878, Vol. 6, Issue 5, May 2018, 485–488

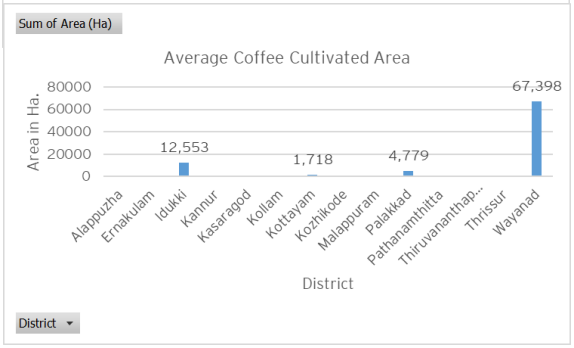
[3] Source: A Compendium of Agricultural Statistics: Kerala 2023, 2023, Directorate of Agriculture Development & Farmers' Welfare

Rubber & Coffee

Rubber cultivated area during 2020-21 was 550650 Ha. Rubber has 1st position in area under the cultivation of plantation crops and the





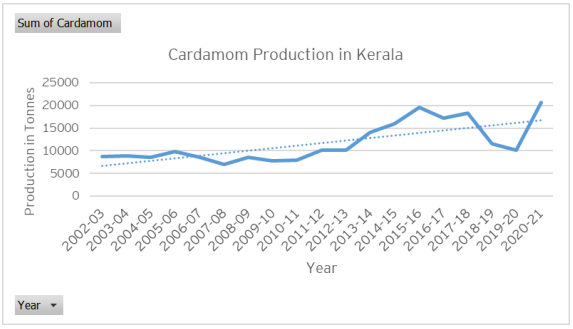


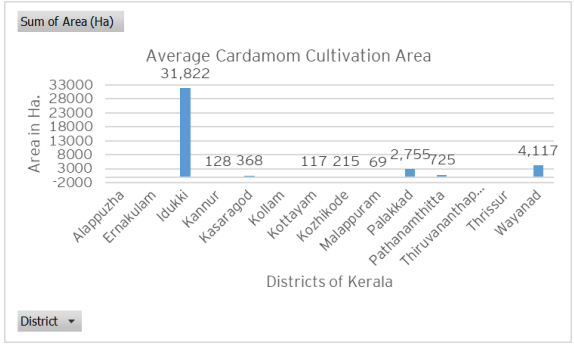
representation is 80.2 %. Kottayam stands 1st with 20.72% area. Ernakulam (10.9 %) and Pathanamthitta (9.23%) districts stands in 2nd and 3rd positions in area under the cultivation of rubber during 2020-21. Replantattion is planned in 30,00ha area under KERA project to increase production and productivity.

Coffee cultivated area during 2020-21 was 85880 Ha. and it is being cultivated only in three districts of Kerala. An increasing trend has been observed in Coffee production in last two decade. Average annual production rate is 63180 tonnes and productivity is 744kg/ha during the year 2002 to 2020. Wayanad district stands 1st with area 67705 Ha (78.84%) followed by Idukki (15.4%) and Palakkad (5.7%) cultivated area share. About 1,150 ha. is planned to be covered under replantation activity proposed under KERA project.

Cardamom

Cardamom is called as the 'Queen of Spices' and is an important spice crop cultivated in Kerala. Even though Cardamom is cultivated only in 7 districts in Kerala, it occupies about 15.22% area under the cultivation of Spices & Condiments and has 3rd largest area among them. Major cultivation of cardamom is in Idukki district and the contribution to total area is 79.90% followed by Wayanad (10.48%). On analyzing the area of last 10 years, cardamom cultivation was the highest during agricultural year 2011-12 with an area of 41600 Ha.[4] To increase the production and productivity, KERA project has planned to replant in 3,500ha. area.





[4] Source: A Compendium of Agricultural Statistics: Kerala 2023, 2023, Directorate of Agriculture Development & Farmers' Welfare

3.2 Sustainable Practices

It seems from response given by respondents that, adoption of sustainable agriculture practice is in higher side in comparison with other states of India. Many farmers are aware of sustainable agriculture practice and they are practicing the same. KILA, Atapadi is providing training to tribal farmers on climate resilient agriculture practices. Adoption of organic farming is reported in many places like millet farmers of Atappadi. Majority of farmers are well aware about SRI process of rice cultivation. However, practice of crop rotation is significantly low in sampled project area even after moderate knowledge on its potentiality to increase soil fertility. Mixed cropping and inter-cropping practice are moderate in sampled project area. Use of soil amendment to maintain soil pH level is found as one of best practices adopted by farmers of sampled area.

Table 1: Sustainable agriculture practice

Parameters	Field Observation
Mixed/ Intercropping	Is reported in cardamom, rubber and coconut cultivation. Pineapple cultivated is observed along with Rubber in Kottayam. Coffee is being cultivated with Rubber in Wayanad; Intercropping is done with association of pineapple farmers as rubber farmers are majorly old so the activities of rubber plantations are shared to large extent by pineapple farmers[5].
Soil Amendment	It is very common practice in all places Soil Acidification in Idduki district led to a decline in pepper productivity[6]
Crop rotation	Reported by very few millet farmers at Atapaddi
Pheromone trapping	Reported at Kannur and Atapaddi
Light Trapping	Reported at Atapadi. Any kind of pesticide is not used for millet cultivation
Biological Treatment	It is prevalent everywhere
Green manuring	Practiced in all places
Azolla /Blue Green Algae	Reported at Alappuzha
Cultivation of N fixing crops	Reported at Chertala, Alappuzha. It is done in many farmers

Source: Community/ Departmental consultation and field visit conducted by EY LLP team

Light trapping process of pest control has totally vanished in all sampled project area except one report from Attapadi region. However, few farmers are still practicing pheromone trapping process for Rabi crop. Almost 70 % respondents are practicing biological treatment of seed as pest control measures.

Table 2: Community/ departmental level consultation output

District Block	GP/ Location	Issues/ Observation
Palakkad Attappady	Puthur, agali, sholayoor	▸ Effect of Climate Change is affecting the yield of crop; ▸ Attapadi thuvara & Aatukoombu avara have GI tag, Millets have organic certificate; ▸ Farmers must cultivate all the crops to reduce the risk; ▸ Millet cultivation is done by various agencies, production of millets is not up to demand. ▸ 3 panchayat in Attapadi has 3 different climate ▸ Most of the farmers are still following old agricultural practice need training to improve ▸ Use of Hilban as pesticide is reported
Palakkad Alathur	Alathur / kannadi	▸ Alathur krishibhavan won the best krishibhavan award for their work on health clinic, crop calendar ▸ Using WatsApp and paper for knowledge dissemination ▸ Carbon neutral schemes are practiced

[5] Source: Field visit carried out by EY LLP team
[6] Source: IISR PGPR Capsule – A Encapsulated Formulation for the Black Pepper growers in Idukki district

District Block	GP/ Location	Issues/ Observation
		▸ Need training on Climate resilient Agri. practice ▸ Bio control agents Tricoderma sp. are used against rice stem borer (pest) ▸ Most of the people are getting crop insurance benefit ▸ Rifit 50 EC, SAATHI, Coreon are commonly used Herbicide ▸ Use of Insecticide *Regent ultra* is reported
Idukki Azhutha	Vandiperiyar	▸ Pesticide use for Cardamom cultivation in Idduki is reported to be on higher side ▸ High fertilizer cost along with labour cost increase the production cost ▸ Coffee board is not supporting intercropping ▸ Need good quality seeds and seedlings ▸ Needs follow-up training and capacity building support after implementation ▸ Cloud Outburst causes huge effect in cultivation ▸ Use of Organic manure prepared from city waste and sugar waste is reported ▸ Utilization of PPE kits during pesticide application is minimal. ▸ Majority of the farmers do not conduct soil testing and they rely on the pesticide recommendations provided by local suppliers. ▸ Usage of chemical fertilizers are very high (300 kg/acre) in this area. ▸ The suppliers exclusively market approved pesticides for use in Kerala ▸ For pineapple and rubber cultivation, the fertilizer regimen consists of 90% chemical fertilizers and 10% organic fertilizers. ▸ Instance of Sterility, Thyroid due to not wearing of PPE kits by farmers is reported ▸ Pest Infestation (Stem Borer, Thrips), with increase in temp, thrips population rises ▸ Only yellow sticky traps used but in very less numbers (mechanical pest control) ▸ Occurrence of Soil Acidification reduces the Pepper productivity
Idukki Kattapana	Kattapana (municipality)	▸ Pest attack is reported to be high ▸ Farmers are using pesticides as per the recommendation of AO as well as suppliers ▸ Cost of fertilizers is high ▸ There is no soil testing facility in nearby area ▸ Knowledge sharing facility /platform is needed ▸ Banned pesticides available in black market ▸ Nursery don't have facility to check the quality of seeds ▸ Farmers participated in many trainings but not implementing the learnings ▸ Mobile agro clinic recommended by farmers
Kannur Irikkur	mayyil	▸ Farmers recommended to cultivate hybrid verity [TxD dwarf] coconut with good management ▸ Training and capacity building on climate resilient agricultural practices is demanded by farmers ▸ Rubber + Pineapple inter cropping is not promoted by rubber board ▸ Climate change is affecting farm cultivation ▸ Scientific water management is required; Subsidies for Micro irrigation facility is demanded
Kannur Iritty	Aralam	▸ Training and capacity building on climate resilient agricultural practices is demanded by farmers ▸ Crop diversification shall be promoted to combat climate change effect ▸ Extensive service for passing the information/ knowledge is needed

District Block	GP/ Location	Issues/ Observation
Wynad Sulthan bathery	ambalavayal	▸ Soil treatment need to be done as per the soil quality and local climatic conditions ▸ Native verity of paddy and other species to be protected and cultivated ▸ Climate resilient crop needs to be promoted ▸ Quality seedlings to be supplied ▸ Use of Banned pesticides are reported
Wynad Noolpuzha	Noolpuzha	▸ Production is affected due to climate change issues like shortage of rain and insufficient irrigation facility ▸ Pest attack in Coconut and Arecanut is high; need proper training on modern IPNM strategy ▸ Climate resilient crop needs to be promoted ▸ Region specific cultivation practice should be promoted ▸ Training on Nano fertilizers is demanded by farmers

3.3 Agro-Chemical Use

Crops grown under various agro-climatic situation are affected by a large number of pests and diseases. Most often chemical control is being resorted to protect the crops to avoid crop losses. Besides adopting situation specific need based Chemical control measures, Government is also providing IPM techniques, Seed Treatment campaigns, e-pest surveillance (mobile based applications for near real-time pest surveillance. As a result, farmers get instant pest advisory from expert on the mobile, registered against Farmer ID), etc.

Fertilizer and Pesticide Use

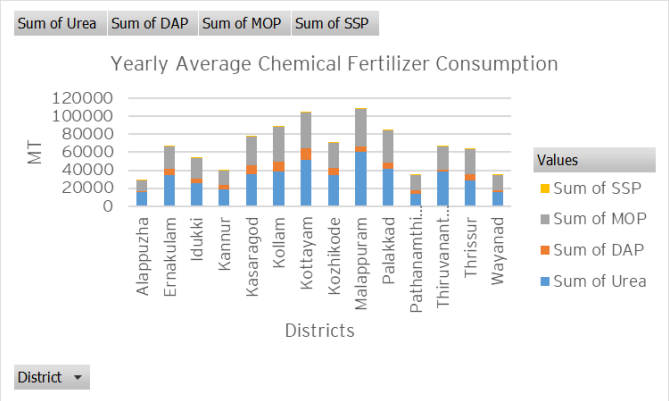
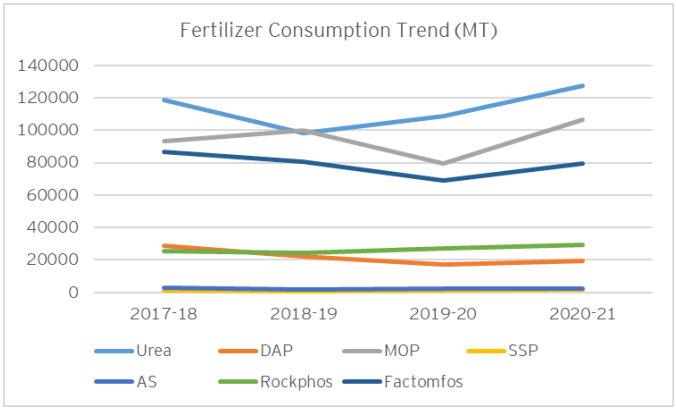


Figure 1: Yearly average chemical fertilizer consumption

With changing climatic conditions, different type of pest attack is increasing year by year. Pest attack has also increased and changing in these changing climatic conditions. To combat pest attack on standing crop, treatment of matured crop, fungicide and etc. and to increase productivity, pesticide use rate for different crops is increasing year on year basis.



Total pesticide consumption of whole state is increasing gradually year on year basis. Decreasing trend in total chemical fertilizer consumption if observed for the state. However, high rate of consumption is reported in certain pockets like Idukki. Per acre consumption rate is reported to be around 300 kg.

Farmers of the project area mostly use Urea, NPK, DAP and MOP fertilizers. Consumption of urea is more than other fertilizers. Use of organic manure (farmyard manure, compost, green manure) is the oldest practiced means of nutrient replenishment.

Application of azolla /blue green algae as fertilizer is reported in many GPs specially in Wayanad and Idukki district. Other organic managing practices like green manuring and cultivation of N-fixing crops are practiced by almost 50% of respondents.

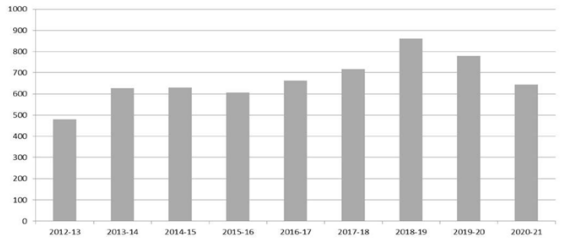


Figure 2: Year wise bio-pesticide consumption in Kerala

Crops grown under various agro-climatic situation are affected by a large number of pests and diseases. Most often chemical control is being resorted to protect the crops to avoid crop losses. The details of pesticides consumption during 2018-21 for whole Kerala is given in this table.

Year	Bio-pesticide	Chemical Pesticide
2018-19	861.74	995
2019-20	778.636	656
2020-21	643.284	585

Field Findings:

Community level consultation were carried out in total 16 GP from 7 blocks spread across 4 sample districts. Field level primary observation is given below:

Table 3: Crop deseses and used synthetic pesticed at sample MI location

Disease	Synthetic Pesticide
Swarming caterpillar in paddy, BPH and BLB in paddy, Aphid and pod borer in arhar, downy mildew in blackgram, leaf curl virus in vegetables, root knot nematode of brinjal, fruit & shoot borer of brinjal, termite in mango	Monophosphate, Coelophysis, Buprofezin (III), Malathion(III), Monocrotophos (Ib)
Blast and brown spot diseases in paddy, sheathrot and sheath blight diseases in paddy, cercospora blight diseases in blackgram, swamping caterpillar attack on paddy, leaf spot diseases in green/ blackgram	Phaspa, Cypermethrin (II), Propanet, Quizolofop(II), Thiophanate-methyl, Mycozal, Tricyclazole (II), Mancozeb, Chloropyrophos, Imidachloropid(II)
Leaf folder in paddy, blast and bacterial leaf bligh (BLB) of rice, rice caseworm and leaf folder attack, swarming caterpillar in paddy, brown plant hopper (BPH) in paddy, bacterial leaf streak and blight in rice, cercosporella blight disease in greengram/ arhar, black aphid in greengram/ arhar, stem borer in mango	Monocrotophos (Ib), Triacontanol, Chlorpyrifos (II), Dimethoate (II), Streptomycin, Endosulfan (II), Streptocycline, Mancozeb
Brown plant hopper (BPH) in paddy, flea beetle in black/Greengram, yellow mosaic virus (YMV) attack on blackgram/ greengram, leaf eating caterpillars on bitter gourd/ leafy vegetables, phomopsis blight of brinjal, black aphid of mango and brinjal	Copper oxychloride (II), Flonicamid, Chlorpyrifos (II), Mancozeb, Phaspa
Gundhy bug in paddy, blast and brown spot diseases in paddy, brown plant hoppers in paddy, pod borer in arhar, flea beetle in black/greengram, blister beetles in arhar, leaf eating caterpillars, Red pumpkin beetle in bitter gourd, leaf spot & blight of bitter gourd/ brinjal	Quizalofop (II), Nuvan, Ekalux, Metalaxyl (II), Streptocycline, Monophosphate, Imidacloprid (II), Cypermethrin (II), Monophosphate,
Swarming caterpillar in paddy, stem borer in paddy, sheath blight/rot of paddy, flea beetle of black/ Greengram, leaf eating caterpillars in bitter gourd/ brinjal	Monocrotophos (Ib), Imidacloprid (II), Dichlorovinyl Dimethyl Phosphate (DDVP)(Ib), Buprofezin(III), Chlorpyrifos (II), Hexaconazole(III), Ekalux, Streptocycline, Jaggery
Blast, Bacterial leaf blight, brown spot, stealth blight, foot rot in paddy, wilting in sunflower, YMV and powdery mildew in green gram, YMV in black gram, Leaf blight and other fungal disease in Brinjal	Tricyclazole(II), Plantomycin, streptocycline, Carbendazim, mancozeb, chloropyrifos Imidacloprid(II), Chloroquine Phosphate
Insecticides used in pineapple	Hillban, Diurex

Source: Survey conducted by EY LLP Team during October, 2023.

Issues:

- Pest attack is very common phenomenon in all sample project blocks.
- Chemical Pesticide consumption rate is increasing year on year basis in all project districts. Most of the farmers are well familiar with pesticide company's brand name but not aware of pesticide's generic name or constituent main chemical and recommended doge. They apply it as per recommendation of local distributor/ dealer/ retailer/ AO. However, few marginal farmers have obtained training or undergone awareness programme organised by Agriculture Officer of Agriculture Department.
- Most of the farmers are not aware about pheromone or light trapping process. Use of these old processes are diluting heavily because of easy availability of chemical pesticides which gives immediate solution.
- Use of bio-pesticides by farmers is gaining in entire Kerala. Many FPO is going for organic certification of their produce
- Awareness level on WHO classified Ib and II pesticides (Banned) is high even though usages of some of these are reported by farmers.
- Use of WHO classified Ib and II pesticides is reported in all sampled project area.
- Farmers are moderately aware about detrimental effect of chemical fertilizer on soil fertility and health.

4. SALIENT FEATURES OF THE PROJECT APPROACH

- Popularizing IPNM approach among the farming community through awareness, training and exposure;
- To play a catalytic role in transfer of innovative IPNM skills/methods/techniques to farmers through extension services;
- Human Resource Development in IPNM by imparting training on IPNM to training of individual service providers, farmers group, FPO, SHG, Kudumbashree group etc.

4.1 MAJOR ACTIVITIES UNDER IPNM PROMOTION

Table 4: IPNM Strategy and Key Activities

Key Activities	Execution Strategy	Responsibility
Training of individual service providers, FPO, SHG, Kudumbashree group on IPNM.	Orientation training by crop type	**Implement**: Director ATMA/ Deputy Director of Horticulture (DDH) (Before & during cultivation) **Supervise**: Asst. Horticulture Officer (Quarterly); PMU-Agronomist & Environmental Expert (Quarterly) **Monitoring**: Director ATMA/ DDH (Monthly)
Training of Farmers on IPNM through trained individual service providers	Crop specific orientation on IPM in phased manner	
Developing IEC materials	IEC materials on crop specific IPNM in local language with visual display	

4.2 CAPACITY BUILDING ON IPNM

The project will adopt a cascading approach for the capacity building of farmers where resource persons will be developed through Training of Trainers (TOT) programme. The ground force available for agriculture extension services, specifically Agriculture Officer, FPO, SHG, Kudumbashree group will be trained on IPNM initiatives. They will provide support to farmers on IPNM in consultation with the local Agriculture Officer.

For capacity building, a need assessment related to IPNM will be done with the stakeholders, including mapping of current practices. Based on the findings of Training Need Assessment (TNA), relevant training modules and IEC materials will be developed covering crop specific IPNM practices (crops grown in different agricultural seasons). Trainings will be organized before the on-set of agricultural seasons, i.e., at least 30-45 days before sowing / planting. It will help the farmers to get acquainted with the IPNM and its adoption during actual cropping period. Hand holding support will be rendered to the farmers through the Agriculture Officer, FPO, SHG, Kudumbashree group during different stages of crop growth. The capacity building activities plan is presented in the table below.

Table 5: Capacity Building Activates & Follow Up

Capacity Building	Preparatory Stage	Pre-Kharif	Kharif	Pre-Rabi	Rabi
A. Preparatory Phase					
Assessment of Training Needs					
Preparation of Training Content					
Designing Training Modules / IEC Materials					
Piloting of the Training Materials					
Finalising Training Window / Session Plan					
Coordinate with Agriculture Officer, FPO, SHG, Kudumbashree					
B. Organisation Phase					
Training of Agriculture Officer, FPO, SHG, Kudumbashree					
Training of farmers					
C. Follow Up Phase					
Monitoring					
Field Guidance					

4.3 MONITORING OF IPNM

Key monitoring indicators covering the capacity building efforts on IPNM will be assessed periodically as part of internal monitoring and periodic monitoring by third party.

Table 6: Monitoring of IPNM Promotion

Activity	Monitoring Areas	Monitoring Indicators	Responsibility [1]	Time Frame
Development of IPNM learning materials and its distribution to farmers / farmer's organizations	Learning materials cover crop specific IPNM practices	No. and type of learning materials developed	PMU - Agronomist & Environmental Expert Director ATMA/ DDH	6 months from project inception
	Distribution of learning materials to individual service providers, and farmers	No. of farmers provided with IPNM related learning materials	PMU - Agronomist & Environmental Expert, Director ATMA/ DDH	1 month from printing of documents
Training and awareness creation	Training of Trainers, and farmers on IPNM	No. of farmers of different holding categories trained on IPNM; No. of Trainers trained on IPNM; No. of women farmers / tenants trained on IPNM	Director ATMA/ DDH; PMU - Agronomist & Environmental Expert	Annually throughout project duration
Monitoring	Adoption of IPNM practices	No. of farmers adopting a minimum of one IPM, one INM activity	PCU, PMU	Six monthly through the project duration

[1] *Additionally, the external M&E agency shall also undertake concurrent monitoring of IPNM implementation on a quarterly basis.*

4.4 Details on Integrated Pest Management Practices

The Integrated Pest Management (IPM) Practices that will feed into the capacity building program on IPNM are detailed in this section.

4.5 Selection of IPM Methods Based on Assessment of Economic Threshold Level

The ETL differs by pest and also by crop types. Pest population is expected to be maintained at levels below those causing economic loss. It is generally assumed that pest tolerant capacity of different crops is limited and when it exceeds or approaching the ETL, chemical control methods can be used. Different pest / disease control methods of IPM will be applied based on the determination of ETL and pest density.

A priority list of different control methods of IPM is presented below.

Table 7:Adoption of IPM Methods & its Priority

IPM Procedures	Methods of Executing	Priority in Application
Cultural	Avoidance of monoculture Improved disease resistant varieties. Summer ploughing. Optimum plant densities. Avoiding excessive irrigation. Avoiding high nitrogenous fertilization. Trap crops	To be given preference as preventive mechanism
Biological	Conservation / promotion of bio agents like birds, parasites & pathogens for biological control of pests.	Second Priority
Mechanical	Damage/Destroying all the eggs of the insect; Destroy any material infested by insect, pest and diseases.	Third Priority
Chemical	Chemical Control when the loss is beyond ETL Use of recommended chemicals only	Last Priority when crop loss is beyond ETL

4.6 Criteria for Pesticide Selection and Use

The criteria to be followed for the selection and use of pesticides are:

(1) they must have negligible adverse human health effects,

(2) they must be shown to be effective against the target species and

(3) they must have minimal effect on non-target species and the natural environment.

Secondly, the pesticides banned by Govt. of India should be avoided in the selection and use along with pesticides listed by WHO under Ia, Ib and II.

4.7 Pesticide Storage, Handling and Disposal

Precautionary Measures

When administering the pesticides, general precautions to be taken are as follows. Farmers will be educated / aware of taking required protective measures during administering pesticides.

Using Personal Protective Equipment: Personal protective equipment will prevent pesticides from coming in contact with the body or clothing. These also protect the eyes and prevent the inhalation of toxic chemicals. Personal safety gear includes clothing that covers the arms, legs, nose, and head. Farmers will be educated to wear gloves and boots to protect the hand and feet, and hats, helmets, goggles, and face masks to protect the hair, eyes, and nose. Respirators are used to avoid breathing dust, mist or vapour.

Body Wear: Body wear made of cotton are the best but should not be worn without additional protective clothing. When there is a chance of contacting wet spray, large sleeves with cuff-buttons, and pants with buttons at the bottom offer good protection. Aprons: Waterproof rubber or plastic aprons are effective. They should be long enough to protect the general clothing.

Head protection: Dust and mist settle easily on hair. Hats that are water resistant, wide brimmed with sweatbands are effective in protecting it. Many helmets provide attachments for face shields and goggles.

Eye Glass / Goggles: Farmers will be educated / oriented to protect their eyes from splashes, spills, mist, and droplets by using glasses / goggles. Goggles with plain lenses and full side shields are preferable. The lenses may become coated with pesticide droplets during spraying; hence cleaning tissues or an extra pair of goggles are a must.

Face shield: A face shield is a transparent acetate or acrylic sheet which covers the face and prevents it from splashes or dust. Face shields allow better air circulation and provide a greater range of vision than goggles

Hand and feet protection Gloves: Dermal exposure occurs the most in the hand region. The use of gloves reduces this risk. Gloves should be up to 2 to 3" long below the elbow i.e., they should extend to the mid forearm. Waterproof gloves, such as those made of rubber, latex or PVC are preferable. After use, they should be discarded away from ponds, wells, and animals or even incinerated.

Footwear: Shoes made of rubber or synthetic materials like PVC and nitrite can be used to prevent dermal exposure of feet. Protective footwear should be calf-high and worn with the legs of the protective pants on the outside to prevent spray from getting in. Leather or fabric shoes should never be worn as they absorb pesticides. Shoes should be checked for any leakage or damage before use.

Respiratory equipment: A respirator is a device that offers protection to the lungs and respiratory tract. Different kinds of respiratory equipment are used based on the type and toxicity of pesticides. They include nose filters/disposable masks, cartridge respirators, canister-type respirators/gas masks, positive pressure breathing apparatus, self-contained breathing apparatus, and powered air cartridge respirator.

Safety in Application of Pesticides: Misuse of pesticides can be extremely dangerous. Apart from polluting the environment, they may prove fatal to human beings, animals, birds, and fish. Phytotoxicity often results when used in excess in plants. Judicious use, and careful and safe handling may prevent hazards. Safe handling of pesticides involves their proper selection and careful handling during mixing and application.

Safety during Application

This reduces risk and prevents pollution. It also ensures safety to animals, which may be nearby. Immediate action shall be taken in case of any of the following:

- In case if any part of the body is exposed and come in contact with the pesticide, it should be washed-off immediately.
- Visit to doctor in case of feeling unwell.

Storage

Precautions to be taken in storing the pesticides are (1) keeping the place of storing of pesticides away from human and animals, (2) keeping away from water sources, (3) keeping at a height which should be out of reach of children, (4) keeping away from exposure to sunlight and moisture, (5) well ventilated place of storing, (6) well stacking to avoid of spillage, (7) away from food / consumable items / must not be stored with food items, and (8) the place of storage should be out of reach of children.

Transportation

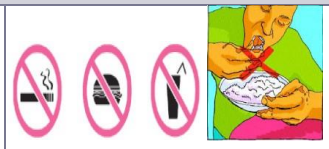
Pesticides should be transported (1) in well-sealed and labelled containers, (2) should be transported separately, i.e. not with any other consumable items, cloths, drugs etc., (3) proper stacking to prevent leakage, (4) display of warning notice on the vehicle transporting pesticides, if transported in bulk with regular checking during transportation.

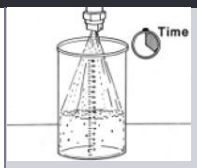
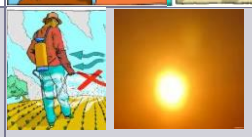
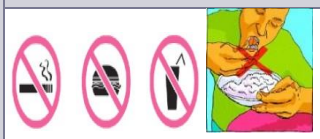
Disposal System

- At the end of the day's work, the inside of the spray pump should be washed and any residual pesticides should be flushed out;
- The rinsing water should be collected and carefully contained in clearly marked drums with a tightly fitted lid. This should be used to dilute the next day's tank loads or disposed properly at disposal sites like pits or digs;
- Decontaminate containers where possible. For glass, plastic or metal containers this can be achieved by triple rinsing, i.e. part-filling the empty container with water three times and emptying into a bucket or sprayer for the next application;
- All empty packaging should be kept away from common approach space and should be returned to the designated organisation / individual for safe disposal. The used packages shall not be left outside to prevent their re-use.
- In case the stock remained unutilised and crossed the date of expiry, it should be returned to the supplier.

Table 8: Safety Precautions in different stages of application of pesticides

SN	Particulars	Safety Measures
1	Purchase	▸ Always purchase only required quantity of pesticides for single application in specified area and avoid bulk purchase; ▸ Purchase as per the prescription of experts from Ag. Dept. / KVKs etc.; ▸ Never purchase leaking containers, loose, unsealed or torn bags. Purchase pesticides before the expiry date ends; ▸ Don't purchase pesticides without proper/approved label. ▸ While purchasing insist for invoice/bill/cash memo
2	Storage	▸ Avoid storage of pesticides in house premises or near grain storage; ▸ Never keep any pesticide near food or feed/fodder; ▸ Keep all pesticides away from reach of children and livestock; ▸ Don't expose them to sunlight for longer period; ▸ Keep all pesticides in original container in intact seal; Don't transfer pesticides to other containers; Don't store weedicides along with other pesticides
3	Handling	▸ Never carry any pesticides along with food material. ▸ Avoid carrying bulk pesticides (dust/granules) on head shoulders or on the back.
4	While preparing solution	▸ Don't eat, drink, smoke or chew while preparing solution; ▸ Read the label on the container before preparing spray solution. ▸ Never mix granules with water except those wettable granules; ▸ Prepare the spray solution as per requirement ▸ Always use clean water; ▸ Concentrated pesticides must not fall on hands, etc. while opening sealed container. Don't smell pesticides; ▸ Avoid spilling of pesticide solution while filling the sprayer tank. ▸ Always protect your nose, eyes, mouth, ears and hands with protective gear; ▸ Use at least polythene bags as hand gloves and to protect bare feet, handkerchiefs or piece of clean cloth



SN	Particulars	Safety Measures	
		as mask and a cap or towel to cover the head. Don't use polythene bag contaminated with pesticides. ▸ Check the output of the sprayer (calibration) before commencement of spraying under guidance of trained person.	
5	Equipment	▸ Select right kind of equipment and nozzle; ▸ Don't use leaky and defective equipment ▸ Don't blow/clean clogged nozzle with mouth; Use old toothbrush tied with the sprayer and clean with water. ▸ Don't use same sprayer for weedicide and insecticide.	
6	While applying pesticides	▸ Apply only recommended dose and dilution; ▸ Apply insecticides preferably in the evening. Avoid rainy or hot sunny or windy days; ▸ Don't apply pesticides against the wind direction; ▸ Maintain normal walking speed while undertaking application. ▸ Don't smoke, chew or eat while spraying	 
	Safety Measures After Application	▸ Thoroughly clean and wash the sprayers, machines & buckets, nozzles etc. with soap water and store in dry place after use; ▸ Containers, buckets, etc. used for mixing pesticides should not be used for domestic purpose; ▸ Wash hands, face and other body parts or take proper bath with soap after completing spray ▸ Wash all cloths and protective gears/ cloths in soap and water and keep them separate from the rest of the family's clothes. ▸ Avoid entry of animals & workers in the field immediately after spraying.	  
7	Disposal	▸ Left over spray solution should not be drained into ponds / tanks / water bodies; ▸ Should not be disposed off near open well / shallow wells or drinking water source; ▸ Used empty containers should be crushed with a stone/stick and buried deep into soil away from water source; ▸ Never re-use empty pesticide container for any other purpose.	

4.8 SAFETY PARAMETERS IN PESTICIDE USAGE

Sl. No.	Pesticide classification as per insecticide rules 1971 Colour of toxicity triangle	WHO classification of hazard	Symptoms of poisoning	First aid measures and treatment of poisoning	Safety Interval (Days)
	Insecticides / Pesticide				
	Fungicide				
1	Copper oxychloride Moderately toxic 	Class III slightly hazardous	Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin etc.	No specific antidote. Treatment is essentially symptomatic	
	Fosetyl Moderately toxic 	Table 5 Unlikely to present acute hazard in normal use	Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin etc.	**Treatment of poisoning:** No specific antidote, Treatment is essentially symptomatic.	
	Copper oxychloride	Class III Slightly Hazardous			

Source: NIPHM

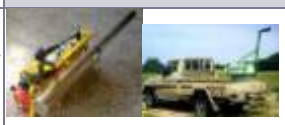
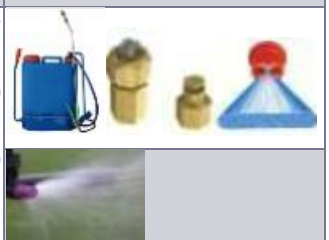
First Aid in case of Exposure to Pesticides

- Find out if possible, the way the poison entered the body. This may either be through the mouth, nose, skin or eyes If the pesticide has been inhaled, move the person to fresh air
- If the pesticide is in the eyes, quickly wash the eyes for 15 minutes with clean, gently running water. If there is no running water, bathe eyes from a container, frequently changing the water
- If the pesticide is on the skin, remove all contaminated clothing and wash the affected area thoroughly with soap and water
- If the patient is not breathing, apply artificial respiration if possible
- Read the label on the pesticide container for any first aid instructions and keep the label for the doctor. It is very important to be able to tell the doctor the name of the pesticide
- If the pesticide is swallowed, and only if the person is conscious, rinse the mouth with plenty of water and read the label on the pesticide container for further instructions
- Quickly arrange for the doctor, or Community Nurse or Health Worker to be called or take the person to the doctor, clinic or hospital immediately

- Keep the patient warm and comfortable

(source: https://nibsm.icar.gov.in/images/newdata/Technical-Bulletin-Safe-Use-of-Pesticides.pdf)

4.9 Pesticide Application Techniques

Application Stage	Types	Equipment	
Category A: Stationary, crawling pest/ disease			
Vegetative stage i) for crawling and soil borne pests ii) for small sucking leaf borne pests	Insecticides and fungicides	▸ Lever operated knapsack sprayer (Droplets of big size) ▸ Hollow cone nozzle @ 35 to 40 psi ▸ Lever operating speed = 15 to 20 strokes/min **OR** ▸ Motorized knapsack sprayer or mist blower (Droplets of small size) ▸ Airblast nozzle ▸ Operating speed: 2/3 rd throttle	
Reproductive stage	Insecticides and fungicides	▸ Lever operated knapsack sprayer (Droplets of big size) ▸ Hollow cone nozzle @ 35 to 40 psi ▸ Lever operating speed = 15 to 20 strokes/min	
Category B: Field Flying pest/ airborne pest			
Vegetative stage Reproductive stage (Field Pests)	Insecticides and fungicides	▸ Motorized knapsack sprayer or mist blower (Droplets of small size) ▸ Air-blast nozzle ▸ Operating speed: 2/3rd throttle **OR** ▸ Battery operated low volume sprayer (Droplets of small size) Spinning disc nozzle	
Mosquito/ locust and spatial application (migratory Pests)	Insecticides and fungicides	▸ Fogging machine and ENV (Exhaust nozzle vehicle) (Droplets of very small size) ▸ Hot tube nozzle	
Category C: Weeds			
Post- emergence application	Weedicide	▸ Lever operated knapsack sprayer (Droplets of big size) ▸ Flat fan or flood jet nozzle @ 15 to 20 psi ▸ Lever operating speed = 7 to 10 strokes/min	
Pre- emergence application	Weedicide	▸ Trolley mounted low volume sprayer (Droplets of small size) ▸ Battery operated low volume sprayer (Droplets of small size)	

Source: NIPHM

4.10 Ecological Engineering for Pest Management

Ecological engineering for pest management has recently emerged as a paradigm for considering pest management approaches that rely on the use of cultural techniques to effect habitat manipulation and to enhance biological control. Ecological engineering for pest management is based on informed ecological knowledge rather than high technology approaches such as synthetic pesticides and genetically engineered crops (Gurr et al. 2004).

Ecological Engineering for Pest Management – Above Ground

Natural enemies play a very significant role in control of foliar insect pests. Natural enemy diversity contributes significantly to management of insect pests both below and above ground.

- Raise the flowering plants / compatible cash crops along the field border by arranging shorter plants towards main crop and taller plants towards the border to attract natural enemies as well as to avoid immigrating pest population
- Grow flowering plants on the internal bunds inside the field
- Not to uproot weed plants those are growing naturally such as *Tridax procumbens*, *Ageratum sp*, *Alternanthera sp.*, etc. which act as nectar source for natural enemies,
- Not to apply broad spectrum chemical pesticides, when the P: D ratio is favorable. The plant compensation ability should also be considered before applying chemical pesticides.
- Reduce tillage intensity so that hibernating natural enemies can be saved.
- Select and plant appropriate companion plants which could be trap crops and pest repellent crops. The trap crops and pest repellent crops will also recruit natural enemies as their flowers provide nectar and the plants provide suitable microclimate.

Ecological Engineering for Pest Management – Below Ground:

There is a growing realization that the soil borne, seed and seedling borne diseases can be managed with microbial interventions, besides choosing appropriate plant varieties. The following activities increase the beneficial microbial population and enhance soil fertility.

- Crop rotations with leguminous plants which enhance nitrogen content.
- Keep soils covered year-round with living vegetation and/or crop residue
- Add organic matter in the form of farmyard manure (FYM), vermin-compost, crop residue which enhance below ground biodiversity of beneficial microbes and insects
- Application of balanced dose of nutrients using bio-fertilizers based on soil test report
- Application of bio-fertilizers with special focus on mycorhyza and plant growth promoting rhizobacteria (PGPR)
- Apply *Trichoderma spp.* and *Pseudomonas fluorescens* as seed/seedling/planting material, nursery treatment and soil application

Table 9: List of Ecological Engineering Plants for Pest Management

Ecological Engineering Plants	Coffee	S. Cardamom	L. Cardamom	Coconut
Attractant plants	Anise	Alfalfa	Alfalfa	Alfalfa
		Anise	Anise	Anise
	Buckwheat	Buckwheat	Buckwheat	Buckwheat
	Caraway	Caraway	Caraway	Caraway
	Carrot	Carrot	Carrot	Carrot
		Cluster bean		
		Coreopsis spp.		Coreopsis spp.
		Cosmos	Cosmos	
	Cowpea	Cowpea	Cowpea	
	Crocuses	Dandelion		
	Dill	Dill	Dill	Dill
	Fennel			
	French bean	French bean	French bean	French bean
		Maize		
	Marigold			Marigold
	Mustard	Mustard	Mustard	Mustard
	Parsley	Parsely	Parsley	Parsley
	Sunflower	Sunflower	Sunflower	Sunflower
	Tansy			
	White Clover			
Repellent plants	Ocimum sp	Ocimum spp.	Ocimum spp.	Ocimum spp.
	Peppermint	Peppermint	Peppermint	Peppermint
			Spearmint	
Barrier/ guard plants			Maize	
			Sorghum	

Source: NIPHM

Ecological Engineering plant suggested under Table 9 for pest management strategy are known as attractant plants to the natural enemies of the selected pests. The information is based on published research literature. However, the actual selection of flowering plants could be based on availability, agro-climatic conditions and soil types.

5. IPNM STRATEGY OF COFFEE PLANTATION

PEST MANAGEMENT

Management	Activity
Nursery	
Brown eye spot	Cultural control: ▸ Improvement of tree nutrition and shading should be sufficient to control the disease
Coffee scales	Cultural control: ▸ Destroy ant nests from the shade trees ▸ Promoting conducive environmental conditions for growth of the white halo fungus (Verticillium lecanii) Biological control ▸ Fungus: Verticillium lecanii ▸ Predators: Ladybugs.Parasitiods : Parasitic wasps.
Young coffee plantations	
Coffee scales	Cultural control: ▸ Destroy ant nests from the shade trees ▸ Promoting conducive environmental conditions for growth of the white halo fungus (Verticillium lecanii) Biological control ▸ Fungus: Verticillium lecanii ▸ Predators: Ladybugs. Parasitiods :Parasitic wasps.
White coffee stem borer	Management: ▸ Maintain optimum shade on the estates. (two tier system of shade trees). ▸ Trace the infested plants prior to flight periods i.e., before end of March and September every year by looking for ridges on the main stem and thick primaries. Collar prune the infested plants, uproot if the borer has entered into the root, and burn the affected plants immediately. ▸ Remove the loose scaly bark of the main stem and thick primaries using a coir glove or coconut husk to eliminate the craks and crevices which are used by the female beetle to place eggs on the stem. Scrubbing should be done just prior to the flight preferably during March to September as this operation is mainly aimed at preventing stem borer females from depositing eggs. but care must be taken not to damage the wood under the bark. ▸ In hot spot areas i.e., open patches and estate borders with badly managed estates, adopt scrubbing or 10% lime coating or stem wrapping with empty fertilizer bags after removing affected plants by tracing. ▸ Pheromone trap can install in the field at a height of 1.8m to 2m from the ground. The traps should be spaced out in the form of a grid of 25 traps ha-1 with a spacing of 20m between them.
Coffee berry borer	Cultural and Mechanical control: ▸ Proper adoption of cultural practices and phytosanitary measures important for management of coffee berry borer. ▸ Transportation of infested coffee to uninfected areas is the main reason for spread. ▸ Gunny bags should be fumigated with aluminium phosphide (ALP) under pest control agency/ technical expert approved by PPA before delivery to estates to avoid cross infestation. Timely harvest. ▸ Spread gunny bags or polythene sheets at the time of harvest to minimize gleaning. ▸ Remove gleanings and leftovers.

Management	Activity
	▸ Maintain optimum shade and good drainage. ▸ Dipping infested berries in boiling water for 2-3 minutes kills all the stages inside. ▸ Drying of coffee beans with prescribed moisture content level during storage. o Arabica (10% moisture content) o Roubsta (11% moisture content) ▸ Install broca traps@ 10/acre at the distance of 20meter to collect the beetles after the coffee harvest. Traps can be installed around the drying yard during drying **Biological control** ▸ Application of spore suspension on the infested coffee bushes using a Knapsac sprayer during evening hours.
Shot hole borer	**Mechanical control:** ▸ Prune the effected twigs 2.5 to 7cm below the sht-hole and burn ▸ Remove and destroy all the unwanted / infested suckers during summer ▸ Maintain thin shade and provide good drainage in the estate. **Chemical control:** ▸ Apply white tree wrap on the trunk from December to April, or paint trunks with a 50% white latex paint/50% water solution.
Root lesion nematode	**Mechanical control:** ▸ Dig up the nursery site and expose the soil to the sun during summer. ▸ Avoid obtaining nursery plants from unknown source
Coffee mealy bug	**Mechanical control:** ▸ Maintain adequate shade ▸ Spray affected patches with 4 l of kerosene in 22 l of water along with 200 ml of any agricultural wetting agent. ▸ If the roots are infested with mealy bug and fungal association, drench the soil near the root zone with any one of the above insecticide along with 160g of Bayleton 25WP in 200 l of water. **Biological control:** ▸ Leptomastix dactylopii
Green Scale & Brown Scale	**Mechanical control:** ▸ Control ants in the case of mealy bugs ▸ Remove and burn weeds which harbor the scale. ▸
Coffee bean beetle	**Cultural control:** ▸ Maintain optimum temperature, relative humidity and moisture content (less than111%)
Coffee leaf rust	**Cultural control:** ▸ Wider spacing and appropriate pruning **Chemical control:** ▸ Systemic triazole fungicide Bayleton 25% EC, 40 which contains triademefon, should be sprayed at a rate of one litre per hectare.
Black rot	**Cultural control:** ▸ Removal of diseased portions **Chemical control:** ▸ 1% Bordeaux mixture and carbendezim 50 WP @ 1g/L to the affected bushes during pre-monsoon and mid monsoon respectively
Berry blotch	**Cultural control:** Maintain medium shade overhead
Dieback/ Anthracnose	▸ Follow common cultural, mechanical and biological practices
Root rot	**Cultural control:** ▸ Burn the plants at site, isolate affected patches by digging deep trenches, ring the bark and poison the shade trees while thinning.

Management	Activity
	▸ Remove the affected plants and treat the soil at 1kg lime per plant to raise the soil pH. ▸ Treat the soil around the affected area with PDCB or brassicol at 0.4%. Maintain the vigour of plants.

Note: The dosages of pesticides use are based on high volume sprayer

Source: Coffee.pdf (niphm.gov.in); https://imskolkata.org/article/011-12-22.pdf

NUTRIENTS MANAGEMENT:

Regular manuring from the first year of planting is essential to achieve higher productivity. For coconut 20-50 Kg

organic manure should be applied/palm/year with the onset of southwest monsoon, when soil moisture content is high. Different forms of organic manures such as compost, FYM, bone meal, fish meal, blood meal, neem cake, groundnut cake etc. could be made use for this purpose. In addition to this the following fertilizer schedule is recommended.

The fertiliser schedule recommended for the palm at different stages is as follows:

<table>
<tr><th>Stages of Plantation</th><th>Management Plan</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Pre-planting</td><td>▸ Soil should be deep, friable, open textured rich in plant nutrients with plenty of humus and of slightly acidic nature (pH – 4.5 to 6.5)</td></tr>
<tr><td>Nursery</td><td>▸ Apply nutrients on the basis of soil test report and recommendation for the agro-climatic zone.
▸ Select light loamy soil of good drainage with high organic matter content with water and shade facilities.
▸ Form raised beds of 15 cm height, 1m width and at convenient length.
▸ Incorporate 30 - 40 kg of well rotten compost, 2 kg of finely sieved agricultural lime and 400 g of rock phosphate to a bed of 1 x 6 m size.
▸ In heavy soils, it is necessary to add coarse sand for drainage and aeration.
▸ Pre-sowing seed treatment with Azospirillum and Phosphobacterium should be done. Seeds are sown in in the bed 1.5 - 2.5 cm apart with the flat side down wards in regular rows and covered with a thin layer of fine soil and a layer of paddy straw. Water the beds daily and protect from direct sunlight by an overhead pandal. Seeds germinate in about 45 days after which they are transplanted to a secondary nursery bed for raising bag nursery.

Bag nursery- Polythene bags are filled with a prepared mixture containing jungle soil, FYM and sand in the proportion of 6:2:1. Seedlings are planted in polythene bags.</td></tr>
<tr><td>Planting stage</td><td>▸ Selective shade lopping may be done After the summer showers, pits of 45 cm x 45 cm x 45 cm are dug at 2 x 2 feet. The pits are left open for weathering and then filled and heaped for planting. At the time of filling, apply 500 g of rock phosphate and 20 g mycorrhiza culture per pit along with top soil.
▸ Planting is done along the contour in sloppy areas.</td></tr>
<tr><td>Young coffee plantations</td><td>**Nutrient Management** - Apply major nutrients according to the age and growth stage of the crop as indicated in the table below;
<table>
<tr><th>Age of plants</th><th>Pre- Blossom March N:P2O5:K2O</th><th>Post – blossom May N:P2O5:K2O</th><th>Post- monsoon October N:P2O5:K2O</th><th>Total</th></tr>
<tr><td>Young coffee 1st year after planting</td><td>15:10:15</td><td>15:10:15</td><td>15:10:15</td><td>45:30:45</td></tr>
<tr><td>2nd and 3rd year</td><td>20:10:20</td><td>20:10:20</td><td>20:15:20</td><td>60:45:60</td></tr>
<tr><td>4th Year</td><td>30:20:30</td><td>20:20:20</td><td>30:20:30</td><td>80:60:80</td></tr>
</table></td></tr>
</table>

Stages of Plantation	Management Plan				
	Bearing coffee 5 years and above	40:30:40	40:30:40	40:30:40	140:90:120
	For heavy bearing plants, nutrient requirement is high so, additional dose of nutrient should be applied.				
Reproductive stage	As per table above. ▸ The rate of fertilizer application for mature coffee varies with yield and soil test values. ▸ Apply the recommended quantity of mixtures along the drip circle of plants. In the semi-circular furrow taken above the plant on the slope. ▸ Apply the fertilizers when there is adequate soil moisture and when the plantations are free from weeds.				

Source: Coffee.pdf (niphm.gov.in)

Table 10: Remedial Measures for Nutrient deficiency

Nutrient	Remedial measure
Nitrogen (N)	Foliar application of 0.5 – 2.5% urea or soil application of N fertilizers.
Phosphorus (P)	Foliar application of 0.5% SSP or 1% DAP.
Potassium (K)	Foliar application of 0.1% MOP.
Calcium (Ca)	Liming of soil with good quality calcitic lime
Magnesium (Mg)	Soil application of dolomitic lime or foliar spray of 0.1% Magnesium sulphate
Sulphur (S)	Soil application of elemental S or fertilizer containing S.
Zinc (Zn)	Foliar spray of 0.25% Zinc Sulphate neutralized with spray lime
Iron (Fe)	Provide good drainage.
Manganese (Mn)	Correcting soil pH
Boron (B)	Foliar application of boric acid 100g/200 litre water

Source: Coffee.pdf (niphm.gov.in)

6. IPNM OF CARDAMOM PLANTATION

PEST MANAGEMENT

Management	Activity
Seedling/nursery*	
Rhizome weevil**	**Cultural control:** ▸ Provide sufficient organic manures to encourage better vegetative growth.
Shoot fly**	**Cultural control:** ▸ Provide sufficient shade to the plants.
Shoot borer	**Cultural control:** ▸ Rogueing and destruction of infested tillers during September-October.
Root-knot nematode	**Cultural control:** ▸ Nursery should be raised in nematode free sites or fumigated or solarized beds. ▸ The roots should be pruned prior to distribution or transplanting. ▸ Avoiding planting of alternate hosts such as banana, colocasia and jackfruit **Biological control:** ▸ Soil application of neem cake @ 500 g/plant.
Damping off or seedling rot	**Cultural control:** ▸ In the primary nursery, practice thin sowing for avoiding overcrowding of seedlings. **Chemical control:** ▸ Spray/drench the soil with fosetyl-AL 80% WP @ 900-1200 g in 300-400 l of water/acre
Primary nursery leaf spot	**Cultural control:** ▸ Raise nursery in fertile soil. ▸ Avoid direct sunlight on nursery beds. Use agro shade net. ▸ Early sowing of seeds in August-September will ensure mature seedlings which are less prone to diseases during southwest monsoon. **Chemical control:** ▸ Prophylactic spraying with fungicides such as mancozeb (0.2%) may be given. First spray is to be given during March-April, depending on the receipt of summer showers and subsequent sprays may be undertaken at fortnightly intervals. Depending on the severity of the disease, two to three rounds of spraying may be given
Secondary nursery leaf spot**/ Cercospora leaf spot	**Cultural control:** ▸ Cardamom seeds should be sown in the month of August – September, to ensure sufficient ▸ growth of seedlings, so that seedlings develop sufficient tolerance to the disease. **Chemical control:** ▸ Spraying mancozeb (0.2%) effectively controls leaf spot disease in secondary nurseries **Cultural control:** ▸ Fill the gaps with healthy disease free materials.
* Apply *Trichoderma viride/harzianum* and *Pseudomonas fluorescens* as seed/seedling/planting material, nursery treatment and soil application.	
Plantation stage	
Cardamom thrips	▸ Follow the common cultural, mechanical and biological practices **Cultural control:**

Management	Activity
	▸ Removal of dry drooping leaves as well as dry leaf sheath (trashing) during January- February. ▸ Destruction of collateral host plants. ▸ Detrashing and weeding reduce thrips infestation. **Biological control:** ▸ Release *Chrysoperla zastrowi sillemi* @ 2 larvae/plant in early stage of the plant and 4 larvae/plant in later stage. **Chemical control:** ▸ Spinosad (0.0135%) during February-March, March-April, April, May, September and October
Shoot borer	▸ Follow the common cultural, mechanical and biological practices **Cultural control:** ▸ Castor seeds 0.4-0.8 Kg/acre may be sown as trap crop in open areas/ boundary. ▸ Rogueing and destruction of infested tillers during September-October. **Mechanical control:** ▸ Castor inflorescence with capsules infested by shoots and capsule may be collected and destroyed. ▸ Use of pheromones in the monitoring of the pest and therefore correct timing of application of biorationals shall be recommended. **Biological control:** ▸ Application of Bacillus thuringiensis when early-instar larvae are found in capsule or panicle or unopened lead buds i.e., within 20 days of adult moth emergence.
Early capsule borer	▸ Follow the common cultural, mechanical and biological practices **Mechanical control:** ▸ Clipping the inflorescence/flower parts of alternate hosts viz., *Alpinia speciosa, A.mutica, Amomum ghaticum, A. pterocarpum, Curcuma heilyherrensis, Hedydium ceranarium* during off season (December to May). **Chemical control:** ▸ Diafenthiuron50% WP @ 320 g in 400 l of water/acre
White grub/ root grub	▸ Follow the common cultural, mechanical and biological practices **Cultural control:** ▸ Avoid planting of jack, mango, fig etc. as shade trees as these trees are alternate hosts of the pest. ▸ Mulching of plant base with leaves of wild Helianthus sp. to prevent egg laying of adult beetles. ▸ Earthing up and detrashing. ▸ Irrigation @15–20 l per plant reduces root grub population. **Mechanical control:** ▸ Set up light trap @ 1/acre. **Biological control:** ▸ GRUB BAN-PR, 3-4 kg per acre | Mix the formulation with 800-1000 Litres of water and broadcast into 01 Acre of land.
Whitefly**	▸ Follow the common cultural, mechanical and biological practices ▸ **Biological control:** ▸ Release Chrysoperla zastrowi sillemi @ 2 larvae/plant in early stage of the plant and 4 larvae/plant in later stage. ▸ Spraying of neem oil @ 50 ml with soap solution in 500 ml in 100 l of water (lower surface of leaf)
Hairy caterpillars**	▸ Follow the common cultural, mechanical and biological practices
Shoot fly**	▸ Follow the common cultural, mechanical and biological practices
Capsule rot/ Azhukal disease	▸ Follow the common cultural, mechanical and biological practices **Biological control:**

Management	Activity
	▸ *Trichoderma harzianum* 0.50% WS @ 100 g/plant (soil treatment): Apply 100 g product/ plant along with neem cake (0.5 Kg/plant) and 5 Kg FYM/plant **Chemical control:** ▸ Spray/drench the soil with fosetyl-AL 80% WP @ 900-1200 g in 300-400 l of water/acre
Clump rot or rhizome rot	▸ Follow the common cultural, mechanical and biological practices **Chemical control:** ▸ The plant base is to be drenched with 2-3 litres of COC (0.25%). Repeat COC drenching at 30 days interval for 2-3 times at monthly intervals
Leaf spot and leaf rust****	▸ Follow the common cultural, mechanical and biological practices **Chemical control:** ▸ Combination fungicide SAAF (carbendazim + mancozeb) @ 0.2 % and carbendazim @ 0.1 % for leaf blight disease

Source: Smallcardamom.pdf (niphm.gov.in);

https://krishi.icar.gov.in/jspui/bitstream/123456789/26076/1/cardamom.pdf

https://krishi.icar.gov.in/jspui/bitstream/123456789/26076/1/cardamom.pdf

http://www.celkau.in/crops/spices/Cardamom/plant_protection_mainfield.aspx#5

https://prionsbiotech.com/grub-ban-pr.html

Note: *The pesticide dosages and spray fluid volumes are based on high volume sprayer.*

*** Pests of regional significance*

NUTRIENTS MANAGEMENT

Table 11: Plantation stage wise nutrition management plan for Cardamom

Stages of Plantation	Management Plan
Plantation stage	▸ Application of organic manures such as FYM, cow dung or compost @ 5 Kg/plant or neem cake @ 1-2 Kg / plant may be done during June-July. ▸ The present recommendation of nutrients for cardamom is N:P2O5:K2O @ 30:30:60 Kg/ acre. ▸ The fertilizers may be applied in two split doses, before and after the southwest monsoon, in a circular band of 20 cm wide and 30-40 cm away from the base of the clumps, and mixed with soil.

Source: Smallcardamom.pdf (niphm.gov.in)

Table 12: Remedial Measures for Nutrient deficiency of Cardamom

Nutrient	Symptom		Remedial measure
Potassium (K)	Older leaves show chlorosis. The symptoms start from margins and become necrotic brown colour. Drying starts from leaf tip towards base. Leaf become pale green and turns yellow with scorching appearance.		Foliar spray of K2SO4 @ 1% at fortnightly intervals.

Source: Smallcardamom.pdf (niphm.gov.in)

7. IPNM OF COCONUT PLANTATION

PEST MANAGEMENT

The major pests of coconut palm are rhinoceros beetle (*Oryctes rhinoceros*), red palm weevil (*Rhynchophorus ferrugineus*), leaf eating caterpillar (*Opisina arenosella*), eriophyid mite (*Aceria guerreronis*), rugose spiralling whitefly (*Aleurodicus rugioperculatus*), coreid bug (*Paradasynus rostratus*) and root eating white grub (*Leucopholis coneophora*).

Management	Activity
Growth stage	
Rhinoceros beetle and cock chafer beetle**	**Cultural control:** ▸ Collect and destroy the various life stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits. **Mechanical control:** ▸ During peak period of population build up, the adult beetle may be extracted from the palm crown using GI hooks. ▸ Install aggregation pheromone traps away from the main plantation. ▸ Set up pheromone trap for rhinoceros beetle @ 1 trap/100 ha by fixing it to the plant at 0.6 to 1 m height to trap and kill the beetles. **Biological control:** ▸ Release of *Baculovirus oryctes* inoculated adult rhinoceros beetle @ 6 beetles/acre reduces the leaf and crown damage caused by this beetle. ▸ Soak castor cake at 1 Kg in 5 l of water in small mud pots and keep them in the coconut gardens to attract and kill the adults. ▸ Apply mixture of either neem seed powder + sand (1: 2) @ 150 g/palm or neem seed kernel powder + sand (1: 2) @ 150 g/palm in the base of the 3 inner most leaves in the crown.
Bud rot	**Cultural control:** ▸ Adopt proper spacing and avoid over-crowding in bud rot prone gardens.
Mature palm	
Coconut eriophyid mite	**Cultural control:** ▸ Grow intercrop (sun hemp, four crops/year) and shelter belt with Casuarina all around the coconut garden to check further entry. ▸ Apply urea 1.3 Kg, super phosphate 2.0 Kg and muriate of potash 3.5 Kg/palm/year. ▸ Increased quantity is recommended to increase the plant resistance to the mite. **Chemical control:** ▸ Azadirachtin 5% (7.5 ml + 7.5 ml water)/ 1 percent (10 ml + 10 ml water) formulation thrice as in case of spraying
Red palm weevil	**Cultural control:** ▸ Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem in order to prevent successful inward movement of the grubs through the cut end. **Mechanical control:** ▸ Set up pheromone trap for red palm weevil @ 1 trap/100 ha by fixing it to the plant at 0.6 to 1 m height to trap and kill the beetles. ▸ Coconut log traps: Setting up of attractant traps (mud pots) containing sugarcane molasses 2½ Kg or toddy 2½ l (or pineapple or sugarcane activated with yeast or molasses) + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/ logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers.

Management	Activity
Leaf eating caterpillar / black headed caterpillar	▸ Follow common cultural, mechanical and biological practices. **Cultural control:** ▸ As a prophylactic measure, the first affected leaves may be cut and burnt during the beginning of the summer season. ▸
Termites	▸ Follow common cultural, mechanical and biological practices. **Cultural control:** ▸ Copious irrigation and drenching nurseries or basin of transplanted seedlings. Mechanical control: ▸ Digging the termitaria and destruction of the queen is the most important in termite management. **Biological control:** ▸ Spray neem oil 5% (50 ml/l) once on the base and up to 2 m height of the trunk for effective control. ▸ EPN infected cadavers of Galleria/Corcyra larvae containing live infective juveniles (IJs) are implanted in soil at plant bases at the rate of four cadavers per plant during May/ June and/or September for termite control.
Stem bleeding	▸ Follow common cultural, mechanical and biological practices. **Cultural control:** ▸ Along with 50 Kg organic manure, apply 5 Kg neem cake containing the antagonistic fungi, Trichoderma culture to the basin during September. ▸ Provide adequate irrigation during summer and drainage during rainy season along with recommended fertilizer. **Mechanical control:** ▸ Destroy the chiselled materials by burning. ▸ Avoid any mechanical injury to trunk. **Biological control:** ▸ Apply neem cake at the rate of 5 Kg/palm in the basin along with other organics.

Source: niphm.gov.in/IPMPackages/Coconut.pdf

https://agritech.tnau.ac.in/crop_protection/coconut_diseases_2.html#:~:text=Remove%20all%20the%20affected%20tissue,1%20litre%20of%20Bordeaux%20paste).

https://krishi.icar.gov.in/jspui/bitstream/123456789/25096/1/CPCRI%20Coconut%20eriophyid%20mite%20Aceria.pdf

Note: *The pesticides dosages and spray fluid volumes are based on high volume sprayer*
*** Pest of regional significance*

NUTRIENTS MANAGEMENT

The first application of chemical fertilizer should be done three months after planting and the quantity of fertilizer to be applied is approximately one tenth of the recommended dose of fertilizer for adult palms. Regular manuring from the first year of planting is essential to achieve higher productivity. During the second year, one third of the dosage recommended for adult palms may be applied in two split doses in May-June and September-October. This dosage may be doubled during the third year. From the fourth year onwards, fertilizers may be applied at the rate recommended for adult palms.

Application of 500 g N, 320 g P2O5 and 1200 g K2O per palm per year is generally recommended for adult plantations. To supply the above quantity of nutrients for an adult palm, it is necessary to apply about 1 kg urea, 1.5 kg rock phosphate (in acidic soil) or 2 kg super phosphate (in other soils) and 2 kg of muriate of potash (MOP). It can be also applied through 700 g Di ammonium phosphate (DAP), 815 g of Urea and 2 kg of MOP. After the receipt of summer showers, in May-June, one-third of the recommended dose of fertilizers may be spread around the palms within the radius of 1.8 m and forked in. Circular basins of 1.8 m radius and 20 cm depth may be dug during August-September and organic manures such as compost, farm yard manure (FYM), bone meal, fish meal, blood meal, neem cake, groundnut cake etc. may be spread at the rate of 50 kg per palm basin. The remaining two-third of the recommended dose of fertilizers may

be spread over the green leaf or compost and covered. Wherever irrigation facilities are available, it is advisable to go for more number of split doses, preferably four split doses (March, June, September and December).

The fertiliser schedule recommended for the palm at different stages is as follows:

Table 13: Quantity of fertilizer to be applied (in gm./palm)

Age of coconut palm	May-June			September- October		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
First year	Planting in May-June			50	40	135
Second year	50	40	135	110	80	270
Third year	110	80	270	220	160	540
Fourth year onwards	170	120	400	330	200	800

Source: coconut-english.pdf (coconutboard.gov.in)

Under rainfed condition[7]:

The full adult dose recommended for the rainfed tall is 0.34 Kg N, 0.17 Kg P and 0.68 Kg K. For the hybrids and irrigated talls the general recommendation is 0.5 Kg N, 0.34 Kg P and 1.0 Kg K subject to changes in accordance with soil test and/or foliar analysis data.

In addition to the above dose of fertilizers two (2) to three (3) Kg of finally ground dolomite lime stone or 0.5 Kg. Magnesium sulphate/palm/year is also recommended for use in acidic soils, light sandy soils and in root wilt affected tracts in Kerala. The dolomite may be broadcasted prior to the onset of monsoon in the basins and forked in and should not be applied along with other fertilizers. There is however no harm in applying magnesium sulphate along with other fertilizers.

Table 14: Remedial Measures for Nutrient deficiency of Coconut

Nutrient	Remedial measure
Nitrogen (N)	Foliar application of 2% urea thrice at fortnightly interval or soil application of 1-2 Kg urea / tree or root feeding of 1% urea 200 ml twice a year.
Phosphorus (P)	Foliar spray of DAP 2% twice at fortnightly interval or soil application of FYM 5 Kg/tree. Root feeding of 1% DAP 2 ml twice a year.
Calcium (Ca)	Soil application of lime based on lime requirement and root feeding of 1% calcium nitrate.
Magnesium (Mg)	Soil application of MgSO4 1-2 Kg/tree/year. Root feeding of 200 ml of 0.2% MgSO4 twice a year
Sulphur (S)	Soil application of gypsum 2 - 5 kg/tree/year. Root feeding of 0.2% gypsum
Zinc (Zn)	Soil application of ZnSO4 @ 10 Kg/acre
Iron (Fe)	Application of FeSO4 0.25 to 0.5 Kg/tree/year
Manganese (Mn)	Soil application of MnSO4 @ 10 Kg/acre
Copper (Cu)	Soil application of CuSO4 @ 10 Kg/acre.
Boron (B)	Application of borax/sodium tetraborate 0.2% (2 g/l of water), (75-100 ml/seedling), borax/ sodium tetraborate/octaborate 15-20 g/plan.

Source: niphm.gov.in/IPMPackages/Coconut.pdf

At growth stage, mite affected plants should be treated with 50 Kg FYM, 0.52 Kg N /acre, 2 Kg SSP/ 3.5 Kg MOP, 1 Kg gypsum & 50 g of Borax

[7] Source: niphm.gov.in/IPMPackages/Coconut.pdf

8. IPNM OF RUBBER PLANTATION

PEST MANAGEMENT

Pests	Management
Scale Insect	▸ Spray organophosphorus insecticides like malathion at 0.05% concentration
Mealy bug	▸ Spray organophosphorus insecticides (malathion) or fish oil rosin spap
Termite (White ant)	▸ Non chemical methods like - removing the queen, using green manures, mulching with neem bark, incorporating tobacco into the soil, applying wood ash or drenching with 20% water extract of Tephrosia can control termites.
Cockchafer grub	▸ Appropriate control measures may be adopted after identifying the pest.
Bark feeding caterpillar	▸ Repeated spraying of Bordeaux mixture is carried out for protecting young rubber and nursery plants. For mature rubber trees the spray volume required is upto 3000 litre per hectare
Mite	▸ Misting the plants with water, spraying sulphur 50 WP @ 2gms/Liter can control mite infestation
Slug and snail	▸ To repel slugs and snails brush Bordeaux paste 10% around the stem above the bud union to a length of 30 cm. Repeat the application after 30-45 days if the attack continues.
Cover crop pests	▸ Spray organophosphorus insecticides like Malathion at 0.05% concentration ▸
Rat	▸ ▸ Use rat traps for control or
Porcupines and wild pigs	▸ . ▸ Fencing (live or using coloured sarees) and methods like noise/using dogs, fires and torches can deter the animals. ▸ Use of natural repellents like chilli powder, cow dung and urine mix, neem leaves soaked in water are reported to control the menace.
Diseases	
Abnormal leaf fall	▸ Prophylactic sprays prior to onset of south west monsoon with Bordeaux mixture 1%. Addition of ZnSo4 @ 0.2% improves the efficacy. ▸ Spraying should be done as close to the monsoon as possible.
Shoot Rot	▸ For mature plants, prophylactic spraying is given, as in the case of abnormalleaf fall. ▸ For young plants in the nursery as well as in the field, spraying with copperfungicides before the onset of south west monsoon coupled with repeated spray roundsduring bright breaks protect the plants. ▸ For ensuring proper sticking of the spray on tender foliage, sticker (Sandovit, Tenac, Teepol, Triton AE etc) may be added at the rate of 0.5 ml/ litre of spray fluid.
Powdery mildew	▸ For young plants spray carbendazim (0.05%) or wettable sulphur (2g/l) at fortnightly interval. ▸ Dusting during the refoliation period commencing from bud break in about 10% of the trees, giving 3 to 5 rounds at weekly to fortnightly interval using 11 to 13 kg 325-mesh fine sulphur dust per round per hectare. ▸ Sulphur mixed with an inert material like talc (70:30) is commonly used. 0.2% Wettable sulphur (1 kg in 400 litres of water) is also effective in nurseries and for young plants as a spray.

Pests	Management
	▸ Bavistin 0.05% a.i. (1g in 1 litre water) spraying is more effective than sulphur for nurseries and young rubber. Alternate use of bavistin and sulphur is recommended to avoid resistance problem.
Birds eye spot	▸ Give repeated spraying with Bordeaux mixture 1% or Dithane M-45 0.2% or Bavistin 0.02%. ▸ Shading the nursery plants reduces the disease incidence. ▸ Maintain seedlings in vigorous condition through adequate balanced nutrition.
Leaf spot	▸ Repeated spraying with Bordeaux mixture 1% or dithane M-45 0.2% or bavistin 0.02% is recommended for nursery. ▸ Shading the nursery reduces the disease incidence. ▸ Maintain seedlings in vigorous condition through adequate balanced nutrition. ▸ High volume spraying with mancozeb (dithane/Indofil M-45) 0.2% or carbendazim (bavistin) 0.05% at 2-3 weeks interval during refoliation is effective in mature plantation.
Pink Disease	▸ **Prophylactic:** Spraying two rounds of 1% Bordeaux mixture (during May and August) on to the fork and branchesreduces disease incidence. For 2-year-old plants, the topmost brown portion has to be applied with Bordeaux paste ina 30 cm wide band all around. The forking region also has to be applied with the paste. In leaning plants, in addition,a 30 cm wide band on the convex side of the bend has to be applied. In 3 years old plants, application has to be madeon all major forking regions except the lowermost one and also on all the leaders of the topmost brown regions.
Patch or bark canker	▸ The affected region may be scraped to remove all the rotting bark and the coagulated rubber and the wound washed well with Dithane (Indofil) M45, 0.75% (10 g per litre of water). ▸ When the fungicide dries up, apply wound dressing compound.
Black stripe/ thread or rot	▸ If tapping is regularly done during rainy season, the tapping panel should be disinfected at weekly intervals by brushing with Dithane (Indofil) M45, 0.375% a.i. (5 g per litre of water). Phosphorous acid 0.08% at weekly intervals is also effective. In the infected cases, scrape off the affected tissues and apply the fungicide. When the fungicide dries up a wound dressing compound may be applied
Dry rot, stump rot, collar rot or charcoal rot	▸ Scrape off the fructifications, affected bark and wood showing black lines. ▸ Apply a wound dressing compound in which Thiride 0.75% a.i is incorporated. Hexaconazole 0.02% a.i (Contaf) is also effective. ▸ Avoid accumulation of rubber at the base of the tree. For root infection, see the treatment for brown root disease.
Brown root disease; Poria root disease	▸ Completely killed and dried roots may be traced, pruned off and destroyed along with any rotting stump in the immediate vicinity. ▸ The dried up plants may be uprooted, root traced, collected and destroyed. ▸

Source: Pests (celkau.in)http://www.celkau.in/Crops/Plantation Crops/Rubber/weed_control.aspx

https://agritech.tnau.ac.in/crop_protection/rubber_diseases_1.html

https://egyankosh.ac.in/bitstream/123456789/12493/1/Unit-11.pdf

NUTRIENTS MANAGEMENT

Stages of Plantation	Management
Seedling Nursery	▸ Apply Basal 2.5 t/ha. of FYM and 350 kg./ha of Rock Phosphate. ▸ 1.5-2 months after planting - 10:10:4:1.5 NPKMg mixture - 2500 kg/ha. ▸ Urea @ 550 kg./ ha. - 3 to 3.5 months

<table>
<tr><td>Immature rubber trees at pre-tapping stage</td><td>

Apply 12 kg. of compost or FYM and 120 g of rock phosphate in each pit before planting.
Apply 10:10:4:1.5 NPK and Mg as per schedule given below:

<table>
<tr><th>Months after planting</th><th>Period of application</th><th colspan="2">Quantity per plant</th></tr>
<tr><td></td><td></td><td>10:10:04</td><td>12:12:06</td></tr>
<tr><td>3</td><td>Sept./ Oct.</td><td>225 g</td><td>190 g</td></tr>
<tr><td>9</td><td>Arril/ May</td><td>445 g</td><td>380 g</td></tr>
<tr><td>15</td><td>Sept./ Oct.</td><td>450 g</td><td>380 g</td></tr>
<tr><td>21</td><td>Arril/ May</td><td>450 g</td><td>480 g</td></tr>
<tr><td>27</td><td>Sept./ Oct.</td><td>550 g</td><td>480 g</td></tr>
<tr><td>33</td><td>Arril/ May</td><td>550 g</td><td>380 g</td></tr>
<tr><td>39</td><td>Sept./ Oct.</td><td>450 g</td><td>380 g</td></tr>
</table>

Apply 400 kg. of mixture/ ha in 2 doses, once in April/ May and another in September/ October from the 5th year till the tree is ready for tapping.

</td></tr>
<tr><td>Matured rubber trees under tapping</td><td>

Apply NPK 10:10:10 grade mixtures at the rate of 900 g/tree (300 kg/ha) every year in two split doses.
Add 10 kg. commercial Magnesium Sulphate for every 100 kg. of the above mixture if there is magnesium deficiency.

</td></tr>
</table>

Source: Horticulture :: Plantation Crops :: Rubber (tnau.ac.in)

9. DETAILS ON INTEGRATED NUTRIENT MANAGEMENT PRACTICES

The Integrated Nutrient Management (INM) Practices that will feed into the capacity building program on IPNM are detailed in this section.

INM embraces soil, nutrient, water, crop, and vegetation management practices, tailored to a particular cropping and farming system. The INM aims at improving and sustaining soil fertility and land productivity and reducing environmental degradation. It optimizes the condition of the soil, with regard to its physical, chemical, biological and hydrological properties, for the purpose of enhancing farm productivity, while minimizing land degradation. It not only provides tangible benefits in terms of higher yields, but also conserve the soil resource.

INM also contributes to pest management. Stressed crops are more susceptible to disease and to the effects of pest attacks. Crops growing in poorly structured soil, under low or unbalanced nutrient conditions or with inadequate water supply will be stressed. Responding to disease or pest attacks by applying pesticides is a costly symptomatic approach to a syndrome which is better addressed by improving the ecological conditions and systems within which the crops are cultivated.

INM practices combine use of inorganic, organic and biological resources in a reasonable way to balance efficient use of limited resources and ensure ecosystem sustainability.

At the farm level, integrated and synergistic approach will be adopted under INM, involving the following:

- Matching the land use requirements with the land qualities present in the area, i.e., the biological, chemical and physical properties of the soil, and the local climatic conditions (temperature, rainfall etc.);
- Seeking to improve yield by identifying and overcoming the most limiting factors that influence yield;
- Better plant management, i.e., (i) planting at the beginning of the rain to increase protective ground cover to enhance infiltration and biological activity and (ii) timely weeding to reduce crop yield losses;
- Promotion of complementary crop, livestock and land husbandry practices in combination to maximize addition of organic materials and recycle farm wastes, so as to maintain and enhance soil organic matter levels;
- Land management practices that ensure favourable soil moisture conditions for the proposed land use (e.g. moisture conservation in low rainfall areas, drainage in high rainfall areas);

- The replenishment of soil nutrients through an integrated plant nutrition management approach like organic manuring, application of crop residues, rhizobial N-fixation, Phosphorous and other nutrient uptake;
- Efficient fertilizer use with application of appropriate quantities and method of application to minimizes losses (for example, rather than broadcasting, project will educate farmers to apply fertilizer into the soil directly).
- Combinations of crop, livestock and land husbandry practices that reduce rainfall impact, improve surface infiltration, and reduce the velocity of surface run-off thereby ensuring soil loss below the 'tolerable' level;
- Crop rotation, agro-forestry and soil restorative practices that maintain and enhance the soils physical properties thereby encouraging root development and rainfall infiltration;
- Promotion of crop-livestock system in project clusters as a part of integrated nutrient management strategy;
- Nutrient monitoring during growing stage by using colour chart and application of nutrients accordingly.

Annexure I: List of Banned Pesticides

According to World Health Organization classification the chemicals categorized under classes Ia, Ib and II are not permissible in project. (https://www.who.int/publications/i/item/9789240005662

S. NO	CHEMICAL NAME	USAGES	NAME THAT IS AVAILABLE IN THE LOCAL MARKET
1	2,4-Dichlorophenoxyacetic acid	Herbicide	Weedmar 80 WP, Safaya, K-D, Nadial -2,4 D
2	Anilofos	Herbicide	Arozin, Foster
3	Bendiocarb	Herbicide	Saturn
4	Benfuracarb 40% EC	Pesticide	Oncal
5	Bifenthrin	Pesticide	Talstar 10% EC, Marker
6	Carbaryl 50 WP	Pesticide	Sevin, Carbaryl, Superabh
7	Carbofuran 3 G	Pesticide	Furadan, Tataphiuran, Lejend, Nagphiuran, Don
8	Carbosulfan 25% EC	Pesticide	Marsal, Atank, Elektra
9	Clorfenvinfos	Pesticide	-
10	Chlorpyrifos 20 % EC	Pesticide	Darsban, koroban, Tataban, Straik, Force, Bordan
11	Clomazone	Herbicide	-
12	Copper Sulfate	Fungicide	Bardo Mixture
13	Coumatetralyl	Raticide	Racumin
14	Cuprous Oxide	-	-
15	Cyfluthrin	-	-
16	Cypermethrin 10% EC	Pesticide	Hamla, Ostad, Surksha, Suparkil, Tata Cyper- 10
17	Cyphenothrin	Pesticide	-
18	Diazinon 20 EC	Pesticide	Delgian, Daitaf
19	Dichloro-Diphenyl Trichloro Ethen	Pesticide	D.D.T (Do not use to Agriculture)
20	Dichlorvos	Pesticide	Nuvan, Bhepona, Dum
21	Dimethoate 30 % EC	Pesticide	Rogor, Crogen, Nagor, Rogohit
22	Edifenphos 50 % EC	Fungicide	Hinosan, Dhanusan
23	Endosulfan 35 % EC	Pesticide	Thayodan, Endosel, Endotaf, Lusalphan
24	Ethion 50 % EC		Phesmait, Superthayan
25	Fenazaquin		Majistar
26	Fenitrothion	Pesticide	Sumithayan, Pholithayan
27	Fenthion 82.25 % EC	Pesticide	Lebasid
28	Fipronil 3, SC	Pesticide	Rejent Dana, Task Dana, Rejent SC,Task SC
29	Imidacloprid 17.8 SL	Pesticide	Tatamida, Kemida, Confidor
30	Lambda Cyhalothrin 5 % EC	Pesticide	Carate, Judo,Tatariva
31	Metaldehyde 75 % EC	Snilcide	Snail Kill
32	Metribuzin 70 % WP	Herbicide	Senkor, Tatamedri, Brariyar
33	Monocrotophos 36 % SL	Pesticide	Phoskil, Starm, Monosil, Nagphos, Luphos
34	Oxydemeton Methyl 15% EC	Pesticide	Metasistok, Himox
35	Permethrin	-	-
36	Phenthoate 50 % EC	Pesticide	Dalsan, Amej
37	Phosalon 35 % EC	Pesticide	Jolon, Ojon
38	Prallethrin	-	-
39	Profenophos 50 % EC		Kurakan, Kyarina, Criphos, Prophos, Ariphos
40	Propetamphos	-	-
41	Quinalphos 25 EC	Pesticide	Akalax, Hitalax, Superphox, Nagin -D
42	Quinalphos Pyara Tefuryl	-	-
43	Sodium Cyanide	-	-
44	Thiacloprid	-	-
45	Thiodicarb 75 % WP	Pesticide	Larbhin, Spiro
46	Triazophos 40 EC	Pesticide	Hostathayan, Jos, Tarjan, Ghatak, Hyatrik
47	Tricyclazole 75 WP	Fungicide	Ban, Bin, Trisel, Trijo,Aktino
48	Tridemorph 80% EC	Fungicide	Caliksin, Crilikisan, Nagmarf
49	Zinc Phosphate	Raticide	Rat Kill, Ryatil, Ryatnil, Comendo