

Ministry of Environment, Forest and Climate Change, Bangladesh
Bangladesh Forest Department



Bangladesh Sustainable Forest and Livelihood (SUFAL)
Project



Pest Management Plan

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LIST OF ACRONYMS

BBS	Bangladesh Bureau of Statistics
BFRI	Bangladesh Forest
CIP	Country Investment Plan
DAE	Department of Agricultural Extension
FAO	Food and Agriculture Organization, UN
GDP	Gross Domestic Product
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GoB	Government of Bangladesh
ICM	Integrated Crop Management)
ICP	FAO's Inter-Country Program
IDM	Integrated Disease Management
IPM	Integrated Pest management
MoA	Ministry of Agriculture
MOEFCC	Ministry of Environment and Forests
NGO	Non-Government Organization
PMU	Project Management Unit
TAPP	Technical Assistance Project Proforma/Proposal
UNCETDG	The United Nations Committee of Experts on the Transport of Dangerous Goods
WHO	World Health Organization

EXECUTIVE SUMMARY

Pest and disease are the one of the major obstacles for development of nursery and plantation of forest species. Proper pest and disease management is crucial for development of healthy and productive plantation forest. Injudicious use of chemicals may grow up resistance among pest and pathogens. It also increases the cost. Environmental and health hazard also occur due to improper use of chemicals for pest and disease management. Keeping the pest population under the economic injury level to reduce cost, environmental and health hazards are the major issue of this Pest Management Plan (PMP). The PMP has been developed by reviewing literature and consulting with different stakeholders like forest department staff, DAE, BFRI staff and nursery growers.

The plan has been developed considering national act, rules, regulations and policies that indicated issues relevant to pest, diseases and chemical management. For preparing the plan a number of national regulatory tools have been studied namely Forest Act 1927, National Forest Policy, 2016 (Draft), Forestry Master Plan (2017-2036), Forest Investment Plan, 2017, Bangladesh Country Investment Plan (CIP) for Environment, Forestry and Climate Change (2016 – 2021), 7th Five Year Plan (2016-2020), National Conservation Strategy, 2017 (Draft), National Biodiversity Strategy and Action Plan (2016-2021), National Agriculture Policy (2013), National Integrated Pest Management Policy (2002), National Crop and Forest Biotechnology Policy (2012), The Pesticide Ordinance (1971), The Pesticide Rules, 1985 (amended), Plant Quarantine Act (2011), The Destructive Insect and Pest Rules (1966). The World Bank's pest management safeguard also addressed in this document.

The plan identified the major pests and diseases of nursery, plantation and storage and suggested IPM measures to reduce the effect of pest and diseases. It also mentioned health safety issues during handling with chemicals for pest and disease management. It has given an implementation guideline for proper implementation of initiatives in relation to pest and disease management. The overall aim of the Pest Management Plan is to promote integrated pest management for minimizing environmental hazard and ensuring health safety.

CHAPTER 1 INTRODUCTION

1.1 Background

Bangladesh is the 8th largest populated country in the world having population of 160 million people and 147,570 km² of area. It is the biggest delta of the world. Bangladesh is a country that predominantly depends on agricultural economy and two third of the population rely on agricultural activities. The country is highly vulnerable to climate change due to its geographical location, flat and low-lying topography, high population density, poverty, resilience of many livelihoods on climate sensitive sectors like agriculture and fisheries, and inadequate institutional structures. Climate change will expose a number of threats like increase in intensity and frequency of flooding, cyclone and storm surges, increase salinity intrusion, changes drought character that ultimately impacts livelihood of people.

Forestry sector has huge potential in minimizing climate change impact. This is the main source of carbon sink. The role of forest in minimizing effect of cyclone and storm surges already been proved. It also plays a vital role in providing livelihood to the people living around forests. More over forest sector contributed 3% of country's gross domestic product (GDP) and employed 2% labor force. Contribution of forest sector in GDP seems low as the GDP figure does not account for the large quantities of fuel wood, fodder, small timber and poles, thatching grass, medicinal herbs, and other forest produce, extracted legally and illegally (MoEF, 2017). The shares of forest sector could be much higher if ecosystem services, value of recreation and carbon locking is considered.

For development of forestry sector Government of Bangladesh (GoB) has approved a TAPP with the financial assistance from the World Bank (PPA, Tk. 197.50 lacs) and GoB in-kind (Tk.78.2994 lacs) during July/2016 – June/2018. The project aims to increase forest coverage and establish sustainable forest management. For enhancing forest coverage, the project will provision nursery establishment and plantation programs in project sites and livelihood development of forest dependents for sustainable forest management. Therefore, the project is likely to increase the potential use of chemicals and pesticides to manage pests and disease. Specifically, use of pesticides and other chemicals in the nurseries and plantations are likely to be intensified which is already proven to be detrimental to the environment and health.

To ensure judicious use of chemicals and minimize environmental hazard a pest management plan is a crying need. Realizing the fact and for fulfilling the pest management compliance of both Bangladesh Government and the World Bank the assignment has been initiated. The document will advocate for adoption of IPM for pest and disease management.

1.2 Project

The project employs a comprehensive approach to scale up action and address the challenges described in the previous sections to: **(i) increase the cover, improve quality and management of natural forests and biodiversity and coastal 'green belt' through collaboration with communities; (ii) improve living standards through alternative income generation options to forest dependent communities; and, (iii)**

improve the policy and regulatory environment to enhance tree planting on private lands. The project will be implemented in selected sites in 147 Upazilas/sub-districts of 28 districts.

Table 1.1: Components and cost

Components	M US\$
Component 1: Institutional Development, Information Systems and Training	17.41
Sub-Component 1.1: Strengthening Organizational Capacity	
Sub-Component 1.2 Applied Research	
Sub-Component 1.3 Training	
Sub-Component 1.4: Strengthening Monitoring, Information Management Systems and Forest Inventory	
Sub-Component 1.5: Communications & Outreach	
Component 2: Strengthening Collaborative Forest and Protected Area Management	96.04
Sub-Component 2.1: Institutionalizing Collaborative Forest Management (CFM)	
Sub-Component 2.2: Restoration of Degraded Forests, Plantations, Coastal Green Belt and Field Infrastructure	
Sub-Component 2.3: Improving Protected Areas and Wildlife Management	
Component 3: Increasing Access to Alternative Income Generating Activities (AIGAs), Forest Extension Services & Trees outside Forest (TOF)	48.38
Sub-Component 3.1 Community Mobilization and Organization	
Sub-Component 3.2 Community Livelihood Grants for AIGAs	
Sub-Component 3.3 Extension Services for Trees Outside Forests	
Component 4: Project Management, Monitoring and Learning	12.16
Sub-Component 4.1 Project Management	
Sub-Component 4.2 Monitoring	
Support to the DPP preparation (SUFAL)	1.00
Grand Total	175.00

Component 1. Strengthening Institutions, Information Systems and Training

Sub-Component 1.1 Strengthening Organizational Capacity: (i) A review of BFD's capacity and roles will focus on the long-term needs of BFD including, IT, GIS and other systems and business processes and staffing and will initially concentrate on incremental change and bolstering existing capacity, with possible functional reorganization being addressed subsequently. (ii) Support for the adoption of the new draft Forest Policy, the draft Forest Master Plan and, a review of key regulations (timber transit and social forestry) and development of options for innovative long-term forest financing will provide. (iii) project area field offices and training centers will be renovated and climate -proofed and serve as cyclone shelters in coastal districts.

Sub-component 1.2 Applied Research: The Bangladesh Forest Research Institute (BFRI) will undertake this task through a Memorandum of Understanding (MoU) with BFD. Applied research will focus on sourcing of high quality and climate resilient planting material for plantations through (i) seed collection systems and seed orchards; and (ii) improved nursery techniques. An *Innovation Window* will fund proposals related to climate change and forests and biodiversity conservation and increasing efficiency of wood and non-wood processing, wildlife management or other topics that support the objective of SUFAL, from

individuals, companies, educational institutions, NGOs, etc. A BFD committee will review and shortlist proposals according to agreed criteria.

Sub-component 1.3 Training: Training for BFD staff, and especially female staff, will be delivered on a number of topics to strengthen capacity in forest and wildlife management and will include training in emerging areas including, climate change, carbon measurement, eco-tourism, gender, collaboration with communities, etc. Other stakeholders e.g., tourism companies, NGOs, will also receive training in eco-tourism, collaborative management, forest and PA regulations, etc. A customized training program will be delivered by the NGOs under Components 2 and 3 for communities on collaborative management and AIGAs.

Sub Component 1.4 Strengthening monitoring, information management systems and forest inventory: A strategy for information management systems will be developed. The Resource Information Management System (RIMS) unit will be resourced to develop a *digital site-specific management planning system* using free and open source software. This approach will build on the Site-Specific Plans developed under Component 2 and will be piloted in 3 Management Planning Divisions and will help in the revision of the Forest Manual and format for management plans. The project will support updating of management plan requirements by piloting preparation of new management plans for both forests and PAs (protected areas). The current NFI will be updated and a team of trained staff will be dedicated to continue the process beyond the project. Precise estimates of TOF, which play an important role in the economy and carbon sequestration, are not normally the focus of NFI but the NFI unit will consolidate the necessary skills and tools to conduct the sophisticated analysis for this work.

Sub-component 1.5. Communication & Outreach: Under a communication and outreach plan formulated in the first year, the PMU will pursue an outreach program to motivate both the participating partners, especially women, about collaborative management, PA management, wildlife protection, etc. The experiences and lessons from the project will be shared with relevant officials, partners and decision-makers for effective project management and implementation. A separate program of outreach will be planned for each of the key interventions under the project: (i) collaborative forest management; (ii) protected areas and wildlife management; and, (iii) Trees Outside Forests (TOF);

Component 2. Strengthening Collaborative Forests and Protected Areas Management

Sub-component 2.1 Institutionalizing collaborative forest management (CFM): The aim of collaborative management is to give forest dependent communities¹ a stake in the management and maintenance of forest cover and to foster local stewardship of forests. Key activities will be: (i) identifying policy and regulatory measures to strengthen collaboration with communities in different ecosystems; (ii) identifying the most forest dependent communities where CFM committees will be established; (iii) awareness raising, capacity development and training on the CFM approach for communities, especially women and BFD staff; (iv) strengthening CFM committees with own bank account, an operating fund and,

¹ A forest dependent community would include forest dependent people (self-selected) residing in villages located within three kilometers from the boundary of the Forest Beat area and would include the nearest village in the case of mangroves.

(v) developing an institutional framework and rules for CFM during implementation. Special emphasis will be given to encourage women's participation as office-bearers in the CFMCs.

Community co-management in PAs will be under the Protected Area Management Rules 2017. In areas where social forestry programs are underway, the BFD will initiate CFM after the 3rd (third) rotation. A template to describe the roles and responsibilities of CFMCs will be developed during the first year of the project in consultation with communities. The CFMC will be the point of entry for the AIGAs under Component 3.

Sub-Component 2.2 Reforestation, Coastal Green Belt and Plantations: Protection, management and planting as appropriate in different forest ecosystems, covering about 76,000 hectares will be financed to enhance forest quality and increase the sustainable supply of fuelwood and non-timber products to communities. This will be achieved through:

- Assisted Natural Regeneration -protection and planting of up to 20% of site
- Enrichment plantations - with up to 60% planting
- Mixed plantation with indigenous and slow or fast-growing species, including NTFPs, medicinal
- Mangrove and other coastal afforestation

Availability of suitable forest land for these activities was assessed by BFD with support from the Center for Environment and Geographical Information Services (CEGIS), Bangladesh, using satellite images and field verification^{2,3}. Selection of areas for afforestation in the coastal districts is based on field verification using the study conducted by CEGIS for this purpose in 2016. Afforestation activities will be preceded by Site-Specific Planning(SSP) for each site based on *actual* site requirements. SSPs will generate a geo-spatial database which will help monitoring of treated sites, increase transparency and be an entry point for involvement of local communities in CFM.

Sub-Component 2.3 Improving Protected Areas (PAs) and Wildlife management: (i)development and implementation of PA management plans for 10 PAs⁴. Management plans will be implemented with co-management committees (CMCs). The members of Village Conservation Forum, the lowest tire of this organizational structure, would be eligible to be part of the livelihood support provided under Component 3. For motivation, networking and organizational development, the NGOs contracted under Component 3 will be responsible for organizing the CMCs and their training and capacity building for AIGAs. (ii) scaling up endangered species conservation programs for 13 endangered species⁵; (iii) enhancing capacity for wildlife law enforcement (excluding support to active enforcement activities): The project will support developing necessary technical and human capacity for scaling up SMART patrolling in 10 PAs outside

² CEGIS, 2017. GIS based Forestland Availability Assessment for Plantation/ Restoration. (Dhaka: CEGIS)

³ Government of Bangladesh (2017), National Land Representation System of Bangladesh, Forest Department, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh.

⁴ Baraiyadhala National Park, Shingra National Park, Nababgong National Park, Birgonj National Park, Pablakhali Wildlife Sanctuary, Hazarikhil Wildlife Sanctuary, Shangu Wildlife Sanctuary, Nagarbari-Mohangonj Dolphin Sanctuary, Shilanda-Magdemra Wildlife Sanctuary, Nazirgonj Wildlife Sanctuary, Altadighi waterbased SBCA, Swatch of No-ground MPA, Char-muguria Eco-park

⁵ Tiger, Elephant, Dolphins, Shark and Rays, Migratory Birds, Vultures, SB Sandpiper, Russel's Viper, C-E Macaque, SW Crocodile, River Terrapin, P-Langur, Gharial Conservation Program

Sundarbans. Training, facilities, equipment including software and hardware, GPS navigators, binoculars, tools for data collection and analysis will be procured. Necessary awareness raising and outreach and training will be provided to the Co-Management Committee (CMC) members. (iv) restoration and protection of natural habitats in select wildlife corridors (3.8 thousand hectares) for wild elephants for the alleviation of human-wildlife conflict in and outside of the country's protected areas and, (v) knowledge and information sharing with regional neighbors to curb trade in wildlife products and enhance wildlife law enforcement in the region and cooperation on transboundary habitat maintenance.

Component 3. Increasing Access to Alternative Income Generating Activities (AIGAs), Forest Extension Services & Trees outside Forest (TOF)

Sub-Component 3.1 Community mobilization and organization for AIGAs: AIGAs will be implemented in up to 600 villages in or close to forests, covering about 40,000 households. A Community Operations Manual (COM) will elaborate the rules and criteria for the implementation of AIGAs. NGOs will be contracted by BFD to mobilize, organize and provide training to communities to plan and implement the AIGAs and manage the AIGA fund. The CFMCs will open a bank account and start community savings and initiate village development activities and receive training for AIGAs. An important aspect will be organizing and targeting women and adolescent girls with tailored training and income generation activities. These activities will be organized in a way that is conducive to women's participation and compatible with their multiple responsibilities.

Sub-Component 3.2 Alternative Income Generation Activities (AIGAs): The COM will elaborate the protocols for implementation including: (i) awareness raising and community mobilization; (ii) criteria and process for selection of AIGAs recipients - priority will be given to members of CFMCs who are (a) the poorest in the village; (b) all women-headed households; (c) landless and those who lack year-round employment; or, (d) belong to ethnic minority communities; the NGO will ensure that all decisions are participatory, inclusive and, transparent and address the specific needs for women's economic empowerment. (iii) capacity building; (iv) assessing AIGA proposals; (v) rules for borrowing and repayment to the AIGA fund; (vi) reporting and procurement; (vii) list of activities that may not be financed by the project; (viii) sustainability.

Funding of AIGAs: Funding will be channeled from the PMU directly to community accounts. Each community will have two accounts: (i) a collaborative forest management committee (CFMC) account for a village development fund of \$5000 per village for carrying out activities that benefit the village as a whole; and, (ii) AIGA fund. The AIGA fund will be maintained as a revolving fund at the community level and will be available to community members as micro-credit. AIGAs that may be financed would be screened, among others, for enhancing climate resilience, reduction of forest degradation and support to the objectives of SUFAL. A list of activities that *may not be financed* by the project will be in the COM. Both on and off-forest income generating activities may be financed. The NGOs will help with the forward linkages to markets and banking and credit facilities where required with special emphasis on providing women with these linkages.

*Sub-component 3.3 Extension services and Trees outside Forests (TOF)*⁶: The existing private sector network of nurseries and planting material distribution tends to use non-certified, low quality seed of unknown origin and germination rates, and generally raises poor quality seedlings using outdated methods. The TOF value chain comprises of. This sub-component will support the TOF value chain (nurseries, homesteads, sawmills) by: (i) establishing a national timber market intelligence system; (ii) technology transfer and training to nursery owners and farmers through Social Forestry Nursery and Training Centers (SFNTCs); (iii) training to improve efficiency of small scale sawmilling; and, (iv) a review and updating of policies to ease costs and difficulty for tree growers, sawmillers and exporters. Activities will include plantations on bare and other unused land available on the sides of roads, coastal embankments, railway tracks, and river and canal banks; outreach programs with Upazila Parishads to encourage planting of trees on public and private land in five Upazilas; seedling distribution to homestead farmers. Special focus will be given to ensure that extension and training is held in locations and at times that encourage participation of women farmers and entrepreneurs.

Component 4. Project Management, Monitoring and Reporting

Sub-Component 4.1 Project Management: This sub-component will finance the BFD's project management unit at the central level in the headquarters and in the 27 districts where field implementation will take place. Support will be provided for contracting key specialists such as in the areas of social and gender, financial management, procurement, knowledge management and community development. In addition, monitoring and evaluation including, baseline survey, mid-term and end of project evaluations, independent third-party monitoring, external and social audits will be financed under the sub-component. *Sub-component 4.2 Monitoring, Reporting and Evaluation*: This component will finance all activities related to M&E and reporting of the project including surveys, social audits, third-party monitoring, geo-spatial monitoring and analysis of administrative records. The forest inventory and the new module on trees outside of forests, will be financed under component 1.

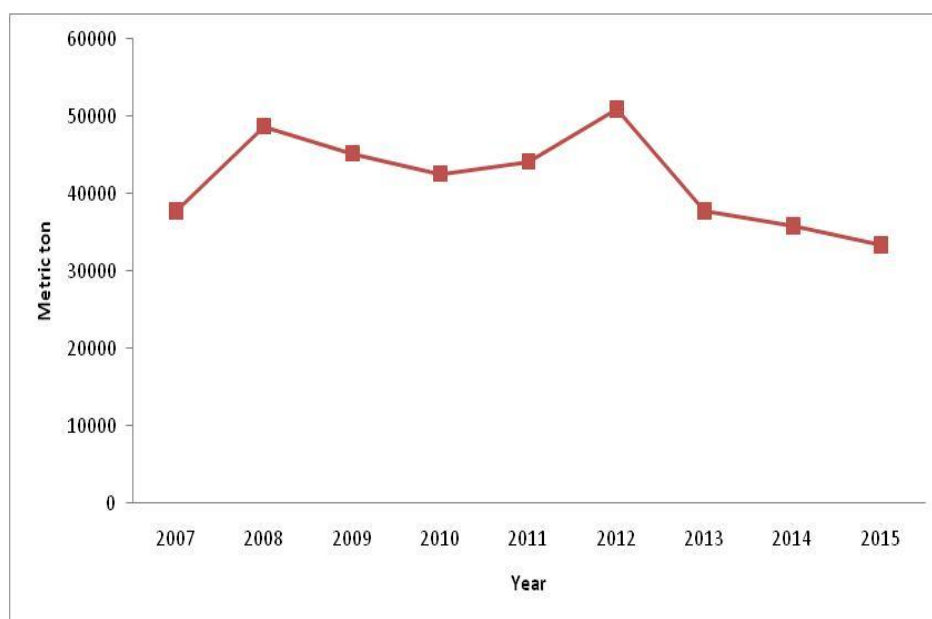
⁶ Trees outside forests (TOF) refers to trees that have been grown on land that is not classified as Reserved Forest or Protected Forest or any land with legal status of a forest. These trees are frequently grown on government or privately-owned land or some are grown as part of the Social Forestry program.

CHAPTER 2 REVIEW ON PEST MANAGEMENT STATUS IN THE COUNTRY

2.1 Present Status and Need for the PMP

In Bangladesh, promotion of pesticides in free of cost by providing subsidy continued up to 1974. In 1974, the subsidy reduced to 50% and in 1979 the government withdraws the subsidy process and the business was transferred to the private sector. After withdrawal of subsidy the use of chemical pesticides initially declined for several years, but the use has increased from 1999 (MoA, 2002).

Figure 2.1 Trends of Chemical use in Bangladesh



Analyzing data from BBS, a slightly decreasing trend of use of chemical has been observed from 2007 to 2015 (Figure 2.1). It was found that the use of chemicals (insecticide, herbicide, miticide, rodenticide and fungicide) has reduced in 2015 (33,371.6 Mt.) from the base year 2007 (37,712.07 Mt.). The highest amount of use of chemicals for controlling pest, disease and weed was recorded in 2012 (50,883.67 Mt.) and the lowest was recorded in 2015 (BBS 2012 and 2015). In addition, Bangladesh spends 590.39 million Taka in FY 1991-92 and the figure reached at 74,41,824 million Taka for importing 28,386 Mt. pesticides in FY 2011-12 which is 12605 times higher than the expenditure of FY 1991-92 (BBS, 2016). All these pesticides are imported every year expending hard-earned foreign exchange.

In Bangladesh, IPM activities first started in 1981 with the introduction of FAO's inter-county programme (ICP) on IPM. However, IPM activities begun to expand and became a popular method for pest control in 1987. The project played a strong role in promoting IPM among government and the donor community during the period of 1989 to 1995. The ICP initiative built up capacity of DAE staff, farmers, and NGO staff that contributed to change in mindset of policy makers, practitioners and donor communities to adopt IPM (MoA, 2002).

The Pest Management Plan intended to provide suggestions for keeping pest populations under economic injury level through using different environmentally friendly pest management options including judicious use of registered chemicals so that environmental and health hazard minimized or reduced in the future.

2.2 Goal of Preparing the PMP

The goal of PMP is “to promote integrated pest management for minimizing environmental hazard and ensuring health safety”.

2.3 The Aim and the Nature of the PMP

The PMP would be prepared with the aim to standardize the pest management in line with the regulatory compliance of government, along with environmental and health safety compliance of the World Bank. Guidance will be given on improved pest management and importance will be given to adopt improved pest, disease and weed management for reducing harmful impact of chemicals on the environment and health. Safety issues for application of chemicals as a part of integrated pest management also will be highlighted to follow.

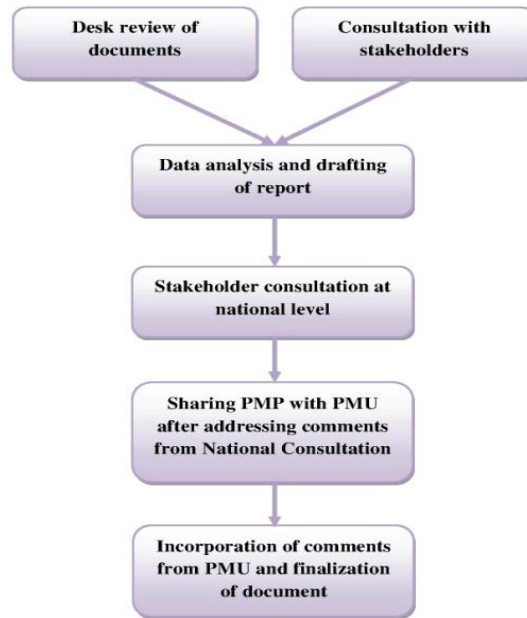
2.4 Promotion of Safer Pesticides Management

Once upon a time, chemical control considered as the magic potion for the control of pest, disease and weeds. Although pesticides may provide temporary relief, it is now proven that the indiscriminate and excessive use of pesticides and the long-term dependency on them threaten the sustainability of agricultural production and environmental integrity. Over dependency of pesticides not only increased expenditure but also leads to environmental and health hazards. Therefore, integrated pest management is the sustainable option for the safe management of pesticides/chemicals.

2.5 Methodology followed in Preparing the PMP

For preparing PMP data has been collected from both primary and secondary sources. Consultations have been carried out with staff of Bangladesh Forest Department to get information regarding pest management practices and pest problems for nursery plantation, weed management and timber storage. Desk review of national legislations in relation to pest management has been carried out. In addition, desk review for documents has been done for having suitable options of safer pest management. After getting primary and secondary data, compilation has been done and prepared draft PMP. The draft PMP has been consulted at national level. The comments from national consultation have been incorporated and shared with PMU. Finally, suggestions of PMU have been addressed in the PMP and finalized (Figure 2.2).

Figure 2.2 Methodology for Developing PMP



CHAPTER 3 POLICIES AND REGULATORY FRAMEWORK FOR PEST MANAGEMENT

3.1 Bangladesh Policies, Laws, Regulations and Plans

Bangladesh has a number of laws, regulations, policies and plans that addressed environmentally safer pest management issue. Most of these regulatory tools have given emphasis on pest management issue for agriculture sector. An assessment on the state of integration of pest management issue in different sectoral and cross-sectoral regulatory tools is given below.

Forest Act 1927

Clause 38C(1) of this act given the authority for making rules for prohibiting, restricting or seeking permits for using pesticides that may pose threat to property, renewable natural resources or the productivity of land.

National Forest Policy, 2016 (Draft)

The National Forest Policy does not directly address pest management issue. The policy declared to go for plantation to attain forest cover up to 20% and also encourage to increase tree cover through agro-forestry. However, the policy made a commitment to implement the suggestions of National Biodiversity Strategy and Action Plan and Forestry Master Plan those addressed need for Integrated Pest Management (IPM). Forestry Master plan emphasized on the collaboration of Bangladesh Forest Department and Department of Agricultural Extension to promote their common agenda like pest management, agro-forestry etc.

Forestry Master Plan (2017-2036)

Forestry Master Plan addressed that indiscriminate use of pesticides may affect the population of pollinating insects and birds those are indispensable for agricultural and forest production. Therefore, it has advocated for Integrated Pest Management during implementation of AIGAs related to agriculture. It also suggested to provide training to forest department officials to promote monitoring and the early detection of climate change impacts on management of pest and disease outbreaks. It also suggested to carry out maintenance of mixed-species forest for increasing resistance to pest invasion.

Forest Investment Plan, 2017

The Forest Investment Plan in its policy section addressed National Agriculture Policy 2013 and mentioned that the objective of implementation of IPM program included in the policy is very much relevant to the forestry sector.

Bangladesh Country Investment Plan (CIP) for Environment, Forestry and Climate Change (2016 – 2021)

The Ministry of Environment and Forest has prepared Bangladesh Country Investment Plan (CIP) for Environment, Forestry and Climate Change (2016 – 2021) to translate policies into an investment program. The CIP has addressed pest management issues and the impact of indiscriminate use of fertilizer

and pesticide over soil fertility and biodiversity. It has strongly suggested for reducing pollution by fertilizer and pesticides from agricultural sector. The CIP recommended for investment to promote Integrated Pest Management.

7th Five Year Plan (2016-2020)

The plan highly encouraged to promote and expand Integrated Pest management (IPM), Integrated Disease Management (IDM) and Integrated Crop Management (ICM) for protecting and conserving the environment. It has expressed concern for developing new technology for pest and disease management. The plan allocated budget for integrated pest, disease and vertebrate management.

National Conservation Strategy, 2017 (Draft)

The document has highlighted that use of pesticides and insecticides in agriculture is one of the reasons for environmental pollution and recommended to adopt IPM technologies in its crop agriculture section. Water resource section of this document blamed pesticides as a source of ground water pollution. Flora part of biodiversity section identified unchecked soil and water pollution as a stress for floral biodiversity. It has emphasized to reform policy and master plan for forestry sector and taking action according to reformed policies and master plan. The Forestry Master Plan already been reformed that argued for up taking IPM and establishing collaboration between Bangladesh Forest Department and Department of Agricultural Extension to promote their common agenda like pest management, agro-forestry etc.

National Biodiversity Strategy and Action Plan (2016-2021)

Soil degradation and biodiversity loss due to excessive use of fertilizers, pesticides, herbicides and insecticides for agricultural production have been attended in the strategy. It has spoken in favor of promoting ICM, IDM and IPM in agricultural crop production for minimizing impact. The use of pesticide, insecticide and herbicides in forestry sector are not addressed separately. Emphasis has been given to take initiative in agriculture sector. However, Draft National Forest Policy, 2016 recommended implement to relevant suggestions for forestry sector development.

National Agricultural Policy, 2013

This policy identifies inadequate capacity to use of pesticide, fertilizer and water judiciously in agriculture as a weakness and indiscriminate use of pesticide and fertilize as risk in agriculture sector. Therefore, it has encouraged promoting activities related to IPM and ICM for biodiversity conservation and emphasized to develop bio-pesticide and IPM technology.

National Integrated Pest Management Policy, 2002

This is most important policy for pest management. Considering environmental and health hazard the policy made following directions to be followed for pest management in the section entitled “Executing Appropriate Actions on Pesticides”

1. GOB has banned all World Health Organization (WHO) Class 1a (extremely hazardous) pesticide compounds, based on formulations, for agriculture purposes and will eliminate compounds in Class

- 1b (highly hazardous). New proposals for registration of any pesticide fall under the above categories will be declined.
2. For the registration of any pesticide in future, experimental toxicity data on beneficial insects, fish and other aquatic animals under Bangladesh conditions must be taken into consideration.
 3. GOB will not provide free pesticides to the farmers for ground applications, except under exceptional circumstances as determined by the National Council of IPM.
 4. Aerial application of pesticides for the control of crop pests shall not be undertaken, except if the National Council of IPM deems it necessary under very exceptional circumstances.
 5. GOB will avoid receiving any aerial formulation of pesticides as overseas development assistance.
 6. GOB will provide support and incentives to the private sector organizations for producing bio-control agents (parasitoids, predators and insect pathogens such as fungi, bacteria and viruses) and botanical pesticides locally.
 7. GOB will review pesticide rules and regulations and amend the same as and where necessary.
 8. GOB will monitor any misleading advertisement toward using pesticides and will initiate appropriate legal actions against such malpractice.

It also recommended for developing capacity of staff of Agriculture, Forestry, Fisheries, Livestock, Environment and Health department as well as farmers and staff of NGOs on IPM. Emphasis has given on developing IPM technology for pest management and strengthening collaboration among DAE, NGOs and other relevant agencies. The implementation of this policy will be led by Ministry of Agriculture and other ministries, departments and research agencies who work in Environment and Forestry, Fisheries and Livestock, Health, Local Government, planning, Finance, Education, Information will be collaborated.

National Crop and Forest Biotechnology Policy, 2012

One of the objectives of this policy is to develop insect and disease resistance variety for agriculture and forestry sector that ultimately contribute towards reduction of agro-chemical use which is a component of IPM and IDM. It also recommended for preparing bio-safety guidelines and Act/rules.

The Pesticide Ordinance, 1971

The ordinance has promulgated to regulate pesticide in Bangladesh. It actually, regulates registration, cancellation, renewal, license, importation, labeling and price fixation etc. processes. Regarding cancellation of any pesticide the ordinance states in its clause 7- " If, at any time after the registration of the brand of a pesticide, the Government is of opinion that the registration has been secured in violation of any of the provisions of this Ordinance or the rules or that the pesticide is ineffective against pests or hazardous to vegetation, other than weeds, or to human or animal life, the Government may, after giving to the person on whose application it had been registered an opportunity of being heard, cancel the registration".

The Pesticide Rules, 1985 (amended)

The ordinance has promulgated to regulate pesticide in Bangladesh. It actually, regulates registration, cancellation, renewal, license, importation, labeling and price fixation etc. processes. This document provisioned for leveling pesticides according to the WHO classification.

Plant Quarantine Act, 2011

The act made provisions for preventing the introduction and spread of insects or pests in Bangladesh. It also provisioned to punish individual or company who export or import any plant or plant product, pest, beneficial organism, soil or packing material prohibited under this Act.

The Destructive Insect and Pest Rules, 1966

The rule has been circulated to restricts/regulate importation of plant and plant products which may carry disease, pest or noxious weed destructive to agriculture. The rule specifically restricts importation of rubber plants except for research subject to prior permission. This also regulates (with some conditions) importation of tree species like Coconut, Betel nut, Banana, Oil palm (*Elaeis guineensis*), Citrus plants, Mango, Cocoa, Ornamental plants, and other like forest tree seeds, forestry products, grass seeds, *Medicago sativa* with prior permission.

3.2. FAO Definition of Pesticide

In a document entitled “The International Code of Conduct on Pesticide Management” prepared by Food and Agriculture Organization (FAO) and World Health Organization (WHO) where definition of pesticide given as “Pesticide means any substance, or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth” (FAO and WHO 2014).

3.3. WHO Classification of Pesticide by Hazard and the Guidelines to Classification, 2009

In 1975, World Health Organization (WHO) classified pesticides on the basis of hazard and was approved by the 28th World Health Assembly. The United Nations Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals (UNCETDG/GHS) approved a document entitled “*The Globally Harmonized System of Classification and Labelling of Chemicals*” in December 2002 with the aim to provide a globally-harmonized system¹ (GHS). The GHS (with subsequent revisions) is now being widely used for the classification and labeling of chemicals worldwide and now WHO is using the Acute Toxicity Hazard Categories from GHG⁶ that is consistent with the World Health Assembly Resolution of 1975 (WHO, 2009). Classes of WHO and GHS are given in tables 3.1 and 3.2 respectively.

Table 3.1: Classes of pesticides according to WHO

WHO class	Category	LD50 for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	<5	<50
Ib	Highly hazardous	5-50	5-200
II	Moderately hazardous	50-2000	200-2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to Present acute hazard	5000 or higher	

Source: WHO, 2009

Table 3.2: GHS Classification

GHS Category	Classification criteria			
	Oral		Dermal	
	LD50 ^a (mg/kg bw)	Hazard statement	LD50 ^b (mg/kg bw)	Hazard statement
Category 1	<5	Fatal if swallowed	<50	Fatal in contact with skin
Category 2	5-50	Fatal if swallowed	50-200	Fatal in contact with skin
Category 3	50-300	Toxic if swallowed	200-1000	Toxic in contact with skin
Category 4	300-2000	Harmful if swallowed	1000-2000	Harmful in contact with skin
Category 5	2000-5000	May be harmful if swallowed	2000-5000	May be harmful in contact with skin

Source: WHO, 2009

According to National Pest Management Policy, 2002, Bangladesh Government has banned all World Health Organization (WHO) Class 1a (extremely hazardous) pesticide compounds, based on formulations, for agriculture purposes. Government also planned to eliminate compounds in Class 1b (highly hazardous). The Government of Bangladesh already banned compounds 21 pesticides partially or completely from 1996-2007 (Chowdhury *et al*, 2017) (Table 3.3). A list of cancelled pesticides by the government of Bangladesh is given in Annex-1. The SUFAL project needs to take proper step during its implementation for avoiding use of pesticides of aforesaid classes of WHO through and cancelled pesticides by the government though proper planning and monitoring.

Table 3.3: Pesticides banned or withdrawn from agricultural practice in Bangladesh

Year	Compound	Status	Reason for ban/withdrawal
1960	Endrin	Withdrawn for all uses	Toxic to fish and aquatic organisms
1997	Chlordane	Withdrawn for all uses	Phasing out of persistent organic pollutants (POPs)

Year	Compound	Status	Reason for ban/withdrawal
1997	DDT	Restricted use only permitted in vector control	Phasing out of persistent organic pollutants (POPs)
1997	Dieldrin	Banned for use on rice and other lowland crops	Phasing out of persistent organic pollutants (POPs)
1997	Heptachlor	Withdrawn for all uses	Phasing out of persistent organic pollutants (POPs)
1998	Pyrethroids	Banned for use on rice and other lowland crops	Toxic to fish and aquatic organisms
1998	Endosulfan	Banned for use on rice and other lowland crops	Environmental Concern
2000	Dichlorvos, dicrotophos, disulfoton, ethyl parathion, methyl parathion, mercury compounds, monocrotophos, phosphamidon	Banned for use on rice and other lowland crops	Removal of all class Ia and Ib pesticides from agricultural use
2004	Methyl bromide	Banned for use on rice and other lowland crops	Montreal protocol on Ozone Layer Depleting Substances (1987)
2007	Hexachlorobenzene, mirex, toxaphene	Banned for use on rice and other lowland crops	Stockholm Treaty on Persistent Organic Pollutants (2001)

Source: Chowdhury *et al.* 2017

3.4 World Bank's Pest Management Safeguard Policy (OP 4.09)

The World Bank has obtained operational policies for assisting borrowers to manage pest that affects agriculture or public health. The Bank encouraged to control pest using IPM technologies like biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest for the agricultural sector and may finance the purchase of pesticides when their use is justified under an IPM approach. The Bank strictly prohibited the use of pesticides that fall under WHO classified Ia and Ib classes. According to National IPM Policy, 2002, Government has already banned pesticides fall under Ia and discourage to use of pesticides fall under class of Ib. The following criteria will be applicable to the selection and use of pesticides in bank financed projects (OP 4.09):

- (a) They must have negligible adverse human health effects.
- (b) They must be shown to be effective against the target species.
- (c) They must have minimal effect on non-target species and the natural environment. The methods, timing, and frequency of pesticide application are aimed to minimize damage to natural enemies. Pesticides used in public health programs must be demonstrated to be safe for inhabitants and domestic animals in the treated areas, as well as for personnel applying them.
- (d) Their use must take into account the need to prevent the development of resistance in pests.

The proposed project has components for nursery and plantation management and may have crop and medicinal plant cultivation for livelihood development that will require pest management. The SUFAL project shall follow IPM and IDM technologies for forest and crop pest and disease management in accordance with OP 4.09.

CHAPTER 4 MAJOR INSECTS PEST AND DISEASES ASSOCIATED WITH FORESTRY SECTOR AS WELL AS THEIR CONTROL MEASURES

4.1 Pest Problems in forestry sector of Bangladesh

One of the major problems of forestry sector is pest and weed management, which has not received adequate attention. Till now technology development for pest, disease and weed management concentrated in agriculture sector. Bangladesh Forest Research Institute identified some major forest pests and diseases of nursery, plantation and timber along with their control measures. Information regarding damage of pest and diseases in forestry sector of Bangladesh are lacking. Therefore, more research needs to be conducted in future for identifying the magnitude of damage and innovating more environmentally friendly pest, disease and weed management.

4.2 Insects Pests and Diseases

Insect pest and diseases are integral part of forest ecosystem. Normally these are present at low density and cause little impact. When the population size of insect or pathogen increased and become threat to causing economically significant damage then control measures are essential. BFRI has already identified major pest and diseases for nursery and plantation of tree species and medicinal plant species. Also identified major timber pest those might be destructive if control measures are not taken on time. Lists of major pest and diseases are given below in table 4.1, 4.2, 4.3, 4.4.

Table 4.1: Major pests of Nursery and Plantation

Sl. No	English name of Pest	Scientific Name	Nature of Damage	Time for high infestation	Host tree
1	Mahogany Shoot Borer	Hypsipyla robusta	The most serious damage to the tree results from the tunneling of the larva in the developing shoots. This boring leads to the death of the terminal shoot and subsequent production of laterals, eventually resulting in a stunted, continuously branched and crooked tree of greatly diminished value for timber production. Growth rate is reduced and death can result from heavy and repeated attacks	When new shoot emerged	Toon, Chikrashi
2	Bengal Amond defoliator	Metanastria hyrtaca	Feed on young leaves and cause defoliation	Infection is high in rainy season	Babla, Kadam, Kanchan, Gamar, Shal, Eucalyptus, Sofeda, Bakul, Hasna, Arjun, Chakua Karai

Sl. No	English name of Pest	Scientific Name	Nature of Damage	Time for high infestation	Host tree
3	Leaf Gall insect of Arjun	<i>Trioza fletcheri</i>	Adult or nymph of this insect sucks juice from young leaves as a result tumor formed in infected part which is called gall. Deformation of leaves and in some cases drying of shoot is the ultimate result.	April-July	--
4	Karai defoliator	<i>Eurema</i> spp., <i>Catopsilia</i> spp.	Feed on leaves without mid rib. In case of high infestation seedlings become weak, growth stunted and finally seedlings may die.	March-November	Sonalu, Rain tree, Minjiri, Lohakath
5	Mosquito bug of Neem	<i>Helopeltis antonii</i>	Sucks sap from young branches and barks of seedlings.	November-December	Guava, Kazu Badam, Korpur, Madar, Mahogany, Tea
6	Teak defoliator	<i>Hyblaea puera</i>	Larvae feed on leaves leaving mid ribs and caused defoliation	March-April	Bormala, Arsol, Horina, Nishinda (Baksha undated)
7	Phyllids of Ipil Ipil	<i>Heteropsylla cubana</i>	It sucks sap from young leaves and shoot. Leaf become yellowish and tender shoot dried up.	October-April	Rain tree (Baksha undated)
8	Termite	<i>Odontotermes</i> spp., <i>Microtermes</i> spp., <i>Microcerotermes</i> spp.	It feed on bark and root of seedlings.		Eucalyptus, Jack fruit, Jhau, Toon, Pine, Shal, Teak, Sisoo, Amra, Mahogany, Litchi, Coconut
9	Cricket	<i>Brachytrypes portentosus</i>	Cut stem of seedlings	March-April and September-October	Teak, Sisoo, Eucalyptus, Jhau, Rubber
10	Mite of Akasmoni	Unidentified	Mite sucks sap of leaves. Leaf turn yellow and dried out	High temperature and less humid condition	Koroi, Coconut, Eucalyptus, Babla, Khoyer, Mengium, Jujube, Mango, Berry
11	Gamar defoliator	<i>Calopepla leayama</i>	Both adult and larvae feed on foliage, cutting large circular holes on them. Sometimes it attacks petioles, buds and shoots. Heavy defoliation causes drying of the leading shoots or even death of whole tree	Rainy season	--

Sl. No	English name of Pest	Scientific Name	Nature of Damage	Time for high infestation	Host tree
12	Scale insect of Babla	Anomalococcus indicus	Both nymph and adult suck sap from twigs and branches results dropping and shedding of foliage, drying up of plants from the top and ultimately death of whole tree	Dry season (Baksha undated)	--
13	Cane top shoot borer	Ommatolopus haemorrhoidalis	The larva of this pest bore bores in the shoot and makes a tunnel inside to feed on the soft internal tissue.	--	--
14	Keora defoliator	Streblothele siva Altica coerulea	The larva <i>Streblothele siva</i> and both larva and adult of <i>Altica coerulea</i> vigorously feed of foliage of seedlings and cause defoliation lead to death of seedlings	--	--
15	Teak Canker Grub	Dihammus cervinus	The insect feed inside the bark and wood of saplings up to 6 years of age. The larva makes tunnel in the cambium and later in the wood. The grinding and injury of cambium stimulate formation of canker.	--	Gamar, Kadam, Bandarhola
16	Amra defoliator	Podontia quatuordecimpunctata	Both larva and adult feed on the foliage leaving the mid-rib and cause defoliation.	July-September	--
17	Bamboo beetle and Bamboo weevil	Cyrtotrachelus dux, and Cyrtotrachelus longimanus	Beetle: Larvae suck sap from tender bamboo shoots. Weevil: Larva make horizontal tunnel along the bamboo	May-October (Rainy season)	Different species of Bamboo
18	Bamboo Leaf Roller	Pyrausta bambucivora and Pyrausta coclesalis	The larva of both insect rolls the leaf and feeds within the roll.	Rainy season	Different species of Bamboo
19	Bamboo Aphid	Oregma bambusae	The juvenile and adult both feed on sap of soft part of Bamboo. It secretes a sweet sticky liquid and later a sooty mold fungus may develop on it.	--	Different species of Bamboo
20	Koroi phyllid	Psylla hyalina, Psylla oblonga	It sucks sap from young leaf, petiole, tender and stem. It started sucking sap before full development of leaves resulting stunted growth of leaf and stem. It secretes a sweet sticky liquid and later a sooty mold fungus may develop on it that hampered food production for tree.	--	Minjiri
21	Bark eater of Koroi	Indarbela quadrinotata, Indarbela tetraonis	Larva of this insect feed on bark. It creates hole in dead branches for its shelter.	--	Mango, Jam, Litchi, Citrus, Jack fruit, Guava
22	Stem borer of Shal	Hoplocerambyx spinicornis	Larva make tunnel into bark and wood. Adults feed on bark and its sap	Rainy season	--

Sl. No	English name of Pest	Scientific Name	Nature of Damage	Time for high infestation	Host tree
23	Shimul Shoor Borer	Tonica niviferana	The larva of this plant make hole at the point of petiole and enter to the stem. Primarily, black excreta and sticky material can be seen in wounded place. It makes hole horizontally along the stem so that the upper portion of injured area dried up.	--	--
24	Kadam defoliator	Arthroschista hilaralis	Larva feed on leaf. Infestation found to be high in young plants	Rainy season	Bandorhola
25	Red Pulm Weevil	Rhynchophorus ferrugineus	Larva make hole on tip of tree and start to feed inside	--	Cocoanut, Betel nut, Khejur
26	Rhinoceros beetle of cocoanut	Oryctes rhinoceros	This insect make hole in tip, petiole, spathe and enter to eat soft tissues. The tip of tree died and when spathe attacked then damage of flower occurs.	Thorough out the year	Betel nut, Nipa pulm, Oil pulm
27	Weevil of Mango	Sternochetus frigidus	Larva feed on mango flesh	--	--
28	Mango phyllid	Aphylla cistellata	This insect sucks sap from young tender shoot and gall formed which prevented leaf and flower to emerge	July-August	--
29	Stem Borer of Jackfruit	Batocera rufomaculata	It bore into bark and stem and feed on tissues. Excreta of insect can be found on wounded place. Plant may die in case of high infestation	--	--
30	Fruit Borer of Jack fruit	Dacus umbrosus	It attacks inflorescence and young fruit and feed on inner portion of the fruit.	--	--
31	Litchi mite	<i>Eriophyes litchi</i>	Both Adult and larva feed on leaves resulting twisting of leaves	High temperature and high humid situation	--
32	Fruit borer of Litchi	Conopomorpha sinensis	Larva feed on seed by making hole near to the stalk	Infestation increased with rain during ripening of fruit	--
33	Jujube Fruit Fly	Carpomya vesuviana	Larva feed on inner portion of fruit.	--	Wild jujube
34	Gall insect of Chatim	Paurophylla tuberculata	This insect sucks sap from leaf, petiole, young stem and fruit and thus gall developed on wounded place	--	--

Source: Baksha *et al.*, 2008; Baksha (Undated); Azad *et al.*, 2017; BFRI, 2001.

Table 4.2: Common timber pests

Sl. No.	Group	Scientific name	Nature of Damage	Host
1	Ambrosia Beetles	<i>Platypus solidus</i>	The insect attacks newly felled logs, branches and unseasoned or green timber. It entered the wood through the intact bark. This beetle grow ambrosia fungus on the walls of tunnel	<i>Acacia catechu</i> , <i>Adina cordifolia</i> , <i>Albizia lebbeck</i> , <i>Albizia procera</i> , <i>Anogeissus acuminata</i> , <i>Anthocephalus chinensis</i> , <i>Artocarpus heterophyllus</i> , <i>Bombax ceiba</i> , <i>Butea monosperma</i> , <i>Dalbergia sissoo</i> , <i>Dipterocarpus pilosus</i> , <i>Duabanga grandiflora</i> , <i>Ficus religiosa</i> , <i>Garuga pinnata</i> , <i>Hevea brasiliensis</i> , <i>Litsea monopetala</i> , <i>Mangifera indica</i> , <i>Shorea robusta</i> , <i>Sterculia villosa</i> , <i>Swintonia floribunda</i> , <i>Tectona grandis</i> and <i>Terminalia bellirica</i>
2		<i>Xyleborus interjectus</i>	The pest attack dead trees, green logs and newly sawn timber. It may attack living trees through injuries or diseased patches of bark. Ambrosia fungus developed on the walls of the tunnels made by the insect.	<i>Albizia lebbeck</i> , <i>Anthocephalus chinensis</i> , <i>Bombax ceiba</i> , <i>Dipterocarpus pilosus</i> , <i>Ficus benghalensis</i> , <i>Ficus religiosa</i> , <i>Garuga pinnata</i> , <i>Gmelina arborea</i> , <i>Mallotus philippinensis</i> , <i>Mesua ferrea</i> , <i>Shorea robusta</i> , <i>Spondius pinnata</i> , <i>Sterculia foetida</i> , <i>Sterculia villosa</i> , <i>Tectona grandis</i> , <i>Terminalia bellirica</i> , <i>Toona ciliate</i> , and <i>Xylia xylocarpa</i>
3	Bark Beetles	<i>Sphaerotrypes siwalikensis</i>	The female penetrates the bark in order to construct gallery for laying eggs. The main damage to the timber associated staining which degrade the value of timber and tunneling which only slightly engraves the surface of the sapwood.	<i>Anogeissus acuminata</i> , <i>Shorea robusta</i> and <i>Terminalia tomentosa</i>
4	Longhorn or Longicorn Beetles	<i>Batocera rufomaculata</i>	They attack living trees as well as freshly felled timber. The larvae make extensive excavation between bark and wood in the early stages. The bark is often completely hollowed out so that it splits and breaks away leaving the tunnel exposed. Later the larvae make extensive, irregular galleries of 2.5 cm. or more in cross-section in the sap and heart wood.	<i>Acacia</i> spp., <i>Adina cordifolia</i> , <i>Albizia lebbeck</i> , <i>Artocarpus heterophyllus</i> , <i>Barringtonia acutangula</i> , <i>Bombax ceiba</i> , <i>Ceiba pentandra</i> , <i>Cocos nucifera</i> , <i>Dalbergia sissoo</i> , <i>Dipterocarpus pilosus</i> , <i>Erythrina orientalis</i> , <i>Ficus</i> spp., <i>Garuga pinnata</i> , <i>Hevea brasiliensis</i> , <i>Lannea coromandelica</i> , <i>Mangifera indica</i> , <i>Morus alba</i> , <i>Shorea robusta</i> , <i>Spondius Pinnata</i> , <i>Sterculia villosa</i> , and <i>Syzygium cumini</i>

Sl. No.	Group	Scientific name	Nature of Damage	Host
5	Flatheaded Borer	<i>Belionota prasina</i>	The insect attacks dead, dying and damaged standing trees. The larva initially bores between bark and sapwood, but later it bores deep in the heartwood making irregular galleries.	<i>Anacardium occidentale</i> , <i>Anogeissus acuminata</i> , <i>Artocarpus lacucha</i> , <i>Mangifera indica</i> , <i>Psidium guava</i> , <i>Sonneratia apetala</i> , <i>Spondius pinnata</i> and <i>Terminalia bellirica</i>
6	Powderpost Beetle	<i>Heterobostrychus aequalis</i>	The insect attacks seasoned (usually below 15% moisture content) wood that contains starch. The larva bores away from the surface a gradually widening tunnel which may reach a length of 25 cm and a diameter of 6 mm.	<i>Adina cordifolia</i> , bamboo, <i>Bombax ceiba</i> , <i>Cassia fistula</i> , <i>Dalbergia sissoo</i> , <i>Dipterocarpus</i> spp., <i>Garuga pinnata</i> , <i>Mangifera indica</i> , <i>Shorea robusta</i> , <i>Sterculia foetida</i> , <i>Tectona grandis</i> , <i>Terminalia bellirica</i> , and <i>Toona ciliata</i>
7	Flattened powderpost Beetle	<i>Lyctus brunneus</i>	Most attack take place at the saw mills in logs or sawn drying timber or anywhere in wood in service. Wood with 15% moisture content is most suitable. Infested timber contains numerous galleries packed fine powdery frass.	<i>Albizia odoratissima</i> , <i>Artocarpus heterophyllus</i> , <i>Bombax ceiba</i> , <i>Dipterocarpus pilosus</i> , <i>Erythrina orientalis</i> , <i>Mangifera indica</i> , <i>Michelia champaca</i> , <i>Quercus</i> sp., and <i>Terminalia bellirica</i>
8	Bamboo Borers or Ghoon Beetles	<i>Dinoderus minutus</i> , <i>D. ocellaris</i> , <i>D. brevis</i>	They attack seasoned bamboo, cane palms and wood with sapwood containing starch. They bore at spots where the external rind is severed or removed. They also bore into the transverse sections of the cut ends and into the terminal walls of the terminal internodes of hallow bamboo	<i>Albizia chinensis</i> , <i>Bambusa arundinacea</i> , <i>Dendrocalamus giganteus</i> , <i>D. hamiltonii</i> , <i>D. strictus</i> , <i>Bombax ceiba</i> , cane, <i>Erythrina orientalis</i> , <i>Melia azedarach</i> , <i>Shorea robusta</i> , <i>Spondius pinnata</i> , <i>Tectona grandis</i> , and palm
9	Termite	<i>Coptotermes</i> spp., <i>Cryptotermes bengalensis</i> , <i>Neotermes bosei</i> , <i>Odontotermes obesus</i> , and	Most termites eat grass and other surface vegetation. Others infest all types of timber and woody materials seasoned or unseasoned.	<i>Artocarpus</i> spp., <i>Casuarina equisetifolia</i> , <i>Toona ciliate</i> , <i>Eucalyptus</i> spp., <i>Mangifera indica</i> , <i>Pinus</i> spp., <i>Shorea robusta</i> , <i>Sterculia villosa</i> and <i>Tectona grandis</i>

Sl. No.	Group	Scientific name	Nature of Damage	Host
		Odontotermes feae		
10	Carpenter Bees	Xylocopa aestuans	The bees usually tunnel in wood which is in poor condition, and rarely damage sound timber. They don't feed on wood. The bore into dead branches or trunk of trees.	Adina cordifolia, Syzygium cumini, and Ficus spp.
11	Marine Borers (Shipworm)	Teredo spp., Bankia spp.	Damage of this insect can be recognized by the white, calcareous lining of the tunnels	Particularly all woods are attacked
12	Marine Borers (Gribbles)	Limnoria spp.	They burrow extensively just below the surface of wood and do not penetrate deeply.	Almost all timbers are attacked
13	Marine Borers (Pill or putty bugs)	Sphaeroma spp.	They burrow extensively just below the surface of wood and do not penetrate deeply. It does less damage than gribbles	Almost all timbers are attacked

Source: Baksha, 2000

Table 4.3: Major diseases of nursery and plantation

Sl. No.	English name	Scientific name of responsible pathogen	Symptom	Time of occurrence/ favorable environment	Host
1	Wilt/Damping off of seedlings	Fusarium spp., Pythium spp., Phytophthora spp., Rhizoctonia solani	After germination rotten lesion has been observed at the base and stem of seedling. Wilting of seedling happened with increase of the lesion	High temperature and humid situation.	Pine, Eucalyptus, Banspata, Chambol, Sisoo, Teak, Kadam, Gamar, Garjan, Mahogany, Jack fruit
2	Root rot of seedlings	Fusarium solani, Rhizoctonia solani, Fusarium oxysporum, Pythium spp., Pseudomonas solanacearum	Brown to black rotten lesion develops on root. Most of the young root has rotten. Green color leaf becomes pale, tender soot die, older leaves dried up.	Excessive rain	Ipil-Ipil, Mahogany, Babla, Mango, Eucalyptus, Jackfruit, Kadam, Bokul, Agar, Kamranga, Negeswar, Gamar, Teak, Rubber, Orshogondha

Sl. No.	English name	Scientific name of responsible pathogen	Symptom	Time of occurrence/ favorable environment	Host
3	Powdery Mildew	Oidium sp.	White powder like fungus develops on leaf	Foggy weather in winter	Hybrid Acacia
4	Top dying	Schizophyllum commune	Seedlings having age of 6 month to 1 year attacked by the disease. Tender shoot dies and leaves become black. Canker with black lesion develops on young stem. Seedlings dry up from upper part.	--	Eucalyptus
5	Leaf spot	Guignardia calami	Small spots develop on infected leaves. Spots are light brown in color later it turns into deep brown. Spots mingle together and form big lesion. Later middle part of spot dries out. Infestation is higher in leaf of lower portion of seedlings.	Dry season	Cane
6	Leaf spot	Cercospora subsessilis	Small spots develop on infected leaves. Center of spots are deep brown in color and margins are pale white. Spots mingle together and form big lesion. Terminal shoot dry out and shading of leaves occur.	--	Neem
7	Collar rot	Chaetomella raphigera	It appears as light brown rotten spots on the collar region, which later coalesced to encircle completely the collar region. The stem above the root bends down and fall to the ground		Keora
8	Blight	Sarocladium oryzae	The fungus causes rot which starts from the top and progresses downwards in the newly emerged culms. Later the affected part die and break down	--	Three species of Bamaboo (Bambusa vulgaris, B. balcoon, B. talda)
9	Leaf Necrosis	Colletotrichum gloeosporioides	Small and big brown spots develop on leaves. Size of spots increased with time and middle	--	Garjan

Sl. No.	English name	Scientific name of responsible pathogen	Symptom	Time of occurrence/ favorable environment	Host
			part of spots shaded. Leaf margin become twisted. Leaves become black and shaded.		
10	Leaf rot	Colletotrichum gloeosporioides	Water soaked lesion develop on leaves. Rotten area found to be higher in leaf margin. Rotten area coalesced together and form big lesion. Later leaves dry up.	Not having proper irrigation facility in nursery	Chapa
11	Dieback of seedlings	Botryosiplodia theobromae	Found in the nursery where grafting has done. Leaf became pale and turn into yellow. Later leaves dry up.	--	Rubber
12	Dieback	Rhizoctonia solani	Rotten lesions develop both in young and older leaves.	--	Kadam
13	Leaf rot	Corynespora csiicola	Yellowish brown spot develops on leaves	--	Rubber

Source: BFRI, 2001; BFRI, 2012; Baksha, 2008.

Table 4.4: Major diseases of some medicinal plants

Sl. No.	English name	Scientific name of responsible pathogen	Symptom	Time of occurrence/ favorable environment	Host
1	Rot root	Fusarium solani	Brown to black rotten lesion develops on root. Most of the young root has rotten. Green color leaf becomes pale, tender soot die, older leaves dried up.	Excessive rain	Orshogondha (Withania somnifera)
2	Leaf blight	Alternaria citri	Yellow spots develop on leaf tip and margin. Center of spots become dry with increase of spot size and hole created in the center of spot. Margin becomes twisted. The whole leaf becomes black and dry.	When the plant reach 3-4 months old	Orshogondha (Withania somnifera)
3	Stem rot	Fusarium Oxysporum	Primarily water soaked light brown spots develop on leaf and stem near to the ground. Spots started to increase towards stem and turn from brown to black. So rotten area can be observed in stem and later stem dried up.	Rainy season due to excessive rainfall	Choi-jal (Pipper chaba)
4	Root rot	Fusarium solani	Brown rotten lesion develops on root. Most of the young root has rotten. With	Rainy season	Choi-jal (Pipper chaba)

Sl. No.	English name	Scientific name of responsible pathogen	Symptom	Time of occurrence/ favorable environment	Host
			the increase of infestation, stem of plant become rotten.		
5	Leaf spot	Cochliobolus lunatus	Small, circular brown spots develop on upper leaf surface. Gradually size of spots increase and turned into deep brown color. Hole formed on the infected area. Tip of leaf become dry when infestation is high.	Foggy weather in winter	Ghritokumari (<i>Aloe indica</i>)
6	Collar rot	Rhizopus stolonifer	Light brown spots develop on leaves near to the ground. Gradually size of spots increase and turned into deep brown color. Lower portion of leaf become rotten. Tip of leaf become dry and later whole leaf rotten when infestation is high	--	Ghritokumari (<i>Aloe indica</i>)
7	Wilting	Fusarium Solani	Leaves become yellow and later dry up. Tap root and its branches become rotten	Rainy season due to excessive rain and water logging	Basak (<i>Adhatoda vasica</i>)
8	Powdery Mildew	Erysiphe sp.	White powdery fungus develops on leaves.	Foggy weather during winter	Tulshi (<i>Ocimum sanctum</i>)

Source: Islam and Nasrin, 2013, Baksha 2008.

4.3 Currently Available IPM Technologies

Integrated Pest Management is an approach for pest management that integrates practices for economic control of pest. This is the process of pest management aims to restrict pest population below the Economic Injury Level (EIL). FAO and WHO, 2016 defines the IPM as “the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and/or the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms”. Integrated pest management has six components for managing pest. The general IPM practices available in Bangladesh are listed below according to IPM components.

1. Regulatory practice
 - Bangladesh has a number of regulatory act, rules, ordinance and polices that have been discussed in policy section those does not allow to enter infected plant material for enter and some encouraged use environmentally safer management methods to avoid environmental damage.
2. Cultural Practice

-
- Preparation of nurseries or main fields or seed beds free from pest infestation by removing plant debris, trimming of bunds, treating of soil, maintaining proper drainage system;
 - Fertilizer application on the basis of soil test;
 - Selecting disease free seed/cutting/sucker and treating them with fungicide or biopesticides before sowing for seed borne disease control;
 - Using organic pesticides;
 - Selecting seed/cutting/sucker of relatively pest resistant/tolerant varieties which play a significant role in pest suppression;
 - Adjusting time of sowing and harvesting to escape peak season of pest attack;
 - Mixed plantation with non-host plant to restrict pest and disease dispersal;
 - Keeping proper plant spacing which makes plants healthier and less susceptible to pests;
 - Optimizing use of fertilizer;
 - Proper water management. High moisture in soil for prolonged period is conducive for development of pests especially soil borne diseases;
 - Proper weed management. It is well known fact that most of weeds besides competing with crop for micronutrients also harbor many pests;
 - Setting up yellow pan sticky traps for white flies and aphids at far above canopy height;
 - Root dip or seedling treatment in pest infested area;
 - While pruning trees remove crowded/dead/broken/diseased branches and destroy them. Do not pile them in the orchards which may act as source of pest infestation;
 - Covering large pruning wounds with Bordeaux paste/paint/coal tar to protect the plants from pest/disease attack;
3. Mechanical Practice
- Removing and destructing egg masses, larvae, pupae and adults of insect pests and disease parts of plants wherever possible.
 - Installing bamboo cage cum bird perches in the field and placing parasitized egg masses inside them for conservation of natural enemies and withholding of pest species wherever possible.
 - Using of light traps.
 - Installing bird perches in the field for allowing birds to sit and feed on insects and their immature stages viz., eggs, larvae and pupae.
 - Using of pheromone trap
4. Genetic practice
- Using pest and disease tolerant varieties
5. Biological Practice
- Using parasitoids, predators and pathogens for controlling pest.
6. Chemical Practice
- Using registered chemicals judiciously when other methods failed to control pest based pest surveillance and Economic Threshold level (EIL).

4.3.1 Current General IPM Measures for Insect Control

Pest infestation during raising seedlings in nurseries, plantations and storage is one of the major problems for forestry sector. Therefore, integrated pest management options are suggested for forest and timber pest management in table 4.5 and 4.6.

Table 4.5: Nursery and plantation pest and their management

Sl. No	English name of Pest	Scientific Name	IPM measures	Chemical control
1	Mahogany Shoot Borer	Hypsipyla robusta	<ol style="list-style-type: none"> 1. Regular observation of nursery to take control measures at initial stage 2. Establishment of nursery at shady place 3. Not producing seedlings of Toon and Chikrashi with Mahogany 4. Regular weeding and cleaning of nursery 5. Infected shoot should be removed and buried into soil of splitting the infected area by knife to kill the larvae. 	<ol style="list-style-type: none"> 1. Mixing Furadan or Curaterr 5G @ 40-50 gm. with soil of each decimal of land
2	Bengal Amond defoliator	Metanastria hyrtaca	<ol style="list-style-type: none"> 1. Hand picking of larvae 2. Collect and destroy egg mass 3. Regular weeding and cleaning of nursery 	<ol style="list-style-type: none"> 1. In case of high infestation, mixing 2-3 ml. Cythine 10 EC with each liter of water and spray on seedlings
3	Leaf Gall insect of Arjun	Trioza fletcheri	<ol style="list-style-type: none"> 1. Regular observation of nursery so that infected leaves can be burned or buried under soil at the initial stage 2. Keeping nursery clean and weed free 3. Infection found to be lower in healthy seedling, so it necessary to use balanced fertilizer 	<ol style="list-style-type: none"> 1. In case of high infestation, mixing 1-2 ml. of Bidrin 87 EC or Perfection 40 EC with each liter of water and spray on seedlings
4	Karai defoliator	Eurema spp., Catopsilia spp.	<ol style="list-style-type: none"> 1. Regular observation of nursery for destroying egg mass and larvae 2. Catching adult with hand net 3. Keeping nursery clean and weed free 4. Making arrangement so that bird can stay at nursery at eat larvae 	<ol style="list-style-type: none"> 1. In case of high infestation, mixing 1-2 ml. of Decis 2.5 EC with each liter of water and spray on seedlings
5	Mosquito bug of Neem	Helopeltis antonii	<ol style="list-style-type: none"> 1. Keeping nursery clean and weed free 2. Collect egg mass and buried into soil 3. Not producing seedlings of any host plant with Neem 	<ol style="list-style-type: none"> 1. In case of high infestation, mixing 1-2 ml. of Decis 2.5 EC with each liter of water and spray on seedlings
6	Teak defoliator	Hyblaea puera	<ol style="list-style-type: none"> 1. Keeping nursery clean and weed free 2. Collect and destroy egg mass and larvae 3. Setting up of light trap to trap adult moths 4. Releasing predatory insects including wasps and spiders 5. Making arrangement so that bird can stay at nursery at eat larvae 	<ol style="list-style-type: none"> 1. In case of early infestation, Mixing 4 ml. of bio pesticide namely Nimbecidine with each litre of water and spray properly on leaf, stem, branches. 2. In case of high infestation, mixing 1-2 ml. of Decis 2.5

Sl. No	English name of Pest	Scientific Name	IPM measures	Chemical control
				EC with each liter of water and spray on seedlings 3. Application of Bacterial insecticide, Thuricide (Bacillus thuringiensis) @ 10gm/10 liter of water can provide effective management of pest (BFRI, 2001)
7	Phyllids of Ipil Ipil	Heteropsylla cubana	<ol style="list-style-type: none"> 1. Keeping nursery clean and weed free 2. Regular observation of nursery to bury infected leaf and shoot under soil 3. Conserving predator insect like lady bird beetle and mites in the nursery 4. Importation of pest tolerant variety 	1. In case of high infestation, mixing 1-2 ml. of Decis 2.5 EC with each liter of water and spray on seedlings
8	Termite	Odontotermes spp., Microtermes spp., Microcerotermes spp.	<ol style="list-style-type: none"> 1. Proper removal of dry leaves, branches, bamboo and wood pieces during nursery establishment 2. Destroying termite's hive in or near to the nursery 3. Care should be taken to protect damage of roots during transplanting 	<ol style="list-style-type: none"> 1. Seed treatment for 10-15 minutes before sowing by Cloropirifos 20 EC @ 2-3 ml. with 1 liter of water 2. Soil treatment at nursery before transplantation or seed sowing by mixing Cloropirifos 20 EC @ 3-4 ml. with 1 liter of water. 3. If infestation occurs after taking proper measures then application of Cloropirifos 20 EC @ 3-4 ml. by mixing with 1 liter of water need to be done in soil in such a way that the mixer will enter deep to soil.
9	Cricket	Brachytrypes portentosus	<ol style="list-style-type: none"> 1. Regular observation of nursery 2. Keeping nursery clean and weed free 3. Destroying insect by inserting water in insect hole 4. Using poison trap 	1. If infestation is not reduced after taking all measures, have to apply Cloropirifos 20 EC 3-4 ml. by mixing with 1 liter of water in insect hole
10	Mite of Akasmoni	Unidentified	<ol style="list-style-type: none"> 1. Keeping nursery clean and weed free 2. Regular observation of nursery to burn or bury infected leaf and shoot under soil 3. Spraying soap water at primary stage 4. In case of high infestation, by mixing 10 gm Urea in 1 liter of water and spay on seedlings 5. Proving shade to nursery 	1. Mix Omaite 57 EC or Talstar 2.5 EC @ 1-2 ml. in each liter of water and spray over seedlings

Sl. No	English name of Pest	Scientific Name	IPM measures	Chemical control
11	Gamar defoliator	<i>Calopepla leayama</i>	<ol style="list-style-type: none"> Adults attracted by white color, white cloth or metal could be used as trap to kill Adult go to hibernation under litter or other shelter that could be used as trap to kill or burn insects The beetle can be collected and killed by hand when they fall to the ground by shaking infested tree. 	<ol style="list-style-type: none"> The pest can be controlled by applying Decis 2.5 EC @ 1-2 ml/1 liter of water on the foliage of the tree
12	Scale insect of Babla	<i>Anomalococcus indicus</i>	<ol style="list-style-type: none"> Feeling and burning of dead trees and looping of infested branches at the initial stage of attack can check further spread of the pest 	<ol style="list-style-type: none"> Applying Dimecron 100 EC @ 12 ml/10 liter of water
13	Cane top shoot borer	<i>Ommatolapusa haemorrhoidalis</i>	<ol style="list-style-type: none"> At the initial stage further attack can be minimize through cutting the infested shoot and killing the larva 	<ol style="list-style-type: none"> Applying Dimecron 100 EC @ 12 ml/10 liter of water on foliage 3 times with 15 days of interval
14	Keora defoliator	<i>Streblote siva Altica coerulea</i>	<ol style="list-style-type: none"> At the initial stage both the pest can be collected and destroyed by hand Making arrangement so that bird can stay at nursery at eat larva Nurseries should be established in such place where tidal water can be used to periodically inundate, kill and wash out pest 	<ol style="list-style-type: none"> Moth and beetle can be controlled by application of Decis 2.5 EC @ 1-2 ml/1 liter of water and
15	Teak Canker Grub	<i>Dihammus cervinus</i>	<ol style="list-style-type: none"> Killing of young larva by opening the tunnel in the bark Painting the lower part of the stem by coaltar or creosote Concealing the bark by wrapping with grass Avoiding growing of teak plantation near other host tree Uprooting host weed Vat (<i>Clerodendrum viscosum</i>) before planting teak Cutting badly cankered stem to obtain coppice shoot 	<ol style="list-style-type: none"> Application of Furadan 5G @ 6 gm/plant in the soil around the base of the plant and subsequently watered can kill pest inside the plant
16	Amra defoliator	<i>Podontia quatuordecimpunctata</i>	<ol style="list-style-type: none"> The adult beetles can be killed when they fall down due to shaking of tree 	<ol style="list-style-type: none"> Application of Ripcord 10 EC @ 12 ml/10 liter of water
17	Bamboo beetle and Bamboo weevil	<i>Cyrtotrachelus dux, and Cyrtotrachelus longimanus</i>	<ol style="list-style-type: none"> Thinning of dense bamboo plantation Cutting the infected part of bamboo and dried under sun 	--
18	Bamboo Leaf Roller	<i>Pyrausta bambucivora and Pyrausta coclesalis</i>	<ol style="list-style-type: none"> The pest can be controlled by tachinid and ichneumonid parasitoids and carabid and mantid predator 	<ol style="list-style-type: none"> Application of Sevin 85 SP @ 8-10 gm/10 liter of water

Sl. No	English name of Pest	Scientific Name	IPM measures	Chemical control
19	Bamboo Aphid	<i>Oregma bambusae</i>	<ol style="list-style-type: none"> Application of soap water mixing with kerosene Avoiding over-fertilizing, which enhances aphid populations 	<ol style="list-style-type: none"> Application of Sumithion 50 EC @ 30-35 ml/10 liter of water.
20	Koroi phyllid	<i>Psylla hyalina</i> , <i>Psylla oblonga</i>	<ol style="list-style-type: none"> Using pest tolerant variety Regular observation of nursery to bury infected leaf and shoot under soil Conserving predator insect like lady bird beetle and mites 	<ol style="list-style-type: none"> Application of Dimecron 100 EC @ 10-15 ml/10 liter of water after a month of interval
21	Bark eater of Koroi	<i>Indarbela quadrinotata</i> , <i>Indarbela tetraonis</i>	<ol style="list-style-type: none"> Cutting of dead branches and painting the cutting point with coal tar or color. Blocking the insect hole with mud or coal tar. Applying kerosene or petrol in insect hole 	<ol style="list-style-type: none"> Applying poison gas or any certified contact insecticide in insect hole
22	Stem borer of Shal	<i>Hoplocerambyx spinicornis</i>	<ol style="list-style-type: none"> Just after the onset of monsoon making trap by cutting nearly dead shal trees and putting them near to the infected trees. This way the adults attracted to the sap released from pieces and come out from trees and can be easily killed by hand 	--
23	Shimul Shoor Borer	<i>Tonica niviferana</i>	<ol style="list-style-type: none"> Regular observation of nursery to take control measures at initial stage Regular weeding and cleaning of nursery Infected shoot should be removed and buried into soil of splitting the infected area by knife to kill the larvae. 	<ol style="list-style-type: none"> Mixing Furadan or Curaterr 5G @ 40-50 gm. with soil of each decimal of land
24	Kadam defoliator	<i>Arthroschista hilaralis</i>	<ol style="list-style-type: none"> It has huge natural predator. So, conservation of predator is good for controlling this insect 	<ol style="list-style-type: none"> Application of Libacid 50 EC @ 20-25 ml/10 liter of water
25	Red Pulm Weevil	<i>Rhynchophorus ferrugineus</i>	<ol style="list-style-type: none"> Killing insect by inserting rod in the insect hole Applying kerosene or insecticide in the insect hole After killing the insect, the hole should be blocked by coal tar or mud Cleaning should be done around the tree 	--
26	Rhinoceros beetle of cocoanut	<i>Oryctes rhinoceros</i>	<ol style="list-style-type: none"> Keeping garden clean and weed free Killing insect by inserting rod in the insect hole Applying kerosene or insecticide in the insect hole After killing the insect, the hole should be blocked by coal tar or mud 	<ol style="list-style-type: none"> Applying Bidrin 85 WSC @ 10-12 ml/10 liter of water
27	Weevil of Mango	<i>Sternochetus frigidus</i>	<ol style="list-style-type: none"> Before bearing flower, weeding should be done around 4 meters of a plan and 	<ol style="list-style-type: none"> Applying Ripcord 10 EC/Basathrin 10 EC/Fenos

Sl. No	English name of Pest	Scientific Name	IPM measures	Chemical control
			spading of soil should be done with it to kill weevils 2. After harvesting all parasitic plants need to be destroyed	10 EC/Simbus 10 EC @ 1 ml/1 liter of water for 2-3 times with 10-15 days interval
28	Mango phyllid	<i>Aphylla cistellata</i>	1. Cutting of branches where gall formed	1. Applying Dimecron 100 EC @ 15-20 ml./10 liter of water for 2-3 times in August with 15 days interval
29	Stem Borer of Jackfruit	<i>Batocera rufomaculata</i>	1. Killing insect by inserting rod in the insect hole 2. Applying kerosene or insecticide in the insect hole 3. After killing the insect, the hole should be blocked by coal tar or mud 4. Cutting of infected branch	--
30	Fruit Borer of Jack fruit	<i>Dacus umbrosus</i>	1. Collecting and destroying infected inflorescence and fruit 2. Keeping garden clean 3. lower portion of growing fruit could be covered by polythene	1. Applying Sumithion 60 EC @ 2 ml./liter for 2-3 times with 10 days interval
31	Litchi mite	<i>Eriophyes litchii</i>	1. Mite infested branches have to be removed and burned during collection of fruit 2. Painting base of plant with coal tar in winter	1. Applying Vertimec 1.8 EC @ 1 ml./liter of water for 2-3 times with 15 days interval
32	Fruit borer of Litchi	<i>Conopomorpha sinensis</i>	1. Keeping garden clean	2. Applying ripcord 10 EC/ Sumicidine 20 EC @ 1 ml./liter of water for 2-3 times with 15 days interval when the fruit reach to marble size
33	Jujube Fruit Fly	<i>Carpomya vesuviana</i>	1. Removal of wild Jujube plant from the area 2. Using Pheromone trap	1. Applying Rogor 40 EC @ 15-20 ml./liter of water after bearing of fruit
34	Gall insect of Chatim	<i>Paurophylla tuberculata</i>	1. Removal of infected part and burned	1. Applying Dimecron 100 EC @ 12-15 ml./liter of water

Source: Baksha *et al.*, 2008; Baksha (Undated); Azad *et al.*, 2017; BFRI, 2001.

Table: 4.6: Common timber pest and their management

Sl. No.	Group	Scientific name	IPM measures
1	Ambrosia Beetles	<i>Platypus solidus</i>	Management 1. Rapid extraction of logs from the forest and their quick conversion and seasoning are the most effective means of reducing the damage 2. Logs should be lined up north and south, raised on skids, not piled, half-turned at intervals so that they can be dried out quickly

Sl. No.	Group	Scientific name	IPM measures
			<ol style="list-style-type: none"> 3. Logs should be completely submerged under water just after felling. It suffices, if the logs are inundated by tidal water once a day 4. Bark of log should be removed and treated with coal tar 5. Some species remain alive after felling and the insect does not attack alive log. Therefore, taking all initiatives (e.g. retention of bark, keeping in shade) should be taken to keep alive after felling. 6. Squaring logs of many species decreases the amount of pin holding owing to the exposure of heartwood which is not attacked 7. Wastage from felling or felling refuse should be disposed quickly. It could be dumped at humid shaded place to make trap and burned it just after attack by insect. 8. At the saw mills or storage depots any local breeding of borers should be prevented by constant inspection and destruction of breeding material. 9. Speeding up drying of sawn timber having sapwood reduces the danger of attack. <p>Remedial</p> <ol style="list-style-type: none"> 1. Timber already attacked by pinhole borers should be quickly dried out by sun heating (1 to 2 weeks) or kiln seasoning (12 hours below 60° C) 2. Infested logs should be immediately converted into timber of small dimensions, peeling of veneers etc. Sawn timber must be must be dipped immediately in a preservative and stacked properly.
2		<i>Xyleborus interjectus</i>	Same as <i>Platypus solidus</i>
3	Bark Beetles	<i>Sphaerotrypes siwalikensis</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. Removal of bark from logs prevents attack 2. Burning of logging debris help to reduce population 3. Trees damaged by fire or uprooted by wind should be removed promptly 4. Spraying logs with residual insecticide will prevent attack <p>Remedial</p> <ol style="list-style-type: none"> 1. Fumigation with registered insecticide 2. Infested logs should be exposed to direct sun light, turning them at 2-3 days interval, so that borers are killed by heating and drying
4	Longhorn or Longicorn Beetles	<i>Batocera rufomaculata</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. Bark should be removed from the log just after felling a tree to prevent oviposition 2. Rapid extraction and conservation of logs 3. Spraying logs with residual insecticide will prevent attack <p>Remedial</p> <ol style="list-style-type: none"> 1. Attacked logs should be debarked, removed and converted to destroy the immature stage inside the wood 2. Kiln drying of timber could kill all stages of the beetle

Sl. No.	Group	Scientific name	IPM measures
5	Flatheaded Borer	<i>Belionota prasina</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. Rapid extraction and conservation of logs 2. Spraying logs with residual insecticide will prevent attack <p>Remedial</p> <ol style="list-style-type: none"> 1. Kiln drying of infested timber could destroy all the stages of the beetle
6	Powderpost Beetle	<i>Heterobostrychus aequalis</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. The insect attack can be prevented by the use of non-susceptible timber 2. Sapwood from the susceptible timber should be removed 3. Timber with sapwood should be impregnated with an approved preservative 4. Articles can be protected by applying paint, varnish or wax polish to all exposed surface 5. All exposed surface of timber may be treated with residual insecticide diluted in water or oil. <p>Remedial</p> <ol style="list-style-type: none"> 1. Infested articles can be disinfected by fumigation 2. Small wooden articles such as curved souvenirs, flower vase, astray, etc. are disinfected by placing them in a freezer 3. Replacement of affected timber with a non-susceptible material
7	Flattened powderpost Beetle	<i>Lyctus brunneus</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. The insect attack can be prevented by the use of non-susceptible timber 2. Sapwood from the susceptible timber should be removed 3. Timber with sapwood should be impregnated with an approved preservative 4. Articles can be protected by applying paint, varnish or wax polish to all exposed surface 5. All exposed surface of timber may be treated with residual insecticide diluted in water or oil. <p>Remedial</p> <ol style="list-style-type: none"> 1. Infested articles can be disinfected by fumigation 2. Small wooden articles such as curved souvenirs, flower vase, astray, etc. are disinfected by placing them in a freezer 3. Replacement of affected timber with a non-susceptible material
8	Bamboo Borers or Ghoon Beetles	<i>Dinoderus minutus</i> , <i>D. ocellaris</i> , <i>D. brevis</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. Bamboo should be felled in the seasons when the starch content in the culm is lowest. 2. Bamboo should be immersed in water (for 6-12 months in fresh water) to leach out certain soluble food material and also impart unpleasant odor. Smoking may impart toxic effect or destroy starch by heating. 3. Bamboo may have dressed in coal tar, paint, varnish or wax polish to all exposed surface 4. Bamboo stacks should be inspected at least twice (March and July) a year and attacked pieces should be destroyed

Sl. No.	Group	Scientific name	IPM measures
			<p>5. Spay or dip treatment with any residual insecticide will provide protection against fresh attack</p> <p>Remedial</p> <ol style="list-style-type: none"> 1. Submersion in cold water for one week or hot water for some time will kill most of the borers 2. Attacked bamboo in which the borings are not too far advanced can be saved by the preservative treatment 3. Small items like curved souvenirs can be disinfected by placing them in a freezer for a week 4. Heat sterilization in kiln (52°C at 60-100% relative humidity for 3-7 hours) will kill borer inside 5. Fumigation of attacked bamboo with methyl bromide, carbon tetrachloride, etc in closed chamber will also kill most of the borers.
9	Termite	<i>Coptotermes spp.</i> , <i>Cryptotermes bengalensis</i> , <i>Neotermes bosei</i> , <i>Odontotermes obesus</i> , and <i>Odontotermes feae</i>	<p>Preventive</p> <ol style="list-style-type: none"> 1. Regular inspection should be made for early detection and removal of damaged timber 2. Physical barriers such as concrete, or metal cap in underground portion of wood should be used 3. Preservative (CCB) treated timber should be used 4. Relatively resistant timber should be used. 5. Painting or spaying with oil-based residual insect on timber 6. Screening of doors, windows and other openings should be done 7. Soils around the base of wooden structure should be treated with residual insecticide <p>Remedial</p> <ol style="list-style-type: none"> 1. In case of high infestation, the wood should be replaced 2. Dry wood termites may be killed by tent fumigant insecticide 3. Minor damage can be treated by drilling the galleries and injecting an oil based insecticide 4. Industrial dust could be blown or injected into the termite galleries or mound 5. Termite nest should be destroyed
10	Carpenter Bees	<i>Xylocopa aestuans</i>	<ol style="list-style-type: none"> 1. Timber which is being attacked by the insect is usually in poor condition and should be replaced
11	Marine Borers (Shipworm)	<i>Teredo spp.</i> , <i>Bankia spp.</i>	<ol style="list-style-type: none"> 1. Infested timber should be removed from salt water to fresh water 2. Resistant timber should be used 3. Timber should be impregnated with a preservative 4. Timber should be covered with antifouling paints such as heavy coal tar or creosote solution.
12	Marine Borers (Gribbles)	<i>Limnoria spp.</i>	<ol style="list-style-type: none"> 1. Infested timber should be removed from salt water to fresh water 2. Resistant timber should be used 3. Timber should be impregnated with a preservative

Sl. No.	Group	Scientific name	IPM measures
			4. Timber should be covered with antifouling paints such as heavy coal tar or creosote solution.
13	Marine Borers (Pill or putty bugs)	<i>Sphaeroma</i> spp.	<ol style="list-style-type: none"> 1. Infested timber should be removed from salt water to fresh water 2. Resistant timber should be used 3. Timber should be impregnated with a preservative 4. Timber should be covered with antifouling paints such as heavy coal tar or creosote solution.

Source: Baksha, 2000

4.3.2 Current General IDM Measures for Disease Control

The concept of Integrated Disease Management (IDM) derived from IPM which includes disease management through applying integrated methods by continuous field observation. The technologies for disease management through land selection and preparation, using resistant variety, changing sowing method, change in micro environment by improving drainage facility, pruning, thinning and providing shade. Lastly, using chemicals judiciously on the basis of disease surveillance and EIL for disease management if the disease could not be controlled by other methods. Integrated management of major diseases of forest species are given in table 4.7 and 4.8.

Table 4.7: Major diseases of nursery and plantation and their integrated management

Sl. No.	English name	Scientific name of responsible pathogen	IDM measures	Chemical control as a part of IDM
1	Wilt/Damping off of seedlings	<i>Fusarium spp.</i> , <i>Pythium spp.</i> , <i>Phytophthora spp.</i> , <i>Rhizoctonia solani</i>	<ol style="list-style-type: none"> 1. Using sandy or sandy loam soil for nursery 2. Avoiding excess use of dung and organic fertilizer 3. Properly spading soil of nursery so that bottom soil comes to upper portion and sun drying of soil properly. 4. Keeping proper drainage for nursery 5. Avoiding dense sowing of seeds 6. Covering seedlings with white polythene to protect them from excessive rain 	<ol style="list-style-type: none"> 1. Applying Dithane M-45 @ 2 gm/liter of water on seedlings with incidence of disease 2. Seed treatment with Bavistin DF @ 2.5 ml/1 liter of water/1 kg seed 3. Soil treatment with formalin with ratio of 1:10 formalin and water. Then watering the soil in such a way that the mixture penetrates up to 10-15 cm of soil. After that the bed should be covered with white polythene for 3 days
2	Root rot of seedlings	<i>Fusarium solani</i> , <i>Rhizoctonia solani</i> , <i>Fusarium oxysporum</i> , <i>Pythium spp.</i> , <i>Pseudomonas solanacearum</i>	<ol style="list-style-type: none"> 1. Using disease free and healthy seed with high germination capacity 2. The place of nursery should be free from water logging 3. Density of seedlings should not be high 	<ol style="list-style-type: none"> 1. Soil treatment with formalin with ratio of 1:10 formalin and water. Then watering the soil in such a way that the mixture penetrates up to 10-15 cm of soil. After that the bed

Sl. No.	English name	Scientific name of responsible pathogen	IDM measures	Chemical control as a part of IDM
			<ol style="list-style-type: none"> Using less amount of organic fertilizer Providing necessary irrigation regularly 	<ol style="list-style-type: none"> should be covered with white polythene for 3 days Applying Sunvit 50 WP @ 2 gm/liter of water at nursery
3	Powdery Mildew	<i>Oidium sp.</i>	<ol style="list-style-type: none"> At primary stage, leaf of tree should be cut and buried in soil or burned. Using resistant cultivars 	<ol style="list-style-type: none"> Applying Nuben 72 WP/ Haymaxyl MZ 72 WP @ 2 gm/liter of water on seedlings
4	Top dying	<i>Schizophyllum commune</i>	<ol style="list-style-type: none"> Using disease free and healthy seed Care should be taken during shifting of seedlings from bed to polybag to avoid any kind of injury Seedlings should not be kept at nursery for long time Providing balance fertilizer and adequate irrigation 	<ol style="list-style-type: none"> Applying Bavistin DF @ 2gm/liter of water with the incidence of disease
5	Leaf spot	<i>Guignardia calami</i>	<ol style="list-style-type: none"> Providing balanced fertilizer at nursery. Providing timely irrigation 	<ol style="list-style-type: none"> Spraying Dithane M 45 @ 2 gm/liter of water.
6	Leaf spot	<i>Cercospora subsessilis</i>	<ol style="list-style-type: none"> Avoiding raising of seedling densely Providing balance fertilizer and adequate irrigation Arranging partial shade at nursery Older seedlings should not be kept at nursery 	<ol style="list-style-type: none"> Spraying Dithane M 45 @ 2 gm/liter of water.
7	Collar rot	<i>Chaetomella raphigera</i>		<ol style="list-style-type: none"> Spraying Dithane M 45 @ 2 gm/liter of water.
8	Blight	<i>Sarocladium oryzae</i>	<ol style="list-style-type: none"> Planting rhizomes collected from healthy clump Adding new soil at the base of the clump in April-May Cutting and burning of dead or affected part Burning of leaf and branch litters in clump in April. 	<ol style="list-style-type: none"> Spraying Dithane M 45 @ 2 gm/liter of water.
9	Leaf Necrosis	<i>Colletotrichum gloeosporioides</i>	<ol style="list-style-type: none"> Arranging partial shade at nursery As spores are spread by water splash, avoid overhead irrigation or exposure to rainfall if possible. If possible water early in the day so that foliage dries out before evening 	<ol style="list-style-type: none"> Spraying Dithane M 45 @ 2 gm/liter of water for 2-3 times with 10-15 days interval

Sl. No.	English name	Scientific name of responsible pathogen	IDM measures	Chemical control as a part of IDM
			<ol style="list-style-type: none"> 4. 4. Promote air circulation and reduce periods of leaf wetness by thinning plant canopies and avoiding close packing of plants/cuttings 5. 5. Do not handle plants when wet 6. 6. Avoid injuries and control insect/mite pests 7. 7. Separate healthy and diseased plants 8. 8. Remove and discard severely affected plants 9. 9. Prune out and discard diseased twigs, shoots and leaves and remove any leaf litter accumulating at the base of plants to minimize the buildup of spores 10. 10. Propagate from disease free stock only 11. 11. If possible, avoid high temperatures and humidity 12. 12. Minimize plant stress (e.g. water and temperature stress) 13. 13. To aid recovery of plants affected by leaf spots and blights, fertilize and water well 14. 14. Where possible, use resistant cultivars and species. 	
10	Leaf rot	<i>Colletotrichum gloeosporioides</i>	<ol style="list-style-type: none"> 1. Arranging partial shade at nursery 2. As spores are spread by water splash, avoid overhead irrigation or exposure to rainfall if possible. 3. If possible water early in the day so that foliage dries out before evening 4. Promote air circulation and reduce periods of leaf wetness by thinning plant canopies and avoiding close packing of plants/cuttings 5. Do not handle plants when wet 	<ol style="list-style-type: none"> 1. Spraying Sunvit 50 WP @ 2 gm/liter of water for 2-3 times with 10-15 days interval

Sl. No.	English name	Scientific name of responsible pathogen	IDM measures	Chemical control as a part of IDM
			<ol style="list-style-type: none"> 6. Avoid injuries and control insect/mite pests 7. Separate healthy and diseased plants 8. Remove and discard severely affected plants 9. Prune out and discard diseased twigs, shoots and leaves and remove any leaf litter accumulating at the base of plants to minimize the buildup of spores 10. Propagate from disease free stock only 11. If possible, avoid high temperatures and humidity 12. Minimize plant stress (e.g. water and temperature stress) 13. To aid recovery of plants affected by leaf spots and blights, fertilize and water well 14. Where possible, use resistant cultivars and species. 	
11	Dieback of seedlings	<i>Botryosiplodia theobromae</i>	<ol style="list-style-type: none"> 1. Seedlings with proper root system need to be transplanted so that seedlings can uptake nutrition and water properly from soil. 2. Care should be taken during transplanting of seedlings to avoid root injury 	<ol style="list-style-type: none"> 1. Spraying Dithane M 45 @ 2 gm/liter of water for 2-3 times with 7 days interval in soil of nursery or poly bag
12	Dieback	<i>Rhizoctonia solani</i>		<ol style="list-style-type: none"> 1. Spraying Cupravit/ Macuprax @2 gm/liter of water for 2-3 times
13	Leaf rot	<i>Corynespora cssiicola</i>	<ol style="list-style-type: none"> 1. Shading the nursery reduces the disease incidence. 2. Maintain seedlings in vigorous condition through adequate balanced nutrition. 	<ol style="list-style-type: none"> 1. Spraying Dithane M 45 @ 2 gm/liter of water for 2-3 times with 7 days interval

Table 4.8: Major diseases of some medicinal plants and their integrated management

Sl. No.	English name	Scientific name of pathogen	Host	IPM measures	Chemical control as a part of IPM
1	Rot root	<i>Fusarium solani</i>	<i>Orshogondha (Withania somnifera)</i>	<ol style="list-style-type: none"> Using disease free and healthy seed with high germination capacity The place of nursery should be free from water logging Density of seedlings should not be high Using less amount of organic fertilizer Providing necessary irrigation regularly 	<ol style="list-style-type: none"> Soil treatment with formalin with ratio of 1:10 formalin and water. Then watering the soil in such a way that the mixture penetrates up to 10-15 cm of soil. After that the bed should be covered with white polythene for 3 days Applying Sunvit 50 WP @ 2 gm/liter of water at nursery
2	Leaf blight	<i>Alternaria citri</i>	<i>Orshogondha (Withania somnifera)</i>	<ol style="list-style-type: none"> Selection of high and well drained land After tillage the soil should be sun dried for few days Mixing 50 kg organic fertilizer and 2 kg Neem cake/ neem fertilizer with each decimal of land Providing balanced fertilizer and adequate irrigation Seed collection from health and disease-free mother plant Keeping garden clean and weed free Collection of infected leaves and buried under soil or burned 	<ol style="list-style-type: none"> Soil treatment with commercial formalin (40%) Seed treatment with Bavistin DF @ 2-4 gm/liter of water Spraying Bordeaux mixture for 2-3 time with 7 days interval If disease cannot be controlled after taking other measures then spraying Sunvit 50 WP @ 2 gm/liter of water
3	Stem rot	<i>Fusarium Oxysporum</i>	Choi-jal (<i>Pipper chaba</i>)	<ol style="list-style-type: none"> Selection of high and well drained land Ground of planting point should be clean and weed free Before planting Neem organic fertilizer @ 100 gm/pit can be used Cutting should be collected from healthy and disease-free plant Infected plant should be uprooted and burned 	<ol style="list-style-type: none"> Cutting should be treated with Bavistin DF @ 2-5 gm/liter of water for 1 hour Spraying Bordeaux mixture for 2-3 time with 7 days interval If disease cannot be controlled after taking other measures then spraying Bavistin 50 WP or Dithane M-45 @ 2 gm/liter of water

Sl. No.	English name	Scientific name of pathogen	Host	IPM measures	Chemical control as a part of IPM
				6. At primary stage of disease spraying 1% soap mixing with water	
4	Root rot	<i>Fusarium solani</i>	Choi-jal (<i>Pipper chaba</i>)	<ol style="list-style-type: none"> 1. Selection of high and well drained land 2. After tillage the soil should be sun dried for few days 3. Mixing 50 kg organic fertilizer and 2 kg Neem cake/ neem fertilizer with each decimal of land 4. Providing balanced fertilizer and adequate irrigation 5. Cutting collection from health and disease-free mother plant 6. Keeping garden clean and weed free 7. Uprooting of infected Plants and buried under soil or burned 8. During excessive rain, seedlings should be covered with polythene. 	<ol style="list-style-type: none"> 1. Cutting need to be treated t with Bavistin DF @ 2-4 gm/liter of water for an hour 2. Spraying Bordeaux mixture for 2-3 time with 7 days interval 3. If disease cannot be controlled after taking other measures then spraying Dithen M 45/Bavistin DF @ 2 gm/liter of water.
5	Leaf spot	<i>Cochliobolus lunatus</i>	Ghritokumari (<i>Aloe indica</i>)	<ol style="list-style-type: none"> 1. After tillage the soil should be sun dried for few days 2. Mixing lime, neem cake and organic fertilizer during land preparation 3. Cutting/sucker collection from health and disease-free mother plant 4. Keeping garden clean and weed free 5. Collecting infested leaves and buried under soil or burned 	<ol style="list-style-type: none"> 1. Cutting/sucker need to be treated with Bavistin DF @ 2-5 gm/liter of water for an hour 2. Spraying Bordeaux mixture for 2-3 time with 7 days interval 3. If disease cannot be controlled after taking other measures then spraying Dithen M-45 @ 2 gm/liter of water on soil and plant.
6	Collar rot	<i>Rhizopus stolonifer</i>	Ghritokumari (<i>Aloe indica</i>)	<ol style="list-style-type: none"> 1. After tillage the soil should be treated by covering it with polythene for 2-3 days or applying formalin (40%). 2. Mixing lime, neem cake and organic fertilizer during land preparation 	<ol style="list-style-type: none"> 1. Cutting/sucker need to be treated with Bavistin DF @ 2-5 gm/liter of water for an hour 2. Spraying Bordeaux mixture for 2-3 time with 7 days interval

Sl. No.	English name	Scientific name of pathogen	Host	IPM measures	Chemical control as a part of IPM
				<ol style="list-style-type: none"> 3. Cutting/sucker collection from health and disease-free mother plant 4. Keeping garden clean and weed free 5. Collecting infested leaves and buried under soil or burned 	<ol style="list-style-type: none"> 3. If disease cannot be controlled after taking other measures then spraying Sunvit 50 WP @ 2 gm/liter of water.
7	Wilting	<i>Fusarium Solani</i>	Basak (<i>Adhatoda vasica</i>)	<ol style="list-style-type: none"> 1. Selection of high and well drained land 2. After tillage the soil should be sun dried for few days (3-4 days). 3. After tillage the soil should be treated by covering it with polythene for 2-3 days or applying formalin (40%). 4. Mixing 50 kg organic fertilizer and 2 kg Neem cake/ neem fertilizer with each decimal of land 5. Cutting collection from health and disease-free mother plant 6. Keeping garden clean and weed free 7. Uprooting of infected Plants and buried under soil or burned 8. During excessive rain, seedlings should be covered with polythene. 	<ol style="list-style-type: none"> 1. Cutting need to be treated with Bavistin DF @ 2-5 gm/liter of water for an hour 2. Spraying Bordeaux mixture for 2-3 time with 7 days interval 3. If disease cannot be controlled after taking other measures then spraying Dithen M 45/Bavistin DF @ 2 gm/liter of water for 2-3 times with 7 days interval.
8	Powdery Mildew	<i>Erysiphe sp.</i>	Tulshi (<i>Ocimum sanctum</i>)	<ol style="list-style-type: none"> 1. After tillage the soil should be sun dried for few days (5-7 days). 2. After tillage the soil should be treated by covering it with polythene for 3-4 days or applying formalin (40%). 3. Primarily collecting infected leaves and buried under soil or burned 4. During foggy and wet condition, seedlings should be covered with polythene. 	<ol style="list-style-type: none"> 1. Spraying Bordeaux mixture for 2-3 time with 7 days interval 2. If disease cannot be controlled after taking other measures then spraying Sunvit 50 WP/Nuben 72 WP @ 2 gm/liter of water for 2-3 times with 10 days interval.

Source: Islam and Nasrin 2013, Baksha, 2008

4.3.3. Weed Management

Bangladesh Forest Department followed burning method for management of weed before plantation in the past. The method is detrimental for conservation of both floral and faunal biodiversity. Recently the department has adopted weeding through cutting of unwanted trees, herbs and shrubs which is costly but environmental friendly practice. During weeding they keep the natural trees which considered being the good practice. The PMP also suggesting to carry out environmental friendly weed management rather than burning.

4.3.4. Pest management for crop based livelihoods

The project intended to provide livelihoods for reducing dependency of people over forest resources. This livelihood component may contain cultivation of crops and fruits where there will be a need for pesticide application. In case of crop and fruit production, for pest and disease management IPM technologies should be followed. Pesticide application is the last component of IPM. Therefore, pesticides can be applied when pest are not controlled by using other environmentally safe measures. Registered pesticides have to be selected and cancelled pesticides must be rejected in case of pesticide selection will be the prime principal to use pesticides for crop and fruit pest management.

CHAPTER 5 FRAMEWORK AND STRATEGIES FOR IMPLEMENTATION OF PEST MANAGEMENT PLAN

5.1 Fundamentals of PMP Planning

When developing a pest management plan, it is important to:

- consider why need a plan for SUFAL
- know what the plan to achieve by the project components
- understand the invasive species and other animals in SUFAL area
- consider the principles of pest management
- consider other pest management plans
- set achievable objectives through implementation of the PMP.

Before finalizing a pest management objective, it is also important to consider the interaction between pests and other issues such as land, water, vegetation and cultural heritage.

5.1.1 Steps to planning PMP

The following 6 steps will assist in effective pest management planning:

1. Understand the pest issue
2. Develop a draft pest management plan
3. Consultations
4. Finalize and implement the plan
5. Monitoring
6. Evaluate and review the overall results

5.1.2 Principles of Pest Management

Eight principles of pest management are suggested to follow as common basis for the management of pest animals throughout project area of SUFAL. The consideration of all these principles is critical to the success of any pest management activity, regardless of scope and scale. These are:

1. Integration: Pest management in aquaculture is an integral part of managing natural resources and agricultural systems.
2. Public awareness: Public awareness and knowledge of pest must be raised to increase the capacity and willingness of individuals to participate in control.
3. Commitment: Effective pest management requires shared responsibility, capability, capacity and a long-term commitment by land owners/ managers, the community, industry groups and government. Those that create the risks associated with pest species introduction or spread and those that benefit from the pest management should help to minimize the impacts of pest animals and contribute to the costs of management.
4. Consultation and partnership: Consultation and partnership arrangements among the users, local communities, industry groups, government agencies and local governments must be established to achieve a collaborative and coordinated approach to management.
5. Planning: Planning for pest management should be based on risk management to ensure that resources target the priorities identified at local, regional, and national levels.

6. Prevention and early intervention: Preventive pest management is generally more cost-effective than other strategies and is achieved by: preventing the spread of pest species, and viable parts of these pests, especially by human activity early detection and intervention.
7. Best practice: Pest management must be based on ecologically and socially responsible practices that protect the environment and the productive capacity of natural resources while minimizing impacts on the community. It should balance feasibility, cost-effectiveness, sustainability, humaneness, community perceptions, emergency needs and public safety.
8. Improvement (research, monitoring and evaluation): Research about pest and regular monitoring and evaluation of control activities is needed to make evidence-based decisions and improve pest management practices.

5.2 Steps in Setting up IPM in SUFAL

5.2.1 Identify the implementation team

Transition to a PMP program requires a diverse, action-oriented PMP Committee. This PMP Committee will be an environmentally conscious committee lead by the Project Director at PMU, FD. A representative of the Divisional Forest Office and Nursery Owners will be members of this Committee. The leader of this team should be familiar with pests, pesticides and pesticide regulations. This arrangement is appropriate, because implementation of an IPM program can be tracked as a performance indicator.

PMP leadership is guided by pest management principles and environmental issues. Leadership with such academic background and experience qualifies to serve as an authority to supervise PMP implementation. Other team members include Environmental, Agriculture Extension , agronomists, plant protection experts (entomologists, pathologists), and health officer.

5.2.2 Decide on the scale of implementation

To determine the scale of implementation, a strategic approach will be taken. IPM will be clearly defined and discussed by the PD as is done for all other development projects. A representative of the Divisional Forest Offices must attend these meetings to help explain the IPM approach and give examples of similar documented success studies. Through these discussions comprehension will be achieved, and potential objections will be addressed with successful practical examples.

5.2.3 Review and set measures objectives for the PMP

The PMP Committee will set measurable objectives and refine the IPM indicators relevant to their areas; and determining factors such as:

- When the IPM program will start
- How much it will cost
- What will be accomplished by choosing IPM
- How success shall be monitored

The determination of above must be done prior to IPM implementation. Additionally, measurable goals will be set, to track:

- Pest management costs;
- Monitoring of pest activity before and after implementation of the IPM program;
- Number of calls related to pest problems and toxic chemical use reduction.

Furthermore, the time when the shift to IPM will occur must be discussed and agreed upon prior to implementation. The initial step will be to establish an implementation timeline that includes time to execute all of the steps outlined in the implementation plan. It is imperative to include time to organize the administration of the IPM and conduct any farmer training as well as manage the IPM process.

The IPM Committee will gather information on previously implemented or currently being implemented IPM programs; the time it took to develop them and how successful they have been. They will obtain the budgetary and any technical information for the previously implemented IPM programs and analyze the elements to establish lessons to learn. Field visits to currently running programmes will be conducted to get a practical insight.

Reduced pesticide use is the substantive yard stick in measuring an IPM's ability to create a safer environment. Baseline study will be conducted and therefore an information data base that includes annual quantities of pesticides used will be designed to enable comparative analysis to the previous years. The goal will be a downward trend over time or ideally, a specific reduction amount, ultimately leading to a scant usage of highly toxic pest control chemicals.

5.2.4 Analysis current housekeeping, maintenance and pest control practices

While preparing to make a transition to IPM, the PMP Committee will familiarize itself with the organization's current policies and practices with respect to structural maintenance, sanitation and pest control. Occasionally, current practice may be consistent with IPM principles. Familiarization will provide the flexibility necessary to adapt to, and prepare for the necessary changes.

Structural maintenance is arguably the most efficient way to keep pests out of a facility because it physically stops pests from entering wherever possible. Structural maintenance will therefore be a regular part of the IPM. Cracks, crevices or other unnecessary openings in the building exterior that can be used by pests as harborage areas or entry points regardless of size, will be sealed appropriately. Sanitation deprives pests of food and water. A sanitation plan must therefore be accounted for in the development of an IPM. Staff must be provided with special sanitation training.

5.2.5 Establish a system of regular IMP inspection

PMP's central focus is regular facility inspections. Such inspections are the "lifeblood" for a continuous cycle of IPM activities that may or may not include chemical treatments. Activities will include:

- a) Routine Inspections
- b) Pest Identification
- c) Selection of Control Methods
- d) Monitoring and Evaluation

IPM inspections must emphasize on the four "zones" of pest activity:

- a) Entry points
- b) Water sources
- c) Food sources
- d) Harborage areas.

During inspections, all existing pest issues and potential problem areas, inside and outside, must be noted for follow-up.

For in-house IPM programs, the greatest inspection challenge will be establishing routine, proactive surveillance by trained specialists. To ensure this is done, the EMC or an independent consultant will conduct inspections and audits twice a year.

5.2.6 Define the treatment policy selection

A clear written policy on how the facility will respond to pests, when they appear, must be developed. Included in the policy will be definitions of both non-chemical and chemical treatment options and the sequence or prioritization in which they will be considered. It should be unequivocal on when and where chemical treatments are appropriate. Finally, it should include an “approved materials” list to ensure informed choices when chemical treatments are applied.

The key to an effective IPM is to correctly identify pests that have invaded the area before. Due to pest behavior variations from one species to the other, the appropriate response will vary accordingly.

Once the pest is identified and the source of activity is pin-pointed, the treatment policy will call for habitat modifications such as exclusion, repair or better sanitation. These counter measures can drastically minimize pest presence before chemical responses are considered. Additional treatment options—chemical and non-chemical can then be tailored to the biology and behavior of the target pest.

The final step in the pest response cycle is Monitoring. The information gained through on-going monitoring of the problem will facilitate determination of supplemental treatment options if required.

5.2.7 Establish communication protocols

Communication protocols must be developed to assist environmental services, facility maintenance, facility management and service providers. IPM is a cooperative effort and therefore effective communication between various parties is essential for success. PMP Committee and Nursery officials/Owners must document pest sightings.

The PMP Committee will make recommendations and notify DFO for pesticide treatments. They will also communicate with the maintenance team to make the necessary repairs.

5.2.8 Develop Nursery officials/owner’s training plans and policies

The Nursery Owners both FD’s and private will serve as a pool of “inspectors” charged with reporting pest sightings to expedite response times and help limit the scope of new infestations. Training sessions will be conducted to acquaint farmers with IPM principles and their responsibilities for the success of the IPM program.

5.2.9 Track progress and reward success

Measurable objectives set at the beginning, must be measured against the IPM program’s performance at least once a year. Documentation to facilitate the evaluation process is as follows:

- a. Detailed description of the parameters and service protocols of the IPM program, stating the ground rules;
- b. Specific locations where pest management work was performed;
- c. Dates of service;
- d. Activity descriptions, e.g., baiting, crack-and crevice treatment, trapping, structural repair; hygiene and
- e. Log of any pesticide applications, including:

- Target pest(s);
- The brand names and active ingredients of any pesticides applied;
- PCB registration numbers of pesticides applied;
- Percentages of mix used in dilution;
- Volume of pesticides used expressed in kilograms of active ingredient;
- Applicator's name(s) and certification identity (copy of original certification and re-certification should be maintained);
- Facility floor plan on which all pest control devices mapped and numbered;
- Pest tracking logs (sightings and trap counts);
- Action plans, including structural and sanitation plans, to correct any pest problems;
- Pest sighting memos for IPM Committee to use in reporting pest presence to District Executive Committee (DEC); and
- Using these records, and the goals of the IPM program (increased efficacy, lower costs and reduced pesticide use), the IPM Committee must see:
 - Fewer pest sightings and farmer complaints;
 - Lower monitoring-station counts over time;
 - Lower costs after the first 12-18 months, once IPM's efficacy advantage has had time to take effect; and
 - Downward trend in volume or frequency of chemical pesticide usage
 - Reduced pest infestations on the seedlings and saplings.

IPM is a team effort. Therefore, the PMP Committee will track and report the program's successes following each evaluation; and encourage good practices by recognizing farmers who played a role. Communicating the success of the program in reducing toxic chemical use and exposure, reducing pest complaints and lowering costs will help farmers to understand the purpose of the program and appreciate its success. The more they understand, the more likely they will participate willingly in helping expand and institutionalize the IPMP.

After the program has been in place for long enough to show significant results, it is recommended for the PMP Committee to work with DoF to publicize successes more broadly and to demonstrate the environmentally responsible approach to effective pest management and control. PMP Committee and DoF will lead the example by sharing success with other stakeholders.

5.3 Principles Governing Selection of Pesticides

Selection of pesticides, under the SUFAL project will be guided by the consideration of several pest management approaches for cultural, physical and biological measures before resorting to application of chemical pesticides.

The use of pesticides must be guided by the principles of cost efficiency, safety to humans, the bio-physical environment and effectiveness in controlling the pests. Pesticides selection will be made in accordance with the World Bank guidelines for the selection of pesticides (World Bank Operational Manual, Good Practice (GP) 4.03) as follows:

- Pesticides requiring special precautions should not be used if the requirements are not likely to be met;

- Pesticides to be selected from approved list, taking into consideration of: toxicity, persistence, user experience, local regulatory capabilities, type of formulation, proposed use, and available alternatives;
- Type and degree of hazard and availability of alternatives; and the following criteria will be used to restrict or disallow types of pesticides under Bank loans:
 - a. **Toxicity:** acute mammalian toxicity, chronic health effects, environmental persistence and toxicity to non-target organisms;
 - b. **Registration status** in the country and capability to evaluate long-term health and environmental impacts of pesticides.

5.4 Pesticides to be Acceptable to SUFAL

The selection of pesticides to be acceptable under the project will be in line with (a) the World Bank Safeguard Policy OP 4.09 on pest management, and will depend on (b) the hazards and risks associated with pesticide use, and (c) the availability of newer and less hazardous products and techniques such as bio-pesticides.

In addition to the toxic characteristics of the pesticide, the hazards associated with pesticide use depend on how the pesticides are handled. Precautions to minimize environmental contamination and excess human exposure are needed at all stages from manufacture, packaging and labelling, transportation, and storage to actual use and final disposal of unused and contaminated containers.

The guidelines in Annex A provide internationally accepted standards on pesticides to minimize the hazards associated with pesticide use.

The use of pesticides under the project will also be guided by the FAO Publication on International Code of Conduct, on the Distribution and Use of Pesticides 1991; *FAO Guidelines for the Packaging, Storage, Good Labeling Practice, Transportation and Disposal of Waste Pesticide and Pesticide Containers 1985*.

5.5 Pest Management Plan (PMP)

The Integrated Pest Management and Monitoring Plan (IPMP) is to be developed from the impacts and mitigation measures identified at the implementation stage based on the principles mentioned in this chapter and also the available techniques for nurseries. The IPMP should include impacts from application of chemical as well as non-chemical pesticides. The reason why chemical pesticides are included is that in the initial stages of implementation of the IPM, chemical pesticides will still be used but will be gradually phased out as the IPM gets established.

When coming up with the IPMP, the following steps should be considered and documented:

- Identify the main pests affecting seedlings and saplings in the region, assess the risks to the operation, and determine whether a strategy and capacity are in place to control them.
- Where possible, apply early-warning mechanisms for pests and diseases (i.e., pest and disease forecasting techniques).
- Select resistant varieties and use the cultural and biological control of pests, diseases, and weeds to minimize dependence on pesticide (chemical) control options. An effective IPM regime should:
 - Identify and assess pests, threshold levels, and control options (including those listed below), as well as risks associated with these control options.
 - Rotate crops to reduce the presence of insects, disease, or weeds in the soil or crop ecosystems.

- Support beneficial bio-control organisms—such as insects, birds, mites, and microbial agents—to perform biological control of pests (e.g., by providing a favorable habitat, such as bushes for nesting sites and other original vegetation that can house pest predators and parasites).
- Favor manual, mechanical weed control and/ or selective weeding.
- Consider using mechanical controls—such as traps, barriers, light, and sound to kill, relocate, or repel pests.
- Use pesticides to complement these approaches, not replace them.
- Prior to procuring any pesticide, assess the nature and degree of associated risks and effectiveness, taking into account the proposed use and the intended users.

The purpose of the IPMP is to ensure that the identified impacts related to application of pesticides are mitigated, controlled or eliminated through planned activities to be implemented throughout the project life. The IPMP also provides opportunities for the enhancement of positive impacts. The IPMP gives details of the mitigation measures to be implemented for the impacts; and the responsible institutions to implement them.

Implementation of the IPMP may be slightly modified to suit changes or emergencies that may occur on site at the time of project implementation. The plan therefore should be considered as the main framework that must be followed to ensure that the key potential negative impacts are kept minimal or under control.

In this regard, flexibility should be allowed to optimize the implementation of the IPMP for the best results in pest management. The IPMP consists of generic or typical environmental impacts that are derived from the site investigations, public consultations and professional judgment. This is because the specific and detailed impacts cannot be predicted without details for the project design and construction activities as well as the specific project locations. The IPMP will however, provide guidance in the development of more detailed IPMP's, once the project design and construction details are known. Site specific Integrated Pest Management and monitoring plans will depend on the scope of identified major impacts to be addressed in the implementation of the SUFAL.

5.6 Monitoring and Reporting

A committee will be formed in each Divisional Forest Offices where project will be operated. Divisional forest Officer (DFO) will chair the committee and Assistant Conservators of Forest (ACF) and Range Officers will be the member of that committee.

Extensive monitoring shall be done by the Range Officers of respective forest ranges during nursery and plantation establishment and report to respective ACFs in every month about application of pesticides. On the basis of that report the ACFs will monitor locations of their respective ranges and check whether the pesticide applier follow compliances given in the screening format (Annex 3). ACFs will report to their respective DFOs. DFO will provide overall guidance for carrying out pesticide related activities and monitor any procurement of pesticides by the divisional offices. Before purchasing pesticides, the prescribed chemical will be checked with registered and banned pesticide list because DAE has updated it after an interval. If any pesticide prescribed in the document banned by DAE in future then the alternative pesticide need to be identified in consultation with DAE or BFRI for further use. DFO will call quarterly

Table 5.1: Integrated Pest Management and Monitoring Plan.

Item No.	Potential Issues/ Concerns	Cause of Concern	Control/ Mitigation Measures	Responsible Person/ Institution and Cost per year per district (Tk.)	Standards/ Regulation	Monitoring Institution	Monitoring Frequency
1.	Increase seedling/ sapling productivity		Implement a long term IPM programme to sustain productivity and combat negative effects of chemical pesticides.	SUFAL, participating institutions and farmers cost included in the IPMP overall cost	IPMP	PMP Committee lead by PD, SUFAL	Semi-annual
2.	Soil degradation	Persistent use of chemical pesticides	Apply pond soil conditioning measures which include IPM Train nursery officials/owners in proper handling and application of pesticides	Farmers	IPMP	PMP Committee lead by PD, SUFAL, EMC	Quarterly
3.	Poisoning of non-target species including natural biological agents	Lack of knowledge of chemical pesticide potency Equipment malfunction Use of wrong type of equipment Wrong time and method of application (spraying)	Supervise and control use of chemical pesticides so that only approved and recommended ones are used Provide PM equipment Regularly maintain and clean equipment as recommended by supplier Dispose old equipment as recommended by manufacturer Provide recommended protective gear Use recommended and appropriate protective gear Conduct trainings in IPM	SUFAL and participating farmers and nursery officials and owners Cost: As estimated for capacity building	IPMP	PMP Committee lead by PD, SUFAL, EMC, DoF	Quarterly
	Health and safety risks	Exposure to pesticides	Provide protective clothing and ensure it is used. Train farmers in proper pesticides handling. Routine medical examination	Agro-dealers, Transporters and Farmers	Labor regulations DoE regulations	Min. of Labor, DAE, FD and PD, SUFAL	Semi-annual

4.	Air pollution and contamination	Exposure of pesticides to air. Disposal of pesticides remains in the open Disposal of pesticides containers and equipment in the open air	Store pesticides in closed containers Dispose chemical remains according to supplier recommendations. Train farmers in appropriate spraying techniques to avoid chemicals being blown away by wind Train farmers to maintain spray equipment in efficient operational order	Pesticides Suppliers, Farmers	Pesticides and equipment manufacturer's recommendations. Air pollution standards.	DoE, SUFAL	Quarterly
		Illegal disposal of pesticides	Prohibit disposal of pesticides wastes into open dumps where they will be blown away by wind	Agro-dealers AGCOM	EMC ECR of DoE	EMC, City/ District authority, DoE	Half-yearly
5.	Pest resistance	Lack of appropriate knowledge in pesticides application	Train farmers on correct application of pesticides	Farmers, SUFAL	Different Laws	SUFAL	Half-yearly
6.	Reduced environmental and health risks		Initiate education programmes Establish demonstration plots to disseminate information on environmental and health benefits of biological control agents to the communities for them to appreciate the advantages	SUFAL	EMC	MoEF, DoE, FD	Half yearly

meetings to know situation of use of pesticide and pest management related initiatives. DFOs will visit different locations to monitor training initiatives on IPM and the application process. DFOs will report to the Project Management Unit (PMU) regarding pest management under their jurisdiction.

5.7 Training

Training on various aspects of pest and pesticide management will be organized by SUFAL project in different project sites. Training will be organized for stakeholders like nursery owners, pesticide dealers and for FD officials. The nursery owners will receive training on IPM, judicious use of pesticide, impact of pesticide on environment, safety measures during pesticide application and pesticides banned by the government. The pesticide dealers will get training on government regulatory issues in relation to pesticide, banned pesticides, bio-pesticides and impact of pesticide over the environment. The staff of Bangladesh Forest Department will get training on IPM, judicious use of pesticide, impact of pesticide on environment, safety measures during pesticide application, pesticides banned by the government, government regulatory issues in relation to pesticide, banned pesticides, bio-pesticides and impact of pesticide over the environment. The training for FD staff will cover more topics than other stakeholders as they play the key role in the implementation and monitoring of project initiatives. The training programs need to be facilitated by the Bangladesh Forest Research Institute (BFRI). Therefore, an MoU could be signed between Bangladesh Forest Department and Bangladesh Forest Research Institute. Department of Agricultural Extension need to be involved with the training process.

5.8 Awareness building

Building mass awareness among communities and other stakeholders are must for ensuring judicious use of pesticides that contributes in reducing environmental impact. For disseminating information and raising awareness among mass people discussion meetings, film show, day celebration, drama, TV program can be organized. Information on impact of pesticide use on the environment and human health and alternative of pesticides will be disseminated through these tools. Field demonstration is a good tool for learning and will be organized by SUFAL project on IPM technologies and safety measures involving nursery growers, pesticide dealers and FD staff.

5.9 Personal Protection

Personal protection during preparation, application and disposal of pesticide is vital for health safety. Carelessness in pesticide mixing, application, disposal and store will cause health hazard. Therefore, following things need to be taken under consideration.

1. This is essential to keep kids, pets and anything non-essential away during mixing and application of pesticide;
2. Have to wear long sleeve shirt, long pants, and closed-toe shoes or plastic boots in addition to any other protective clothing or equipment required by the level;
3. Pesticide need to be mixed outside or in well ventilated areas;
4. Mix only what you need to use in the short term to avoid storing or disposing of excess pesticide;
5. Have to wear non-absorbent gloves during mixing and applying pesticide;
6. When spraying pesticides indoors, make sure the area is well ventilated.

7. Avoid windy weather and during gentle breeze apply pesticide along the wind direction
8. After using pesticides, wash your hands before smoking or eating.
9. In case of any contamination of pesticide in human body, take immediate the patient to nearest hospital

5.10 Estimated Costs for Pest Management and Monitoring

Estimated costs for managing and monitoring plan provided in Table 5.1 need to be developed during implementation period. A sample of cost estimation format is provided in Table 5.2.

It is assumed that some of the PMP measures will be part of the normal responsibility of the respective government ministries, agro-dealers, transporters, nursery officials/owners and other relevant stakeholders, within their institutional mandates and budgets.

It is important to appreciate that some of the stakeholder institutions may not have sufficient capacity to manage environmental and social impacts of pesticides and to adequately monitor implementation of the enhancement and mitigation measures. Therefore, it is necessary to train them. The cost of training for the managing impacts is necessary to build it within the SUFAL budget. The table also include costs for conducting awareness and sensitization campaigns on pesticides application, management and adoption of IPM in the project areas. Costs for setting-up, adoption and use of IPM by nursery officials/owners are also necessary to consider. The costs for managing and monitoring various mitigation and enhancement measures indicated in Table 4.1 should be estimated for throughout the project period i.e. 5 years.

Table 5.2: Example Format of Management and Monitoring Costs of PMP.

Impact/Measures	Management Cost (BDT)	Monitoring Cost (BDT)
Provide PM equipment (sprayers)		
Provide recommended protective gear		
Pesticide inspection, sampling and testing		
Routine medical examination		
Rehabilitation of laboratories		
Construct pond, draining channels and draining dams.		
Disposal of chemical pesticides remains according to supplier recommendations		
Enforce regulation prohibiting importation of banned chemical pesticides		
Grand Total =		

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ANNEX 1: LIST OF CANCELLED PESTICIDES IN BANGLADESH

Sl. No	Trade name of pesticide	Registration No	Name of company
1	Diazinon 14G	AP-08	Shetu Corporation Limited
2	Bizguard 2P	AP-09	Ciba-Geigy (Bangladesh) Limited
3	Roxion 40 EC	AP-11	International Services (BD) Limited
4	Dankavapon 100 EC	AP-13	Shetu Corporation Limited
5	Damfin 2P	AP-19	Ciba-Geigy (Bangladesh) Limited
6	Diazinon 90L	AP-20	Ciba-Geigy (Bangladesh) Limited
7	Danmfin 950 EC	AP-25	Ciba-Geigy (Bangladesh) Limited
8	Dichlorvos	AP-27	Bayer (Bangladesh) Limited
9	Curaterr 3G	AP-30	Bayer (Bangladesh) Limited
10	2,4-D Na Salt	AP-34	Bayer (Bangladesh) Limited
11	Folithion ULVC 98	AP-36	Bayer (Bangladesh) Limited
12	Methybron	AP-38	Excel Trading Company
13	Heptachlor 40 WP	AP-39	Krishi Banijya Protisthan
14	Chlordane 40 WP	AP-40	Krishi Banijya Protisthan
15	Aerovap 100 EC	AP-41	Liza Enterprise Limited
16	Aerodriel 20 EC	AP-42	Liza Enterprise Limited
17	Aeromal 57 EC	AP-44	Liza Enterprise Limited
18	Padan 10G	AP-52	Data Enterprises Limited
19	Fenitrothion 98	AP-53	Farm Chemical Corporation Limited
20	Carbin 85 WP	AP-54	Farm Chemical Corporation Limited
21	Diamal 57 EC	AP-55	Farm Chemical Corporation Limited
22	Detia Gas EXT	AP-56	Farm Chemical Corporation Limited
23	Dichlorvos 100 EC	AP-57	Farm Chemical Corporation Limited
24	Methyl Bromide 98	AP-57	Farm Chemical Corporation Limited
25	Malathion 57 EC	AP-68	BPI Limited
26	Curaterr 3G	AP-69	Bayer (Bangladesh) Limited
27	Dieldrin 20 EC	AP-73	Shell Company of Bangladesh Limited
28	Bidrin 24 WSC	AP-74	Shell Company of Bangladesh Limited
29	Malathion 57 EC	AP-78	Burmah Eastern Limited
30	Vapona	AP-79	Shell Company of Bangladesh Limited
31	Bidrin 85 WSC	AP-80	Shell Company of Bangladesh Limited
32	Dieldrin 50 WP	AP-82	Shell Company of Bangladesh Limited
33	Dieldrin 40 WP	AP-83	Shell Company of Bangladesh Limited
34	Furadan 3G	AP-85	FMC International S.A.
35	Actellic 2% Dust	AP-99	Bangladesh Manufacturers Limited
36	Quickphos	AP-102	Agrani Traders
37	Torque 550g/l	AP-115	International Services (BD) Limited

Sl. No	Trade name of pesticide	Registration No	Name of company
38	Ridan 3G	AP-131	Rupali Sangstha Limited
39	Bkzne 14G	AP-135	B. K. Traders
40	Aerocypermethrin 10 EC	AP-137	Liza Enterprise Limited
41	Karmex	AP-145	Beximco Agrochemicals Limited
42	Carbaryl 85 WP	AP-147	Shetu Corporation Limited
43	Agridan 3G	AP-154	Shetu Pesticides Limited
44	Tecto 2% Dust	AP-157	Alco Pharma Limited
45	Manex-II	AP-163	Shetu Corporation Limited
46	Phytox MZ 80	AP-164	Liza Enterprise Limited
47	Uniflow TM Sulphur	AP-167	Shetu Corporation Limited
48	Fenkil 20 EC	AP-169	Agrani Traders
49	Sunfuran 3G	AP-171	Shetu Corporation Limited
50	Hekthion 57 EC	AP-178	Farm Chemical Corporation Limited
51	Poligor 40 EC	AP-180	Farm Chemical Corporation Limited
52	Melbromid 98	AP-185	Horizon Trade Limited
53	Mebrom	AP-186	Bengal Wings Trade Limited
54	Agrine 85 WP	AP-187	Edgro (Private) Limited
55	Drawizon 60 EC	AP-190	Keeco Pesticides Limited
56	Gastoxin	AP-195	Bright Corporation
57	Cekomethrin 10 EC	AP-219	Premier Traders
58	Cythrln	AP-220	Bari & Company Limited
59	Cekuthoate 40 EC	AP-225	Premier Traders
60	Arifos 20 EC	AP-229	Bari & Company Limited
61	Malathion 57 EC	AP-230	Sabrina Trading Corporation
62	Cardan 5G	AP-234	Bari & Company Limited
63	Diazinon 14G	AP-236	Liza Enterprise Limited
64	Rizinon 60 EC	AP-239	Bari & Company Limited
65	Zincphosphide	AP-258	Liza Enterprise Limited
66	Davison Glyphosate	AP-266	Shetu Pesticides Limited
67	Morestan 25 WP	AP-269	Beximco Agrochemicals Limited
68	Manzate 200	AP-301	Auto Equipment Limited
69	Dimecron 100 SL	AP-22&276	Novartis (Bangladesh) Limited
70	Pillarcron 100 SL	AP-148	Shetu Pesticides Limited
71	Benicron 100 WSC	AP-06	Sabrina Trading Corporation
72	DDVP 100 W/V	AP-03	ACI Formulations Limited
73	Chemo DDVP 100 EC	AP-245	Chemsfil Bangladesh Limited
74	DDVP 100 EC	AP-151	McDonald Bangladesh (Pvt) Limited
75	Nogos 100 EC	AP-26&274	Novartis (Bangladesh) Limited
76	Phosvit 100 EC	AP-56	Data Enterprises Limited
77	Daman 100 EC	AP-325	Petrochem (Bangladesh) Limited

Sl. No	Trade name of pesticide	Registration No	Name of company
78	Azodrin 40 WSC	AP-336	BASF Bangladesh Limited
79	Nuvacron 40 SL	AP-18&275	Novartis (Bangladesh) Limited
80	Megaphos 40 SL	AP-175	McDonald Bangladesh (Pvt) Limited
81	Phoskil 40 SL	AP-339	United Phosphorus (Bangladesh) Ltd
82	Kadette 40 WSC	AP-284	Bisco Pesticide & Chemical
83	Monophos 40 WSC	AP-328	Alpha Agro Limited
84	Monodrin 40 WSC	AP-07	Sabrina Trading Corporation
85	Corophos 40 SL	AP-342	Corbel International Limited
86	Luphos 40 SL	AP-388	ACI Formulations Limited
87	Amcodrin 40 SL	AP-340	Atherton Imbros Company Limited
88	Vitacron 40 SL	AP-341	Shetu Marketing Company
89	Monotaf 40 WSC	AP-331	Auto Equipment Limited
90	Tamaron 40 SL	AP-188	Haychem (Bangladesh) Limited
91	Folithion 50 EC	AP-32	Haychem (Bangladesh) Limited
92	Macuprax 65%	AP-65	Bayer CropScience Limited
93	Zithiol 57 EC	AP-126	Rhone Poulenc Bangladesh
94	Delapon Na-84	AP-66	Rhone Poulenc Bangladesh
95	Anthio 25 EC	AP-64	Rhone Poulenc Bangladesh
96	Zolone 35 EC	AP-67	Rhone Poulenc Bangladesh
97	Rentokill CC Type 75%	AP-221	Getco Limited
98	Paramount CC Type	AP-300	BD Associate and Company
99	Darsban 20 EC	PHP-5	Auto Equipment Limited
100	Darsban 20 EC	PHP-85	Auto Equipment Limited
101	Basudin 10G	AP-23	Syngenta Bangladesh Limited
102	Diazinon 60 EC	AP-24	Syngenta Bangladesh Limited
103	Mortin King Mosquito Coil	PHP-54	Reckitt Benckiser Bangladesh Limited
104	Mortin Mosquito Coil	PHP-101	Reckitt Benckiser Bangladesh Limited
105	Sarfium 56%	AP-689	Sar Trade Fertilizer Limited
106	Sicofen 20 EC	AP-624	Genetica
107	Cythrane 10 EC	AP-310	ACI Formulations Limited
108	Diazonyl T-60	AP-283	ACI Formulations Limited
109	Salmathion 57 EC	AP-1066	Agrimax Bangladesh Limited
110	Basamid Granular	AP-205	BASF Bangladesh Limited
111	Ducord 17 EC	AP-793	BASF Bangladesh Limited
112	Argold 10 EC	AP-409	BASF Bangladesh Limited
113	Dicofol 18.5 EC	AP-359	McDonald Bangladesh (Pvt) Limited
114	Carbaryl 85 WP	AP-150	McDonald Bangladesh (Pvt) Limited
115	Amitage 20 EC	AP-476	McDonald Bangladesh (Pvt) Limited
116	Neoron 500 EC	AP-551	Syngenta Bangladesh Limited
117	Anvil 5 SC	AP-472	Syngenta Bangladesh Limited

Sl. No	Trade name of pesticide	Registration No	Name of company
118	Ridomil Gold MZ 68 WG	AP-377	Syngenta Bangladesh Limited
119	Folio Gold 440 SC	AP-1133	Syngenta Bangladesh Limited
120	Dolma 5G	AP-1226	Syngenta Bangladesh Limited
121	Sonnet 50 SP	AP-1488	Syngenta Bangladesh Limited
122	Basudin 10GR	AP-532	Syngenta Bangladesh Limited
123	Ricon 60 EC	AP-533	Syngenta Bangladesh Limited
124	Paprika 50 EC	AP-1250	Syngenta Bangladesh Limited
125	Touchdown	AP-404	Syngenta Bangladesh Limited
126	Touchdown HiTech 500SL	AP-873	Syngenta Bangladesh Limited
127	Dual Gold 960 EC	AP-111	Syngenta Bangladesh Limited
128	Lintur 70 WG	AP-633	Syngenta Bangladesh Limited
129	Koranda	AP-794	Auto Crop Care Limited
130	Seda 50 SP	AP-420	Auto Crop Care Limited
131	Lorsban 15G	AP-371	Auto Crop Care Limited
132	Autoguard 25 EC	AP-1147	Auto Crop Care Limited
133	Focus 50 SC	AP-828	Auto Crop Care Limited
134	Alert 50 EC	AP-648	Auto Crop Care Limited
135	Quinguard 25 EC	AP-1106	Auto Crop Care Limited
136	Fendor 5G	AP-279	Auto Crop Care Limited
137	Edfen 50 EC	AP-191	Sea Trade Fertilizer Limited
138	Malatox 57 EC	AP-286	Sea Trade Fertilizer Limited
139	Edthoate 50 EC	AP-307	Sea Trade Fertilizer Limited
140	Metasystox R 25 EC	AP-493	United Phosphorus (Bangladesh) Ltd
141	Sumithion 3% Dust	AP-156	Shetu Corporation Limited
142	Sumibas 75 EC	AP-255	Shetu Corporation Limited
143	Arozin 30 EC	AP-383	Bayer CropScience Limited
144	Basta SL 15	AP-265	Bayer CropScience Limited
145	Baycarb EC 500	AP-488	Bayer CropScience Limited
146	Curaterr 5G	AP-490	Bayer CropScience Limited
147	Cupravit 50 WP	AP-489	Bayer CropScience Limited
148	Hinosan EC 50	AP-491	Bayer CropScience Limited
149	Labaycid 50 EC	AP-492	Bayer CropScience Limited
150	Sunrice Super 315 EC	AP-1777	Bayer CropScience Limited
151	Benefiter 315 SC	AP-2105	Bayer CropScience Limited
152	Thiodan 35 EC	AP-1147	Bayer CropScience Limited
153	Fantush 300 EC	AP-2569	Asia Trade International
154	Ultima 40 WG	AP-2560	Mimpex Agrochemicals Limited
155	Abate 15 G	PHP-118	BASF Bangladesh Limited
156	Fendona 1.5 SC	PHP-84	BASF Bangladesh Limited
157	Edfen 50 EC	PHP-40	Sea Trade Fertilizer Limited

Sl. No	Trade name of pesticide	Registration No	Name of company
158	Coopex 25 WP	PHP-191	Bayer CropScience Limited
159	Sislin 2.5 EC	PHP-192	Bayer CropScience Limited
160	Crack down	PHP-193	Bayer CropScience Limited
161	Resigen 50 E	PHP-194	Bayer CropScience Limited
162	Resigned OS	PHP-196	Bayer CropScience Limited
163	Bilshot M 46.5 EC	AP-586	Pharma & Farm
164	Pharzeb 80 WP	AP-784	Pharma & Farm
165	Phartap 50 SP	AP-605	Pharma & Farm
166	Cypercid 10 EC	AP-523	Pharma & Farm
167	Glyphar 41 SL	AP-896	Pharma & Farm
168	Topsin M 70 WP	AP-193	Data Enterprises Limited
169	Homai 80 WP	AP-179	Data Enterprises Limited
170	Padan 50 SP	AP-555	Data Enterprises Limited
171	Diazinon 14G	AP-554	Data Enterprises Limited
172	Diazinon 60 EC	AP-557	Data Enterprises Limited
173	Diazinon 90 ULVC	AP-560	Data Enterprises Limited
174	Trebon 10 EC	AP-161	Data Enterprises Limited
175	Bassa 50 EC	AP-142	Data Enterprises Limited
176	Elsan 50 EC	AP-556	Data Enterprises Limited
177	Elsan 92 ULVC	AP-558	Data Enterprises Limited
178	Vitavax 200B	AP-559	Pioneer Equipment & Chemical Co.
179	Pyriban 20 EC	AP-381	Agro Development Services Co. (Pvt) Ltd
180	Aimal 57 EC	AP-1136	Agro Development Services Co. (Pvt) Ltd
181	Asset	AP-364	Agrodev United
182	Padan 4 G	AP-372	Krishi Kallyan Limited
183	Diazinon 10GR	AP-385	Krishi Kallyan Limited
184	Limithion 57 EC	AP-264	ACI Formulations Limited
185	Knockout Liquid Insect Sprya	PHP-28	Shetu Pesticides Limited
186	Victor 1G	PHP-340	Shetu Pesticides Limited
187	Night Queen Mosquito Coil	PHP-46	Shetu Pesticides Limited
188	Sovathion 50 EC	AP-240	Shetu Pesticides Limited
189	Pillartex 50 EC	AP-414	Shetu Pesticides Limited
190	Kap 50 EC	AP-216	Shetu Pesticides Limited
191	Dipterex 80 SP	AP-561	United Phosphorus (Bangladesh) Ltd
192	Cekufon 80 SP	AP-257	Shetu Pesticides Limited
193	Palash 57 EC	AP-312	Petrochem (Bangladesh) Limited
194	Pounce 1.5G	AP-419	FMC Chemical International AG
195	Acekro 20 EC	AP-318	McDonald Bangladesh (Pvt) Limited

Source:

[http://dae.portal.gov.bd/sites/default/files/files/dae.portal.gov.bd/page/a71472c4_de10_4e51_b657_4fa3e9fe8dd1/Approved%20\(66%20PTAC%20&%2095%20PTASC-PPW\)%20Registered%20Pesticides_Banned%20List.pdf](http://dae.portal.gov.bd/sites/default/files/files/dae.portal.gov.bd/page/a71472c4_de10_4e51_b657_4fa3e9fe8dd1/Approved%20(66%20PTAC%20&%2095%20PTASC-PPW)%20Registered%20Pesticides_Banned%20List.pdf)

ANNEX-2: NURSERY AND PLANTATION MONITORING FORMAT

Nursery Monitoring Format

Project:

Location:

Area covered by seedlings:

Implementing Agency:

Monitoring Date:

Parameters	Survival rate of the species		Number of Native/Exotic species	
	60-70% (+)	30-40% (-)	Native (%)	Exotic (%)
Number of seedling raised in the nursery				

Conducted by:

Calculation for Nursery seedling

Location of Nursery:

Plantation Target (ha):

Number of seedling rising (Nos.):

SL	Name of the Species	Type of Species (Native/Exotic)	Quantity	Percentage (%)
1				
2				
3				
4				
5				
6				
7				
8				
9				
Total				

Initial Plantation Monitoring Format

Project:

Location:

Area under Plantation:

Implementing Agency:

Monitoring Date:

Conducted by:

Calculation for Plantation

Location of Nursery:

Plantation Target (ha):

Target for Number rising (Nos.):

Actual number of seedlings raised:

Number of seedlings planted:

SL	Name of the Species Planted	Type of Species	Quantity	Percentage (%)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Plantation Monitoring Format

Project:

Location:

Area under Plantation:

Implementing Agency:

Monitoring Date:

Parameters	Survival rate of the species		Number of Native/Exotic species	
	60-70% (+)	30-40% (-)	Native (%)	Exotic (%)
Number of Planted seedlings				

Summary of monitoring findings:

Recommended Actions:

Conducted By:

Calculation

Number of Plot studied:

Average survival rate:

Species combination:

SL	Name of the Species Planted	Type of Species	Percentage (%)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

ANNEX-3 PESTICIDE/CHEMICAL USE SCREENING FORMAT FOR NURSERY, PLANTATION AND STORAGE

Implementing agency		
Name of Project		
Location		
Name of Field Monitoring Officer		
Designation and Place of Posting		
Date (visited)		

A. Chemical use [Please tick (v) in the YES/NO box below]

Id No.	Environmental Monitoring issue	Associated Interventions	Possible observation/indicators	Compliance (Yes)	Compliance (No)	Remarks
1	Nursery	Use of chemical (pesticide/insecticide/herbicide/other chemicals)	Use organic/chemical pesticide/herbicide/other chemical in recommended dose and interval			
		Use of fertilizer	Use organic fertilizer/use chemical fertilizer in recommended dose and interval			
		Weed management	Timely weed wiped out and dumped in proper place			
		Waste management	Extra chemical dumped in proper location (distant from water/crop/grazing land)			
		Use of Polythene bags	Tree plantation guideline of BFD is followed			
		Application of IPM/IDM	Alternative safe methods of pest management followed to reduce use of chemicals			
2	Plantation	Use of chemical (pesticide/insecticide/herbicide/other chemicals)	Use organic/chemical pesticide/herbicide/other chemical in recommended dose and interval			
		Use of fertilizer	Use organic fertilizer/use chemical fertilizer in recommended dose and interval			
		Weed management	Timely weed wiped out and dumped in proper place			
		Waste management	Extra chemical dumped in proper location (distant			

Id No.	Environmental Monitoring issue	Associated Interventions	Possible observation/indicators	Compliance (Yes)	Compliance (No)	Remarks
			from water/crop/grazing land/locality)			
		Use of Polythene bags and dumping procedure	Tree plantation guideline of BFD is followed			
		Application of IPM/IDM	Alternative safe methods of pest/disease management followed to reduce use of chemicals			
3	Wood storage	Use of chemical (pesticide/insecticide/herbicide/other chemicals)	Use organic/chemical pesticide/herbicide/other chemical in recommended dose and interval			
		Waste management	Extra chemical dumped in proper location (distant from water/crop/grazing land/locality)			
		Application of IPM/IDM	Alternative safe methods of pest management followed to reduce use of chemicals			
4	Health	Mixing of chemicals	Used hand gloves during mixing of chemicals			
			Wear long shirt, pant and shoe			
			Covered mouth and nose during mixing of chemicals			
			Washed body properly with soap after mixing of chemicals			
			Mixed chemicals in proper place (far from homestead and children's reach)			
			Washed mixing equipment properly in proper place (distant from water source/wetland crop/grazing land/locality)			
		Spraying of chemicals	Used hand gloves, long shirt, pant and shoe during spraying of chemicals			
			Covered mouth and nose during spraying of chemicals			
			Sprayed chemicals along the wind direction			
			Washed body properly with soap after spraying of chemicals			

Id No.	Environmental Monitoring issue	Associated Interventions	Possible observation/indicators	Compliance (Yes)	Compliance (No)	Remarks
			Washed spray machine properly in proper place (distant from water source/wetland/crop/grazing land/locality)			
5	Store	Safe storage	Kept chemical children's out of reach			
			Stored chemicals in proper way and in proper place			
6	Training	Training for staff and nursery owner	Trained personnel applied chemicals			

B. SUMMARY OF MONITORING FINDINGS [To be filled by Field Monitoring Officer]

Sl.	CATEGORICAL ISSUE	FINDINGS
1	Ecological	
2	Environmental	
3	Others (social, ethical etc.)	

C. RECOMMENDED ACTIONS BASED ON THE FINDINGS AS MENTIONED IN "B" [To be filled by Reviewer & Approval Authority]

Sl	CATEGORICAL ISSUE	RECOMMENDATION	Remarks/Approved Actions (Approval Authority)
1	Ecological		
2	Environmental		
3	Others (social, ethical etc.)		

(Signature of the Field Monitoring Officer)	(Name & signature of the Reviewer)	(Signature of the Project Director)
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